OCS EIS/EA
BOEM 2012-030

Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017

Final Programmatic Environmental Impact Statement

July 2012

U.S. Department of the Interior
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ABBREVIATIONS AND ACRONYMS

ACSAR	Atlantic continental slope and rise
ABC	American Bird Conservancy
ABM	Alabama beach mouse
ACC	Arctic Coastal Current
ACIA	Arctic Climate Impact Assessment
ACMP	Alaska Coastal Management Program
ACP	Arctic Coastal Plain
ADCED	Alaska Department of Community and Economic Development
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
AEB	Aleutian East Borough
AEO	Annual Energy Outlook
AER	Annual Energy Review
AEWC	Alaska Eskimo Whaling Commission
AFB	Air Force Base
AFN	Alaska Federation of Natives
AFSC	Alaska Fisheries Science Center
AHTS	anchor handling towing supply
Alaska OHA	Alaska Office of History and Archaeology
AMMP	adaptive mitigation and management plan
ANCSA	*Alaska Native Claims Settlement Act* of 1971
ANILCA	Alaska National Interest Lands Conservation Act
ANIMIDA	Arctic Nearshore Impact Monitoring in Development Area
ANSC	Aleutian North Slope Current
ANSCA	Alaska Native Claims Settlement Act
ANWR	Arctic National Wildlife Refuge
AO	Arctic Oscillation
AOC	Area of Concern
AOGA	Alaska Oil and Gas Association
APD	Application for Permit to Drill
API	American Petroleum Institute
APTA	American Public Transportation Association
ARCSEES	Arctic Science Engineering Education for Sustainability
ARRT	Alaska Regional Response Team
BBB	Bristol Bay Borough
Bbbl	billion barrels
bbl	barrels
bbl/yr	barrels per year
BBO	billion barrels of oil
BBOE	billion barrels of oil equivalent
Bcf	billion cubic feet

BCNP	Big Cypress National Preserve
BLM	Bureau of Land Management (USDOI)
BNWR	Breton National Wildlife Refuge
BOP	blowout preventer
B.P.	before present
bpd	barrels per day
BSAI	Bering Sea and Aleutian Islands, Alaska
BTEX	benzene, toluene, ethylbenzene and xylene
BPXA	British Petroleum (Exploration) Alaska
°C	degrees Centigrade
^{14}C	carbon-14
CAA	Clean Air Act or conflict avoidance agreement
CAFE	corporate average fuel economy
CAH	Central Arctic Herd
CBM	Choctawhatchee beach mouse
CCP	Comprehensive Conservation Plan
CDE	catastrophic discharge event
CEC	Commission on Environmental Cooperation
CEI	Coastal Environments, Inc.
CEQ	Council on Environmental Quality
CER	categorical exclusion review
CFC	chlorofluorocarbons
CFR	Code of Federal Regulations
CH_4	methane
CIAP	Coastal Impact Assistance Program
CIBSE	Chartered Institute of Building Services Engineers
CIRI	Cook Inlet Region, Inc.
cm	centimeter
CMP	coastal management program
cm/s	centimeter per second
CMSP	Coastal and Marine Spatial Planning
CO	carbon monoxide
CO_2	carbon dioxide
COE	Corps of Engineers (U.S. Army)
CPA	Central Planning Area
CPUE	catch per unit effort
CVI	coastal vulnerability index
CWA	Clean Water Act
CWPPRA	Coastal Wetlands Planning, Protection, and Restoration Act
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
dB	decibel
dB re 1 µPa-m	dB referenced to 1 micropascal within 1 meter of the source
DCS	Drilling, Completion, and Stimulation Program

DDT	dichlorodiphenyltrichloroethane
DHHS	Department of Health and Human Services
DIN	dissolved inorganic nitrogen
DIP	dissolved inorganic phosphorus
DLP	defense of life and property
DOSS	dioctylsulfosuccinate
DP	dynamic positioning
DPnB	dipropylene glycol n-butyl ether
DPS	distinct population segment
DTNP	Dry Tortugas National Preserve
DWH	Deepwater Horizon
DWH event	Deepwater Horizon MC252 Spill of National Significance
E&D	exploration and development
EA	environmental assessment
ECOS	Environmental Conservation Online System
EDA	estuarine drainage area
EEZ	Exclusive Economic Zone
EFH	essential fisheries habitat
EIA	Energy Information Administration; economic impact area
EIS	environmental impact statement
EJ	environmental justice
ENP	Everglades National Park
ENSO	El Niño-Southern Oscillation
EO	Executive Order
ER	Ecosystem Resources
EROS	explosive removal of offshore structures
ERS	Economic Research Service (USDOA)
ESA	Endangered Species Act
ESI	Environmental Sensitivity Index
ESP	Environmental Studies Program
ESPIS	Environmental Studies Program Information System
EV	electric vehicle
°F	degrees Fahrenheit
FAA	Federal Aviation Administration
FAD	fish aggregation device
FCMA	Fishery Conservation and Management Act of 1976
FDA	fluvial drainage area
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FGBNMS	Flower Garden Banks National Marine Sanctuary
FKNMS	Florida Keys National Marine Sanctuary
FLIR	Forward Looking Infrared Radar
FLM	Federal land manager
FMC	fishery management council

FMP	fishery management plan
FOSC	Federal On-Scene Coordinator
FPSO	floating production, storage, and offloading
FR	Federal Register
FS	Forest Service (USDOA)
FSB	Federal Subsistence Board
FWPCA	Federal Water Pollution Control Act
FWS	Fish and Wildlife Service (USDOI)
GAO	Government Accountability Office
GCCF	Gulf Coast Claims Facility
GHG	greenhouse gas
GINS	Gulf Island National Seashore
GMFMC	Gulf of Mexico Fishery Management Council
GOA	Gulf of Alaska
GOM	Gulf of Mexico
GRS	geographic response strategy
GSA	Geographic Society of America
GTP	Gas Treatment Plant
GWP	global warming potential
H_2S	hydrogen sulfide
ha	hectare
HAPC	habitat area of particular concern
HAPs	hazardous air pollutants
HCA	Habitat Conservation Area
HDDC	high density deepwater communities
HIA	Health Impact Assessment
HPA	Habitat Protection Area
HSE	Health, Safety, and Environment
HVAC	heating, ventilation, air conditioning
Hz	hertz
IBA	Important Bird Area
ICAS	Inupiat Community of the Arctic Slope
IECC	International Energy Conservation Code
IOSC	International Oil Spill Conference
IPCC	Intergovernmental Panel on Climate Change
IPHC	International Pacific Halibut Commission
IUCN	International Union Conservation Network
IWC	International Whaling Commission
JBER	Joint Base Elmendorf-Richardson
JIP	Joint Industry Program
kHz	kilohertz
KIB	Kodiak Island Borough

km	kilometer
km^2	square kilometer
km/hr	kilometers per hour
KPB	Kenai Peninsula Borough
kwh	kilowatt hours
lb	pounds
LCI	Lower Cook Inlet
LLC	Limited Liability Corporation
LMA	Labor Market Area
LME	Large Marine Ecoregion
LNG	liquefied natural gas
LOOP	Louisiana Offshore Oil Port
LPB	Lake and Peninsula Borough
LPG	liquid petroleum gases
LRRS	Long-Range Radar Site
LSU CMI	Louisiana State University Coastal Marine Institute
LCWCRTF	Louisiana Coastal Wetlands Conservation and Restoration Task Force
m	meter
m^3	cubic meter
m^3/s	cubic meter per second
m/s	meters per second
m/yr	meters per year
MAFLA	Mississippi, Alabama, and Florida
MAG-PLAN	MMS Alaska-GOM Modeling Using IMPLAN
MARAD	Maritime Administration
MARB	Mississippil and Atchafalaya River Basins
MARPOL	International Convention for the Prevention of Pollution from Ships
Mbbl	million barrels
MBTA	Migratory Bird Treaty Act
MCF	million cubic feet
MECS	Manufacturing Energy Consumption Survey
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mi^2	square miles
mi^2/yr	square miles per year
ML	Richter low magnitude
ml/L	milliliters per liter
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service (USDOI)
MOA	Memorandum of Agreement
MODU	mobile offshore drilling unit
MOU	Memorandum of Understanding
MPA	Marine Protected Area
mph	miles per hour

MPI	Main Production Island
MPPRCA	Marine Plastic Pollution Research and Control Act
MPRSA	Marine Protection Research and Sanctuaries Act
MRFSS	Marine Recreational Fisheries Statistics Survey (NMFS)
MSA	metropolitan statistical area
MSP	marine spatial planning
M_w	moment magnitude
NAA	No Action Alternative
NAAQS	National Ambient Air Quality Standards
NAFTA	North Atlantic Free Trade Agreement
NAO	North Atlantic Oscillation
NASA	National Aeronautics and Space Administration
NAST	National Assessment Synthesis Team
NCP	National Contingency Plan
NDBC	National Data Buoy Center
NEMS	National Energy Modeling System
NEPA	National Environmental Policy Act
NGL	natural gas liquid
NGO	non-governmental organization
NHPA	National Historic Preservation Act
NIC	National Incident Command
NIOSH	National Institute for Occupational Safety and Health
NM	nautical miles
NMFS	National Marine Fisheries Service (USDOC, NOAA)
N_2O	nitrous oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxide
NOAA	National Oceanic and Atmospheric Administration (USDOC)
NOC	National Ocean Council
NOP	National Policy for Stewardship of the Ocean, Our Coasts, and the Great Lakes
NORM	naturally occurring radioactive material
NO_x	nitrogen oxides
NP	National Park
NPDES	National Pollutant Discharge Elimination System
NPFMC	North Pacific Fishery Management Council
NPR–A	National Petroleum Reserve–Alaska
NPS	National Park Service (USDOI)
NRC	National Research Council
NRDA	Natural Resource Damage Assessment
NRDC	National Resources Defense Council
NREL	National Renewable Energy Laboratory
NRHP	*National Register of Historic Places*
NRP-A	National Petroleum Preserve-Alaska
NRC	National Research Council

NSB	North Slope Borough
NSRE	National Survey on Recreation and the Environment (NOAA)
NTL	Notice to Lessees
NWA	national wilderness area
NWAB	Northwest Arctic Borough
NWR	national wildlife refuge
NWS	National Weather Service
O&G	oil and gas
O_3	ozone
OBIS-SEAMAP	Ocean Biogeographic Information System-Spatial Ecological Analysis of Megavertebrate Populations
OBM	oil-based mud
OCD	Offshore and Coastal Dispersion Model
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
ODMDS	ocean dredged material disposal sites
OECM	Offshore Environmental Cost Model
OGP	International Association of Oil and Gas Producers
OOC	Offshore Operators Committee
OPA 90	Oil Pollution Act of 1990
OPAREA	(military) operating area
ORPC	Ocean Renewable Power Company
OSAT	Operational Science Advisory Team of the Unified Area Command
OSRA	Oil Spill Risk Analysis
OSRF	oil-spill financial responsibility
OSRP	oil spill response plan
OSRO	Oil Spill Response Organizations
OSV	offshore supply vessel
PAH	polyaromatic hydrocarbons
Pb	lead
PCB	polychlorinated biphenyl
PCH	Porcupine Caribou Herd
PCPI	per capita personal income
PDO	Pacific Decadal Oscillation
PEIS	programmatic environmental impact statement
PeMex	Petroleos Mexicanos
PFP	Proposed Final Program
PHEV	plug-in hybrid electric vehicle
PICES	North Pacific Marine Science Organization
PINS	Padre Island National Seashore
PKBM	Perdido Key beach mouse
PM	particulate matter
PM_{10}	particulate matter less than 10 microns in diameter
$PM_{2.5}$	fine particulates less than 2.5 microns in diameter

ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
PSD	Prevention of Significant Deterioration
PTS	permanent threshold shift
RCRA	Resource Conservation and Recovery Act
RHA	Rivers and Harbors Act
ROD	record of decision
ROP	required operating procedure
ROV	remote operating vehicle
ROW	right-of-way
RRT	Regional Response Team
SAAQS	State Ambient Air Quality Standards
SABM	St. Andrew's beach mouse
SAMP	Special Area Management Plan
SBF	synthetic-based drill fluids
SCAT	Shoreline Cleanup Assessment Team
SDI	Satellite Drilling Island
SEED	Shelf Energetics and Exchange Dynamics
SEMS	Safety and Environmental Management Plan
SETAC	Society for Environmental Toxicology and Chemistry
SIP	State Implementation Plan
SMB	synthetic-based muds
SO_2	sulfur dioxide
SO_x	sulfur oxides
SOA	secondary organic aerosol
SOAR	Synthesis of Arctic Research
SONS	spill of national significance
SST	sea-surface temperature
SSDC	single steel drilling caisson
SU	subsistence use
SUA	Special Use Airspace
SUSIO	State University System of Florida Institute of Oceanography
SWSS	Sperm Whale Seismic Study
t	metric ton (tonne)
TAPS	Trans–Alaska Pipeline System
TAR	Technology Assessment and Research
TATEC	Turnagain Arm Tidal Energy Corporation
Tbbl	trillion barrels
tcf	trillion cubic feet
TcfG	trillion cubic feet of gas
TcfGE	trillion cubic feet of gas equivalent
TEIA	Transboundary Environmental Impact Assessment

TERA	Troy Ecological Research Associates
Tg	teragram
TLH	Teshekpuk Lake Herd
TMDL	total maximum daily load
TLSA	Teshepuk Lake Special Area
TPWD	Texas Parks and Wildlife Department
TTI/E	Ten Thousand Islands/Everglades Unit
TTS	temporary threshold shift
UCI	Upper Cook Inlet
$\mu g/m^3$	migrograms per cubic meter
ULSD	ultra-low-sulfur diesel
μm	micrometer
UME	unusual mortality event
UNEP	United Nations Environment Programme
μPa	microPascal
μPa-m	microPascal at 1 meter
USAF	U.S. Air Force
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USDOC	U.S. Department of Commerce
USDOD	U.S. Department of Defense
USDOE	U.S. Department of Energy
USDOI	U.S. Department of the Interior
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service (USDOI)
USGS	U.S. Geological Survey (USDOI)
VLOS	very large oil spill
VOC	volatile organic compound
WA	Wilderness Area
WAH	Western Arctic Herd
WBF	water-based fluid
WBM	water-based muds
WCID	Well Construction Interface Document
WEA	Wind Energy Area
WPA	Western Planning Area
yd^3	cubic yards

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SUMMARY

The Proposed Action

Section 18 of the Outer Continental Shelf Lands Act (OCSLA) requires the Secretary of the Interior to prepare and maintain a schedule of proposed OCS oil and gas lease sales determined to "best meet national energy needs for the 5-year period following its approval or reapproval." The Proposed Final Program establishes a schedule that the U.S. Department of the Interior (USDOI) will use as a basis for considering where and when leasing might be appropriate over a 5-year period. The USDOI proposes 15 lease sales in six of the Outer Continental Shelf (OCS) Planning Areas in the Gulf of Mexico (GOM) and offshore Alaska during the period 2012-2017 (Table S-1). Five lease sales are proposed for each of the Central and Western GOM Planning Areas, with one to two lease sales in the extreme western portion of the Eastern GOM Planning Area. Scheduled in the Alaska region are one sale with two whaling deferrals in the Beaufort Sea Planning Area, one sale with a 40-km (25-mi) coastal buffer in the Chukchi Sea Planning Area, and one sale in the Cook Inlet Planning Area. No lease sales are proposed off the U.S. east and west coasts. The later scheduling of the potential sales in the Beaufort Sea, Chukchi Sea, and Cook Inlet Planning Areas represents a strategic approach to leasing in the Alaska region and is structured to allow time for further work in critical areas such as further scientific study and environmental assessment, further information collection on the geologic conditions and resource potential in the area through exploration under existing leases, and further development of oil spill response preparedness and infrastructure capabilities. During implementation of the 2012-2017 OCS Oil and Gas Leasing Program (hereafter referred to as "the Program"), this will also allow the Secretary of the Interior to develop a more tailored vision for leasing in the Arctic addressing specific resource opportunities and the special environmental and subsistence concerns. A decision to adopt the Program proposal is not a decision to hold lease sales, issue specific leases, or to authorize any drilling or development.

Oil and gas activities may occur on OCS leases after a lease sale is held pursuant to this proposed action, and these activities may extend over a period of 40 to 50 years. These activities may include (1) seismic surveys; (2) drilling oil and natural gas exploration and production wells; (3) installation and operation of offshore platforms and pipelines, onshore pipelines, and support facilities; and (4) transport of hydrocarbons using tankers or pipelines.

TABLE S-1 Proposed 2012-2017 Program Lease Sale Schedule

OCS Planning Area	Proposed Lease Sale Year
Western Gulf of Mexico	Annual sales beginning in 2012
Central Gulf of Mexico	Annual sales beginning in 2013
Eastern Gulf of Mexico	2014, 2016
Cook Inlet	2016
Beaufort Sea	2017
Chukchi Sea	2016

Alternatives

Seven alternatives to the Proposed Action Alternative (Alternative 1) are evaluated in this programmatic environmental impact statement (PEIS). Each alternative represents a reduction from the proposed action, differing only in which planning areas (and associated number of lease sales) would be included for possible future lease offerings under the Program.

- **Alternative 2** – Exclude the Eastern GOM Planning Area for the duration of the Program. Leasing in the other five planning areas would be the same as Alternative 1.

- **Alternative 3** – Exclude the Western GOM Planning Area for the duration of the Program. Leasing in the other five planning areas would be the same as Alternative 1.

- **Alternative 4** – Exclude the Central GOM Planning Area for the duration of the Program. Leasing in the other five planning areas would be the same as Alternative 1.

- **Alternative 5** – Exclude the Beaufort Sea Planning Area for the duration of the Program. Leasing in the other five planning areas would be the same as Alternative 1.

- **Alternative 6** – Exclude the Chukchi Sea Planning Area for the duration of the Program. Leasing in the other five planning areas would be the same as Alternative 1.

- **Alternative 7** – Exclude the Cook Inlet Planning Area for the duration of the Program. Leasing in the other five planning areas would be the same as Alternative 1.

- **Alternative 8** – No Action. No lease sales would be conducted in any OCS Planning Area during the period 2012-2017. Exploration, development, and production activities would continue in lease blocks previously leased.

Principal Issues and Concerns

Programmatic Deferrals and Mitigation. Decisions at the 5-year Program stage are, generally speaking, broad-based and focused on determining which areas to include in the Program during what years. Numerous and varied recommendations for more focused leasing, spatial and temporal deferrals, and mitigation were provided in scoping comments and echoed in Draft PEIS comments and in discussions with PEIS cooperating agencies. The PEIS does not analyze specific deferrals and mitigations as alternatives. However, the PEIS includes a substantial presentation of potential mitigation strategies that may be appropriate for further consideration throughout the different stages of the leasing process in different Program areas, with the goal of ensuring that these strategies are thoroughly considered, analyzed where appropriate, and readied for implementation at the appropriate stage in the process. Since the process for developing and implementing mitigation strategies could require additional research and coordination and consultation over an extended time, the 5-year PEIS serves its planning and tiering function by establishing a process that can be used during the Program to evaluate, track, and provide for stakeholder input into the development of informed mitigation strategies.

Impact-Producing Factors. It is important to note that establishing a schedule of lease sales by itself will have no direct effects on most resources on the OCS. With the exception of pre-sale geophysical surveys used by industry to inform lease bid decisions, most activities that could impact resources would only occur following a lease sale, and then only following approval for exploration and development to be initiated within lease areas. However, all activities would only occur with issuance of a geophysical or geological permit, authorization of ancillary on-lease activities, and/or approval of an exploration or development plan. Because the nature, location, and level of future project-specific oil and gas activities is unknown at this time, the environmental analyses presented in this PEIS are based on reasonable assumptions about future activities and apply to each of the seven action alternatives under consideration for the Program. Estimates of oil and gas resources that might be found in and produced from the areas being considered for leasing provide the basis for making the assumption of the levels of exploration and development that might occur. Each exploration and development scenario contains the major elements of activity needed to support exploration, production, and transportation of oil and gas that may be discovered and found to be economically producible.

Several types of routine oil and gas activities are identified that could cause impacts under the proposed action or alternatives (excluding the No Action Alternative) following subsequent lease sale, plan, or permit considerations. None of the action alternatives, if implemented, would authorize oil and gas exploration and development activities. These activities are, however, evaluated in the PEIS in resource-specific analyses to provide decision-makers with programmatic information regarding the nature and magnitude of potential impacts that may be incurred with development following a lease sale under any of the seven action alternatives. Location- and resource-specific impacts would be evaluated in subsequent lease sale and plan-specific NEPA analyses and decision-making.

The impact-producing factors related to routine OCS activities and evaluated in this PEIS include:

- The disposal of liquid wastes, including drilling fluids (i.e., drill muds), produced water, ballast water, and sanitary and domestic wastewater generated by OCS-related activities.

- Solid waste disposal, including material removed from the well borehole (i.e., drill cuttings), solids produced with the oil and gas (e.g., sands), cement residue, bentonite, and trash and debris (e.g., equipment or tools) accidentally lost.

- Gaseous emissions from offshore and onshore facilities and from construction, support, and transportation vessels and aircraft.

- Noise from seismic surveys, ship and aircraft traffic, pipeline trenching, drilling and production operations, and explosive platform removals.

- Physical impacts from ship and aircraft traffic and use conflicts with oil tankers and barges, supply/support vessels and aircraft, and seismic survey vessels and aircraft.

- Physical emplacement, presence, and removal of facilities including offshore platforms; seafloor pipelines; floating production, storage, and offloading systems; onshore infrastructure such as pipelines, storage, processing, and repair facilities; ports; pipe coating yards; refineries; and petrochemical plants.

Oil Spills. The greatest concern related to oil and gas development under any of the alternatives addressed in this PEIS is that of an accidental oil spill. Spills may be associated with loss of well control, production accidents, transportation failures (e.g., tankers, other vessels, seafloor and onshore pipelines, and storage facilities), and platform accidents. The magnitude and duration of effects from an accidental spill would depend on the location, timing, and volume of the spill; the environmental setting of the spill (e.g., restricted coastal waterway, deepwater pelagic location); and the species (and their ecology) and other sensitive resources exposed to the spilled oil. Spill-response operations could result in short-term disturbance of fauna and human activities in the vicinity of cleanup activities.

Evaluating historical spill data and taking into account the amount of oil production anticipated to occur with exploration and development following leasing, spill scenarios are provided for the GOM, Cook Inlet, Beaufort Sea, and Chukchi Sea Planning Areas. BOEM estimates the number of small (<1,000 bbl) and large (≥1,000 bbl) oil spills that are expected during the Program, given historical spill rates and projected OCS activity levels. Most expected spills would be less than 50 bbl in size, and impacts to most resources from such small spills would be negligible to minor, as weathering, dispersion, and other natural processes would be expected to quickly disperse and degrade the spill, limiting exposure of, and effects to, resources in the vicinity of the spill. In addition, the farther from the coast a small spill were to occur, the less likely it would be that the spill would adversely affect coastal and nearshore resources. In contrast, a large spill may be expected to affect more resources, do so over a much larger area and for a much longer period of time, and potentially result in major impacts.

For analytical purposes, the PEIS presents analyses of the effects of varying sizes of oil spills on sensitive resources. While this analysis provides the Secretary of the USDOI with information about the potential impacts if spills were to occur and contact environmental resources, the analyses cannot predict if, when, or where specific oil spills would occur or whether any spills would contact environmental resources. In all Program areas, the analyses consider the effects of at least one very large, catastrophic spill event, even though the occurrence of such a spill is unexpected, given the estimated drilling and oil production scenario. Again, the analyses of these spills does not mean the USDOI expects such a catastrophic event to occur under any of the action alternatives considered in this PEIS; rather, the analyses identify potential impacts to resources that may be incurred, should such a catastrophic discharge event occur, even if it is unlikely that such an event would occur. The effects of a catastrophic discharge event could significantly affect physical, biological, and socioeconomic resources over large areas and for long periods of time.

Major regulatory reforms and advances in drilling and containment technology and practice have occurred and continue to occur following the Deepwater Horizon event, potentially reducing the frequency of oil spills or potential size of oil releases into the environment from OCS operations. The PEIS includes a detailed discussion addressing the risk of catastrophic discharge events, as well as many of the important governmental and industry reforms and improvements under way to further reduce risk and improve safety and environmental performance.

Sensitive Biological and Ecological Resources and Critical Habitats

The Program encompasses large areas in the GOM and portions of the Alaska OCS. These areas constitute diverse marine and coastal environments that support a tremendous diversity of habitats and biota, including species and habitats protected by the Endangered Species Act, Magnuson Stevens Fishery Conservation and Management Act, Migratory Bird Treaty Act, and other Federal and State laws and regulations. At this programmatic stage, it is not possible, or appropriate, to conduct site-specific analyses of all potentially affected resources or identify all relevant mitigation. Therefore, in keeping with NEPA and Council on Environmental Quality (CEQ) regulations, the PEIS focuses on those aspects of marine and coastal resources that are unique, ecologically important, or most susceptible to impacts from offshore oil and gas activities. The PEIS also concentrates on those life stages and habitats that may be most sensitive to routine oil and gas activities, as well as to accidental oil spills.

The identification and evaluation of potential impacts focus on three main categories: animals, plants, and habitats. Among the animal groups evaluated are marine and terrestrial mammals, marine and coastal birds, fish, sea turtles, and benthic invertebrates. Special attention is given to migratory species, species taken commercially and for Alaska Native subsistence (including whales, other marine mammals, fish, and birds), and threatened and endangered species. With respect to habitats, both marine (e.g., corals and chemosynthetic communities) and coastal (e.g., estuaries and wetlands/marshes, dunes) areas are identified and evaluated for possible adverse impacts from OCS oil and gas activities.

Social, Cultural, and Economic Resources

Specific concerns regarding social, cultural, and economic resources include potential impacts on tourism, recreation, commercial and recreational fishing, subsistence harvests, aesthetics, local economies, land and water use conflicts, disproportionate impacts on low-income and minority groups, and disproportionate impacts on Alaska Natives. The social, cultural, and economic topics analyzed in the PEIS are as follows:

- Population, employment, income, and public service issues from the effects of the Program, including issues relating to "boom/bust" economic cycles.

- Land use and infrastructure, including construction of new onshore facilities, and land use and transportation conflicts among the oil and gas activities and other uses.

- Sociocultural systems effects, including concerns about the effects on subsistence resources and activities (e.g., bowhead whale hunting), loss of cultural identity, health impacts including psychological health, and social cost of oil spills.

- Environmental justice (i.e., the potential for disproportionate and high adverse impacts on minority and/or low-income populations [Executive Order 12898]).

- Commercial and recreational fisheries.

- Tourism and recreation, including the use of coastal areas for sightseeing, wildlife observations, swimming, diving, surfing, sunbathing, berry picking and gathering roots and greens, hunting, fishing, clamming and gathering shellfish, boating, and the visual impacts of offshore OCS structures.

- Archaeological resources, including historic shipwrecks and sites inhabited by humans during prehistoric times.

Climate Change

The PEIS considers how climate change, based on the observed changes that have been occurring during the past several decades, may affect baseline conditions of resources over the 40 to 50 year period during which oil and gas activities could occur following lease sales under the Program. The effects of climate change on ecosystems are complex and non-uniform across the globe and vary among atmospheric, terrestrial, and oceanic systems. Considerations of climate change effects in OCS Planning Areas focus on impacts to marine and coastal systems where environmental sensitivities are typically associated with increasing atmospheric and ocean temperatures, sea level rise, and ocean acidification. These general categories of climate change responses are occurring in addition to human-induced pressures related to coastal population densities (e.g., land use changes, pollution, overfishing) and trends of increasing human use of coastal areas. The PEIS presents resource-specific discussions of the affected environment with discussions of the effects of ongoing, observable climate changes for those resources. In addition, the impacts of the continuing trend in climate change during the life of the Program are considered as well.

Summary of Impact Conclusions (Alternatives 1–7)

The analyses in this PEIS describe in detail the nature and extent of potential impacts of future oil and gas activities on the OCS that may occur under the proposed action or any of the action alternatives. Specifically, the PEIS evaluates the potential direct, indirect, and cumulative impacts of routine operations and accidental oil spills. Cumulative effects are addressed in the PEIS, but are not summarized in this Summary. The analyses assume the implementation of all mitigation and other protective measures currently required by statute, regulation, or BOEM policy and practice. One objective of the PEIS is to convey to decision makers and the public the relative extent of potential impacts. Conclusions for most analyses generally indicate the ability of most affected resources to recover from impacts that could result from oil and gas development following leasing.

Under the proposed action, or Alternatives 2 through 7, routine operations associated with each of these phases will have similar impact-producing factors associated with them, and these have "typical" types of impacts (summarized below), regardless of location. The magnitude and importance of those impacts on the resource, however, will be site- and project-specific. The types of impacts identified and discussed below will be similar for each of the alternatives except the No Action Alternative. The principal difference in potential impacts among the action alternatives would be in where those impacts may be incurred, as well as the nature of exposure. Each of the alternatives to the proposed action excludes one of the six planning areas included in the proposed action from the Program; thus, most resources in an excluded planning area would not be expected to be affected by routine operations occurring in other planning areas. Because routine operations include some impacting factors (such as seismic survey noise and support vessel traffic) that may extend beyond planning area boundaries, resources in an excluded planning area may be affected by some of the routine operations associated with development in adjacent planning areas. Similarly, accidental oil spills may be transported from the planning area in which the spill occurs to adjacent planning areas, affecting resources in those other areas.

The six action alternatives to the proposed action each exclude one of the planning areas (Alternatives 2–7). Beneficial environmental effects would be mostly realized in the area(s) excluded. Those beneficial effects could be realized through avoided adverse effects which may otherwise stress environmental resources, sensitive ecosystems, and subsistence practice. Cumulative actions and effects may also be reduced.

The evaluation of a No Action Alternative is required by the regulations implementing NEPA (40 CFR 1502.14(d)). If the Secretary were to adopt this alternative, it would halt OCS pre-sale planning, sales, and new leasing from 2012 to 2017. However, exploration, development, and production stemming from past sales would continue. As demand for energy is not expected to substantially decrease, the energy demand would need to be met by switching energy sources. Environmental effects could occur from other domestic and international energy producing activities, such as non-domestic oil production and tankering, coal extraction and consumption, and hydropower.

Water Quality

In the GOM and Alaska planning areas, routine operations could result in minor to moderate, localized, short-term impacts. Any such impacts would be associated with structure placement and construction (pipelines, platforms), operational discharges (produced water, bilge water, and drill cuttings), and sanitary and domestic wastes. Structure placement and removal could increase suspended sediment loads as a result of bottom disturbance, while operational discharges, sanitary and domestic wastes, and deck drainage could affect chemical water quality. Compliance with National Pollutant Discharge Elimination System (NPDES) permit requirements and U.S. Coast Guard (USGS) regulations would reduce most impacts of routine operations.

The impacts of accidental oil spills could range from minor to major, depending upon the material spilled, spill size, spill location, and remediation activities. Small spills (<1,000 bbl) would likely result in short-term, localized impacts. Impacts from a large oil spill (≥1,000 bbl) could persist for an extended period of time because of potential remobilization from sediments or if oil were to reach shore and be deposited in wetland and beach sediments or low-energy environments. The speed of natural recovery in the Alaska OCS, as compared to GOM waters, could be slowed by the persistence of oil in cold water temperatures and ice cover. Although unexpected, a catastrophic discharge event (CDE) spill, if one were to occur, would have moderate to major impacts and would affect water quality over a much larger area, including possibly in planning areas adjacent to the one where the spill occurs. The potential for more widespread and long-term water quality impacts may be expected to be greater in cold Alaskan waters, especially under ice-cover conditions. In the Alaska Beaufort Sea and Chukchi Sea Planning Areas, winter conditions (e.g., complete ice cover and extremely cold conditions) could substantially complicate spill response, given current spill control and remediation technologies.

Air Quality

Routine operations affecting air quality in the GOM and Alaska planning areas include emissions from construction equipment; machinery supporting production operations; helicopters and aircraft; marine vessels, including drill ships, production platforms, and oil spill support vessels; and, in Alaska, ice breakers. Only minor impacts to air quality are expected from routine activities under any of the action alternatives. Emissions during routine operations under any of the action alternatives would cause localized increases in concentrations of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter less than 10 or 2.5 micrometers in diameter (PM_{10} and $PM_{2.5}$, respectively), and carbon monoxide (CO) in the planning areas where such activities would occur, although concentrations would not be expected to exceed U.S. Environmental Protection Agency (USEPA) National Ambient Air Quality Standards (NAAQS) and the Prevention of Significant Deterioration (PSD) increments. Increases in ozone may occur, but would be less than 2% of total concentrations. Air quality impacts from oil spills and *in situ* burning would generally be localized and of short duration. Overall, impacts on air quality from oil spills and any spill-response activities are expected to be minor for small spills (<1,000 bbl) and moderate for large spills (≥1,000 bbl), depending on the location, duration, size, and time of the spill. Although unexpected, a CDE spill, if one were to occur, may affect air quality over a larger area, given burning and other spill-response measures, including possibly affecting air quality in planning areas adjacent to the one where the spill occurs. However, effects are expected to be moderate, given the relatively short duration of deteriorated air quality.

Acoustic Environment

Routine operations in the GOM and Alaska OCS planning areas could affect ambient noise conditions, with increases in noise levels expected to result in minor to moderate impacts to ambient noise levels. Noise-generating activities associated with routine operations include seismic surveys, drilling and production, infrastructure placement and removal, and vessel and aircraft traffic. Depending on the source and activity, increases in ambient noise levels could be short-term and localized (e.g., from vessel traffic), short-term and less localized (from seismic surveys), or long-term and localized (from production). Oil spills (including a CDE) could result in temporary minor to moderate impacts to the acoustic environment associated with noise generated by spill-response activities, including spill-response vessels and aircraft. Effects of sound on marine biota are considered in the respective resource areas.

Marine and Coastal Habitats

***Coastal and Estuarine Habitats*.** Under any of the action alternatives, coastal and estuarine habitats could incur minor to moderate, localized impacts from routine operations such as pipeline and landfall construction, maintenance dredging of inlets and channels, and vessel traffic. Coastal and estuarine habitats could be disturbed by activities such as pipeline trenching and onshore facility construction. Shoreline habitats may also be affected by wake-induced erosion during routine dredging activities or ship traffic. Habitats potentially affected would include coastal dunes, wetlands, and barrier islands. The magnitude of these impacts would depend on the location of the construction activities, the level of dredging or shipping activity in a specific area, and existing environmental conditions (such as ongoing shoreline degradation).

Coastal and estuarine habitats could be affected by accidental oil spills and incur minor to major impacts. The magnitude of potential impacts to coastal and estuarine habitats would depend on a variety of factors, including the location, size, timing, and duration of the spill; the effectiveness of remediation efforts; existing environmental conditions (e.g., vegetation, substrate type, ice cover); and natural localized erosion and deposition patterns. The effects of small spills would generally be localized and relatively short-term and are anticipated to be negligible to moderate for small spills (<1,000 bbl) that occur offshore. In the event of a large spill (≥1000 bbl) or a CDE, habitats over a much greater geographic area may be affected and may incur more severe impacts where oil is concentrated or remobilized after burial. Large spills could result in moderate to major impacts to marine and coastal habitats, whereas a CDE could result in major impacts, depending on the location, duration, and timing of the spills; the habitats exposed to the spill; and the effectiveness of cleanup activities. In some cases, habitats such as coastal wetlands may not fully recover even following remediation.

Marine Benthic Habitats. Moderate impacts from routine OCS oil and gas activities could result from the construction and removal of infrastructure (wells, platforms, and pipelines), vessel traffic, and from authorized operational discharges (e.g., drilling muds and cuttings). Construction activities that involve the physical disturbance of the seafloor will result in moderate impacts to benthic habitats within and immediately adjacent to the disturbance footprint. In most cases, disturbed soft-bottom habitats would recover. Protective measures, currently required at the lease sale phase through lease stipulations, exist for seafloor habitats such as live bottom and pinnacle trend areas in the GOM (see Section 4.4.6.2.1, Marine Benthic Habitats – Gulf of Mexico, for a description of lease sale stipulations). These measures are expected to help reduce potential impacts on both nearshore and deeper water habitats.

Small and large accidental oil spills could affect benthic habitats and result in minor to moderate impacts to affected habitats. The magnitude of these impacts would depend upon the location, size, timing and duration of the spill; weather conditions; effectiveness of containment and cleanup operations; and other environmental conditions at the time of the spill. Impacts from small spills would be mostly localized and of short duration, and negligible for most small spills. If a large spill were to occur at the seafloor (i.e., from a wellhead or a pipeline), a greater variety and amount of habitat could be affected and incur minor to moderate impacts over a longer period of time. Although unexpected, a CDE may adversely affect benthic habitats over larger areas for long durations depending on the oil spill plume dynamics and dispersion, and result in moderate impacts. As a consequence, full recovery of oiled habitats could take many years in some locations.

Marine Pelagic Habitats. Overall, no long-term degradation of pelagic habitat is anticipated from the proposed action, and effects would be negligible to minor in the GOM and Alaska planning areas. During routine operations (including routine discharges), marine pelagic habitats could be affected as a result of increased turbidity associated with bottom-disturbing activities, and from operational discharges such as produced water and drilling muds and cuttings. Impacts would be largely localized and short-term in duration.

Small accidental spills may be expected to result in negligible (for spills <50 bbl) to minor (for spills up to 1,000 bbl) localized impacts on pelagic habitats. The effects from oil spills would depend on the location, magnitude, duration, and timing of the spill, on environmental factors (e.g., presence of sea ice, storms, ocean currents), and on the range and sensitivity of the habitats affected by the spill. A large spill or a CDE could reduce habitat quality over a larger area and result in minor to moderate impacts to affected habitats before oil is degraded. In the GOM, oil contacting *Sargassum* mats could result in complete or partial short-term loss of these unique habitats in some areas and cause substantial, but localized impacts on associated biota. In Alaska, accidental spills occurring under ice cover or in sea ice habitats could result in potentially long-term impacts to pelagic habitats.

Marine and Terrestrial Mammals

Impacts to marine mammals from routine operations include noise disturbance from seismic surveys, vessels, helicopters, construction and operation of platforms, and removal of platforms with explosives; potential collision with vessels; and exposures to discharges and wastes. Impacts to cetaceans could range from negligible to moderate, with species or stocks inhabiting continental shelf or shelf slope waters most likely to be affected. Meeting the requirements of the Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA), which is accomplished at the lease sale and/or plan stage, would reduce the likelihood and magnitude of adverse impacts from routine operations to most marine mammal species. For terrestrial mammals, no impacts are expected from routine operations in the GOM to endangered beach mice subspecies or the Florida salt marsh vole. In Alaska, impacts to terrestrial mammals from routine OCS operations would be negligible to moderate, with local, population-level effects possible for some species (i.e., muskoxen).

Accidental oil spills may result in the direct and indirect exposures of mammals and their habitats to the oil. Fouling of fur of some species (e.g., sea otter, polar bear, and fur seal) could affect thermoregulation and reduce survival, while ingestion of oil and oil-contaminated food could have acute and chronic effects. The magnitude of effects from accidental spills would depend on the location, magnitude, duration, timing, and volume of the spills; the habitats affected by the spills (e.g., marine and coastal habitats); and the species exposed. Spills in open waters may be expected to affect the fewest number of individuals. Very large spills, such as a CDE, could affect the greatest number of species and individuals, and have the greatest potential for adversely affecting local mammal populations. In Alaska, the greatest risk to marine mammals would be associated with large spills (≥1,000 bbl) reaching rookeries and haulout locations where large numbers of individuals could be exposed and population-level impacts on some species could occur. Overall, small spills would affect relatively few individuals and have negligible to minor impacts to marine and terrestrial mammals. Large spills could affect many more species, with minor to major impacts to marine and terrestrial mammals. Very large spills, such as an unexpected CDE, could result in local population-level effects.

Marine and Coastal Birds

Routine operations may result in negligible to moderate, localized, short-term impacts. Impacts would be associated primarily with infrastructure construction and ship and helicopter traffic. The primary effect would be the behavioral disturbance of birds in the immediate vicinity of the activity. In most cases, disturbed birds would temporarily leave the area, while in other cases, the displacement could be longer-term. Because many birds tend to habituate to human activities and noise, potential impacts from disturbance may be short-term and not expected to result in population-level effects. However, construction activities near coastal habitats could disrupt breeding and nesting activities of colonial nesting birds. Depending on the species, the numbers of birds affected, and the activity disturbed (nesting, molting, feeding, and staging), the displacement of disturbed birds could reduce reproductive success, foraging success, and survival. Some collision mortality with offshore platforms would be expected. Many avian species are attracted to platform lights whereby collisions ensue. This risk is increased in bad weather situations. Loss or alteration of preferred habitat due to pipeline landfalls or other onshore construction could result in the localized displacement and possible localized decrease of nesting activities.

Accidental oil spills pose the greatest threat to marine and coastal birds. Small spills could have negligible (for spills <50 bbl) to minor (for spills up to 1,000 bbl) impacts, while large spills (≥1,000 bbl) could result in moderate to major impacts to marine and coastal birds. An unexpected CDE could result in local population-level effects to unique bird species or concentrated populations in rare habitat areas. The magnitude and ecological importance of any effects would depend upon the size, location, duration, and timing of the spill; the species and life stages of the exposed birds; and the size of the local bird population. Exposure to spills in deep water would be largely limited to pelagic birds. Shallow-water spills that reach coastal habitats could affect the greatest variety and number of birds, including shorebirds, waterfowl, wading birds, gulls, and terns. Spills reaching onshore locations have the greatest potential for affecting the greatest number of birds, especially if a spill occurs in or reaches an area where birds have congregated and are carrying out important activities (such as nesting, molting, and staging areas for some of the Alaskan waterfowl and shorebirds). Exposed birds may experience a variety of lethal or sublethal effects, and the magnitude and ecological importance of any such effects would depend upon the size and location of the spill, the species and life stage of the exposed birds, and the size of the local bird population.

Fish Resources and Essential Fish Habitat

Overall, impacts to fish or essential fish habitat (EFH) from routine Program activities are expected to range from negligible to minor for fish and up to moderate for EFH, and no impacts on threatened or endangered fish species are expected. The primary potential impacts from routine Program activities could result from noise-generating and bottom-disturbing activities such as vessel traffic, seismic surveys, drilling, platform placement and mooring, and pipeline trenching and placement, which could displace, injure, or kill fish or disturb EFH in the vicinity of the activity. Fixed platforms, particularly the large numbers projected for the GOM, would also serve as artificial reefs that would attract substantial numbers of fish. Oil and gas activities would be temporary, and no permanent or population-level impacts on fish are expected. Displaced fish and invertebrate food sources would repopulate the area over a short period of time in the GOM, but fish habitat recovery may be longer-term in the Alaska OCS waters. The effects of drilling muds and produced water discharge would be localized, and no population-level effects are expected. When fixed oil and gas platforms are removed during the decommissioning phase, both explosive and non-explosive methods may be used to sever conductors and pilings. Non-explosive removals (e.g., abrasive, mechanical, or diver cutters) are expected to temporarily displace resident fish communities, but have little overall impact to the fish resources or EFH. Explosive platform removals may occur in the GOM potentially resulting in injury, mortality, and displacement for a large number of fish.

Small spills may have negligible (for spills <50 bbl) to minor (for spills up to 1,000 bbl) impacts on fish or EFH. Small spills would be localized and are unlikely to affect a substantial number of fish before dilution and weathering would reduce concentrations of toxic fractions to nontoxic levels. Large spills (≥1,000 bbl) could result in minor to moderate impacts to fish and EFH; such spills would affect a wider area (as a consequence, likely more fish species and individuals), with the magnitude of the impacts depending on the location, timing, and volume of spills, distribution and ecology of affected fish species, and other environmental factors. An unexpected CDE could result in moderate impacts to fish and moderate to major impacts to EFH, depending on the nature of exposure, sensitivity of habitat, and effectiveness of spill response. Most adult fish are highly mobile and would likely avoid lethal hydrocarbon exposures, although they may be subjected to sublethal concentrations. Smaller species and egg and larval life stages are more likely to suffer lethal or sublethal exposures from oil contact because of their relative lack of mobility. Under most circumstances, any single large spill would affect only a small proportion of a given fish population; therefore, overall population levels may not be affected. However, fish species that currently have depressed populations or have critical spawning grounds present in the affected area could experience population-level impacts. Oil contacting shoreline areas used for spawning or providing habitat for early life stages of fish could result in large-scale lethal and long-term sublethal effects on fish. In Alaskan waters, where oil may be slow to break down, coastal oiling could measurably depress some fish populations for several years. However, no chronic impacts on fish populations are expected from small or large spills.

Reptiles

Five species of sea turtles occur in the three GOM planning areas: green, hawksbill, Kemp's ridley, leatherback, and loggerhead, and all are listed as threatened or endangered under the ESA. All but the hawksbill have been reported to nest on beaches within the GOM planning areas. In addition to these turtles, the American crocodile, which is federally endangered, occurs in the Eastern GOM Planning Area along the southern coast of Florida. Routine operations in the GOM are not expected to affect the American crocodile. This species could be affected in the event there is a very large oil spill that reaches the southern Florida coast, although that is unlikely even if such a spill were to occur. In such an event, adults and young could be directly exposed, and nest sites could be fouled. No reptiles occur in the Alaska OCS Planning Areas.

Impacts to reptiles from routine operations are expected to range from minor to moderate. Sea turtles could be directly affected by seismic surveys, vessel traffic, construction of offshore and onshore facilities, operational discharges, and removal of platforms. Noise generated during exploration and production activities and platform removal may result in the temporary disturbance of some individuals, while some turtles may be killed during the use of underwater explosives for platform removal. The construction and operation of new onshore facilities may impact nest sites, possibly result in eggs being crushed, and disturb hatchling movement from the nest sites to the water. Sea turtles may also be injured or killed by collisions with OCS vessels. Permit requirements, ESA regulations and requirements, regulatory stipulations, and BOEM guidelines could limit the seriousness of any potential effects on sea turtles. Therefore, while routine operations could affect individual sea turtles, population-level impacts are not expected.

Oil spills may expose one or more sea turtle life stages to oil or its weathering products. Oil reaching nests may reduce egg hatching and hatchling survival and inhibit hatchling access to water. Exposed hatchlings, juveniles, and adults may incur a variety of lethal or sublethal effects. The presence of oil on nesting beaches may affect nest site access and use. Small spills are unlikely to affect a large number of sea turtles or their habitats, and thus are not expected to have substantial or long-term effects. Small spills may have negligible (for spills <50 bbl) to minor (for spills up to 1,000 bbl) impacts, with relatively few individuals or habitats being affected. Large spills could affect more species, individuals, and habitats, and result in moderate impacts to affected species. The magnitude of effects from accidental spills would depend on the location, timing, duration, and volume of the spills; the environmental settings of the spills; and the species and life stages of sea turtle exposed to the spills. A CDE, although unexpected, could affect the greatest number of individuals, life stages, and habitats and result in major impacts to the affected species. A very large spill could affect sensitive habitats, including nesting beaches, and potentially lead to population-level effects.

Invertebrates

Routine operations could result in negligible to moderate impacts to invertebrates, especially to benthic invertebrates. The primary impacts of routine Program activities would be from bottom-disturbing activities during the exploration and site development phases. Routine operations involving bottom disturbance (including pipeline trenching) could displace, bury, injure, or kill invertebrates in the immediate vicinity of the activities. Affected invertebrate communities would generally repopulate the disturbed areas over a short period of time (especially soft-bottom communities), although a return to the pre-disturbance community may take longer, particularly in the Arctic. If discharged into open water, the effects of drilling muds and produced water on invertebrates would be localized, and no population-level effects are expected. No long-term or population-level impacts on invertebrates are expected from routine operations following lease sales under any of the action alternatives.

Small surface or subsurface oil spills (<1,000 bbl and especially <50 bbl) would be rapidly diluted and likely result in negligible to minor, localized impacts on invertebrates. Large spills (≥1,000 bbl) would affect a larger number of benthic and pelagic invertebrates and their habitats, and could result in minor to moderate impacts to the affected biota and habitats. The location, size, duration, and timing of the spill would be important determinants of the impact magnitude of large spills. Impacts of a CDE could range up to moderate. Although unexpected, a CDE contacting shoreline areas with sensitive intertidal and shallow subtidal habitats could result in large-scale and long-term sublethal and lethal effects to the benthic communities in those habitats. In Alaska, local populations of intertidal organisms affected by such large spills could be measurably depressed for several years and oil could persist in shoreline sediments for decades.

Areas of Special Concern

Impacts to Areas of Special Concern (AOCs) resulting from routine Program activities are expected to be negligible to moderate because of the existing protections and use restrictions. Routine operations that could affect AOCs (e.g., National Marine Sanctuaries, National Parks) include the placement of structures, pipeline landfalls, operational discharges, and vessel traffic. However, direct impacts from these activities are unlikely, as no infrastructure (e.g., pipeline landfalls, shore bases) would be sited in National Parks, National Wildlife Refuges (NWRs), or other AOCs. In Alaska, no OCS-related activities would occur in National Park lands, thereby minimizing the potential for impacts from routine operations to these AOCs, and impacts from routine activities in adjacent areas would be minimal. However, offshore construction of pipelines and platforms could have temporary effects on wildlife due to noise and activity levels and on scenic values for park visitors.

Small spills could have negligible (for spills <50 bbl) to minor (for spills up to 1,000 bbl) impacts on AOCs, while large spills (≥1,000 bbl) could have minor to moderate impacts on AOCs in the vicinity of the spill. Although unexpected, a CDE could have moderate impacts on AOCs related to direct oil contact or indirect spill response activities. The magnitude of the potential impact would depend on the location, size, duration, and timing of a spill; the weather conditions at the time of the spill; the nature and effectiveness of response operations; and other environmental conditions (e.g., presence of sea ice) at the time of the spill. Accidental oil spills reaching AOCs could negatively affect fauna and habitats, subsistence use, commercial or recreational fisheries, recreation and tourism, and other uses.

Impacts on Population, Employment, and Regional Income

The main effect on population and employment that could result from leasing will be the employment generated by routine Program activities. In the GOM, direct expenditures associated with routine operations would result in negligible impacts from small increases in population, employment, and income over the duration of the leasing period, corresponding to less than 1% of the baseline. In Alaska, direct expenditures would result in minor impacts from small increases in population, employment, and income in each region over the duration of the leasing period, corresponding to an increase of less than 5% of the baseline. Given existing levels of leasing activity, impacts on property values in the GOM and Alaska planning areas would be negligible. Small spills would have negligible (for spills <50 bbl) to minor (for spills up to 1,000 bbl) impacts, while impacts of larger accidental oil spills (and especially a very large but low-probability CDE) could range from minor to moderate, and could result in the short-term loss of employment, income, and property values. Expenditures associated with potential spill-response and cleanup activities would create short-term employment and income in some parts of the affected coastal region(s).

Land Use and Infrastructure

Routine Program activities would result in negligible to minor impacts in the GOM and negligible to moderate impacts in Alaska, on land use, development patterns, and infrastructure. In the GOM, existing infrastructure generally would be sufficient to handle exploration and development associated with potential new leases. In Alaska, additional infrastructure would be necessary to support Program development. Projected impacts in both the GOM and Alaska from an accidental oil spill (especially from a low-probability CDE) would alter land use temporarily, but would not likely result in long-term changes. The magnitude of the impacts would depend upon the location, size, timing, and duration of the spill and the existing land use at the spill location. Impacts from small spills may range from negligible (for spills <50 bbl) to minor (for spills up to 1,000 bbl), and minor for large spills (≥1,000 bbl) in all planning areas. Although unexpected, a CDE in the GOM could result in minor to moderate impacts to land use and infrastructure, primarily due to the existing infrastructure already in place to address such an event. A CDE in the Cook Inlet Planning Area could have moderate impacts to land use and existing infrastructure, again primarily owing to the presence of existing infrastructure in place in some areas to address such an event. Impacts in the Cook Inlet Planning Area would likely be greater than in the GOM planning areas. Impacts of a CDE in the Arctic could range from moderate to major because of the limited existing infrastructure present for addressing such events and the need to mobilize substantial resources in a short period of time into an otherwise remote area.

Commercial and Recreational Fisheries

Routine operations could have minor impacts on commercial and recreational fisheries. Impacts would be associated primarily with vessel traffic and structure placement, presence, and removal, each of which could temporarily displace fishes away from the area and limit fishing success. However, these impacts would be temporary, and population-level effects on commercial and recreational fishery resources are not anticipated from these routine operations. Once platforms are installed and production activities begin, offshore structures would act as fish attraction devices for both pelagic and reef-associated species; these structures would also be attractive for recreational fishing. Seismic surveys and construction of platforms and pipelines could result in space-use conflicts with commercial and recreational fishing activities, although these effects would be localized. Space-use conflicts, in the case of seismic surveys, would be short in duration.

The level of effects from accidental oil spills on subsistence, commercial, and recreational fisheries would depend on the location, timing, duration, and volume of spills, in addition to other environmental factors. Small spills (up to 1,000 bbl and especially those <50 bbl) would have negligible to minor impacts, and would be unlikely to have a large effect before dilution and weathering reduces concentrations and, therefore, would not have long-term effects on subsistence, commercial and recreational fisheries. Impacts from large spills (≥1,000 bbl) and from CDE-level spills could range from minor to moderate, with impacts from CDE spills affecting a much larger area and potentially more resources, but over a limited period of time. If large oil spills were to occur, commercial, and recreational fisheries could be affected. The potential for oil-soaked fishing gear and potentially contaminated fish may reduce commercial and recreational fishing efforts and affect subsistence use of the resource. Very large spills could also indirectly affect fisheries by degrading habitats that are critical for the survival of target species, but would only be serious if they led to severe declines in target species populations. Highly mobile fish species (tunas, sharks, and billfish) could move away from surface oil spills in deep water, disrupting fishing efforts.

Tourism and Recreation

Routine operations would have minor, short-term negative effects on recreation and tourism, with potential adverse aesthetic impacts on beach recreation and sightseeing and potential positive impacts on diving and recreational fishing in the GOM coast. In Alaska, routine operations would have minor, short-term, adverse effects on sightseeing, boating, fishing, and hiking activities in the Cook Inlet area; and sightseeing, hiking, and boating activities in the Chukchi Sea and Beaufort Sea Planning Areas.

Potential impacts on recreation and tourism resulting from an oil spill in any of the planning areas would likely include direct impacts (e.g., oil contamination of a beach), access restrictions to a particular area (e.g., no diving or fishing while cleanup is being conducted), and aesthetic impacts. These impacts could persist for several months or more pending cleanup completion and any required habitat restoration. The extent and duration of impacts, which could range from negligible (for spills <50 bbl) to moderate for large spills ($\geq 1,000$ bbl) and up to major for a CDE, would depend on the location, size, duration, and timing of the spill and on the effectiveness of response operations. Since oiled coastal sediments are often removed via mechanical means, such shoreline activity would effectively close the area to public use for the duration of cleanup operations. If restoration is required (i.e., to restore the proper beach profile), additional time may be required before public access is allowed. Historical evidence pertinent to the effects of major oil spills has indicated that spills may prompt either a seasonal decline in tourist visits and/or tourist movement to other coastal areas in the region. Impacts of a CDE would be expected to be most widespread and longest lasting.

Sociocultural Systems and Environmental Justice

Impacts of routine operations on sociocultural systems and environmental justice vary across OCS regions. In the GOM, where sociocultural systems have a long experience with offshore oil and gas operations, impacts on sociocultural systems would be few and impacts would be minor. The greatest impacts of routine operations on sociocultural systems in the GOM are expected to result from the ongoing expansion of oil and gas activities in the GOM, especially in expansion to deepwater and ultra-deepwater areas. This expansion of oil and gas activities has contributed to the cultural heterogeneity of the area by drawing the offshore workforce from a wider geographic range. Expansion to deepwater and ultra-deepwater areas has resulted in the creation of jobs that require more specialized skills and in requiring longer, unbroken periods of work offshore. While there is onshore oil development in the vicinity of Prudhoe Bay as well as in portions of Cook Inlet, there is currently no OCS oil and gas development in the Arctic. Thus, impacts to sociocultural systems from routine operations in the Alaska OCS Planning Areas may be minor for the Cook Inlet Planning Area and range from minor to moderate for the Arctic OCS Planning Areas. Of greatest concern to the Alaska Natives who inhabit the area are threats to their subsistence base and way of life. Noise from seismic surveys and exploratory drilling has the potential to deflect whales and other marine mammals from their accustomed migration routes and potentially make them more difficult to harvest.

A large environmental justice concern is the potential health risk to residents from nearby OCS-related infrastructure, including helipads, heliports, waste management facilities, pipe coating yards, shipyards, platform fabrication yards, supply bases, natural gas storage facilities, repair yards, refineries, port facilities, and terminals. In the GOM, with existing industrial infrastructure, routine Program operations are not expected to substantially change the health risk exposure of nearby residents, and impacts are expected to be negligible. Environmental justice impacts from routine Program activities in the Cook Inlet and Arctic Planning Areas are expected to be minor.

The importance of marine mammals (such as the bowhead whale) to subsistence by Alaska Natives (especially in the Arctic) raises particular concerns with regards to oil spills. Any adverse environmental impacts on fish and mammal subsistence resources from accidental oil spills would have sociocultural impacts (primarily associated with disruption of subsistence activities) and could have disproportionately higher health or environmental impacts on Alaska Native populations. Impacts from small spills (<1,000 bbl) would range from negligible (for spills <50 bbl) to minor (for spills up to 1,000 bbl) in the GOM planning areas, primarily as a result of localized impacts to subsistence resources. Similarly, impacts from very small spills (<50 bbl) in the Alaska OCS Planning Areas would likely have negligible impacts on subsistence resources, especially if the spills occurred well off shore, while small spills up to 1,000 bbl could result in minor to moderate localized impacts to subsistence activities if concentrated in subsistence whaling areas. Effects of large spills (≥1,000 bbl) could be moderate to major in the GOM and Cook Inlet Planning Areas and major in the Arctic Planning Areas. The potential for greater impact in the Arctic primarily results from disturbance of or conflict with subsistence activities. Although unexpected, in the event of a CDE, impacts to sociocultural systems would be moderate to major in the GOM planning areas and major in the Cook Inlet and Arctic Planning Areas, especially if oil were initially trapped in ice and persisted over several open-water seasons in whaling areas. An oil spill (especially a large spill or CDE) that contacts subsistence resources could also have disproportionately high impacts on the Alaska Native population, if the subsistence resources were diminished or tainted as a result of the spill.

Archaeological Resources

Archaeological resources that could be affected by the proposed action include historic shipwrecks and inundated prehistoric sites offshore and historic and prehistoric sites onshore. Although shipwrecks tend to concentrate in shallow, nearshore waters in all OCS regions, historic shipwrecks are scattered across the entire continental shelf, and many are found even in deepwater areas. Inundated prehistoric sites may occur on those portions of the continental shelf that were exposed as dry land during the period of lower sea levels of the last ice age. The extent of the continental shelf that was exposed varies from area to area; however, globally, sea levels were approximately 120 m (394 ft) lower than present approximately 21,000 to 19,000 years ago. Onshore historic properties include sites, structures, and objects such as historic buildings, forts, lighthouses, homesteads, cemeteries, and battlefields. Onshore prehistoric archaeological resources include sites, structures, and objects such as shell middens, earth middens, campsites, kill sites, tool manufacturing areas, ceremonial complexes, and earthworks.

Routine operations associated with the proposed action that may affect archaeological resources in all regions include drilling wells, installing platforms, installing pipelines, anchoring, and constructing onshore infrastructure. Impacts may range from negligible to major, depending on the significance and uniqueness of the affected resources and the number of resources affected. Existing Federal, State and local laws and regulations require that archaeological surveys be conducted prior to permitting any activity (onshore or offshore) that might disturb a significant archaeological site. Compliance with existing laws and regulations should protect archaeological resources to the maximum extent possible from most impacts associated with routine activities; however, it is still possible that some impacts could occur.

Should direct physical contact between a routine activity and a shipwreck site occur, it could destroy fragile ship remains and/or disturb the site context and result in major impacts associated with a loss of data on ship construction, cargo, and the social organization of the vessel's crew, as well as the concomitant loss of information on maritime culture for the time period from which the ship dates. Ferromagnetic debris associated with OCS operations could mask the magnetic signature of historic archaeological resources, making them difficult to detect with magnetometers. Interaction between a routine activity and a prehistoric archaeological site could destroy artifacts or site features and could disturb the stratigraphic context of the site.

Oil spills could affect coastal historic and prehistoric archaeological resources and could also result in minor to major impacts associated with the unavoidable loss of information and physical damage of oiled artifacts and sites. The level of this impact would depend on the significance and uniqueness of the information lost. Archaeological resource protection during an oil spill requires specific knowledge of the resource's location, condition, nature, and extent prior to impact; however, the coastal areas of the various OCS regions have not been systematically surveyed for sites. Existing information indicates that prehistoric sites in all regions occur frequently along the mainland coast and barrier islands and along the margins of estuaries, bays, and lagoons; thus, any spill that contacts these areas could involve a potential impact on a prehistoric site.

Alternative 8 – No Action

The evaluation of a No Action Alternative is required by the regulations implementing NEPA (40 CFR 1502.14(d)). If the Secretary were to adopt this alternative, it would halt OCS pre-sale planning, sales and new leasing from 2012 to 2017, even in the Central and Western GOM Planning Areas. However, exploration, development, and production operations stemming from past sales would continue and may possibly occur relatively sooner than may otherwise occur, given a no new sale decision.

This alternative would eliminate new leasing from mid-2012 through mid-2017, but affect OCS operations for up to 40–50 years. The amounts of OCS natural gas (up to 35 trillion cubic feet) and oil (up to 8.1 billion barrels of oil) that could help meet national energy needs would be forgone. That amount of energy would have to be replaced by a combination of imports, alternative energy sources, and conservation.

Market forces are expected to be the most important determinant of the substitute mix for OCS oil and gas. Key market substitutes for forgone OCS oil production would be imported oil, conservation, switching to gas, and onshore production. For OCS natural gas, the principal substitutes would be switching to oil, onshore production, imports, and conservation. This contributes to a greater potential for major effects in different OCS Planning Areas from oil spills from increased tankering. As a partial replacement for the forgone natural gas, increased reliance on coal, nuclear, hydroelectric, or wind-generated electric power is also expected. Other types of major impacts can occur with development of these energy substitutes to OCS oil and gas. For example, as in international offshore oil and gas extraction, catastrophic accidents can occur upstream in the energy chain. In other cases, there is potential for catastrophic accidents in downstream activities such as domestic power production (i.e., nuclear accident).

In addition to market-based substitutes, the nation or individual States might choose to encourage or even impose programs designed to deal with the energy shortfall. To replace oil, these programs might favor alternative vehicle fuels such as ethanol or methanol, vehicles with greater fuel efficiency, or alternate transportation methods such as mass transit. The government may give more emphasis to programs encouraging more efficient electricity transmission and more efficient use of gas and electricity in factories, offices, and home. Conservation and reduced demand are not expected to make up a substantial fraction of the energy demand or foregone OCS oil and gas production.

Conclusions

This PEIS is consistent with the requirements of the OCSLA (43 USC 1331 *et seq*.), NEPA (42 USC 4321), and CEQ regulations for implementing NEPA (40 CFR Part 1500). Scoping for preparation of the Draft PEIS and public commenting on the Draft PEIS were used to obtain input from stakeholders, including individuals, public interest organizations, and governmental agencies. This input was used to develop the alternatives and issues analyzed in this PEIS.

On the basis of the analyses in this PEIS, the types of impacts that could occur during routine Program activities would be similar among the action alternatives. The alternatives differ principally on the basis of where the impacts could occur and to what extent, which is directly related to the planning areas included in each alternative. Routine operations are expected to result in impacts that range from negligible to major, with most being short-term and recovering following completion of the routine activities. Accidental spills may also result in impacts that range from negligible to major depending on the nature of the spill and spill response. Although unexpected, the greatest effects would occur with a low-probability CDE, but the nature and magnitude of impacts would vary substantially and depend on the location, size, duration, and timing of the spill, the resources affected, and the effectiveness of the spill containment and cleanup activities.

The USDOI's procedures for implementing NEPA provide for adaptive strategies that allow for the refinement of an action during implementation, where appropriate (43 CFR 46.415). BOEM's process for implementing a 5-year Program through the various OCSLA stages represents an opportunity for adaptive management and more detailed treatment of both longstanding and developing concerns. The Secretary's decision to address size, timing, and location of potential lease sales is the initial step in a multi-year, deliberate process; the actual Program is subsequently materialized through numerous subsequent decisions on lease sales, geological and geophysical permits, exploration and development plans, and, ultimately, decommissioning plans.

BOEM is committing to several process enhancements to ensure effective tiering and make decisions more transparent during the phased OCSLA and tiered NEPA processes of this Program. Although specific approaches to implementation may be tailored to the different needs of the regions and their stakeholders, BOEM is determined to improve the process by:

- Committing to implementing an **alternative and mitigation tracking table** to track the receipt and treatment of alternative and mitigation suggestions starting with those received during preparation of the 5-year Program.

- Committing to **strengthening the pre-lease sale process** by taking a number of steps to enhance opportunities for members of the public to comment and provide new information in the pre-lease sale planning process.

- Committing to preparing an **annual progress report** of the 5-year Program voluntarily, expanding the requirement of Section 18(e) of the OCSLA.

- Committing to **systematic planning** opportunities that foster improved governmental coordination, communication, and information sharing.

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1 INTRODUCTION

1.1 BACKGROUND

Section 18 of the Outer Continental Shelf Lands Act (OCSLA) of 1953 (67 Stat. 462) as amended (43 USC 1331 *et seq.*) requires the U.S. Department of the Interior (USDOI) to prepare a 5-year schedule that specifies, as precisely as possible, the size, timing, and location of areas to be assessed for Federal offshore oil and gas leasing on the U.S. Outer Continental Shelf (OCS). The Federal action being evaluated is the preparation of this 5-year schedule. A schedule is needed to increase the predictability of sales in order to facilitate planning by industry, affected states, and the general public. This schedule is the 5-year program. The OCSLA also requires the 5-year program to be developed and maintained in a manner that is consistent with several management principles. Within the USDOI, the Bureau of Ocean Energy Management (BOEM or the Bureau) (formerly the Bureau of Ocean Energy Management, Regulation and Enforcement and prior to that, the Minerals Management Service) must manage the OCS oil and gas program to ensure a proper balance among oil and gas production, environmental protection, and impacts on the coastal zone. OCSLA defines the OCS as all submerged lands lying seaward of State coastal waters which are under U.S. jurisdiction. BOEM is organized into four regional offices, each of which is responsible for overseeing the safe and environmentally responsible development of traditional and renewable ocean energy and mineral resources in four OCS regions: Alaska, Pacific, Gulf of Mexico (GOM), and Atlantic — for a combined total of 1.7 billion acres of the OCS.

In recent years, the leasing of OCS oil and gas resources has been subject to suspensions of activities or moratoria. In 1982, Congress imposed a moratorium on oil and gas leasing for offshore California. Over the next decade, Congress expanded the moratorium to include almost all Atlantic and Pacific planning areas. From 1990 through 2000, an Executive Withdrawal enacted by President George H. Bush was in effect on a portion of the same OCS acreage subject to the 1982 congressional moratorium. Separate and apart from the congressional moratorium, the Executive Withdrawal served to independently limit offshore development. In 1998, President Clinton extended the Executive Withdrawal through 2012. On July 14, 2008, however, President George W. Bush lifted the OCS Executive Withdrawal. On August 1, 2008, the Minerals Management Service (MMS) issued a Request for Comments for the preparation of a new 5-year OCS leasing program to cover 2010 through 2015.

On January 21, 2009, a notice for Request for Comments on the Draft Proposed 5-Year OCS Oil and Gas Leasing Program for 2010-2015 and the Notice of Intent to Prepare an Environmental Impact Statement (EIS) for the Proposed 5-Year Program were published in the *Federal Register* (*Federal Register*, January 21, 2009, Volume 74, Number 12, pages 3631–3635). On February 10, 2009, the Secretary of the Interior extended the comment period by 180 days to September 21, 2009.

As a result of the comment period extension and the Bureau's reconsideration of existing policies and regulations in response to the Deepwater Horizon (DWH) event on April 20, 2010, the time period to be covered by the new program shifted from 2010-2015 to 2012-2017. The

January 2009 Draft Proposed Plan remains the first of three draft decisions for the program (now for 2012-2017) that will replace the existing 2007-2012 program. However, in response to comments and other considerations, the Secretary has reduced the scope of the 5-year EIS to exclude several planning areas that were originally included in the Draft Proposed Plan decision.

On April 2, 2010, the Bureau issued a Notice of Intent (NOI) to prepare an EIS with respect to the OCS Oil and Gas Leasing Program for 2012-2017 (hereafter referred to as "the Program") and requested comments for the purpose of determining the scope of the EIS. The updated strategy limited lease sales to the following planning areas: Beaufort Sea, Chukchi Sea, Cook Inlet, the Central and Western GOM, and the area of the Eastern GOM excluded from Congressional moratoria (see Figure 1-1). The NOI also announced that scoping meetings would be held during June and early July 2010 in coastal States bordering the Mid- and South Atlantic; Western, Central, and the portion of the Eastern GOM; and at several locations in Alaska. Subsequently, on June 30, 2010, the Secretary announced that the scoping meetings were postponed until later in 2010 because of the need for BOEM to focus on reviewing and evaluating safety and environmental requirements of offshore drilling in response to the DWH event and that a new public comment period would later be announced. On December 1, 2010, the Secretary announced an updated oil and gas leasing strategy for the OCS. The Secretary engaged in the balancing mandated by Section 18 of OCSLA and decided to proceed with caution and to focus on leasing in areas with current active leases, therefore, the Mid- and South Atlantic Planning Areas were no longer considered for potential sales and development through 2017, nor was the area in the Eastern GOM that remains under a congressional moratorium. Accordingly, scoping meetings were not held in these areas. It was also announced that the Western GOM, Central GOM, and the Cook Inlet, Chukchi Sea, and Beaufort Sea areas offshore Alaska would continue to be considered for potential leasing in the Program.

Congress, in its yearly appropriations to the USDOI, continues to maintain an annual moratorium on OCS oil and gas leasing in the Eastern GOM Planning Area with the exception of a small area along the boundary between the Central and Eastern Planning Areas that was excluded from the moratorium by the GOM Energy Security Act of 2006. Additionally, Presidential moratoria have withdrawn all national marine sanctuaries from leasing through June 30, 2017 (Hagerty 2011). On March 31, 2011, President Obama, under the authority of Section 12(a) of the OCSLA, withdrew the Bristol Bay area of the North Aleutian Basin for consideration of leasing through June 30, 2017. The Congressional and Presidential moratoria prohibit future oil and gas leasing but do not apply to existing leases. Although there are current leases in the Pacific region, no new OCS leasing will take place in the Pacific region under the Program.

BOEM has prepared this programmatic environmental impact statement (PEIS) to assess the environmental, social, and economic impacts associated with the Program. The following Federal, State, and local agencies are serving as cooperating agencies on the development of the PEIS, due to their special expertise:

- U.S. Department of Commerce National Oceanic and Atmospheric Administration (NOAA)

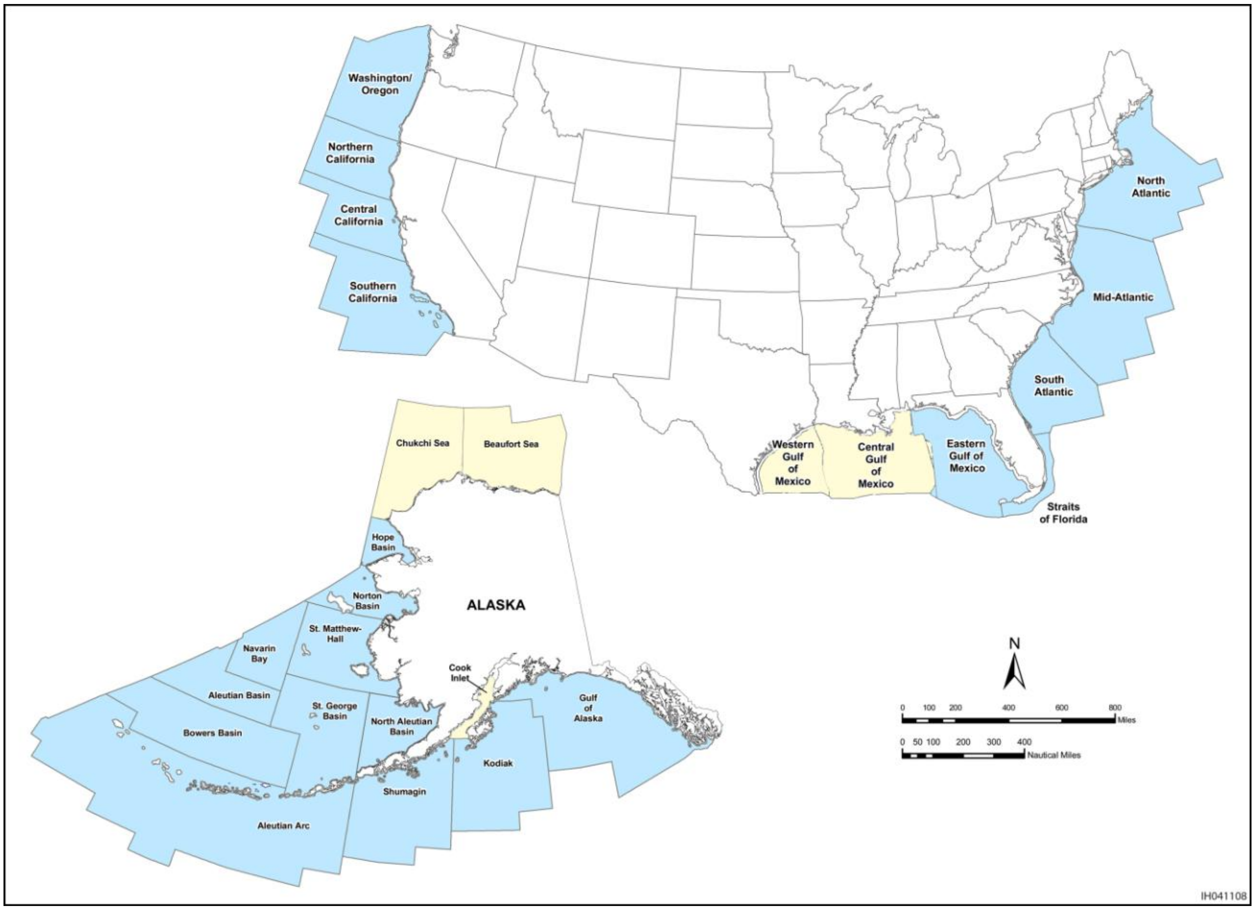

FIGURE 1-1 OCS Planning Areas (planning areas being considered for the Program are shown in yellow)[1]

- The State of Alaska
- Alaska North Slope Borough

The Program is scheduled to begin in September 2012. The Program consists of a national schedule of potential OCS lease sales within 6 of the 26 OCS Planning Areas (Figure 1-1). The Program will be the eighth such program prepared since Congress amended the OCSLA in 1988. The Program establishes a framework for managing the OCS oil and gas leasing in a manner that accounts for all of the factors required by OCSLA. It also provides the public with a clear statement of the USDOI's OCS leasing intentions during the period from 2012 to 2017.

1 The two whaling deferrals in the Beaufort Sea and the 40-km (25-mi) coastal deferral in the Chukchi Sea Planning Areas included in the 2012-2017 Arctic program area are not visible at this map scale. These deferral areas are shown in Figure 2-3).

1.2 PURPOSE OF AND NEED FOR ACTION

The purpose of and need for preparing a schedule of potential OCS oil and gas lease sales is to "best meet national energy needs for the 5-year period following its approval" (43 USC 1344) by balancing the potential for environmental harm, the potential for the discovery of oil and gas, and the potential for adverse impact on the coastal zone. In developing the 5-year leasing schedule, BOEM considers regional and national energy needs; leasing interests as expressed by possible oil and gas producers; applicable laws, goals, and policies of affected States, local governments, and tribes; competing uses of the OCS; relative environmental sensitivity and marine productivity among OCS regions; public input; and the equitable sharing of benefits and risks among stakeholders.

Energy use in the United States is expected to continue to increase from present levels through 2035 and beyond (EIA 2011). For example, the U.S. consumption of crude oil and petroleum products has been projected to increase from about 19.1 million barrels (Mbbl) per day in 2010 to about 21.9 Mbbl per day in 2035 (EIA 2011). Oil and gas reserves in the OCS represent significant sources that currently help meet U.S. energy demands and are expected to continue to do so in the future. The benefits of producing oil and natural gas from the OCS include not only helping to meet this national energy need, but also generating money for public use. In 2009, the OCS produced 2.5 trillion cubic feet (Tcf) of natural gas and more than 590 Mbbl of oil and condensate. These numbers represent 10 and 30%, respectively, of the total U.S. domestic production of oil/condensate and natural gas in 2009. The Federal Government has received, on average, more than $10 billion per year between 2000 and 2010 from OCS bonuses, rental payments, and royalties. The highest revenues per year occurred in 2008, when the government received $23.3 billion in total revenues.

1.3 OVERSIGHT OF OCS OIL AND GAS ACTIVITIES

On October 1, 2011, the USDOI established two new, independent bureaus: Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE). These agencies are collectively responsible for offshore energy management and safety and environmental oversight missions formerly under the jurisdiction of the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE). The establishment of BOEM and BSEE marked the completion of the reorganization of the former Minerals Management Service (MMS).

BOEM is responsible for managing environmentally and economically responsible development of the nation's offshore energy and mineral resources. Principal functions include offshore leasing, resource evaluation, review and administration of oil and gas exploration and development plans, renewable energy development, marine mineral development, environmental assessment, and environmental studies. BOEM's regulations related to offshore oil and gas operations are in 30 CFR Parts 550, 551, 552 and 556.

BSEE is responsible for safety and environmental oversight of offshore oil and gas operations, including permitting and inspections of offshore oil and gas operations. Principal functions include the development and enforcement of safety and environmental regulations, permitting offshore exploration, development and production, inspections, offshore regulatory programs, oil spill response, and newly formed training and environmental compliance programs. BSEE's regulations related to offshore oil and gas operations are in 30 CFR Parts 250 and 254.

1.4 ENVIRONMENTAL REVIEW UNDER NEPA

Section 18 of the OCSLA directs the USDOI to conduct environmental studies and prepare any EIS required in accordance with the OCSLA and with Section 102(2)(C) of the National Environmental Policy Act of 1969 (NEPA) (42 USC 4332(2)(C)). Under NEPA, Federal agencies are required to prepare a "detailed statement for major Federal actions significantly affecting the quality of the human environment" (NEPA 102(2)). The preparation of this PEIS is also consistent with the Council on Environmental Quality (CEQ) regulations (40 CFR 1502.4(b)), which state that "environmental impact statements may be prepared and are sometimes required for broad Federal actions such as the adoption of new agency programs or regulations (Section 1508.18). Agencies shall prepare statements on broad actions so that they are relevant to policy and are timed to coincide with meaningful points in agency planning and decision making." The preparation of this PEIS is consistent with, and meets the requirements of OCSLA, CEQ's regulations for implementing NEPA, and USDOI's regulations implementing NEPA (43 CFR 46).

The OCSLA leasing and development process consists of four major stages. The Secretary first prepares a nationwide 5-year oil and gas leasing program that establishes a schedule of lease sales. Thereafter, individual lease sales scheduled in the 5-year program are held following a series of pre-lease planning actions. Once a lease is issued to an OCS lessee, an Exploration Plan (EP) must be submitted for approval before an operator may begin exploratory drilling on a lease. The EP establishes how the operator will explore the lease and includes all exploration activities, the timing of these activities, information concerning drilling, the location of each well, and other relevant information. If the lessee discovers oil and/or natural gas, a Development and Production Plan (DPP) must be submitted for agency approval. This DPP includes how many wells, where these wells will be located, what type of structure will be used, and how the operator will transport the oil and natural gas. The OCSLA also requires operators to apply for permission prior to drilling wells, pursuant to an EP or, in most areas, a DPP.

In this phased process, the final PEIS may, through tiering, greatly assist subsequent lease sale-specific analyses by allowing incorporation of relevant portions of the final PEIS into those later analyses and NEPA documents. Tiering is defined by the CEQ (40 CFR 1508.28) as "the coverage of general matters in broader environmental impact statements (such as national program or policy statements) with subsequent narrower statements or environmental analyses (such as regional or basin-wide program statements or ultimately site-specific statements) incorporating by reference the general discussions and concentrating solely on issues specific to the statement subsequently prepared."

When a broad NEPA document such as a PEIS or environmental assessment (EA) has been prepared, any subsequent site-specific assessment or evaluation can summarize (and include by reference) the issues discussed in the broader document, and thus the site-specific assessment can focus its analyses on project-specific issues of the particular proposed action (40 CFR 1502.20). Following selection of the Program, subsequent lease sale-specific NEPA analyses and documentation may tier off the PEIS for the Program.

This PEIS is the first of many NEPA analyses that will be done for the activities that occur as a result of the Program. The NEPA assessments, including EISs and EAs associated with various stages of OCS oil and gas development, are shown in Table 1-1 and Figure 1-2.

1.4.1 Scope of the PEIS

This PEIS was prepared to evaluate the potential environmental impacts of alternatives for OCS oil and gas leasing under the Program, and presents those impacts in a comparative manner that provides a clear basis for making a reasoned choice among the alternatives by the decision-maker. The analyses and evaluations in this PEIS are intended to inform decisions on the size, timing, and location of leasing activity that will be made to create the schedule of lease sales for the Program (43 USC 1344). The OCSLA requires that, for potential leasing to occur in a specific planning area during the applicable 5-year OCS oil and gas leasing program, the specific planning area in which the lease sale would be held must be included in the approved 5-year program. Pursuant to the OCSLA (43 USC 1344(e)), the Secretary must review the leasing program approved at least once each year.

Portions of planning areas can be deferred from leasing during any 5-year oil and gas program because of the presence of sensitive environmental resources, space-use conflicts, or other reasons. The USDOI can also cancel or restrict the area offered in a lease sale based on information, events, and other conditions that arise during any 5-year oil and gas program. Examples of the exercise of this authority occurred during the 2007-2012 Oil and Gas Leasing Program (the Program) when the single sales scheduled in the North Aleutian Basin and offshore Virginia were cancelled in 2010.

At the programmatic stage, considering the full planning area provides for the broadest and most extensive analysis in order to support the balancing of different considerations — including social, economic, and environmental issues. Because leasing of portions of planning areas (subareas) can be deferred during a 5-year leasing program, the USDOI is maintaining flexibility in fulfilling its OCSLA mandate to provide for both the nation's energy needs and protect the marine and coastal environment by including in the Program the total area of all 6 OCS Planning Areas (except for the three specified Arctic deferrals) that were decided upon by the Secretary. If conditions changed during the Program as a result of new information, technologies, or other developments that mitigated the issues responsible for the deferral of a subarea, it would not be possible to offer the subarea for leasing during the existing Program if it were not included in the Program at the outset. There are some exceptions to the approach described above for the 5-year program; for example, the two subsistence deferrals in the Beaufort Sea and the 25-mi no-leasing buffer in the Chukchi Sea have been deferred in past lease

TABLE 1-1 NEPA Assessments Conducted within the OCS Oil and Gas Leasing Program

Program Level	Program Stage	NEPA Analysis[a]	Geographic Scope	Focus and Scope
Planning	Program	Programmatic EIS	Continental	Identification of program areas and number and schedule of lease sales for the Program
	Lease sale	Lease sale EIS or EA	Planning area	Identification of potential impacts and mitigation measures
Project[b]	Exploration Production Decommissioning	CER, EA, or EIS CER, EA, or EIS CER, EA, or EIS	Lease block(s) Portion of lease block Specific facility within a lease block	Application and enforcement of mitigation measures; monitoring of mitigation effectiveness

[a] CER = categorical exclusion review; EA = environmental assessment; EIS = environmental impact statement.

[b] The level of NEPA review at the project level is determined by the complexity of the project, risk factors associated with the project, whether the project occurs in a frontier or mature OCS area, the technologies being used for the project, and other factors.

sales and have subsequently been incorporated into past 5-year programs. These deferrals (described in detail in Chapter 2 of this PEIS) will be included in the proposed action for the current 5-year leasing program.

The detailed information and fine geographic scale needed to evaluate block-by-block deferrals or other mitigations in a specific planning area are not typically available or appropriate for the PEIS, which needs to adopt a broad geographical scale for its national coverage. Decisions about exclusions and mitigations can be premature at the programmatic stage when the focus is the development of a leasing program that identifies how many sales will be included in the program, where to have the sales, and when to schedule the sales. During the NEPA process, many stakeholders encouraged BOEM to include additional deferrals or equivalent mitigation in this Program. BOEM has considered the numerous deferral and mitigation recommendations in Section 4.3.2 to begin the process of developing mitigation strategies for the 2012-2017 OCS Program. This section includes a discussion of the process BOEM will use during the Program to ensure that these suggestions are evaluated, when appropriate and as warranted.

The PEIS informs these decisions by identifying areas, environmental resources, and types of OCS activities that, acting together, suggest the potential for important interactions between environmental resources and OCS-related activities that could result in significant impacts. In this way, the PEIS identifies the broad issues that will likely require more focused

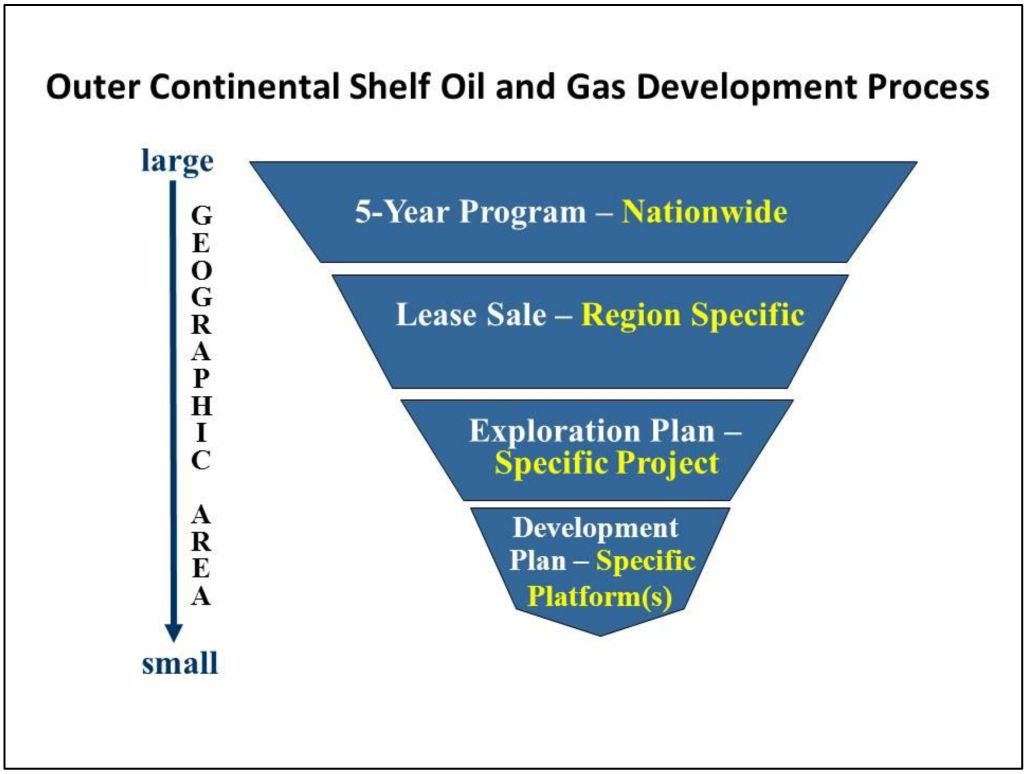

FIGURE 1-2 The Outer Continental Shelf Oil and Gas Development Process

and fine-scale evaluations in subsequent NEPA assessments, leading to the possible development and application of mitigations, should leasing and development actually occur.

1.4.2 Incomplete and Unavailable Information

CEQ regulations require an agency to obtain, or explain why it cannot obtain, relevant information about reasonably foreseeable significant adverse impacts that is essential to a reasoned choice among the alternatives presented in an EIS (40 CFR 1502.22). This PEIS provides the level of NEPA analysis corresponding to the first stage of the Program. The PEIS sets forth alternatives for the Secretary to consider and analyzes issues of programmatic concern, which pertain to the Program as a whole.

Programmatic-level analyses and decisions do not require the same detailed analysis that may be necessary at a later stage in the OCS leasing process. Lease sale-specific issues, such as determining which stipulations should apply to a lease sale, are not ripe for analysis at the programmatic stage. Resolving uncertainty related to significant adverse effects on some resources, such as that surrounding global climate change impacts in the Arctic or the potential environmental baseline change brought about by the DWH event in the GOM, is not essential at this programmatic stage. In the instances of missing resource-specific information noted in the PEIS, BOEM has determined that the information was not essential to the Secretary’s choice among alternatives at this broad, programmatic decision point because the Secretary is only establishing a schedule of potential lease sales. The Secretary retains the discretion to delay and cancel lease sales that are part of an approved program, but the Secretary will not have the discretion to add program areas that are not included in the Program without program re-approval. It would be imprudent to foreclose program areas at this time based on uncertainty due to incomplete and unavailable information. Over the course of the Program, information relevant to decision making may become available before the decision maker is actually in the position to decide whether to hold a specific lease sale.

This PEIS presents the information necessary for the Secretary to make a general planning decision, which will be implemented in the future through a series of subsequent, planning area-specific decisions that authorize lease sales and OCS exploration and development activities. To the degree possible, the PEIS uses scientifically credible information and uses accepted scientific methods to make reasoned judgments and arrive at reasoned conclusions. Moreover, some missing information, such as definitive information about baseline changes to resources in the GOM resulting from the DWH event, will not be available in a time frame relevant to timely fulfillment of the OCSLA statutory mandate to establish a program every five years.

1.4.3 Public Involvement

As previously discussed, the development of the Program includes preparation of this PEIS which, in accordance with NEPA, analyzes the potential effects of the adoption of a schedule of proposed lease sales that identifies the size, timing, and location of proposed leasing activity. NEPA requires draft and final versions of a PEIS to be published, fostering public involvement through two public involvement opportunities: the scoping public comment period prior to the preparation and publication of the Draft PEIS and the Draft PEIS public comment period prior to the preparation and publication of the Final PEIS.

The content of a Draft PEIS is based on a process called "scoping." The regulations implementing NEPA require that scoping be included in the environmental analysis process (40 CFR 1501.7). Scoping for the Draft PEIS included several key elements: (1) gathering information and ideas from the public and elsewhere about the analytical issues related to the Program; (2) making determinations about which issues should be analyzed; and (3) identifying alternatives to the proposal that warranted analysis. The scoping process is dynamic in that it begins before the PEIS analyses are initiated and continues throughout the period of document preparation.

In January 2009, the previous Administration published a Draft Proposed Program and a NOI to prepare an EIS that set out a schedule for scoping meetings in the areas of the Draft Proposed Program. In February 2009, the Secretary of the Interior extended the comment period on the Draft Proposed Program and postponed the scoping meetings to allow time to consider further public comment before determining which areas in the Draft Proposed Program should be scoped and analyzed for consideration in the subsequent program proposals. A preliminary revised program for 2012-2017 was proposed on March 31, 2010, and on April 2, 2010, an NOI to prepare and scope the 2012-2017 OCS Oil and Gas Leasing Program PEIS was published in the *Federal Register* (75 FR 16828). That NOI invited the public to provide comments on the scope and content of the PEIS and identified as many as 14 locations where public scoping meetings could be held to obtain comments.

On June 30th, 2010, Secretary of the Interior Salazar announced that the public scoping meetings would be postponed in response to the DWH event. The additional time would be used to evaluate safety and environmental requirements of offshore drilling. On December 1, 2010, Secretary Salazar announced an updated oil and gas strategy for the OCS. The new strategy continued a moratorium for areas in the Eastern GOM (Figure 1-2) and eliminated the Mid-Atlantic and South Atlantic Planning Areas from consideration for potential sales and development through the 2017 planning horizon. The Western GOM, Central GOM, Eastern GOM (only a very small portion thereof), Cook Inlet, Chukchi Sea, and Beaufort Sea OCS Planning Areas (Figure 1-1) would continue to be considered in the PEIS. Subsequently, on January 4, 2011, a Notice of Scoping Meetings for the proposed 2012-2017 OCS Oil and Gas Leasing Program PEIS was published in the *Federal Register* (76 FR 376) and a second scoping period was conducted from January 6, 2011, through March 31, 2011. During this scoping period, public scoping meetings were held for 12 locations in Alaska, Texas, Louisiana, Alabama, and Washington, D.C. In addition, BOEM received comments through the mail and maintained a public website to accept electronic scoping comments.

Recent EISs and EAs for GOM and Alaska OCS oil and gas lease sales provided additional scoping information. Many of the analytical issues raised during the lease sale review process are applicable to this PEIS for the proposed Program. Subject matter experts at BOEM also identified analytical issues relevant to the PEIS analyses. In addition, alternatives developed for past leasing program proposals were reviewed to determine whether it would be appropriate to analyze any of them in detail in this PEIS.

On November 10, 2011, a Notice of Availability (NOA) for the public release of the Draft PEIS was published in the *Federal Register*. The notice announced a 60-day public comment period from November 10, 2011, until January 9, 2012. During this Draft PEIS public comment period, public hearings were held for 13 locations in Alaska, Texas, Louisiana, Alabama, and Washington, D.C. In addition, BOEM received comments through the mail and maintained a public website to accept electronic comments. All comments received during the public comment period were impartially considered and given equal weight by BOEM. Section 8.4.4 of this Final PEIS presents the responses to these comments prepared by BOEM.

Through all of the above public commenting opportunities, the following major issues were identified for consideration in preparing the PEIS:

- Oil and gas activities that could cause impacts (termed “impact-producing factors”);

- Ecological resources that could be affected by oil and gas activities;

- Social, cultural, and economic resources that could be affected by oil and gas activities;
- Human health;
- Climate change;
- Regulatory oversight, regulatory and industry reforms, and safety; and
- Oil spills.

In addition, comments received through the NEPA process provided suggestions for alternatives to be considered in the PEIS. These suggestions fell into the following major categories:

- Prohibiting leasing and development in one or more planning areas;
- Limiting leasing and development to specific areas on the OCS (e.g., no deep water);
- Including more OCS planning areas than the six identified in the proposed action;
- Developing new, or expanding existing, deferral areas; and
- Developing alternative energy sources to replace oil and gas.

The alternatives evaluated in this PEIS, as well as those considered but removed from further consideration, are discussed in Chapter 2 of this PEIS.

For analytical purposes only, this PEIS considers mitigation and other protective (see Appendix B: Assumed Mitigation and Other Protective Measures) measures already established and required by existing statutes or regulations, as well as sale-specific measures (stipulations) that were commonly adopted in past sales and that would likely be implemented for any lease sales that would occur under the Program. However, it is at the lease sale stage that more detailed and geographically focused analyses are conducted to evaluate the magnitude of potential impacts and, if needed, to develop effective mitigation strategies to reduce the magnitude of those potential impacts to acceptable levels. Therefore, the impact analyses presented in this PEIS assume implementation of mitigation and other protective measures that are required by statute or regulation as well as sale-specific mitigation measures (stipulations) commonly adopted in past sales (see Appendix B). This PEIS also assumes that existing mitigations and other protective measures in areas with currently active leases, such as the GOM and parts of Alaska, will be applied to areas included in the Program that do not have a history of OCS activity. However, this PEIS does not adopt or apply any mitigation or other protective measures because this is done during Program implementation, including the lease sale, exploration plan, and development plan phases.

1.5 ANALYTICAL ISSUES

A number of analytical issues, many of which are addressed in this PEIS, were identified during the NEPA process. These include the geographic scope of the PEIS, the analytical scope of the PEIS, the impacting factors to be considered in the analyses, and the resources that may be affected by the Program. These analytical issues are discussed below.

1.5.1 Geographic Scope

There are 26 planning areas on the OCS, and six of these have been identified for leasing consideration as part of the Program (Figure 1-1). Twenty planning areas located along the Atlantic, Pacific, Florida, and Alaska coasts are neither part of the proposed action nor analyzed in any alternative considered in this PEIS.

1.5.2 Analytic Scope

The analyses conducted in preparation of this PEIS were based on current, available, and credible scientific data. Interpretation of these scientific data was used to evaluate direct, indirect, and cumulative impacts associated with the proposed action and alternatives. Throughout this PEIS, Alternative 1 (referred to herein as the proposed action) is used as the default scenario on which to base analysis of potential impacts. This does not mean that Alternative 1 has already been chosen as the operative alternative for the Program. Rather, the proposed action includes the largest geographic scope of any of the alternatives contemplated, so using it to analyze impacts results in the most all-inclusive analysis possible, compared to the other alternatives presented. The proposed action is the alternative that has the potential to cause the greatest geographic range of impacts, with each of the other alternatives representing, in effect, a subset of the proposed action. Therefore, using the proposed action as the basis for analysis provides the most complete and meaningful assessment of potential impacts.

As a programmatic evaluation, this PEIS does not evaluate site-specific issues that would be associated with specific lease sales in specific planning areas. As previously discussed, a variety of location-specific factors (such as water depth, sea floor topography, distance from shore, ecological communities, and the presence of threatened and endangered species and cultural resources) may vary considerably, not only between planning areas but also among lease sale blocks within individual planning areas. In addition, variations in project design and study (including the seismic survey approach and technology selected) will influence and/or determine the nature and magnitude of impacts that might occur with a given lease sale. The combined effect of these location-specific and project-specific factors cannot be fully anticipated or addressed in a programmatic analysis, and can only be evaluated at the lease-sale or finer level.

1.5.3 Impact-Producing Factors

Several types of impact-producing factors were identified that warrant consideration. All of the following impact-producing factors are included in the exploration and development scenarios for the proposed action presented in Section 4.4, and are evaluated as applicable in the resource-specific impact evaluations presented elsewhere in Chapter 4. In addition, the cumulative impact analysis includes activities unrelated to OCS activities but relevant to assessing cumulative impacts (Section 4.6). The impact-producing factors related to OCS exploration and development that were identified include:

- Accidental oil spills including those from loss of well control, production accidents, transportation failures (e.g., from tankers, other vessels, seafloor and onshore pipelines, and storage facilities), and low-level spillage from platforms.

- The offshore and onshore disposal of liquid wastes, including well drilling fluids (i.e., drill muds), produced water, ballast water, and sanitary and domestic wastewater generated by OCS-related activities.

- Solid waste disposal, including material removed from the well borehole (i.e., drill cuttings), solids produced with the oil and gas (e.g., sands), cement residue, bentonite, and trash and debris (e.g., equipment or tools) accidentally lost, including those that contain materials such as mercury that may bioaccumulate.

- Gaseous emissions from offshore and onshore facilities and transportation vessels and aircraft.

- Noise from seismic surveys, ship and aircraft traffic, drilling and production operations, and explosive platform removals.

- Invasive species whose introduction may be facilitated by activities associated with the construction of offshore facilities or with the movement of materials and equipment by way of transportation systems.

- Physical impacts from ship and aircraft traffic and use conflicts with oil tankers and barges, supply/support vessels and aircraft, and seismic survey vessels and aircraft.

- Physical emplacement, presence, and removal of facilities, including offshore platforms; seafloor pipelines; floating production, storage, and offloading systems; onshore infrastructure such as pipelines, storage, processing, and repair facilities; ports; pipe coating yards; refineries; and petrochemical plants.

- Other activities including oil spill response (cleanup), including both response and recovery under extreme sea and ice conditions.

- Interaction of oil and gas industry workers and local residents, including interaction associated with the employment of local residents.

In addition to the activities that may result from the proposed action, the PEIS considers natural processes and phenomena that could cause indirect impacts by affecting the safe conduct of OCS oil and gas exploration, production, and transportation activities, or the environmental conditions under which these activities occur. These include geologic hazards such as earthquakes and continental slumping; gas hydrates; physical oceanographic processes such as water currents, sea ice, and waves; subsea permafrost; shoreline erosion; and meteorological and climatic events and processes such as hurricanes and climate change, including global warming and ocean acidification. The PEIS also considers space-use conflicts with military operations in designated offshore military areas and potential future alternative uses of the OCS, including the program for alternative energy development and production and alternate use of offshore facilities. It also considers the effects of the Program on the introduction of invasive species into U.S. waters.

This PEIS gives particular attention to the issue of climate change, based on the observed changes that have been occurring during the past several decades, particularly in the Arctic environments in Alaska. Chapter 3 presents a discussion of climate change and baseline conditions (Section 3.3), while many of the subsequent resource-specific discussions of the affected environment include discussions of the effects of ongoing, observable climate changes for those resources. Additional analyses are included in the cumulative analysis (Section 4.6) in which the impacts of the continuing trend in climate change during the life of the proposed action are evaluated along with all other factors affecting a particular resource.

1.5.4 Potentially Affected Resources

This PEIS evaluates resources that may potentially be impacted by oil and gas leasing and development under the Program. The resources evaluated include not only natural resources (physical and biological) but social, cultural, and economic resources as well. The natural resources and topics evaluated in this PEIS are as follows:

- *Water Quality (including marine and estuarine areas)*. The water quality issues are related primarily to marine water quality and how changes in water quality caused by OCS activities could affect biological resources (for example, by potentially contributing to the GOM hypoxia zone).

- *Air Quality*. The principal concern is the transport of offshore emissions to onshore areas leading to potential violations of Federal and State air quality standards intended for the protection of human health and welfare.

- *Biologic Resources*. Primary concerns are related to habitat disturbance or loss (including designated critical habitats, pursuant to the Endangered Species Act of 1973 (ESA), and habitat areas of particular concern, pursuant to the Magnuson-Stevens Act), direct physical impacts on biota, and disturbance of normal behaviors (feeding, courtship, migration) by OCS-related activities.

- *Socioeconomic and Sociocultural Resources.* Socioeconomic and sociocultural resources included potential impacts on tourism, recreation, commercial fishing, subsistence harvests, aesthetics, local economy, land and water use conflicts, equitable sharing of program benefits and burdens, disproportionate impacts on Louisiana, and disproportionate impacts on Alaska Natives.

The issues we examine in this PEIS regarding possible impacts on biology and ecology fall into three main categories: animals, plants, and habitats or ecological systems. Among the animal groups identified as needing analysis for potential program impacts were marine mammals, birds, fish, and sea turtles. Special attention was drawn to migratory species, species taken commercially and for Alaska Native subsistence (including whales, fish, and birds), and threatened and endangered species. With respect to habitats or systems, both marine (e.g., sanctuaries, marine parks/preserves, seagrasses, mangroves, and "hard bottom" areas) and coastal (e.g., estuaries, wetlands/marsh, intertidal zone, seashore parks) areas were identified as subject to possible adverse impacts. The issue of bioaccumulation is also discussed in this PEIS.

The specific biological and ecological resources analyzed in detail are:

- Marine mammals, including a variety of endangered and nonendangered cetaceans (e.g., whales, dolphins, etc.), pinnipeds (seals, sea lions, walruses), sirenians (manatees), sea otters, and polar bears.

- Terrestrial mammals, including caribou and grizzly/brown bear in Alaska, and five species of federally listed mice and voles that inhabit certain coastal areas of the GOM.

- Birds, including a variety of endangered and nonendangered seabird, shorebird, waterfowl, and raptor species. Particular concern was identified for migratory species, including those taken by Alaska Native for subsistence.

- Fish, including a variety of finfish and shellfish species used for commercial, subsistence, or recreational purposes. Particular concern was identified regarding chronic pollution from polycyclic aromatic hydrocarbons. Particular concern was also identified for salmon in Alaska.

- Reptiles, including sea turtles.

- Coastal habitats, including wetlands, estuaries, seagrass and kelp beds, mangroves, dunes, beaches, and barrier islands.

- Lower trophic level organisms and food chains.

- Open water habitats, such as *Sargassum* mats.

- Seafloor habitats, including submarine canyons, topographic features, corals, live bottom areas (benthic environments), and seeps (e.g., brine and oil seeps).

- Areas of Special Concern, including coastal and marine sanctuaries, parks, refuges, reserves, sanctuaries, and forests. Particular concern was raised in regard to "essential fish habitat" as designated by the U.S. Department of Commerce (USDOC) National Marine Fisheries Service (NMFS).

Specific concerns regarding social, cultural, and economic resources included potential impacts on tourism, recreation, commercial and recreational fishing, subsistence harvests, aesthetics, local economy (especially the "boom/bust" phenomenon), land and water use conflicts, equitable sharing of program benefits and burdens, and disproportionate impacts to certain populations. The social, cultural, and economic topics analyzed in this PEIS are as follows:

- Population, employment, income, and public service issues from the effects of the Program, including issues of "boom/bust" economic cycles.

- Land use and infrastructure, including construction of new onshore facilities, and land use and transportation conflicts between the oil and gas development and other uses.

- Sociocultural systems effects were primarily identified with respect to Alaska. These include concerns about the effects on subsistence (e.g., bowhead whale hunting), loss of cultural identity, psychological health of people, and social costs of lease sales and oil spills.

- Environmental justice (e.g., the potential for disproportionate and high adverse impacts on minority and/or low-income populations [Executive Order 12898]).

- Commercial, subsistence, and recreational fisheries.

- Tourism and recreation, including the use of coastal areas for sightseeing, wildlife observations, swimming, diving, surfing, sunbathing, hunting, fishing, and boating, as well as visual impacts of offshore OCS structures.

- Archaeological resources, including historic shipwrecks and surface or subsurface sites that had been inhabited by humans during prehistoric times.

1.5.5 Issues Not Analyzed in This PEIS

The following discussions address issues identified during the NEPA process that were not analyzed in this PEIS. These issues include concerns about affected resources or analytical techniques employed in the PEIS.

1.5.5.1 Worker Safety

Generally, concerns mentioned regarding worker safety risks from OCS oil and gas development were broad and not defined during scoping. The issue of worker safety is appropriately addressed in BOEM's regulations. The OCSLA and the implementing regulations require that all drilling and production operations use the best available and safest technologies. A principal reason for this requirement is to minimize the adverse effect of OCS operations on human safety. BOEM considers whether a proposed project would be conducted in a manner that conforms to the many specific requirements developed to protect worker safety during the review of proposals to conduct lease operations. Worker safety considerations, are not, however, necessary for, or appropriate to, the determination of the size, timing, and location of leasing activity in the Program and therefore are not addressed in this PEIS.

1.5.5.2 Proposed Seismic Inventory

Many comments were received through the public involvement process on the issue of the Federal Government conducting seismic surveys to identify potential OCS oil and gas resources. Industry must hold leases before it commits to very expensive exploration drilling activities. Generally, industries, States, and individuals supportive of OCS petroleum development favored holding leases before industry commits to exploration activities, and those against OCS development opposed it. Those in favor argued that it was prescribed in duly enacted law, it would support national energy planning, and it would provide information relevant to the equitable sharing of the benefits and burdens of the OCS leasing program. Those against oil and gas leasing and development on the OCS argued that it would subvert previous laws and policies (e.g., coastal zone management and Congressional moratoria), it might not comply with all NEPA requirements, and it might create pressure to develop areas that are currently under Congressional moratoria and Presidential withdrawals. The procedures under which a seismic inventory for all of the oil and gas resources on the OCS might be conducted are not yet established and are, therefore, unrelated to the Program and not addressed in this PEIS.

1.5.5.3 Neighboring Countries Drilling on OCS Border with the United States

It was suggested that the United States should lease selected tracts on the OCS in order to protect U.S. mineral rights in border areas. The issue of foreign governments exploring and developing petroleum resources in their territorial waters is unrelated to the Program and is, therefore, not addressed by this PEIS.

1.5.5.4 Endangered Species Act Section 7 Consultations for Threatened and Endangered Species

Section 7(a)(2) of the ESA (16 USC 1536(a)(12)) requires each Federal agency, in consultation with and with the assistance of the Secretary of the Interior and the Secretary of Commerce, to ensure that any action it authorizes, funds, or carries out in the United States or upon the high seas is not likely to jeopardize the continued existence of any listed species or result in destruction or adverse modification of critical habitat. The regulations at 50 CFR 402.02 defines "action" as "all activities or programs of any kind authorized, funded, or carried out in whole or in part." Preparing the Program does not fit the definition of a Federal action because no OCS activities are being "authorized, funded, or carried out" at this Program level. Therefore, ESA Section 7 consultations (whether informal or formal) at the 5-year programmatic stage are premature. Instead, decision options for the leasing program are preserved for the Secretary at the time the decision is made for each sale. Therefore, it is at the lease sale stage that BOEM begins ESA Section 7 consultation.

In further support of the position not to consult at the 5-year programmatic stage, the U.S. Fish and Wildlife Service (USFWS) and NMFS, in their final rulemaking establishing procedural regulations for Section 7 consultations (51 FR 19926), clarified that informal and formal consultations are a "post-application process when applicants are involved." BOEM would therefore not approach this stage until the lease sale level or for any pre- or off-lease permits that may be requested. Further, BOEM believes the intent of Congress when passing the ESA was to exclude consultations on actions that are remote or speculative in nature. While the following quote addresses ESA Section 7 early consultations (a pre-application process defined in the above-referenced *Federal Register* notice), we believe it clearly expresses Congress' intent and is consistent with our position.

> "The Committee expects that the Secretary will exclude from such early consultation those actions which are remote or speculative in nature and to include only those actions which the applicant can demonstrate are likely to occur. [. . .] The Committee further expects that the guidelines will require the prospective applicant to provide sufficient information describing the project, its location, and the scope of activities associated with it to enable the Secretary to carry out a meaningful consultation." (H.R. Rep. No. 567, 97th Cong., 2nd Sess. 25 [1982])

Ultimately, decisions regarding the size and configuration of a lease sale area, lease stipulations, and some mitigation measures are determined by the presale process. Prior to the presale process, greater uncertainties exist. Some of the uncertainties may result from an industry firm's interest in a particular area and its willingness to bid, which depend, in part, on continually changing perceptions about potential benefits that might result. Limitations on predicting a firm's investment decisions also limit the ability to predict OCS activities. With so much uncertainty at this programmatic stage, ESA consultation would be premature.

1.5.5.5 Life Cycle Effects of Oil and Gas Development

A recommendation was made that the PEIS address all reasonable effects of new oil and gas development, production, and consumption. Such "full cycle" effects would include oil and gas exploration, construction and placement of infrastructure, continued drilling, production, processing, treatment, refining, transportation and storage, final decommissioning, and ultimate consumption of the finished product. Additionally, addressing the contribution of OCS development and OCS oil and gas consumption activities to climate change was stressed.

The scope of the proposed action analyzed in this PEIS encompasses the exploration, development, production, and transport of crude oil, and decommissioning. The consumption of the refined oil is not considered because the scope of this PEIS is limited to issues that have a bearing on the decisions for the proposed leasing program. The determination of the size, timing, and location of lease activity does not require USDOI to consider the impact of consuming oil and gas extracted under an offshore leasing program. USDOI's obligations extend to assessing the relative impacts of production and extraction of OCS oil and gas on the localized areas where such activities occur. But, OCSLA does not require USDOI to consider the environmental impact of post-exploration activities such as consuming fossil fuels on either the world at large, or the derivative impact of global fossil fuel consumption on OCS areas.

1.5.5.6 Resource Estimates and Impact Analyses

A concern was expressed that conclusions for environmental impacts should not be linked only to the potential for undiscovered economically recoverable hydrocarbon resources in a given planning area. It was suggested that low oil and natural resource estimates, and subsequent low probabilities of commercial finds, could erroneously be equated with insignificant environmental impacts. The PEIS does not assume that the potential for oil and gas resources dictates impact significance. The PEIS assesses the potential impacts of exploration, production, transporting crude oil and gas, and decommissioning on environmental resources, including the potential impacts of a large oil spill, of the proposed action and alternatives, regardless of the oil or gas resource estimate in a planning area. The analytical conclusions reflect the likely impacts of routine activities, as well as those that could occur in the event a large spill contacted environmental resources. The estimated number of large spills that could occur is a function of the assumptions regarding anticipated (future) production. Therefore, impacts could be greater on some environmental resources in one planning area because they could be exposed to relatively more large spills than other environmental resources in a different planning area, characterized by lesser oil potential. If exploration fails to identify oil and gas projects that are commercially feasible, then no development would occur and the only impacts will be associated with exploration activities.

A suggestion was made that the analysis of relative marine productivity should not be limited to a measure of the primary productivity. This measure is used because it is well documented and understood. However, we agree that it should not be the only factor used; therefore, BOEM uses other information as well in its consideration of the productivity of marine environments.

A suggestion was made in the Alaska region that BOEM use development scenarios that reflect the concerns of affected communities rather than such industry-related factors as water depth and proximity to existing infrastructure. As is the intent of CEQ guidance, our development scenarios are constructed to identify those events that are most likely to happen to better focus the analysis of future activities. However, we address the concerns of affected communities in the analyses of such topics as possible impacts on species and on subsistence.

1.6 ORGANIZATION OF THIS PEIS

This PEIS is organized as follows:

- Chapter 1 provides background information, identifies the purpose and need for the action, and discusses scoping and analytical issues.

- Chapter 2 describes the alternatives evaluated in the PEIS, identifies alternatives considered but not evaluated in the PEIS, summarizes the cost-benefit analysis prepared in support of the 5-year program, and presents a summary comparison of the environmental impacts of the alternatives.

- Chapter 3 provides an overview of the marine and coastal ecoregions where oil and gas development under the Program may occur and presents descriptions of the physical, natural, cultural, and economic resources or conditions that may potentially be affected by the proposed action and other alternatives.

- Chapter 4 describes the impact-producing factors associated with routine operations under each phase of OCS oil and gas development, discusses accidental events and spills, describes the impact analysis approach of the PEIS, and defines impact levels. This chapter also discusses the relationship of the physical environment to oil and gas development and identifies issues of programmatic concern, including deferrals and mitigation. Finally, Chapter 4 presents the exploration and development scenarios, as well as the accidental oil spill scenarios, assumed for this PEIS; discusses the potential impacts of these scenarios for each alternative; and discusses the potential cumulative impacts of the alternatives.

- Chapter 5 identifies the unavoidable adverse impacts associated with the alternatives.

- Chapter 6 discusses the relationship between short-term use of the environment and long-term productivity.

- Chapter 7 discusses the significant irreversible and irretrievable commitments of natural and man-made resources.

- Chapter 8 discusses the process used for preparing the Program and the list of agencies, organizations, governments, and individuals that received the PEIS. Chapter 8 also includes Draft PEIS public comments and responses.

- Chapter 9 lists the names, education, and experience of the persons who helped to prepare the PEIS. Also included are the subject areas for which each person was responsible.

- Appendix A presents a glossary of terms used throughout this PEIS.

- Appendix B identifies the mitigation and other protective measures that are required by existing statutes or regulations, as well as sale-specific measures (stipulations) that were commonly adopted in past sales and that are assumed will be implemented for any lease sales that would occur under the Program.

- Appendix C identifies Federal laws and Executive Orders that would apply to leasing under the Program.

1.7 REFERENCES

EIA (U.S. Energy Information Administration), 2011, *Annual Energy Outlook 2011*, Office of Integrated and International Energy Analysis, Washington, D.C.

Hagerty, C.L., 2011, *Outer Continental Shelf Moratoria on Oil and Gas Development*, CRS Report to Congress, 7-5700, R41132, Congressional Research Service, Washington, D.C., May 6.

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2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

The Notice of Intent (NOI) for this programmatic environmental impact statement (PEIS), which was published on April 2, 2010 (75 CFR Part 63: 16828–16829), identified eight Outer Continental Shelf (OCS) planning areas for possible inclusion in the 2012-2017 OCS Oil and Gas Leasing Program (the Program), but identified no specific lease sale alternatives. The eight planning areas identified in that NOI were as follows:

- The Beaufort Sea, Chukchi Sea, and Cook Inlet Planning Areas in Alaska.
- The Western, Central, and Eastern Gulf of Mexico (GOM) Planning Areas, with the latter focusing on a small area along the western boundary of this planning area.
- The South and Mid-Atlantic Planning Areas.

Subsequently, on December 1, 2010, the Secretary of the Interior announced an updated oil and gas leasing strategy for the OCS (FR Notice; FR Doc. 2010–33149). Consistent with the Secretary's direction to proceed with caution and focus leasing in areas with currently active leases, the area in the Eastern GOM Planning Area, which remains under a Congressional moratorium except for the area not restricted from leasing and development per the Gulf of Mexico Energy Security Act of 2006, and the South and Mid-Atlantic Planning Areas were dropped from consideration for potential sales and development through 2017, and thus are no longer under consideration in this PEIS.

The following six OCS planning areas are considered in this PEIS:

- The Beaufort Sea, Chukchi Sea, and Cook Inlet Planning Areas in Alaska.
- The Western, Central, and Eastern GOM Planning Areas, with the latter focusing only on a small area along the western boundary of this planning area.

This PEIS analyzes eight alternatives for the leasing of Federal offshore lands by the U.S. Department of the Interior (USDOI), Bureau of Ocean Energy Management (BOEM), under the Program.

The PEIS analyses assume the implementation of all mitigation and other protective measures required by statute, regulation, or standard lease stipulations. All BOEM sale proposals must account for rules and regulations prescribing environmental controls applicable to lease operators. Lease stipulations, OCS regulations, and other measures provide a regulatory base for implementing environmental protection on leases issued as a result of a sale. The BOEM Environmental Studies Program and the analyses and monitoring of activities in a sale area provide information used in formulating the Agency's regulatory control over the activities that occur during the life of the leases. This PEIS also assumes that the Bureau of Safety and

Environmental Enforcement (BSEE, formerly part of BOEMRE (see Chapter 1), will continue to use its broad permitting, monitoring, and enforcement authority to ensure safe operations and environmental protection, including use of the best available and safest technologies and requiring existing mitigations. The PEIS assumes that BSEE will continue to monitor operations after drilling has begun and will carry out periodic inspections of facilities (in certain instances, in conjunction with other Federal Agencies such as the U.S. Environmental Protection Agency [USEPA]) to ensure safe and clean operations over the life of the leases. The seven action alternatives (Alternatives 1 through 7) listed below are not mutually exclusive, and the Secretary has the discretion to combine alternatives or elements of different alternatives (43 CFR 46.420(c)). These alternatives include the following:

- Alternative 1 – Proposed Action

Under the proposed action, there would be as many as 15 lease sales distributed among the six OCS planning areas (Figure 2-1), including 12 sales in the GOM and three sales in Alaska. The GOM sales include five annual sales in each of the Central and Western Planning Areas and up to two sales in a small area of the Eastern GOM Planning Area that includes 83 lease blocks being considered for this Program (Figure 2-2). The Alaska sales would occur late in the Program and include one sale in each of the Beaufort Sea and Chukchi Sea Planning Areas (Figure 2-3) and one sale in the Cook Inlet Planning Area (Figure 2-4).

Neither the proposed action nor any alternative to the proposed action includes consideration of leasing in the Pacific or Atlantic OCS regions. The OCS Planning Areas included in the proposed action are shown in Figure 2-1. All the other action alternatives, i.e., Alternatives 2 through 7, are the same as the proposed action, except as specified below. Any of these action alternatives, or elements thereof, can be combined at the Secretary's discretion.

- Alternative 2 – Exclude the Eastern GOM Planning Area for the duration of the Program

- Alternative 3 – Exclude the Western GOM Planning Area for the duration of the Program

- Alternative 4 – Exclude the Central GOM Planning Area for the duration of the Program

- Alternative 5– Exclude the Beaufort Sea Planning Area for the duration of the Program

- Alternative 6 – Exclude the Chukchi Sea Planning Area for the duration of the Program

- Alternative 7 – Exclude the Cook Inlet Planning Area for the duration of the Program

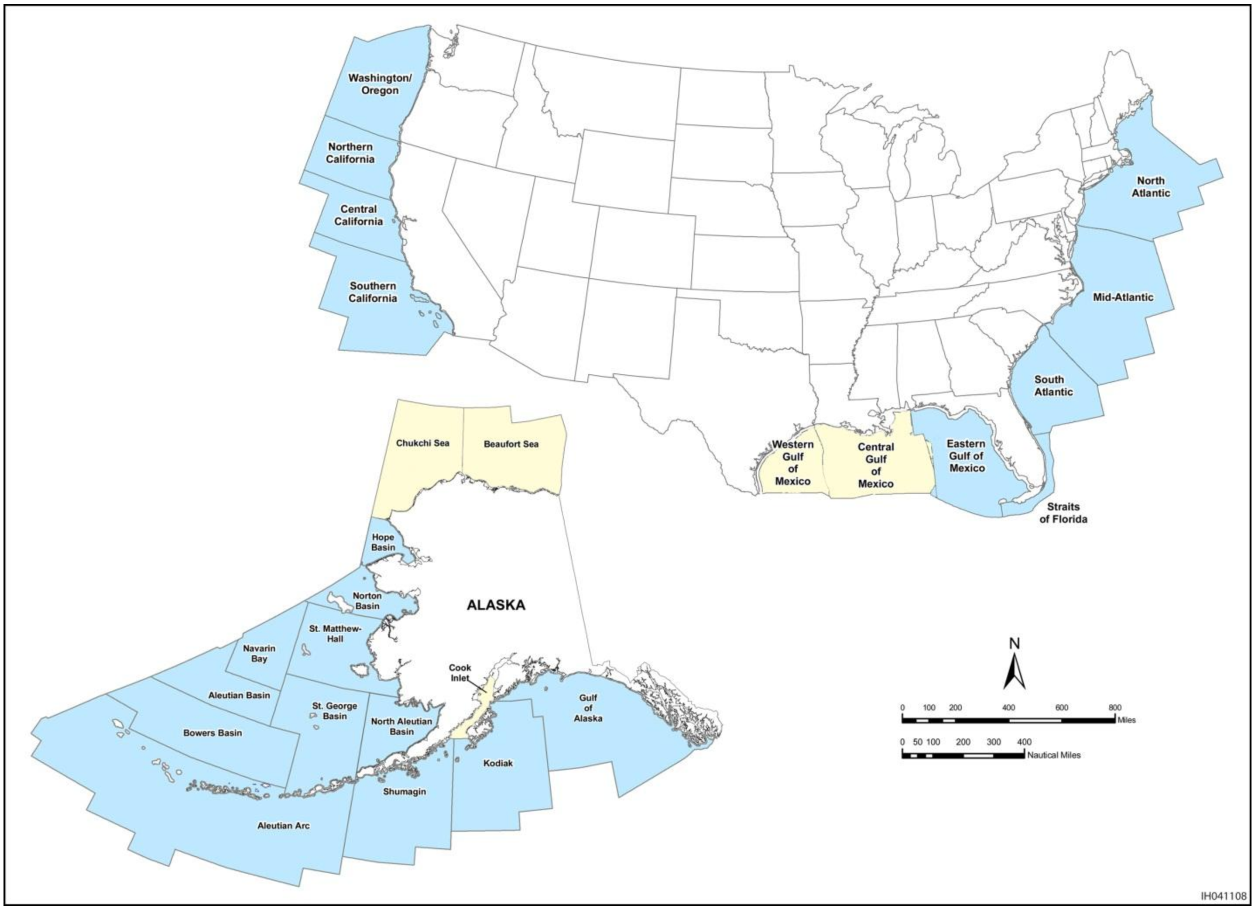

FIGURE 2-1 OCS Planning Areas — Planning Areas in Yellow Are under Consideration for Inclusion in the 2012-2017 OCS Oil and Gas Leasing Program[1]

- Alternative 8 – No Action

This chapter describes each alternative and summarizes the potential environmental impacts of the alternatives in comparative form. The summary describes the primary impacts based on the detailed analysis of all potential impacts presented in Chapter 4, Environmental Consequences. The impact analyses presented in this PEIS were generated from exploration, development, transportation, and oil spill scenarios developed specifically for analytical purposes. See Sections 4.4.1, 4.4.2, and 4.6.1 for more information on the analytical scenarios used in this PEIS.

1 The two whaling deferrals in the Beaufort Sea and the 40-km (25-mile) coastal deferral in the Chukchi Sea Planning Areas that are included in the 2012-2017 Arctic program area are not visible at this map scale. These deferral areas are shown in Figure 2-3.

FIGURE 2-2 Gulf of Mexico Planning Areas Where Leasing for Oil and Gas Development May Occur under the 2012-2017 OCS Leasing Program

2.1 ALTERNATIVE 1 – PROPOSED ACTION

The four OCS regions are divided into 26 OCS Planning Areas (Figure 2-1), and under the proposed action, leasing is considered in two of the four BOEM OCS regions: GOM and Alaska. Within the GOM OCS region, leasing is being considered in the Central and Western GOM Planning Areas, and in a small extreme western portion of the Eastern GOM Planning Area (Figure 2-2). Because of the small portion of the Eastern GOM Planning Area under consideration for the program, which contains only 83 of the nearly 11,000 lease blocks in the Eastern GOM Planning Area, and because of the relatively small amount of production that might occur in these blocks, the exploration and development and the oil spill scenarios identified for both one and two sales in the Eastern GOM are analytically identical. Therefore, the impact analysis for a proposed action that includes two eastern GOM sales would also apply to a proposed action that included only a single sale. In addition, the USDOI is considering leasing in three of the 15 Alaska OCS planning areas: the Beaufort Sea and Chukchi Sea Planning Areas (Figure 2-3), and the Cook Inlet Planning Area (Figure 2-4). The later scheduling of the potential sales in the Beaufort Sea, Chukchi Sea, and Cook Inlet Planning Areas represents a strategic approach to leasing in Alaska and is structured to allow time for further work in critical areas such as further scientific study and environmental assessment, further information collection on the geologic conditions and resource potential in the area through exploration under existing leases, and further development of oil spill response preparedness and infrastructure capabilities. During Program implementation, this will also

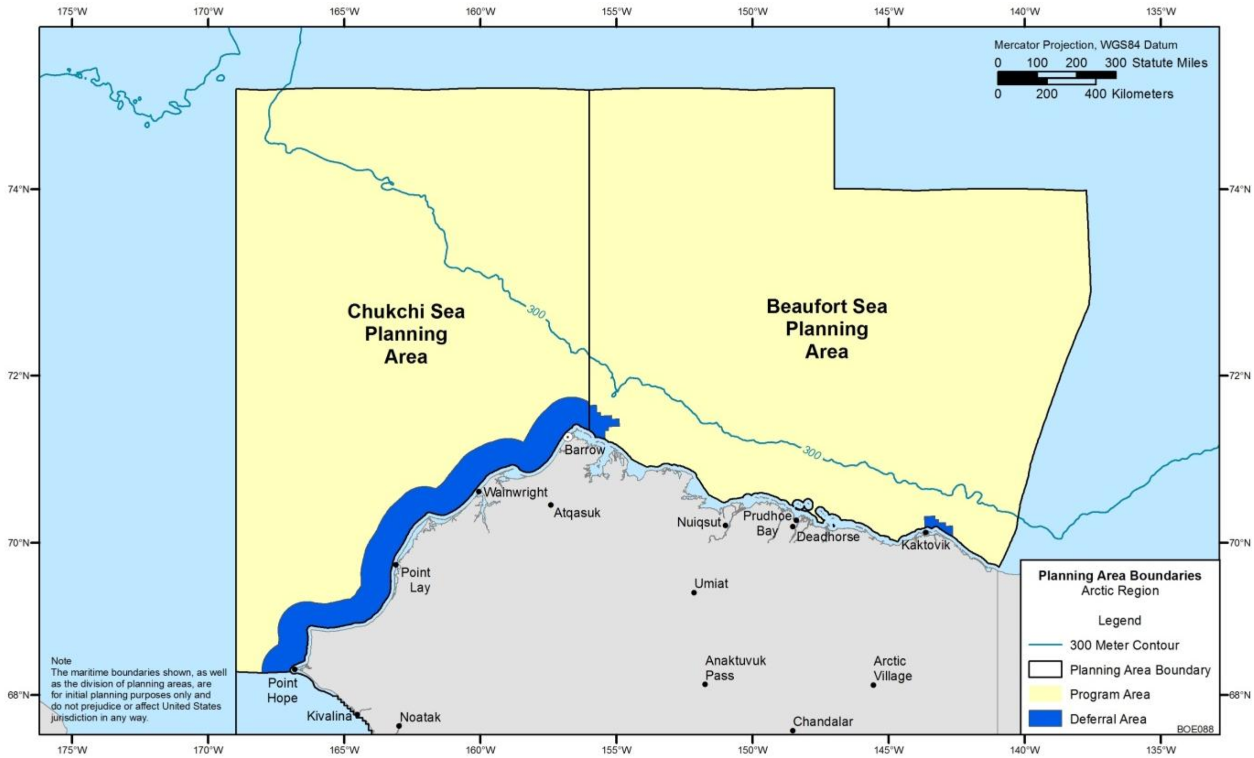

FIGURE 2-3 Arctic Region Beaufort Sea and Chukchi Sea Planning Areas Where Leasing for Oil and Gas Development May Occur under the 2012-2017 OCS Leasing Program

allow the Secretary of the Interior to develop a more focused vision for leasing in the Arctic. No other OCS Planning Areas are analyzed in this PEIS because the USDOI is not considering those areas for leasing under the Program. The proposed action is the USDOI's preferred alternative.

Specifically, the proposed action calls for 15 lease sales under the Program:

- Western Gulf of Mexico Planning Area — five area-wide lease sales; one sale annually beginning in 2012.

- Central Gulf of Mexico Planning Area — five area-wide lease sales; one sale annually beginning in 2013.

- Eastern Gulf of Mexico Planning Area — one to two lease sales in the extreme western portion of the planning area; one sale in 2014 and one sale in 2016.

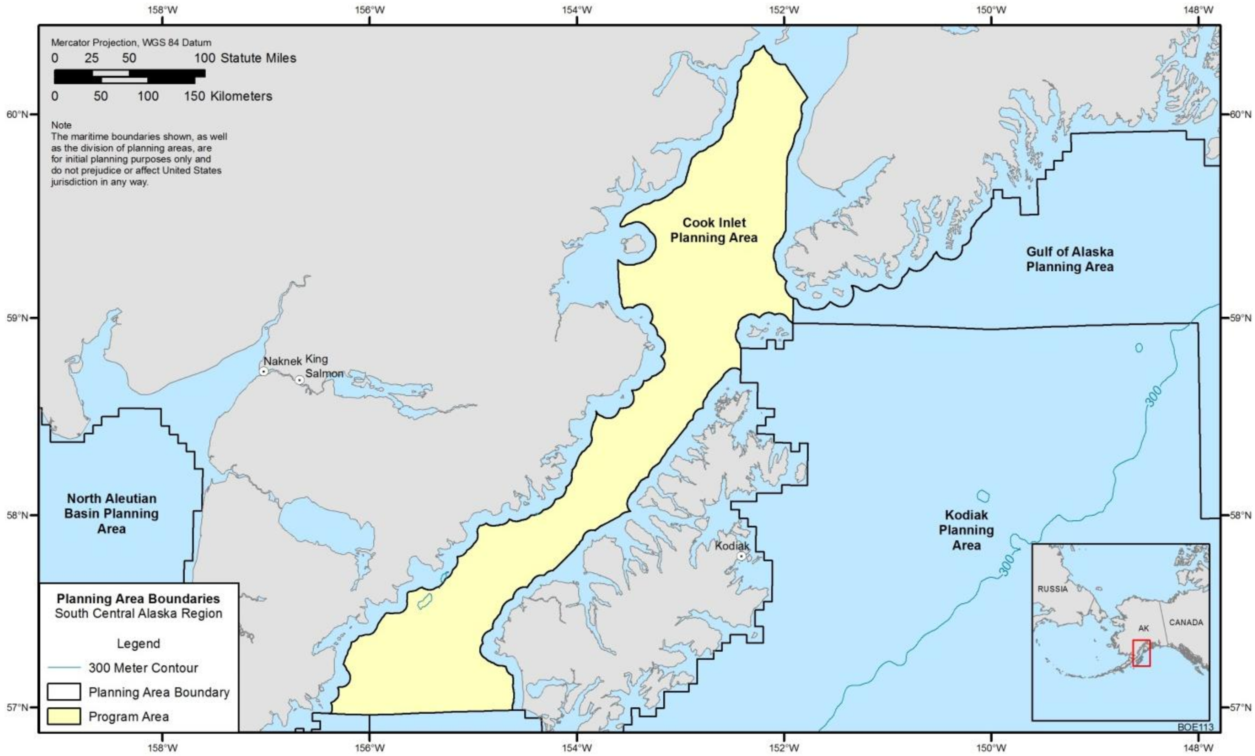

FIGURE 2-4 Cook Inlet Planning Area Where Leasing for Oil and Gas Development May Occur under the 2012-2017 OCS Leasing Program

- Cook Inlet Planning Area — one sale in 2016.[2]
- Beaufort Sea Planning Area — one sale in 2017 that excludes two bowhead whaling areas (Figure 2-3):
  - The excluded Barrow Subsistence Whaling area is 49 whole or partial blocks located at the western border of the planning area
  - The excluded Kaktovik Subsistence Whaling area is 28 whole or partial blocks located offshore of Kaktovik.
- Chukchi Sea Planning Area — one sale in 2016 with a 40 km (25 mi) coastal buffer exclusion (Figure 2-3).

[2] The Cook Inlet Planning Area is included in the Proposed Final Program as a special interest sale. On March 27, 2012, BOEM issued a request for interest in the *Federal Register* (77 FR 18260) to determine the level of industry interest in a possible Sale 244 in 2013 in the Cook Inlet Planning Area, whether focused on a few blocks or prospects, or on a larger portion of the Program area. The comment period closed on May 12, 2012. BOEM has considered the level of industry interest and other issues and concerns reflected in comments and has decided to proceed with the pre-sale process to consider initially the entire planning area. The sale date has been moved to 2016 to allow time to conduct all the steps necessary to hold a sale, meeting the various requirements under the Act, NEPA, and other appropriate statutes.

Activities that could occur as a result of the 15 lease sales under the proposed action may extend over a period of 40–50 years. The impact-producing factors associated with these activities include the placement, use, and decommissioning of offshore infrastructure such as rigs, platforms, and pipelines, and the expansion or construction of, and use of onshore facilities such as support bases and processing plants, and these impacting factors apply to activities in any of the planning areas that are part of the proposed action and alternatives considered in this PEIS.

Chapter 4, Environmental Consequences (Sections 4.4.1, 4.4.2, and 4.6.1), presents the basic assumptions about anticipated production, exploration, development, transportation, and accidental oil spills used to prepare the PEIS. The scenarios help define the location, timing, and scope of possible exploration and development that are expected to result from the suite of lease sales proposed. For example, potential exploration and development is expected to occur on the shallow shelf (within the 300-m [984-ft] depth contour) in the vicinity of historical leasing interest and not in relatively deep waters of the Arctic (Figure 2-3). The specific estimates of offshore infrastructure required to support exploration and development of the hydrocarbon resources (scenarios) associated with Alternative 1 (the proposed action) are provided in Tables 4.4.1-1, 4.4.1-3, and 4.4.1-4 in Section 4.4.1 of this PEIS. Impacting factors and activity-specific impacts are discussed in additional detail in Section 4.1, and in the resource-specific impact discussions presented elsewhere in Chapter 4 of this PEIS.

Transportation for most oil and gas from the GOM planning areas would be accomplished by extending and expanding the existing offshore pipeline systems. Some of the oil in deepwater areas and a small amount of the oil from the nearshore areas of the GOM Planning Areas would be transported by barge or shuttle tanker.

In the Alaska OCS region, the temporary lifting of the export ban on Alaskan crude oil has led to infrequent and limited shipments to East Asia. However, the vast majority of oil transported via the Trans-Alaska Pipeline System (TAPS) has been sent to the U.S. West Coast. Oil from the Beaufort Sea and Chukchi Sea Planning Areas would be transported by new subsea and overland pipelines to the TAPS and delivered to the marine terminal facilities in Valdez, where it would be loaded on tankers and shipped primarily to West Coast ports. Natural gas development and production is not expected to begin for at least a decade in the Arctic. A new gas export system (likely to be a large diameter overland pipe) would need to be built and installed before gas production could begin. Gas would be transported by new subsea and overland pipelines that would be constructed through the same corridor as the new oil pipelines. The offshore pipelines would be trenched into the seafloor as a protective measure against damage by submerged ice ridges (ice keels). A second new pipeline would be required to transport gas from shore to a main transportation hub near Prudhoe Bay. Oil and gas from the Cook Inlet Planning Area would be transported to shore using new subsea pipelines, with new onshore common-carrier pipeline systems delivering the oil to existing refineries in Nikiski and gas to transmission facilities in the Kenai area.

2.2 ALTERNATIVE 2 – EXCLUDE THE EASTERN GOM PLANNING AREA FOR THE DURATION OF THE PROGRAM

Under Alternative 2, the Program would not include new leasing in the Eastern GOM Planning Area. This alternative includes 13 lease sales, with the same number of sales in other planning areas and the same exploration and development and oil spill scenarios as identified for the proposed action. The potentially available resources in the Eastern GOM Planning Area available for leasing are estimated to include no more than 0.1 billion barrels (Bbbl) of oil and 0.2 trillion cubic feet (Tcf) of natural gas.

2.3 ALTERNATIVE 3 – EXCLUDE THE WESTERN GOM PLANNING AREA FOR THE DURATION OF THE PROGRAM

Alternative 3 has no lease sales occurring in the Western GOM Planning Area, with the resultant Program having 10 lease sales. The potentially available resources in the Western GOM Planning Area include up to 1.0 Bbbl of oil and 4.6 Tcf of natural gas.

2.4 ALTERNATIVE 4 – EXCLUDE THE CENTRAL GOM PLANNING AREA FOR THE DURATION OF THE PROGRAM

Under this alternative, there would be no lease sales in the Central GOM Planning Area, and only 10 lease sales under the Program. The potentially available resources in the Central GOM Planning Area include as much as 4.3 Bbbl of oil and 19.1 Tcf of natural gas.

2.5 ALTERNATIVE 5 – EXCLUDE THE BEAUFORT SEA PLANNING AREA FOR THE DURATION OF THE PROGRAM

Alternative 5 includes a total of 14 lease sales in all OCS Planning Areas identified for the proposed action except for the Beaufort Sea Planning Area. Under this alternative, OCS oil and gas leasing under the Program and any subsequent exploration and development in the Arctic region would occur only in the Chukchi Sea Planning Area (except in the deferred area). The potentially available resources in the Beaufort Sea Planning Area that would not be made available under this alternative include as much as 0.4 Bbbl of oil and as much as 2.2 Tcf of natural gas.

2.6 ALTERNATIVE 6 – EXCLUDE THE CHUKCHI SEA PLANNING AREA FOR THE DURATION OF THE PROGRAM

Under Alternative 6, there would be a total of 14 lease sales held under the Program in all OCS Planning Areas included in the proposed action except for the Chukchi Sea Planning Area. Under this alternative, OCS oil and gas leasing under the Program and any subsequent exploration and development in the Arctic region would occur only in the Beaufort Sea Planning

Area (except in the deferred areas). The potentially available resources in the Chukchi Sea Planning Area that would not be made available under this alternative include as much as 2.1 Bbbl of oil and as much as 8.0 Tcf of natural gas.

2.7 ALTERNATIVE 7 – EXCLUDE THE COOK INLET PLANNING AREA FOR THE DURATION OF THE 2012-2017 PROGRAM

Under Alternative 7, no sales would be held in the Cook Inlet Planning Area, resulting in 14 sales in the Program. Under this alternative, OCS oil and gas leasing under the Program and any subsequent exploration and development in the Alaska region would occur only in the Beaufort Sea and Chukchi Sea Planning Areas, except in the deferred areas. The potentially available resources in the Cook Inlet Planning Area that would not be made available under this alternative include as much as 0.1–0.2 Bbbl of oil and as much as 0.7 Tcf of natural gas.

2.8 ALTERNATIVE 8 – NO ACTION

Alternative 8 is the No Action Alternative. Under this alternative, there would be no lease sales conducted under the Program in any OCS Planning Areas. As much as 8.2 Bbbl of oil and 35 Tcf of natural gas would not be available under this alternative. Energy substitutes are discussed in Section 4.5.7.

2.9 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM FURTHER PROGRAMMATIC EVALUATION

Pursuant to the National Environmental Policy Act (NEPA), BOEM conducted two public scoping periods (one extending from April 2, 2010, through June 30, 2010, and another from January 6, 2011, through March 31, 2011) and a Draft PEIS public comment period (extending from November 10, 2011, through January 9, 2012) to solicit comments for the purpose of developing and finalizing this PEIS (see Chapter 1). Comments received through these commenting opportunities were used to identify issues to be addressed and to provide input into the development of the alternatives considered in this PEIS. Additional alternatives suggested through the public commenting opportunities that differ from Alternatives 1–8 above include:

- Expand the oil and gas leasing program to include more or all OCS Planning Areas beyond those identified in the NOI.
- Hold multiple sales in some OCS Planning Areas.
- Delay sales until further data regarding oil spill response, drilling safety, and baseline conditions are collected and analyzed for the Arctic and GOM areas.

- Develop alternative/renewable energy sources as a complete or partial substitute for oil and gas leasing on the OCS.

- Add spatial exclusions and temporal deferrals, such as no leasing in parts of planning areas and seasonally limiting activity in other parts of planning areas.

- Reduce the lease sale sizes to smaller than area-wide (less than full planning areas).

- Defer deepwater leasing in the GOM planning areas.

These alternatives were considered but eliminated from further evaluation in this PEIS for a variety of reasons, and each alternative is discussed separately below. As discussed in Section 4.3.2, many suggested alternatives are more appropriate for consideration at later phases of 5-year Program implementation, such as the lease sale phase. Section 4.3.2 identifies the range of alternatives, deferrals, and mitigations suggested during the NEPA process and discusses how these suggestions will get carried through to later phases of the Program and addressed in subsequent NEPA documents.

2.9.1 Expand the Oil and Gas Leasing Program to Include More or All OCS Planning Areas

Under discretionary authority conferred by Section 18 of OCSLA, the Secretary of the Interior hosted regional public meetings in Atlantic City, NJ, New Orleans, LA, Anchorage, AK, and San Francisco, CA, in April 2009 to gather information and public comment to help build a comprehensive energy strategy for the OCS. Invited to each of these meetings were regional governors, elected Federal officials, private citizens, interested organizations, energy producers, advocacy groups, and local governments. Using the information that was collected from these meetings, and from the extended comment period, the Secretary decided which planning areas to include.

The alternatives considered in this PEIS (excluding the No Action Alternative) include oil and gas leasing in as many as 6 of the 26 OCS Planning Areas (Figure 2-1). Alternatives that include more OCS Planning Areas (either adding selected individual areas such as the Atlantic Planning Areas, or including all 26 OCS Planning Areas) were not considered in this PEIS for several reasons.

Most of the Eastern GOM Planning Area, as well as areas of the Central GOM Planning Area within 161 km (100 mi) of the Florida coast, are restricted from leasing and development until 2022 as a result of the Gulf of Mexico Energy Security Act of 2006. In Alaska, Bristol Bay in the North Aleutian Basin Planning Area was withdrawn, by the President, on March 31, 2010, from leasing consideration through June 30, 2017, pursuant to Section 12 of OCSLA. As a matter of caution, in the aftermath of the Deepwater Horizon (DWH) event, in April 2010, the Secretary of the Interior announced, on December 1, 2010, a narrowing of the scope of the PEIS by removing the South and Mid-Atlantic Planning Areas from consideration for potential sales and development through 2017. Because of these moratoria and removals, expansion of the Program to all planning areas is not possible, and expanding it to planning areas other than those considered in this PEIS is not feasible without further postponement of the Program. Also, inclusion of all OCS Planning Areas would have been inconsistent with the December 1, 2010, direction of the Secretary of the Interior to focus the scope of the PEIS on leasing in areas with current active leases. Many of the 26 OCS Planning Areas do not currently have active leases or substantial interest from industry, and were thus not considered for inclusion in the Program, or for evaluation in this PEIS.

2.9.2 Hold Multiple Lease Sales in Some OCS Planning Areas

The proposed action identifies 15 lease sales in six planning areas: five sales each in the Western and Central GOM Planning Areas, two sales in the Eastern GOM Planning Area, and one each in the Cook Inlet, Beaufort Sea, and Chukchi Sea Planning Areas. Alternatives with additional sales, such as having more than two sales in the Eastern GOM Planning Area or more than one sale in each of the Alaska Planning Areas, would be inconsistent with the Secretary of the Interior's Program announced on December 1, 2010, of an updated oil and gas leasing strategy for the OCS that would focus on leasing in areas with currently active leases and an existing knowledge base and proceed with caution. The Secretary decided on this strategy after consideration of various Section 18 factors (as outlined in the Proposed Final Program document that is being published concurrently with this PEIS), such as laws, goals, and policies of adjacent states; the level of knowledge or lack thereof concerning the potential for recoverable oil and gas resources, and the environmental and other relevant information needed to make informed decisions. Holding one sale in each planning area is more consistent with a cautionary approach in the Arctic.

2.9.3 Delay Sales until Further Evaluation of Oil Spill Response, Drilling Safety Reform, and Baseline Environmental Conditions Is Complete

Following the DWH event, there has been considerable activity by not only BOEM but also other Federal and State agencies with regard to the adequacy of past oil spill response plans and drilling safety, as well as the development of new approaches for spill response and increasing drilling safety. USDOI has raised standards for offshore drilling safety and environmental protection in order to reduce the risk of another loss of well control in our oceans and improve our collective ability to respond to a blowout and spill. USDOI and other agencies across the Federal Government remain focused on these issues and are expected to maintain this focus throughout the duration of the Program and in the future. Moreover, BOEM continues to closely analyze environmental conditions in the GOM in light of the DWH event, and will continue to update analysis as new information becomes available. BOEM will continue to integrate new information — including analysis of the effects of changes in regulation, notices to lessees, or other policy changes — as it becomes available, and as the agency conducts additional analysis at subsequent stages of the leasing process, including analysis in preparation for specific lease sales. Waiting until further evaluation is completed would delay the Program beyond the 5-year revision requirement specified in Section 18 of OCSLA.

It has been suggested that BOEM could delay GOM sales several years while more scientific information is gathered regarding the DWH event. These suggestions to delay lease sales have been incorporated into the programmatic discussion of deferrals and mitigation in Section 4.3.2. OCSLA mandates that the Secretary prepare a schedule of proposed lease sales every five years that balances the timing and location of leasing with the potential for environmental harm. While approval of a Program establishes a schedule for potential lease sales, BOEM undertakes robust planning and analysis, including NEPA review, before reaching a final decision about whether to hold each individual lease sale scheduled in the Program. The consequences of approving the proposed program would be to establish a schedule for one or more lease sales within the areas included in the program, but that does not require that any particular sale will occur; a scheduled lease sale can be canceled if deemed necessary in the future. Should the Program be approved, before a lease sale can occur, an additional NEPA document, which would consider a no action or no-sale alternative, would need to be prepared for each of the OCS lease sale areas included in the Program. These subsequent NEPA documents would also focus in greater detail on local conditions in the lease sale area. At the time of the lease sale itself, decisions as to subarea deferrals specific to that particular sale would be made. Therefore, the concept and possibility of delaying lease sales is implicit in the alternatives presented in this PEIS and in the phased OCSLA process. In view of the increasing focus and specificity of NEPA documents that would be prepared if the Program is approved and progresses to further stages, the Bureau believes that the level of analyses in this PEIS are appropriate at this preliminary planning stage of the Program.

In addition, in the GOM, where annual lease sales are the norm, holding fewer or delaying lease sales does not necessarily equate to significantly less cumulative OCS activity in the short-term. Under a fewer or delayed GOM lease sales scenario, BOEM still expects that most of the OCS activity that could occur over the next few years will occur under existing 5-year Programs, existing and imminent lease sales, already approved or imminently approved plans, new geophysical and geological permit applications, etc. These activities will occur in the absence of a new 2012-2017 Program. With continuing environmental studies and technical research, additional information will become available to the decision maker at later stages of the Program when specific activities are proposed and evaluated.

2.9.4 Develop Alternate/Renewable Energy Sources as a Complete or Partial Substitute for Oil and Gas Leasing on the OCS

Energy use in the United States is expected to continue to increase from present levels through 2035 and beyond (EIA 2011). For example, the U.S. Energy Information Administration (EIA) has projected that U.S. consumption of crude oil and petroleum products will increase from about 18.8 million bbl per day in 2009 to about 21.9 million bbl per day in 2035 (EIA 2011). Oil and gas reserves in the OCS (and especially the GOM) represent significant sources that currently help meet U.S. energy demands, and are expected to continue to do so in the future. Although BOEM recognizes recent advances in renewable energy technology, renewable energy-friendly Federal and State energy policy changes (e.g., Department of Energy and tax subsidies, State renewable energy portfolio standards), and increases in U.S. market demand and supply, renewable energy, under the present set of policy assumptions, is not a major partial substitute in the immediate future. Investments and policy changes required to achieve such a significant shift in reliance on such sources are not reasonable or economically practicable within the 2012-2017 framework. This fact supports a less-searching treatment of alternative energy as a reasonable alternative to some oil and gas OCS development. A more detailed discussion of alternate fuels and other energy substitutes for oil and gas appears in Section 4.5.7, which considers the environmental effects of the No Action Alternative. Also, consistent with judicial guidance on the 5-year Program, BOEM has incorporated by reference and summarized the Energy Alternatives and Environment report (BOEM 2012) within the framework of the No Action Alternative to address the potential for substitution toward renewable energy sources.

The OCSLA, in conjunction with other statutes, extends broad powers to the President and designated Federal Agencies (such as BOEM) over leasing activities on the OCS. Section 18 of the OCSLA specifically directs the Secretary of the Interior to prepare and periodically revise an oil and gas leasing program to implement the policies of OCSLA, and BOEM conducts oil and gas lease sales and executes leases under the OCSLA. Renewable energy projects on the OCS are also managed in conjunction with other Federal and State authorities. Under the OCSLA, Federal planning does not specifically integrate oil and gas leasing with renewable energy leasing. BOEM has issued a final rule specific to the establishment of a program to grant leases, easements, and rights-of-way for renewable energy projects on the OCS (30 CFR Parts 250, 285, and 290).

2.9.5 Add Areal and Temporal Exclusion and Restriction Zones around Sensitive Areas and Resources

BOEM indicated in its April 2010 NOI that other areal or temporal exclusions within planning areas may be considered. BOEM received comments requesting that the PEIS include alternatives that exclude portions of program areas from leasing during the Program or that seasonally exclude or restrict drilling in some Arctic areas when ice is present. Specific examples include creating more exclusion areas in the Arctic, particularly in the Hanna Shoal and Camden Bay areas, protecting the bowhead whale migration corridors, and temporal exclusion or restriction of drilling in the Arctic when ice is present. Other comments suggested exclusion of sensitive areas in the GOM to avoid or minimize contact from a DWH-like discharge event. Specific examples include excluding areas of the GOM OCS in which the Loop Current could transport oil from a large discharge event over great distances, avoiding important ecological areas and features, and developing buffer zones around areas as appropriate, such as coastal migratory corridors, population centers, and critical habitat of listed species.

The Proposed Action excludes areas in the Arctic that were excluded in the 2007-2012 Program. The PEIS does not analyze additional deferrals at this time. Detailed analyses of the large number of proposed exclusions in different planning areas, which vary widely in spatial definition and the completeness of supporting scientific information, can be more meaningfully accomplished at the lease sale stage. As the implementation of the Program continues, the Secretary may carve out additional deferral areas. The determination of other areal and temporal exclusions and restrictions will depend on the location of specific lease sale areas and whether exploration and further analysis of resource potential, environmental concerns, and potential effects on other uses such as subsistence and fishing. New scientific information may become available or public input may be provided later in the Program in advance of actual lease sales that help inform such exclusion decision-making. The exclusion of specific areas or blocks within a planning area is generally considered at the lease sale stage of the Program or when specific OCS projects are being evaluated.

The PEIS is a planning disclosure document that informs "big-picture" decisions about the overall size of the Program, the planning areas included in the Program, and the number of lease sales that could occur during the Program. The ecoregional scale used in the PEIS to identify areas where OCS effects and vulnerable environmental resources are likely to intersect and where mitigations may need to be developed during the Program to reduce potential impacts does not provide the fine scale and detailed information needed to develop protected areas on a block-by-block basis. Furthermore, the lease sale process is a phased process, and additional site-specific studies, consultations, and analyses may be required before effective mitigations and exclusions can be developed. By including most of the areal extent of the included six planning areas in the Program, the USDOI is attempting to maintain flexibility in fulfilling its mandate to provide for both U.S. energy needs and to protect the marine and coastal environment. However, BOEM recognizes the importance of considering temporal and spatial deferrals and mitigation at the appropriate OCSLA phase to avoid and minimize environmental effects, and has expanded this PEIS in Section 4.3.2 to outline measures that BOEM will use to enhance the transparency of the process for the consideration of such deferrals and mitigation throughout the tiered phases of Program implementation.

2.9.6 Reduce the Lease Sale Sizes to Smaller Than Area-Wide (less than full planning areas)

At the programmatic stage, considering the full planning area provides for the broadest and most extensive analysis in order to support the balancing of different considerations — including social, economic, and environmental issues. While significant domestic energy resources are assumed to be located on the OCS, the precise locations and quantities are unknown because not all promising areas and reservoirs have been fully explored and delineated. One way to optimize discovery of significant oil and gas deposits is to encourage companies to pursue unique and diverse exploration and development strategies based on differing views as to resource location, availability, and extractability. The area-wide process allows lessees to concentrate efforts on tracts they consider most promising as opposed to those pre-identified by the government, unless those areas have been already excluded through pre-lease sale planning and environmental review. The Secretary can reduce the area offered for leasing within a planning area at the lease sale stage of the Program based on more information about the location and value of recoverable resources, the potential vulnerability of environmental resources, or other Section 18 concerns. Section 2.10 below and Section 4.3.2 discuss BOEM's commitment to enhance transparency of the tiering process, which includes considering other leasing strategies as Program implementation takes place. Leasing strategies other than area-wide leasing are described in the Proposed Final Program.

2.9.7 Defer Oil and Gas Leasing in Deepwater Areas of the Central and Western GOM Planning Areas

During the scoping and Draft PEIS comment periods, several commenters expressed opposition to drilling in deepwater areas. The comments expressed general concerns about deepwater drilling in the GOM after the DWH event that occurred on April 20, 2010, and resulted in a discharge estimated to be 4.9 million barrels of oil (although about 17% of that is estimated to have been contained). The comments did not specify a definition of deep water to apply to an alternative that excludes certain areas from leasing to reduce the risk of occurrence of a catastrophic discharge event, nor did the comments identify specific risk factors associated with drilling in "deep" water compared to drilling at other water depths. The Secretary defined deepwater in the context of areas of the GOM with potential for increased drilling risk as water depths of 152 m (500 ft) and deeper when he directed BOEM on May 28, 2010, to exercise its authority under the OCSLA to suspend certain drilling activities for a period of up to 6 months in those water depths. The Secretary later clarified the suspension to cover deepwater operations that involved the use of certain deepwater technology. On October 12, 2011, BOEM lifted the May 28, 2011, drilling suspension on the basis that major issues pertaining to deepwater drilling risk had been addressed through multiple venues in the intervening 5 months.

The PEIS acknowledges the importance of understanding catastrophic discharge event risk for planning, leasing, and regulatory decisions during the Program. To further this understanding, the PEIS includes in Section 4.3, Assessment of Issues of Programmatic Concern, a discussion of the current knowledge of the relative importance of catastrophic discharge event risk factors, and a synthesis of this information to identify catastrophic event risk in different program areas. This section identifies water depth as one of many risk factors that should be considered with other factors when making specific leasing decisions. True vertical depth is a better exposure variable for considering downhole well integrity risk, which applies to both continental shelf and slope OCS activities. True vertical depth is the vertical distance from the current drilling depth or final well depth to the drilling rig floor. True vertical depth, in part, determines bottomhole pressure conditions. Similarly, while there may be greater logistical difficulties to containing a catastrophic discharge event in deep water, the risk to environmental resources from shallow water drilling could be greater, because of the proximity to and greater likelihood of oil contact to many of those resources. Therefore, excluding deepwater areas from the Program does not necessarily equate to avoiding adverse environmental impacts. Section 4.3.4 also describes recent and ongoing regulatory and industry reforms targeting improvements in drilling safety and reducing the risk of the occurrence of catastrophic discharge events.

Furthermore, to exclude all deepwater areas in the GOM from potential oil and gas exploration and development would not be reasonable in light of the purpose and need for the oil and gas leasing program, which is to help meet the Nation's energy needs by developing oil and gas resources in a manner consistent with environmental protection and the laws and policies of affected States. According to the analytical scenario used in this PEIS, based on recent lease sale and industry exploration and development activity, without deepwater activity in the GOM, 93% of the expected oil production in the GOM would be unavailable, essentially removing it from the program (see Table 4.4.1-2 for related scenario information). Over the last approximately

20 years, leasing, drilling, and production have moved steadily into deeper waters. As of 2009, there were approximately 7,310 active leases in the U.S. GOM, 58% of which were in deep water. Likewise, deepwater oil production rose about 786% and deepwater gas production increased about 1,067% from 1992 to 2007 (Nixon and Shepard 2009). The leasing schedule must ensure a proper balance between oil and gas production and possible environmental impacts, while also considering relative environmental sensitivity among OCS regions and competing uses of the OCS. Portions of planning areas, such as deepwater areas, can potentially be deferred from leasing during the program at the lease sale stage if there is, for example, a demonstrated and significant relative risk of a spill or blowout associated with certain deepwater areas, the presence of sensitive environmental resources, space use conflicts, or other reasons.

2.10 MEASURES TO ENHANCE TRANSPARENCY IN TIERING PROCESS

The USDOI's procedures for implementing NEPA provide for adaptive strategies that allow for the adjustment of an action during implementation where appropriate (43 CFR 46.415). BOEM's process for implementing the Program through the OCSLA phases represents an opportunity for adaptive management. The Secretary's decision to include a schedule of potential lease sales in a 5-year Program is the initial step in a long, complex process; the actual Program is then materialized through numerous subsequent decisions on lease sales, geological and geophysical permits, exploration and development plans, and ultimately, decommissioning plans.

As discussed in more detail in Section 4.3.2, BOEM is committing to several process enhancements to ensure transparency during the phased OCSLA and tiered NEPA processes of this Program. Although specific approaches to implementation may be tailored to the different needs of the Regions and their stakeholders, BOEM is determined to improve the effectiveness of the tiering process by:

- Committing to implementing an **alternative and mitigation tracking table** to track the receipt and treatment of alternative and mitigation suggestions starting with the 5-year Program.

- Committing to **strengthening the pre-lease sale process** by taking a number of steps to enhance opportunities for members of the public to comment and provide new information in the pre-lease sale planning process.

- Committing to preparing an **annual progress report** of the 5-year Program voluntarily, expanding the requirement of Section 18(e) of the OCSLA.

- Committing to **systematic planning** opportunities that foster improved governmental coordination, communication, and information sharing.

2.11 SUMMARY OF IMPACTS ANTICIPATED FROM THE PROPOSED ACTION AND ALTERNATIVES

In general, oil and gas development follows a four-phase process, beginning with (1) exploration to locate viable deposits, (2) development of the production well and support infrastructure, (3) operation (oil or gas production), and (4) decommissioning of the offshore facility once it is no longer productive or profitable. Under the proposed action, or Alternatives 2 through 7, routine operations associated with each of these phases will have the same or similar impact-producing factors associated with them (Table 2.11-1), and these have "typical" types of impacts, regardless of location. The magnitude and importance of those impacts on the sensitive environmental resources, however, will be site- and project-specific. For example, pipeline trenching, regardless of location, will result in disturbance of the sea floor and associated biota and habitats, and generate suspended sediments that will affect local water quality. The importance of such impacts will depend on the types of biota and habitats present (seagrass beds vs. mud bottom; endangered species) and ambient water quality conditions. The types of impacts identified for the proposed action are therefore the same as those expected under each of the alternatives except the No Action Alternative. Table 2.11-2 presents a summary comparison of impacts of all the alternatives, including the No Action Alternative. The difference in potential impacts among the action alternatives will largely be in where those impacts may be incurred. Each of the alternatives to the proposed action excludes one of the six planning areas included in the proposed action from the 2012-2017 OCS leasing program, and most resources in the excluded planning area would not be expected to be affected by routine operations in the other planning areas. Because routine operations include some impacting factors (such as seismic survey noise and support vessel traffic) that may extend beyond planning area boundaries, resources in deferred planning areas may be affected by routine operations associated with development in adjacent planning areas.

One potential impact-producing factor of oil and gas development under each of the seven action alternatives is an accidental oil spill. The types of effects such accidental spills may have on specific resources will be similar between the proposed action and the other action alternatives, although the duration and magnitude of the impacts will depend on the location, size, timing, and duration of the spill; the effectiveness of spill containment and cleanup operations, and the biological and cultural resources affected by the spill.

The evaluation of a No Action Alternative is required by the regulations implementing NEPA (40 CFR 1502.14(d)). If the Secretary were to adopt this alternative, it would halt OCS pre-sale planning, sales, and new leasing from 2012 to 2017. However, exploration, development, and production stemming from past sales would continue.

This alternative would shut down the OCS leasing program from mid-2012 through mid-2017. The amounts of OCS natural gas (up to 35 trillion cubic feet) and oil (up to 8.1 billion barrels of oil) that could help meet national energy needs would be forgone. That amount of energy would have to be replaced by a combination of imports, alternative energy sources, and conservation.

TABLE 2.11-1 Impact-Producing Factors Associated with OCS Oil and Gas Development

	Development Phase				
	Exploration				
Impact-Producing Factor	Seismic Survey	Exploration Well	Development	Operation	Decommissioning
Noise	X	X	X	X	X
Seismic noise	X	X			
Ship noise	X	X	X	X	X
Aircraft noise		X	X	X	X
Drilling noise		X	X		
Trenching noise			X		
Production noise				X	
Offshore construction			X		
Onshore construction			X		
Platform removal					X
Traffic	X	X	X	X	X
Aircraft traffic		X	X	X	X
Ship traffic	X	X	X	X	X
Drilling Mud/Debris		X	X		
Bottom/Land Disturbance		X	X		
Coring and drilling		X	X		
Pipeline trenching			X		
Onshore construction			X		
Air Emissions	X	X	X	X	X
Offshore	X	X	X	X	X
Onshore			X	X	X
Explosives					X
Platform removal					X
Lighting	X	X	X	X	
Offshore	X	X	X	X	
Onshore			X	X	
Visible Infrastructure		X	X	X	
Offshore		X	X	X	
Onshore			X	X	
Space Use Conflicts	X	X	X	X	
Offshore facilities	X	X	X	X	
Onshore facilities			X	X	
Accidental Spills	X	X	X	X	X

Market forces are expected to be the most important determinant of the substitute mix for OCS oil and gas. Key market substitutes for forgone OCS oil production would be imported oil, conservation, switching to gas, and onshore production. For OCS natural gas, the principal substitutes would be switching to oil, onshore production, imports, and conservation.

In addition to market-based substitutes, the Nation or individual States might choose to encourage or even impose programs designed to deal with the energy shortfall. To replace oil, these programs might favor alternative vehicle fuels such as ethanol or methanol, vehicles with greater fuel efficiency, or alternate transportation methods such as mass transit.

As a partial replacement for the forgone natural gas, governments might mandate increased reliance on coal, nuclear, hydroelectric, solar, or wind-generated electric power. In addition, governments might give more emphasis to programs encouraging more efficient electricity transmission and more efficient use of gas and electricity in factories, offices, and homes.

2.12 COST-BENEFIT ANALYSIS OF ALTERNATIVES

As a complement to the impact conclusions presented in Section 2.13 below, BOEM presents here the conclusions of its cost-benefit analysis. Per OCSLA Section 18 requirements, BOEM prepares a cost-benefit analysis (CBA) in support of each 5-year Program. That analysis, presented in full as the Net Benefits analysis in the Proposed Final Program, quantifies social benefits from the production of oil and natural gas, as well as the environmental and social costs associated with the anticipated exploration, development, and production under the activities of the 2012-2017 Program (Table 2.12-1; Figure 2.12-1). The CBA incorporates the environmental and social costs associated with substituted energy sources that become necessary if no sales are held in a given program area (no new sales are held in any program area under the No Action Alternative). The analytical methodology is also summarized in the Proposed Final Program and detailed information on the methodology and economic assumptions can be found in the *Economic Analysis Methodology for the Five Year OCS Oil and Gas Leasing Program for 2012-2017* (BOEM 2012). Although the PEIS and the Proposed Final Program are companion documents provided to the decision-maker, the cost-benefit analysis is incorporated by reference and summarized here since it is relevant to a choice among environmentally different alternatives. In addition, unquantified environmental effects, values, and amenities are also discussed per Section 102(2)(B) of NEPA.

Figure 2.12-1 summarizes the components of the BOEM Net Benefits analysis. The cost-benefit analysis includes impacts from economic activities, as well as impacts associated with economic value. The Net Economic Value (NEV) analysis looks at changes in economic activity measured as commercial revenues, tax receipts, and other government revenues. The environmental and social costs, as well as the consumer surplus calculations, measure economic value. Economic value is measured as consumers' willingness to pay, both for natural resources and for goods they want to consume. Another perspective on economic impact involves comparison of the benefits of incremental employment, labor income, and other such factors

Anticipated Production of the Planning Area	x	Assumed Price Level	=	Gross Revenue
Gross Revenue	-	Private Costs	=	Net Economic Value (NEV)
Net Economic Value	-	Environmental and Social Costs of Program Proposal - Environmental and Social Costs of Energy Alternatives (resulting from the No Action Alternative)	=	Net Social Value (NSV) (Net Supply-Side Benefits)
Net Social Value	+	Consumer Surplus Benefits - Lost Domestic Producer Surplus Benefits	=	Net Benefits

FIGURE 2.12-1 Principal Elements of Cost-Benefit Analysis

when considering impacts from the local or regional perspective. These impacts are considered in Section 4.4.9 of the PEIS.

The net benefits analysis includes the social and environmental costs of reasonably foreseeable oil spills, but the results do not directly include the costs of a catastrophic discharge event, which is not expected to occur as a result of the proposed action. An analysis of the potential costs of such an unexpected event is presented in BOEM (2012).

2.12.1 Gross Revenue

In the first stage of the cost-benefit analysis, BOEM estimates the gross revenue from the production anticipated from the 5-year Program (Table 2.12-1). Gross revenue is the anticipated production of each resource multiplied by the assumed price level. Leasing under the 2012-2017 Program is expected to contribute to exploration, development, and production activity for approximately 40 to 50 years, during which time oil and natural gas prices are expected to fluctuate. To account for this likelihood, BOEM derives three level-price-scenarios where the inflation-adjusted, or “real,” prices for oil and natural gas are assumed to remain constant. The cost-benefit analysis includes resource development, cost, and benefit estimates for three different price scenarios: low ($60/bbl oil; $4.27/mcf natural gas); mid ($110/bbl oil; $7.83/mcf natural gas); and high ($160/bbl oil; $11.39/mcf natural gas). A real discount rate of 3% is used in the proposed program analysis.

Oil and natural gas resource estimates are derived for each Planning Area from the 2011 National Assessment of Undiscovered Technically and Economically Recoverable Oil and Gas Resources on the OCS (accessible at http://www.boem.gov/Oil-and-Gas-Energy-

Program/Resource-Evaluation/Resource-Assessment/Index.aspx). The National Assessment considers recent geophysical, geological, technological, and economic information and utilizes a probabilistic, geologic play-based approach to estimate the undiscovered technically recoverable resources (UERR) of oil and natural gas for individual plays.

Estimates of UERR expected to be available for leasing as part of the new 5-year Program account for recent leasing activity in each planning areas and OCS lease sales scheduled in the interim. Estimated oil and gas likely produced under the Program is a subset of the total resource potential (see Section 4.4.1 for scenario assumptions). Anticipated production differs from undiscovered technically and economically recoverable resource estimates in that anticipated production only includes oil and natural gas resources that are expected to be leased, discovered, developed, and produced as a result of a series of lease offerings. In the GOM, the anticipated production expected to result from the 12 lease sales proposed is based on historical sale-specific field discovery volumes, production and drilling activity, leasing trends, and BOEM's most recently published 10-year GOM production forecast.

In the Arctic, oil is the priority commodity of interest due to its higher market value and the existing TransAlaska Pipeline System (TAPS) infrastructure. Accordingly, the scenarios in the Beaufort and Chukchi Seas assume that large oil fields will be developed first. Natural gas is of secondary interest and is assumed to be commercially viable if a new large-volume transportation system pipeline is built and oil production provides funding for much of the infrastructure. Natural gas is likely to be reinjected to assist in oil production; therefore, commercial natural gas production is likely to be delayed until oil pools are depleted and transportation infrastructure is available. In comparison, the Cook Inlet has established infrastructure in State waters and a nearby market for oil and natural gas production. With access to existing infrastructure and a local market, smaller oil or natural gas pools could become commercial projects, and natural gas could be produced more quickly.

2.12.2 Net Economic Value

The second stage in the cost-benefit analysis is to estimate the NEV, or the discounted gross revenue from the produced oil and natural gas less the discounted costs of exploring, developing, producing, and transporting the oil and natural gas to the market, or the costs required to realize the economic value of the resources. The NEV estimates are calculated for each program area using the same scenario assumptions of exploration, development, and production activities that are used in this PEIS (Table 2.12-1). The Federal Government, as lessor, collects a portion of the NEV as transfer payments in the form of cash bonuses, rentals, royalties, and taxes. The lessees, as private firms, retain the remainder of NEV as economic profits that may be distributed to shareholders around the country or reinvested in exploration and development projects. The NEV can be equated to the sum of the present values of royalties, rents, bonuses, taxes, and after-tax profits. Based on the calculated government share and general estimates of foreign shareholder proportions in U.S. companies, only 95% of the NEV is used to measure the domestic piece of NEV derived from a program area.

2.12.3 Net Social Value

The third stage in the cost-benefit analysis is estimation of net social value (NSV). The NSV is the NEV less the present value of net environmental and social costs of the 5-year Program (Table 2.12-1). The environmental and social costs, calculated by program area, result from actual and potential effects on the environment and social systems during the exploration, development, production, and transportation of OCS oil and natural gas resources. In order to calculate the *net* environmental and social costs, the costs incurred if leasing did not occur in one or all of the program areas (under Alternatives 2 through 8) must also be subtracted from Program costs. Under the No Action Alternative, no new leasing would take place in those areas for at least five years and domestic oil and natural gas supply at some point in the future would be reduced by the amount of foregone production. This reduction in production would cause only a small price increase which would lead to a small decrease in demand for oil and natural gas (see Section 4.5.7). The increase in price would lead to increases in imports and domestic onshore production, as well as fuel switching to other energy sources, including renewable energy sources. The increased production and fuel switching would be necessary to meet the continuing domestic demand for oil and natural gas resources (see Section 4.5.7).

BOEM uses its Market Simulation (MarketSim) Model to estimate the substitutions for offshore oil and natural gas development if one or more program areas are excluded from the program. Detailed information on the Market Simulation Model can be found in Industrial Economics et al. (2012). The Offshore Environmental Cost Model (OECM) is used to estimate both the environmental and social costs that would result from OCS activities and the costs that would result from selecting the No Sale Option in each program area. Detailed information on the OECM can be found in Industrial Economics (2012). The OECM uses the levels of OCS activity from the exploration and development scenarios, as well as the energy market substitutions from the MarketSim to calculate environmental and social costs. Impacts on recreation, air quality, property values, subsistence harvests, commercial fishing, and ecosystem services from routine impacting factors and accidental spills are quantified.

OECM takes into consideration the environmental costs of energy substitutes that would be required to fulfill U.S. demand in the absence of new OCS production under the No Action Alternative. Because additional energy imports, onshore production, and fuel switching would have to take place under the No Action Alternative, OECM calculates the environmental and social costs of these energy market substitutions. In order to get an accurate value of the net environmental and social costs of the 5-year Program, the no sale costs are subtracted from the environmental and social costs resulting from program activity in each program area. In the event that no sale(s) is (are) held in a particular program area, the environmental and social costs of the no sale option are attributed to the area in which the sale(s) is (are) not held. In the event of the No Action Alternative, the environmental and social costs of the No Action Alternative are distributed to the six program areas based on the relative amount of production expected from each area. However, since natural gas, mostly substituted with increased onshore production, is more costly to replace than oil, which would be replaced primarily by increased imports, natural gas-prone program areas would have higher costs than would more oil-prone areas under the No Action Alternative.

Environmental costs under the No Action Alternative principally result from the added risk of oil spills and additional air emissions from increased tanker imports, as well as from additional air emissions resulting from increased onshore production of oil, natural gas, and other energy sources, such as coal, closer to domestic population centers. In each planning area considered, the costs of relying on the substitute sources of energy are equal to or greater than the environmental and social costs from producing program area resources under the proposal. Environmental and social costs resulting from foreign oil production for export to the United States and from transportation of that oil to U.S. waters or borders are excluded from the model because the cost-benefit analysis only addresses a national perspective.

2.12.4 Net Benefits

To estimate net benefits, BOEM adds the NSV supply-side benefits (NEV minus net environmental and social costs) to the demand-side benefits (the difference between domestic consumer surplus and lost producer surplus). Consumer surplus is the difference between the price actually charged for a service or product and the maximum price consumers would be willing to pay for the same service or product. Producer surplus is the difference between the actual price that producers receive and the minimum price they would be willing to accept. In general, new OCS oil and natural gas production increases the domestic supply of oil and natural gas, which in turn lowers the price consumers pay and the price producers receive. For a given energy source, changes in consumer surplus occur as a result of changes in both price and quantity relative to baseline conditions. In the OCS case, the consumer surplus gains come almost entirely from the price reduction or pecuniary effects of increasing OCS oil and gas production. BOEM uses MarketSim to calculate the price changes in the international oil market and the domestic natural gas market as a result of new OCS production to estimate the change in consumer surplus.

The equilibrium change in the consumer surplus of the oil, gas, coal, and electricity markets overstates the national change in social welfare. Most of this surplus is not a net gain to society as a whole, but only a transfer from producer surplus. As OCS production increases, consumers pay a slightly lower price on each unit of consumption, which means that producers also receive a slightly lower price. As a result, for domestic production, the net consumer surplus gain is only the relatively small difference between consumer and producer surplus. However, when substituting for OCS oil, the resulting lower world oil price leads to a lower annual cost of imported oil, resulting in a gain for the domestic consumer. MarketSim computes and compiles the net consumer surplus associated with all of the non-U.S. supplied quantities of oil and gas so as to exclude these non-domestic producer surplus losses from the domestic consumer surplus gains attributed to the Program.

Table 2.12.4-1 summarizes the net benefits analysis for the proposed action by planning area. Considering those benefits and costs amenable to monetization, leasing any of the program areas is expected to result in net economic and societal benefits, with the exception of the Eastern GOM in the low-price case. An important component of the benefits is the environmental and social costs avoided by producing from the OCS, rather than from the energy substitutes. These societal costs of *not* approving one or more proposed lease sales are largely

TABLE 2.12.4-1 Summary of Net Benefits Analysis for the Proposed Action (Alternative 1, BOEM's Preferred Alternative)

						Discounted Billions of 2012 Dollars					
						Environmental and Social Costs					
Program Area		Oil (BBO)[a]	Gas (Tcf)	BBOE[a]	NEV[a]	Program	Energy Alternatives	Net	NSV[a]	Net Domestic Consumer Surplus	Net Benefits
Central GOM	Low	2.24	9.47	3.92	36.66	3.47	10.08	–6.61	43.27	19.37	62.64
	Mid	3.77	16.41	6.69	153.59	5.94	17.43	–11.49	165.08	35.14	200.23
	High	4.34	19.07	7.73	287.16	6.94	20.26	–13.32	300.48	44.52	344.99
Western GOM	Low	0.56	2.63	1.03	10.31	1.27	2.73	–1.45	11.77	5.08	16.85
	Mid	0.86	4.07	1.58	38.73	1.89	4.42	–2.53	41.26	8.32	49.59
	High	0.97	4.59	1.79	69.56	2.13	4.76	–2.63	72.19	10.28	82.47
Eastern GOM	Low	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Mid	0.05	0.11	0.07	2.30	0.06	0.11	–0.05	2.35	0.37	2.73
	High	0.07	0.16	0.10	5.32	0.07	0.17	–0.10	5.42	0.58	6.00
Chukchi Sea	Low	0.50	0.00	0.50	5.02	0.04	0.24	–0.20	5.22	2.66	7.88
	Mid	1.00	2.50	1.44	31.06	0.08	0.43	–0.36	31.41	7.54	38.95
	High	2.15	8.00	3.57	135.37	0.15	1.03	–0.89	136.25	25.00	161.26
Beaufort Sea	Low	0.20	0.00	0.20	0.14	0.02	0.05	–0.03	0.18	1.03	1.20
	Mid	0.20	0.50	0.29	3.68	0.02	0.58	–0.56	4.25	1.51	5.75
	High	0.40	2.20	0.79	16.57	0.03	2.30	–2.27	18.84	5.54	24.38
Cook Inlet	Low	0.10	0.00	0.10	1.56	0.01	0.03	–0.02	1.58	0.57	2.15
	Mid	0.10	0.04	0.11	3.71	0.01	0.07	–0.07	3.77	0.59	4.37
	High	0.20	0.68	0.32	12.30	0.02	0.10	–0.09	12.39	1.39	13.78

[a] BBO = billion barrels of oil; BBOE = billion barrels of oil equivalent; NEV = Net Economic Value; NSV = Net Social Value.

due to the environmental and social costs of the most likely substitutes for the OCS production including increased oil imports and onshore oil and gas production, which result in additional air emissions in port or onshore (often in Clean Air Act nonattainment areas), and the risk of oil spills from tankers.

2.12.5 Benefits and Costs of EIS Alternatives

Figure 2.12.5-1 compares the estimated average net benefits for the action alternatives (relative to no sale) analyzed in this PEIS. The proposed action's net benefit is the sum of each individual planning area's net benefit. As shown in Figure 2.12.5-2, the Central GOM Planning Area is estimated to have the highest net benefit contribution, followed by the Chukchi Sea Program Area and then the Western GOM.

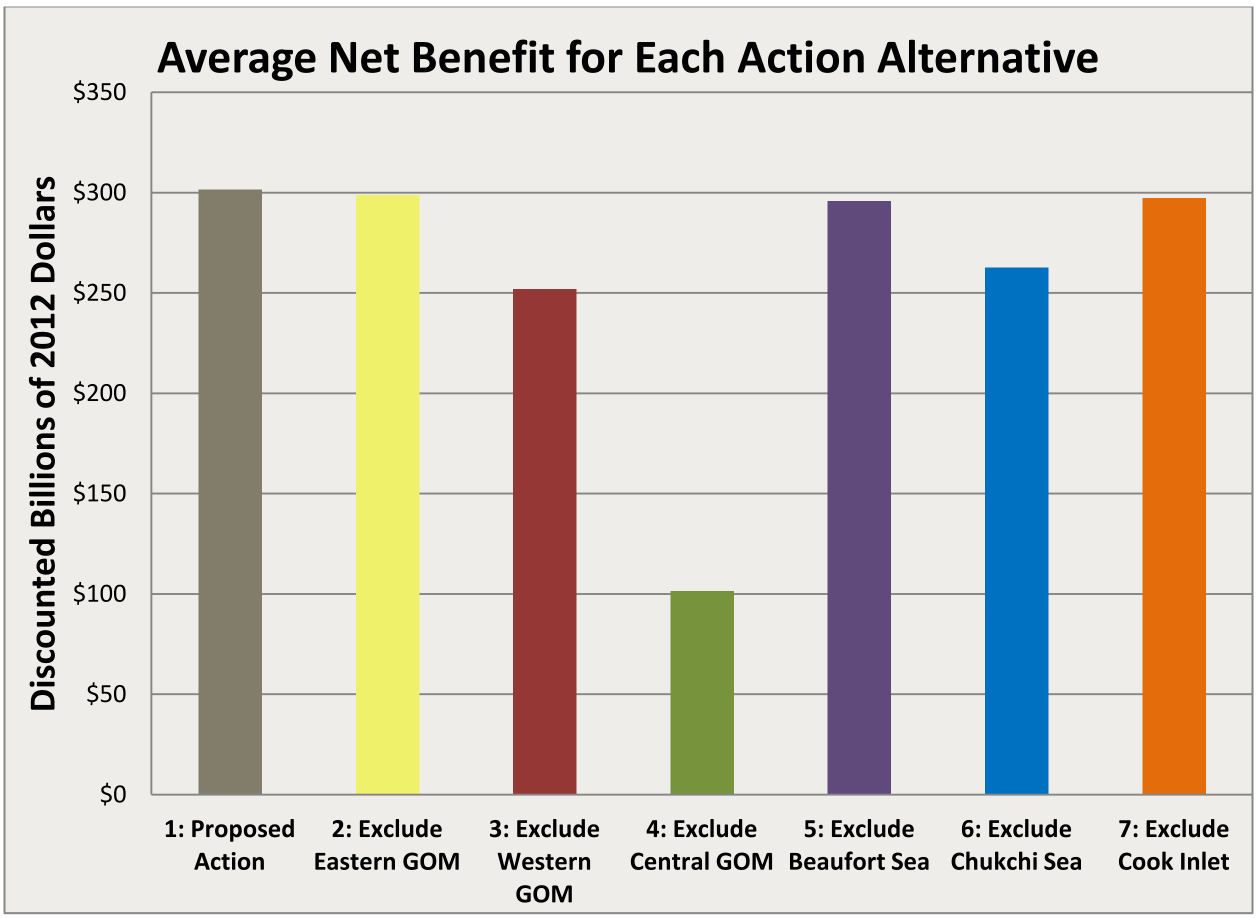

FIGURE 2.12.5-1 Comparison of Net Benefits for All Action Alternatives

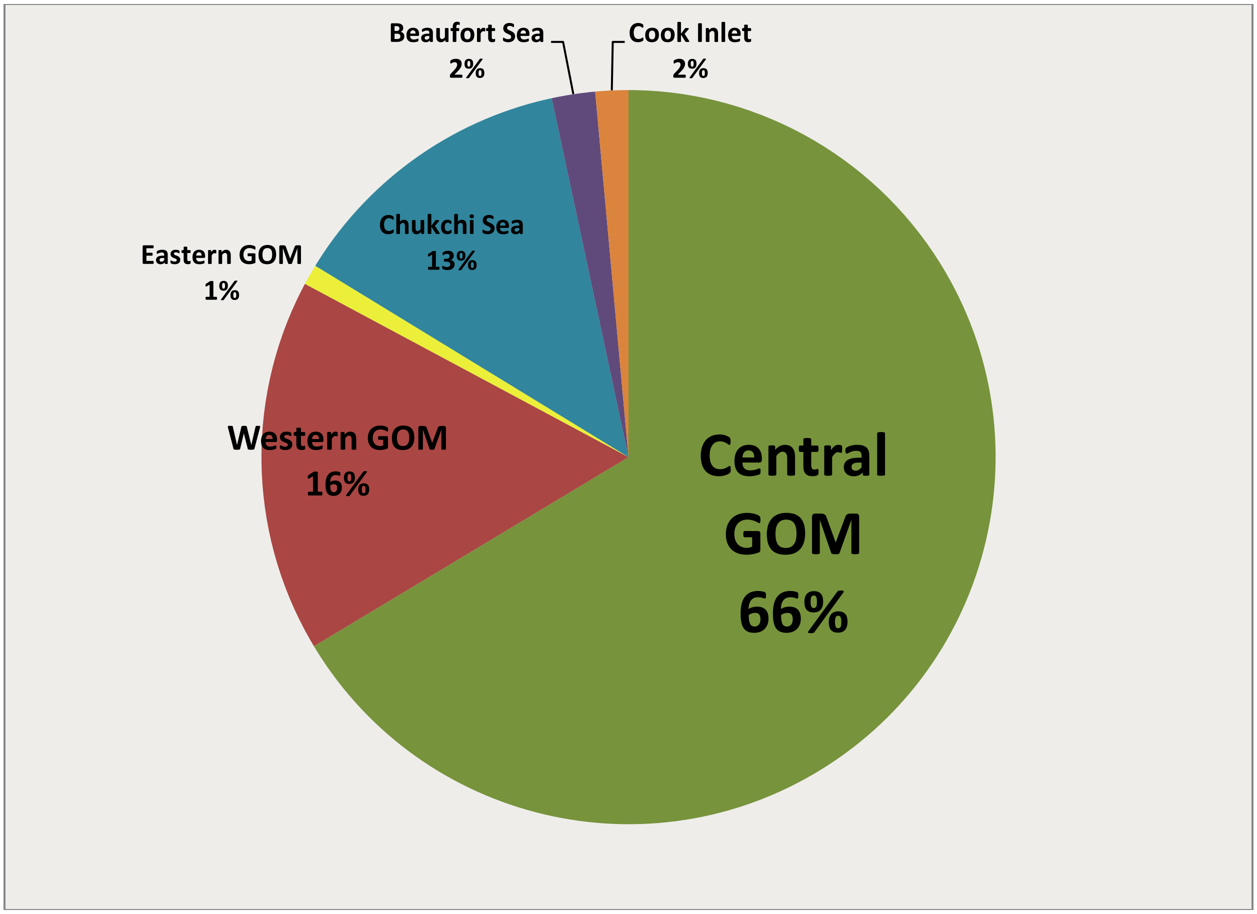

FIGURE 2.12.5-2 Alternative 1 (Proposed Action) Net Benefit Contribution by Program Area

2.12.6 Unquantified Environmental Effects, Values, and Amenities

When incorporating a cost-benefit analysis by reference, Council on Environmental Quality (CEQ) regulations require that the EIS discuss the relationship between that analysis and unquantified impacts, values, and amenities discussed in the EIS or other supporting analyses (40 CFR 1502.23). Although the 5-year Program cost-benefit analysis and the PEIS impact analysis presented in Chapter 4 are based on the same activity scenarios and assumptions, the NEPA assessment of impacts is done qualitatively, whereas comparable impacts in the cost-benefit analysis are compartmentalized, parameterized, and treated quantitatively. Although specific assumptions about the pathways, context, and/or trigger of impacts may not be identical, the analyses are complementary and serve to inform the decision-maker. While the cost-benefit analysis includes and monetizes many of the most important potential effects considered in the PEIS effects analysis, the PEIS also discusses other potential impacts on the human environment, untreated in the cost-benefit analysis, which may represent important considerations for the decision-maker, such as impacts on cultural resources or water quality; multiple use conflicts resulting from competing use of the same area; indirect, cascading impacts realized through impacts on keystone species in food webs; etc. As previously indicated, the cost benefit analysis does not incorporate the cost of an unexpected catastrophic discharge event. Limited historical data makes it difficult to provide reliable estimates of the environmental and social costs likely to result from a discharge of a given amount, not to mention even the probability that such an event might occur. However, if a catastrophic discharge event were to occur, it could complete change the net benefits whether resulting from OCS production or from the transportation of imported oil because of a decision not to lease.

The costs and benefits of environmental resources, cultural systems, and ecosystem services can also be difficult to quantify, or perhaps, cannot be or should not be monetized. This can be true for both adverse effects that could occur under the proposed action or under the No Action Alternative, as well as "effects avoided," or beneficial effects, that result from pursuing any of the eight alternatives over the others. In avoiding or minimizing adverse environmental impacts, the flow of services from the environment to or from people, in terms of active use and passive non-use, may contribute to changes in the long-term sustainability or productivity of some resource or human system. For example, if the Secretary of the Interior were to foreclose leasing in the Arctic, certain potential environmental effects on sensitive biological resources (such as bowhead whales, or in doing so, native cultural practices) in the Arctic could be lessened or potentially avoided. However, different environmental effects associated with the development of substituted energy sources would occur elsewhere in the world, and they could be worse for different environmental resources or human systems, but to different stakeholders with different values. Therefore, spatial and temporal allocation of the environmental and social costs that may occur elsewhere or between alternatives is a challenging problem, especially since energy substitutions away from regional production may not reasonably be expected to be made up in totality in that same region.

While the cost-benefit analysis captures much of the stream of economic value, it does not quantify all of it. For example, the cost-benefit analysis quantifies the costs of animal mortality, lost habitat, and decreased ecosystem services from an oil spill through habitat equivalency analysis, where costs are estimated in terms of the anticipated expense to restore or recreate habitat. Welfare economics suggests net benefits could include other benefits and costs stemming from the similar changes in the level of resources consumed, exhausted, extirpated, or saved, and with those changes, some flow of cost/benefit is accruing to someone.

The net benefits analysis does not quantify the costs of animal mortality, lost habitat, and decreased ecosystem services as a result of the increased number of new oil and gas platforms, pipeline installations, and other infrastructure expected throughout the program. However, the net benefits analysis similarly does not consider the impacts of infrastructure development from the incremental onshore production that would be necessary to replace OCS production in the No Action Alternative.

Within the PEIS and cost-benefit analysis, certain passive-use values, such as bequest value, option value, existence value, and altruistic value are not quantitatively or qualitatively captured, but can be very important to certain stakeholders that stand to be affected by the proposed action. However, these values exist from both the program and from energy substitutes under the No Action Alternative.

2.13 REFERENCES

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TABLE 2.11-2 Summary of Potential Impacts of the Proposed Action and Alternatives for a 2012-2017 OCS Oil and Gas Leasing Program

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Alternative 1 – Water				
Routine Operations	Potential for **minor** to **moderate**,[a] localized, short-term impacts due to increased sedimentation and changes to water quality from structure and pipeline placement and removal; operational discharges; and sanitary and domestic wastes. Compliance with National Pollutant Discharge Elimination System (NPDES) permits and U.S. Coast Guard (USCG) regulations would reduce most impacts.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	Minor water quality impacts could also occur from fluids entrained in ice roads when they break up in the spring.
Expected Accidental Oil Spills[b]	Impacts are expected to be **minor** to **major**, depending on the location, timing, and magnitude of the event. Small spills would result in short-term, localized, minor impacts. A large spill in coastal waters could result in longer-term impacts.	No additional area-specific impacts expected.	Winter conditions (i.e., temperature and ice cover) may result in longer-term impacts.	Winter conditions (i.e., temperature and ice cover) may result in longer-term impacts.
Unexpected Catastrophic Discharge Event (CDE)	**Moderate** to **major** impacts could occur, depending on spill location, timing, and magnitude. Effects may persist for an extended period of time if oil were deposited in wetland and beach sediments or low-energy environments because of potential remobilization.	No additional area-specific impacts expected.	Winter conditions (i.e., temperature and ice cover) may result in longer-term impacts.	Winter conditions (i.e., temperature and ice cover) may result in longer-term impacts.

[a] See Section 4.1.4 for definitions of impact levels.

[b] Small spills are <1,000 bbl (and most are <50 bbl); large spills are ≥1,000 bbl; see Section 4.4.2.2 for assumed CDE spill volumes.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a catastrophic discharge event (CDE) would be similar to those identified for Alternative 1, except none would be expected for the excluded planning areas. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, water quality could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			
Alternative 1 – Air Quality				
Routine Operations	Only **minor** impacts are expected. Sources of air pollutants include diesel and gas engines, turbines, and support vessels, and routine operations would not result in exceedance of air quality standards or impact visibility.	Increases of ozone, if they occur, would be about 2% of total concentrations.	No additional area-specific impacts expected.	No additional area-specific impacts expected.
Expected Accidental Oil Spills	Small accidental spills could have localized, temporary **minor** impacts, primarily from volatile organic carbon (VOC) emissions, while large spills and any associated *in situ* burning, if used, would have **moderate** impacts. An accidental release of H_2S could present a serious hazard to platform workers and persons close to the platform, and result in **minor** to **moderate** impacts.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Unexpected CDE	Impacts from a CDE, including any associated *in situ* burning, would be **moderate**. Greatest impacts would occur during the initial explosion of gas and oil and during the spill response and cleanup. **Moderate** impacts could continue for days during the initial event and **minor** impacts could continue for months during the spill response and cleanup.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, and spill response activities (such as *in situ* burning) carried out, air quality could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Alternative 1 – Acoustic Environment				
Routine Operations	Impacts expected to range from **minor** to **moderate**. Ambient noise levels could be affected by seismic surveys, drilling, ship and aircraft traffic, onshore and offshore construction, operational activities, and decommissioning. Effects from seismic surveys would be short-term and detectable over a fairly wide area. Ship and aircraft noise would be transient and along flight routes. Construction noise would tend to be limited to the vicinity of the activity, except for drilling, dredging, and pile driving, which can be detected over fairly wide areas. Operational noises would be low-level and localized and continue over the lifetime of the activity.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.
Expected Accidental Oil Spills	Changes in ambient noise levels would occur during spill response activities, and are expected to be **minor**. Support vessels and aircraft would be the primary noise sources, and changes in ambient noise levels would persist for the duration of the response activities, then return to pre-spill levels. Noise from responses to small spills would be short-term and localized, but more long-term and widespread for response activities to large spills.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Unexpected CDE	Noise impacts from response activities for a CDE are expected to be **minor** to **moderate**. Support vessels and aircraft would be the primary noise sources, and changes in ambient noise levels could continue for months during spill response and cleanup, after which they would return to pre-spill levels.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that few impacts would be expected in the excluded planning areas. Noise generated in one planning area during seismic surveys and drilling could affect ambient noise levels in an adjacent excluded planning area. In such a case, impacts would be similar to those identified for the planning area under Alternative 1. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, and spill response activities were conducted, ambient noise levels could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			
Alternative 1 – Coastal and Estuarine Habitats				
Routine Operations	**Minor** to **moderate** localized impacts could occur as a result of pipeline construction, maintenance dredging of inlets and channels, construction of onshore facilities, and support vessel traffic.	Construction of new landfalls, as well as expansion of existing ports, docks, and other infrastructure could affect coastal habitats.	Secondary impacts on wetlands could occur from water and air quality degradation.	Secondary impacts on wetlands could occur from water and air quality degradation, ice roads, fugitive dust, and altered drainage caused by pipelines and roads.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Expected Accidental Oil Spills	Impacts on coastal habitats could range from **negligible** to **minor** for most spills, and up to **major** for large spills. Effects may range from a short-term reduction in photosynthesis to extensive vegetation injury or mortality, as well as changes in community structure and direct loss of habitat. Cleanup operations could also affect wetlands. The effects of spills will depend on the specific habitat affected; the size, location, duration, and timing of the spill; and on the effectiveness of spill containment and cleanup activities. Small spills would likely result in short-term impacts while large spills could incur short- and long-term impacts depending on habitat type and location and effectiveness of cleanup activities.	Spills of oil or other materials could potentially affect both the surface and subsurface of beach and dune substrates in the GOM, and result in accelerated erosion.	Habitats along the western shoreline have the greatest likelihood of contact based on surface currents in the inlet. Winter temperatures and conditions (i.e., ice cover) would likely delay recovery of oiled habitats.	Freshwater wetlands on the Arctic coastal plain could be affected by spills from onshore pipelines. Winter temperatures and conditions (i.e., ice cover) would likely delay recovery of oiled habitats.
Unexpected CDE	Impacts could range from **moderate** to **major** as a result of heavy oiling over extensive areas of shoreline, with heavy deposits in multiple locations. The effects would be similar to those identified for expected accidental oil spills, but would be more widespread and of longer duration.	No additional area-specific impacts expected.	Winter temperatures and conditions would likely delay recovery of oiled habitats.	Winter temperatures and conditions would likely delay recovery of oiled habitats.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large accidental spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, coastal and estuarine habitats could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			
Alternative 1 – Marine Benthic Habitats				
Routine Operations	**Moderate** impacts to marine benthic habitats may occur. Benthic habitat, primarily soft sediments, could be disturbed by platform and pipeline placement, dredging, and operational discharges (produced water and cuttings). Soft sediment habitats can recover within a few years from most disturbances. Existing mitigation and other protective measures should eliminate most direct impacts to sensitive and protected benthic habitats.	Existing regulations on the placement of oil and gas infrastructure would limit impacts to high-relief banks and coral reefs, but low-relief hard-bottom and high density deepwater communities could be affected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.
Expected Accidental Oil Spills	Impacts would range from **negligible** to **minor** for small spills and from **minor** to **moderate** for large spills. Small spills are not likely to result in the degradation of benthic marine habitat because they would be quickly diluted. Larger spills are likely to result in localized habitat degradation.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Unexpected CDE	Impacts could range **minor** to **moderate**, and could be long-term depending on the habitat affected the size, duration, timing, and location of the spill and the effectiveness of response activities.	**Major** impacts to coral reef habitats could occur if the Flower Gardens Banks are heavily oiled and high mortality occurs.	No additional area-specific impacts expected.	**Major** impacts to hard-bottom kelp habitat could occur if these areas were heavily oiled and high mortality occurs.
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, benthic habitats could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			
Alternative 1 – Marine Pelagic Habitats				
Routine Operations	**Negligible** to **minor** short- and long-term impacts to pelagic habitats, primarily from operational discharges and from turbidity generated during infrastructure placement.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.
Expected Accidental Oil Spills	Impacts would range from **negligible** to **minor** for small spills and from **minor** to **moderate** for large spills. Most accidental spills would be small and result in short-term, localized impacts. Large spills would temporarily reduce habitat quality over large areas of pelagic habitat.	Spills could contact *Sargassum*, but would generally not affect the resource as a whole.	Oil spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect pelagic habitats for an extended period.	Oil spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect pelagic habitats for an extended period.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Unexpected CDE	**Minor** to **moderate** impacts to pelagic habitats, depending on the location, size, duration, and timing of the spill; the habitats affected; and the effectiveness of spill containment and cleanup activities.	Spills could contact *Sargassum*, but would generally not affect the resource as a whole.	Oil spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect pelagic habitats for an extended period.	Oil spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect pelagic habitats for an extended period.
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for habitats in the excluded planning area. If a large accidental spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, pelagic habitats could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts identified for routine operations and accidental oil spills under Alternative 1 would occur.			
Alternative 1 – Essential Fish Habitat (EFH)				
Routine Operations	No more than **moderate**, short- and long-term impacts to EFH and managed species are expected. Most impacts would result from bottom disturbance and the creation of artificial reefs by production platforms. Managed species, particularly egg and larval stages, could be killed, injured, or displaced from disturbance areas, but no population-level impacts on managed species are expected. Existing mitigation and other protective measures should eliminate most direct impacts to the following EFH: deepwater corals, chemosynthetic communities, warm water corals and live\hard-bottom, and topographic features.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Expected Accidental Oil Spills	Impacts would range from **negligible** to **minor** for small spills and from **minor** to **moderate** for large spills. The severity of effects would depend on spill size and location, environmental factors, and the uniqueness of the affected EFH. While most would have relatively small impacts, large spills that reach coastal EFH could have more persistent impacts and could require remediation.	No additional area-specific impacts expected.	Oil spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect EFH for an extended period.	Oil spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect EFH for an extended period.
Unexpected CDE	Impacts from a CDE-level spill could range from **moderate** to **major**, depending on the size, duration, timing, and location of the spill; the habitats affected; and the effectiveness of spill containment and cleanup activities. Managed species that suffer large losses of early life stages could suffer population-level effects from a catastrophic oil spill. A CDE could cause long-term declines of managed species that rely on shallow coastal, intertidal, and freshwater areas.	No additional area-specific impacts expected.	Oil spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect EFH for an extended period.	Oil spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect EFH for an extended period.
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, EFH could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Alternative 1 – Mammals				
Routine Operations	Impacts to cetaceans could range from **negligible** to **moderate**, with species or stocks inhabiting continental shelf or shelf slope waters most likely to be affected. Marine mammals could be affected by noise from seismic surveys, ship and helicopter traffic, platform construction and operation, and explosive removal of platforms; potential collisions with ships; and exposure to discharges and wastes. Meeting the requirements of Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA) would reduce the likelihood and magnitude of adverse impacts to most species.	The West Indian manatee and rare or extralimital whale species are not likely to be affected. Meeting the requirements of the ESA and MMPA would reduce the likelihood and magnitude of adverse impacts from routine operations to most species. No impacts to endangered beach mice subspecies or the Florida salt marsh vole are expected.	**Negligible** to **minor** impacts on terrestrial mammals. Construction of onshore pipeline could result in some loss or modification of habitat for terrestrial mammals, and aircraft overflights could cause short-term disturbances to terrestrial mammals.	**Negligible** to **minor** impacts on terrestrial mammals. Construction of onshore pipeline could result in some loss or modification of habitat for terrestrial mammals, and aircraft overflights could cause short-term disturbances to terrestrial mammals.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Expected Accidental Oil Spills	Small oil spills are expected to have negligible to minor impacts on marine mammals. Larger spills are expected to have **minor** to **moderate** impacts on marine mammals. Expected oil spill impacts on species that are extralimital or rare are expected to be negligible to minor, but could in unusual circumstances be **moderate** to **major** depending on the number of individuals contacted by a spill. Impacts on marine mammals from oil spill response activities are expected to be **minor**.	Oil spills are not expected to contact areas inhabited by the endangered rodent species. However, if their habitats are oiled, the potential impacts are expected to be **minor** for very small spills and **minor** to **moderate** for large spills. Protective measures required under the ESA should prevent any oil spill response and cleanup activities from having more than **minor** to **moderate** impacts on the endangered rodent species and their habitats.	Oil spills may expose terrestrial mammals to oil or its weathering products. Accidental spills and associated cleanup activities are expected to have **negligible** to **minor** impacts on terrestrial mammals. Oil spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect marine mammals for an extended period.	Expected oil spill impacts on species that are extralimital or rare are expected to be **negligible** to **minor**, but could in unusual circumstances be **moderate** to **major** depending on the number of individuals contacted by a spill. Oil spills may expose terrestrial mammals to oil or its weathering products. Accidental spills and associated cleanup activities are expected to have **negligible** to **minor** impacts on terrestrial mammals. Oil spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect marine mammals for an extended period.
Unexpected CDE	In the case of an unexpected, very low-probability CDE-level spill, there is a greater potential for more severe and population-level effects on marine mammals compared to a large oil spill, and impacts could be **moderate** to **major** on one or more species.	A CDE and associated cleanup activities could potentially result in oiling and physical destruction of habitats (including designated critical habitat) for one or more of the endangered rodent species, and result in **minor** to **major** to these species. A CDE would increase the threat of extinction for one or more of the beach mice subspecies and the Florida salt mouse vole.	Impacts to terrestrial mammals could be **minor** to **major**. Spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect marine mammals for an extended period.	Impacts to terrestrial mammals could be **minor** to **major**. Spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect marine mammals for an extended period.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, some mammals could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			
Alternative 1 – Marine and Coastal Birds				
Routine Operations	Overall impacts would range from **negligible** to **moderate**, would be primarily behavioral in nature and result from generally short-term disturbance during drilling and platform construction, pipeline trenching, vessel and helicopter traffic, and landfall construction.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Expected Accidental Oil Spills	Small spills would only impact small areas of habitat and relatively few individuals and are expected to have no more than **minor** impacts. Impacts from a large spill are expected to be **moderate** to **major**. Impacts would be the result of direct oiling of birds and habitats as well as ingestion of toxic materials with lethal and sublethal effects, including reduced reproductive success. Large spills, especially those occurring during the fall or spring migrations, may expose large numbers of birds in both nearshore coastal waters and in coastal habitats. A shallow water spill in an offshore or nearshore area may impact a greater number of bird species than a deepwater spill, as spills reaching shoreline habitats have the potential to affect shorebirds, wading birds, wetland birds, and migratory birds.	The GOM acts as an important stopover site for many migratory bird species. Large spills can foul foraging areas and food resources along extensive areas of shoreline and directly oil large numbers of birds.	Large spills, especially those occurring under ice and those that reach important wintering habitats, may result in lethal and sublethal effects on large numbers of birds. A spill under incomplete ice cover could, because of cleanup difficulties, result in longer-term exposure and subsequent effects than a spill in ice-free conditions.	Large spills, especially those that enter coastal lagoons and delta areas may result in lethal and sublethal effects, including reduced reproductive success, on birds using those habitats for molting and staging. A spill under incomplete ice cover could, because of cleanup difficulties, result in longer-term exposure and subsequent effects than a spill in ice-free conditions.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Unexpected CDE	**Moderate** to **major** impacts may be incurred, depending on the location, timing, and duration of the event and the species, habitats, and numbers of birds exposed.	The GOM acts as an important stopover site for many migratory bird species. An unlikely CDE can foul foraging areas and food resources along extensive areas of shoreline and directly oil large numbers of birds.	The Cook Inlet contains important migratory staging areas for waterfowl and shorebirds. A CDE occurring in spring or winter months would be expected to have a higher impact on bird populations due to the rapid occurrence at those times of large numbers of migratory birds and the difficulties associated with spill cleanup in ice conditions.	The Beaufort Sea and Chukchi Sea Planning Areas provide important nesting, molting, and stopover habitat for many species of coastal and marine birds. A CDE in the Arctic has the potential to affect large numbers of birds that rely on coastal habitats for nesting and migratory activities.
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, marine and coastal birds could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			
Alternative 1 – Fish				
Routine Operations	Impacts to fish from routine operations include noise, bottom disturbance, discharge of drilling muds and produced water, and removal of platforms with explosives. Routine operations are expected to result in **negligible** to **minor** impacts to fish and **negligible** impacts to threatened or endangered fish species.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Expected Accidental Oil Spills	Impacts would range from **negligible** to **minor** for small spills and from **minor** to **moderate** for large spills. Exposure to oil could result in lethal or sublethal impacts to fish at various life stages, depending on the level of exposure and the species and life stages exposed.	Impacts to Gulf sturgeon from small spills would range from **negligible** to **minor** for small spills and from **minor** to **moderate** for large spills. Impacts to smalltooth sawfish are expected to range up to minor.	Impacts would be greatest if oil were to reach intertidal habitats, which could result in long-term impacts to fish. Spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect fish for an extended period.	Impacts would be greatest if oil were to reach intertidal habitats, which could result in long-term impacts to fish. Spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect fish for an extended period.
Unexpected CDE	Impacts could range up to **moderate**, but are not expected to result in population-level impacts except possibly for spills that greatly affect overfished species and their spawning grounds.	Impacts to Gulf sturgeon could range up to **moderate**, and up to minor for the smalltooth sawfish.	Impacts would be greatest if oil were to reach intertidal habitats, which could result in long-term impacts to fish. Spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect fish for an extended period.	Impacts would be greatest if oil were to reach intertidal habitats, which could result in long-term impacts to fish. Spills occurring near or under ice could be difficult to clean and may persist in the water column and continue to affect fish for an extended period.
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, fish could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Alternative 1 – Reptiles				
Routine Operations	Species only occur in the GOM planning areas.	**Minor** to **moderate** localized, short-term impacts from seismic exploration, infrastructure construction, channel dredging, and vessel traffic. Noise may temporarily disturb some individuals. Explosive removal of platform, as well as collisions with support vessels, may injure or kill some turtles. Onshore construction may impact nest sites, while lighting of onshore facilities may disturb hatchling movements from nest sites. Sea turtles may also be exposed to waste material that could cause lethal and sublethal effects. Many of these impacts would be localized and of relatively short duration.	No species in Alaska.	No species in Alaska.
Expected Accidental Oil Spills	Species only occur in the GOM planning areas.	Impacts may range from **negligible** to **moderate**. An accidental spill may result in exposure of one or more life stages of reptiles to oil or its weathered products. Oil may reduce hatching and hatchling survival; and inhalation or ingestion of oil or oil vapors may incur lethal or sublethal effects.	No species in Alaska.	No species in Alaska.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Unexpected CDE	Species only occur in the GOM planning areas.	Impacts would be expected to be **major** and long-term if multiple individuals and their habitat (especially nest habitat) are exposed to large amounts of oil for long periods of time. The magnitude of effects would depend on the location, timing, and volume of the spills.	No species in Alaska.	No species in Alaska.
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each of the alternatives that exclude a GOM planning area, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large accidental spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, sea turtles could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			
Alternative 1 – Invertebrates and Lower Trophic Levels				
Routine Operations	**Negligible** to **moderate** impacts resulting primarily from habitat disturbance associated with infrastructure placement and from routine discharges. These activities would primarily affect benthic invertebrates and recovery would be short-term to long-term.	**Negligible** impacts to the ESA listed elkhorn coral.	No additional area-specific impacts expected.	No additional area-specific impacts expected.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Expected Accidental Oil Spills	Impacts would range from **negligible** to **minor** for small spills and from **minor** to **moderate** for large spills. Small spills would likely result in localized impacts, but larger spills would affect a wider area depending on factors such as the size of the spill and the habitats affected.	No additional area-specific impacts expected.	Spills occurring under ice would result in prolonged exposure of invertebrates and lower trophic level biota.	Spills occurring under ice would result in prolonged exposure of invertebrates and lower trophic level biota.
Unexpected CDE	Impacts could range up to **moderate**, and result in measurably depressed invertebrate populations, especially in intertidal areas and in sensitive coral habitat.	No additional area-specific impacts expected.	Spills occurring under ice would result in prolonged exposure of invertebrates and lower trophic level biota.	Spills occurring under ice would result in prolonged exposure of invertebrates and lower trophic level biota.
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, invertebrates and other lower trophic level biota could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			
Alternative 1 – Areas of Special Concern (AOC)				
Routine Operations	Impacts are expected to be **negligible** to **moderate** because of the existing protections and use restrictions applicable to these areas. Vessel traffic and construction activities could result in temporary and localized effects on wildlife and reduce the scenic value of affected AOCs.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Expected Accidental Oil Spills	Impacts would range from **negligible** to **minor** for small spills and from **minor to moderate** for large spills. Impacts would beprimarily associated with adverse effects on fauna and habitats, subsistence use where allowed, commercial or recreational fisheries, recreation, and tourism.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.
Unexpected CDE	Impacts would **moderate** at Areas of Special Concern (AOCs) affected by a CDE. Impacts would primarily associated with adverse effects on fauna and habitats, subsistence use where allowed, commercial or recreational fisheries, recreation and tourism.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, AOCs if present could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			
Alternative 1 – Population, Employment, and Income				
Routine Operations	Impacts would result from increases in population, employment and income in each planning area over the duration of the leasing period.	Impacts would be **negligible**. Increases in population, employment, and income in each region over the duration of the leasing period would correspond to less than 1% of the baseline level in the GOM.	Impacts would be **minor**. Population, employment, and income levels would increase by less than 5% of baseline levels in Alaska.	Impacts would be **minor**. Population, employment, and income levels would increase by less than 5% of baseline levels in Alaska.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Expected Accidental Oil Spills	Small spills would have **negligible** to **minor** impacts, while large spills would have **minor** to **moderate** impacts. Localized impacts from a large spill could include the short-term loss of employment, income, and property value; increased traffic congestion; increased cost of public service provision; and possible shortages of commodities or services. Short-term, localized impacts could include cleanup expenditures and employment created in cleanup and remediation activities. Longer-term impacts could affect commercial fishing and/or tourism and recreation if these activities were to suffer due to the real or perceived impacts of the spill, and could include substantial changes to the energy industries in the region as a result of the spill.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Unexpected CDE	The impacts would range from **minor** to **moderate**. A CDE could result in the loss of employment, income, and possible shortages of commodities or services in both coastal and inland areas affected by the spill. Losses of property value could occur in coastal communities, with increased cost of local public service provision also possible. In the short term, impacts measured in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities would be expected to be large. Longer-term impacts would likely be small, unless recreational activities and tourism suffered as a result of the real or perceived impacts of the CDE, or if there were substantial changes to energy production in the region as a result of the accidental spill.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, population, employment, and income could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur. In addition, none of the net benefits identified under the proposed action would occur.			

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Alternative 1 – Land Use and Infrastructure				
Routine Operations	Impacts would be associated with incompatibility with local land use/comprehensive planning patterns, incompatibility with existing/planned development, loss of use (intended or perceived) to existing landowners or users, and potential changes to the physical and/or infrastructural composition of the coast.	**Negligible** to **minor** impacts. Existing infrastructure generally would be sufficient to handle exploration and development associated with potential new leases.	**Negligible** to **minor** impacts. Impacts would vary in intensity dependent on specific location within Cook Inlet. The existing infrastructure would help to limit the intensity of the impacts.	**Minor** to **moderate** impacts. Existing land use and infrastructure likely would be able to accommodate new leases. In general, land use changes would be needed only in locations where new onshore pipeline routes would be constructed, and in areas requiring new transportation networks.
Expected Accidental Oil Spills	Accidental spills could have both direct and indirect effects on land use, development patterns, and existing infrastructure, depending on the type, size, location, and duration of the incident.	Impacts on land use and existing infrastructure typically would be **minor** and **negligible** for very small spills.	Impacts would be **minor** and associated with demands on local communities to support cleanup activities and with land use restrictions.	Impacts would be **minor** and associated with demands on local communities to support cleanup activities and with land use restrictions.
Unexpected CDE	A CDE could affect land use, development patterns, and the infrastructure composition of affected areas.	**Minor** to **moderate** impacts. Major impacts would not be expected, in part because existing infrastructure is in place in some locations to address this type of event, limiting the potential for much larger effects to occur.	**Moderate** impacts. Major impacts would not be expected, in part because existing infrastructure is in place in some locations to address this type of event, limiting the potential for much larger effects to occur.	**Moderate** to **major** impacts. There is limited existing infrastructure in place in the Arctic to address this type of event. Impacts would be greater in areas with little infrastructure in place to handle accidents and where a greater reliance is placed on coastal activities for subsistence.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, land use and infrastructure could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			
Alternative 1 – Commercial and Recreational Fisheries				
Routine Operations	Impacts are expected to be **minor**. Routine operations could cause temporary changes in the distribution or abundance of fishery resources, reduce the catchability of fish or shellfish, preclude fishers from accessing viable fishing areas, or cause loss of or damage to equipment or vessels.	No population-level effects or long-term loss of fishery resources are expected to result in the GOM.	No population-level effects or long-term loss of fishery resources are expected to result in Cook Inlet.	Commercial and recreational fisheries in the Beaufort Sea and Chukchi Sea Planning Areas are relatively small and localized. Impacts on these fisheries are unlikely.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Expected Accidental Oil Spills	Impacts from small spills would be negligible, while those for large spills could range up to **moderate**. A large spill would likely affect only a small proportion of a given fish population, and long term effects would not be expected. Large spills result in localized reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods, and reduced recreational fishing due to fish tissue contamination, degradation of aesthetic values that attract fishers, and temporary closure of fishing areas. Oil from large spills could contact intertidal habitat and contaminate or reduce the abundance of commercial and recreational species that depend on such habitats. Impacts from a large spill could be long-term, but are not expected to result in the long-term loss of fishery resources.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.
Unexpected CDE	Impacts are expected to be **moderate**. Impacts to fisheries would be similar to those identified for expected accidental spills, but a larger proportion of a fish population could be affected, and impacts could be much more long-term in duration.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. However, if a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, commercial and recreational fisheries could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			
Alternative 1 – Tourism and Recreation				
Routine Operations	Routine operations would have **minor**, short-term negative effects on recreation and tourism, with potential adverse aesthetic impacts on sightseeing, boating, fishing, and hiking activities.	Routine operations could have **minor**, positive impacts on diving and recreational fishing in the GOM coast.	No additional area-specific impacts expected.	No additional area-specific impacts expected.
Expected Accidental Oil Spills	Small spills could have **negligible** to **minor** impacts, while large spills could have **minor** to **moderate** impacts. Temporary impacts could occur if a spill reaches a beach or other recreational- or subsistence-use areas.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Unexpected CDE	A CDE could result in **minor** to **moderate** impacts, and effects may include beach and coastal access restrictions; restrictions on visitation, fishing, or hunting while cleanup is being conducted; and aesthetic impacts associated with the event itself and with cleanup activities. These impacts are expected to be temporary. Longer-term impacts may be substantial if tourism were to suffer as a result of the real or perceived impacts of the CDE, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, tourism and recreation could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Alternative 1 – Sociocultural Systems				
Routine Operations	Routine operations may affect community structure and composition as well as subsistence patterns, and increase cultural and social stress. Impacts may include effects on resources that support subsistence, commercial and recreational fisheries, tourism, recreation, and elements of quality of life, and economic losses.	Routine operations may be expected to have **minor** impacts on the sociocultural systems of the region. Expansion of deepwater development could lead to longer offshore work shifts, which could increase stress to workers, families, and communities.	No more than **minor** impacts on sociocultural systems are expected. Any oil and gas development would be supported primarily by existing workforce infrastructure. Access restrictions to subsistence and commercial marine resources would be short-term and localized.	Potential impacts can range from **minor** to **moderate**. Noise from exploration and production activities may displace marine mammal subsistence resources, making them more difficult to harvest. Development could also result in the short-term disturbance of, or restriction of access to, fish and wildlife subsistence resources. An influx of oil and gas workers from outside the local area could result in social and cultural stress on local predominantly Alaska Native communities, depending on the proximity of new support facilities and infrastructure to existing communities.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Expected Accidental Oil Spills	Impacts may include effects on resources that support subsistence, commercial and recreational fisheries, tourism, recreation, and elements of quality of life, and economic losses.	Small offshore spills would result in **minor** impacts while small coastal spills could have **moderate** impacts on subsistence. The impact of a large spill would vary from **moderate** to **major**. Temporary access restrictions to fisheries could result in **moderate** impacts from short-term economic and social stress. Spills that affect the viability of some resources could result in major impacts associated with long-term economic and social stress.	Impacts would range from **minor** to **major**. Because portions of the planning area are relatively confined, releases are more likely to reach the shore and important intertidal and estuarine zones. Small spills are likely to have **minor** to **moderate** impacts. A large spill reaching areas with subsistence resources could render those resources unsuitable for harvest and result in **moderate** impacts. Long-term loss of resources would not be expected.	Small spills are likely to have temporary **minor** impacts on subsistence fish and wildlife resources. A large spill could disrupt marine mammal subsistence harvests, which would have **major** impacts to food security and cultural continuity. Impacts of a large spill would be **major** if intertidal zones, lagoons, and estuaries that support locally important subsistence resources (e.g., fish, waterfowl, mollusks) were oiled.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Unexpected CDE	Impacts would be similar in nature to those identified for expected accidental spills, but would be more widespread and of longer duration.	Local and regional economies may be disrupted, and long-term closures of fisheries may result in social and cultural stress, and possible social pathologies. Small communities along the coast that depend to some extent on subsistence harvesting would see **moderate** to locally **major** impacts from the loss of some measure of food security.	Impacts would be **major** and long-lasting. There would be unavoidable impacts on subsistence and commercial harvesting of marine resources. The influx of population as part of the cleanup workforce would place stress on local communities. Loss of income and prolonged litigation is likely to create community divisions and lead to sociopathic behavior. Loss of subsistence resources could threaten the continuation of traditional culture in Alaska Native communities.	**Major** impacts to sociocultural systems and subsistence would be expected, primarily associated with impacts to subsistence resources (especially marine mammals) and subsistence harvests. In general, the impacts would be **major** not only for the villages along the northern coast, but for all communities that depend on the sea mammals, fish, and birds that migrate to or through the Chukchi and Beaufort Seas and their shores. Subsequent cleanup activities could also displace some subsistence resources and hunters. The associated influx of cleanup workers is likely to overwhelm the resources of local communities and could result in cross-cultural conflicts.
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, sociocultural systems could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Alternative 1 – Environmental Justice				
Routine Operations	Environmental justice could be affected if any adverse health and environmental impacts are high and disproportionately affect minority and low-income populations.	Impacts to environmental justice are expected to be **negligible**. Anticipated new levels of infrastructure use and construction would be similar to those that have already occurred along the GOM coast during previous programs. Routine operations are not expected to expose residents to notably higher risks than currently occur. Air emissions from the proposed program are not expected to result in air quality impacts on minority or low-income populations, with emissions from the proposed program not being expected to exceed the National Ambient Air Quality Standards (NAAQS) in any affected area.	Impacts are expected to be **minor**. Much of the Alaska Native population in the Cook Inlet region resides in the coastal areas, and any new onshore and offshore infrastructure occurring under the Program could be located near these populations or near areas where subsistence hunting occurs. Any adverse environmental impacts on fish and mammal subsistence resources from Program infrastructure and routine operations could result in health or environmental justice impacts on Alaska Native populations.	Impacts are expected to be **minor**. Much of the Alaska Native population in the Arctic region resides in the coastal areas. Any new onshore and offshore infrastructure occurring under the Program could be located near these populations or near areas where subsistence hunting occurs. Any adverse environmental impacts on fish and mammal subsistence resources from new infrastructure and routine operations could result in health or environmental justice impacts on Alaska Native populations.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Expected Accidental Oil Spills	Accidental spills could disproportionately expose minority and low-income populations and result in adverse health and environmental impacts.	Small spills would have **negligible** to **minor** impacts, while large spills would have **minor** to **moderate** impacts. Impacts from accidental oil spills expected in the GOM would not raise additional environmental justice concerns because of the movement of oil and gas activities farther away from coastal areas and the demographic pattern of more affluent groups (and fewer low-income and minority populations) living in coastal areas.	Small spills would have **negligible** to **minor** impacts, while large spills that affect subsistence resources could have **moderate** to **major** impacts on the Alaska Native population, particularly if the subsistence resources were diminished or tainted as a result of the spill.	Small spills would have **negligible** to **minor** impacts, while large spills that affect subsistence resources could also have **moderate** to **major** impacts on the Alaska Native population, particularly if the subsistence resources were diminished or tainted as a result of the spill.
Unexpected CDE	A CDE could have **moderate** to **major** impacts on low-income and minority communities, although the magnitude of impacts of a CDE would partly depend on the location, size, and timing of the event.	The long-term impacts of a CDE on low-income and minority communities are unknown.	Long-term impacts to subsistence resources may be expected, and these may lead to longer and greater environmental justice impacts. Mitigation measures, cooperative agreements between Native and industry groups, and government-to-government consultations are designed to limit the effects from oil spills and routine operations.	Long-term impacts to subsistence resources may be expected, and these may lead to longer and greater environmental justice impacts. Mitigation measures, cooperative agreements between Native and industry groups, and government-to-government consultations are designed to limit the effects from oil spills and routine operations.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, there could be environmental justice concerns, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			
Alternative 1 – Archeological and Historic Resources				
Routine Operations	Impacts could range from **negligible** to **major** depending on the presence of significant archaeological or historic resources in the area of potential effect. Archaeological and historic resources (especially offshore resources) may be affected by platform and pipeline construction and by dredging, which could damage or destroy affected resources. Onshore impacts (resource damage or loss; visual impacts) are possible from pipeline landfall, onshore pipeline, and road construction. Anchor drags could affect seafloor resources such as shipwrecks. Most resources are expected to be avoided.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.

TABLE 2.11-2 (Cont.)

Alternatives and Resource	Program Impacts Common to All OCS Planning Areas	Additional Impacts Specific to the GOM Planning Areas	Additional Impacts Specific to the Cook Inlet Planning Area	Additional Impacts Specific to the Arctic Planning Areas
Expected Accidental Oil Spills	Accidental oil spills could result in **minor** to **major** impacts to archaeological and historic resources, depending on the number of resources affected and the significance and uniqueness of the resources damaged or lost. As spill sizes increase, the number and likelihood of sites that could be affected increases.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.
Unexpected CDE	Impacts could range from **minor** to **major**, depending on the location, size, and duration of the CDE; the effectiveness of cleanup activities; and the significance and uniqueness of the resources affected. Local funds for archaeological and historic resources projects could be diverted to cleanup activities for a CDE.	No additional area-specific impacts expected.	No additional area-specific impacts expected.	No additional area-specific impacts expected.
Alternatives 2-7 – Exclusion of Individual Planning Areas	Under each alternative, impacts of routine operations would be similar in nature and magnitude to the impacts identified under Alternative 1 except that no impacts would be expected in the excluded planning areas. Impacts from accidental oil spills and a CDE would be similar to those identified for Alternative 1, except none would be expected for the excluded planning area. If a large spill or a CDE were to occur in an adjacent planning area and reach the excluded planning area, archeological and historic resources could be affected, and impacts would be similar to those identified for the planning area under Alternative 1.			
Alternative 8 – No Action	None of the potential impacts associated with routine operations and accidental oil spills under Alternative 1 would occur.			

3 AFFECTED ENVIRONMENT

3.1 INTRODUCTION

This programmatic environmental impact statement (PEIS) evaluates eight alternatives: the proposed action, six alternative actions, and a No Action Alternative. The proposed action would establish a 2012-2017 Outer Continental Shelf (OCS) Oil and Gas Leasing Program (the Program) that includes three planning areas in the Gulf of Mexico (GOM) (the Western and Central GOM Planning Areas, as well as a small portion of the Eastern GOM Planning Area), two planning areas in the Arctic (the Beaufort and Chukchi Sea Planning Areas), and Cook Inlet in south central Alaska. Each of the alternatives is identical to the proposed action, except that one of the six planning areas included in the proposed action is deferred from consideration for the duration of the Program; a different planning area is deferred in each alternative. Chapter 3 describes the nature and condition of natural, physical, and socioeconomic resources in these planning areas that may be affected by the Program in these planning areas.

Information regarding each resource presented in Chapter 3 and evaluated for potential impacts in Chapter 4 is presented as follows. Each resource is presented separately. For each resource, the nature and condition of the resource is provided in three groupings, based on the geographic settings of the planning areas included in the proposed action — the GOM, Cook Inlet, and Arctic Alaska. As applicable, the effects of the Deepwater Horizon spill (DWH event) on the baseline conditions of a resource are discussed, and a description is provided of potential changes in baseline conditions from climate change over the 40- to 50-yr expected period of oil and gas activities anticipated for the Program. Some information is currently unavailable, particularly with regard to affected environmental baseline changes; however, this information is not crucial in order to make a reasoned choice among alternatives at this programmatic stage (see Section 1.4.2, Incomplete and Unavailable Information).

3.2 MARINE AND COASTAL ECOREGIONS

With the exception of the Cook Inlet Planning Area, the planning areas being considered for leasing under the Program cannot be readily delineated from adjacent planning areas on the basis of clear, distinct geographical or physical boundaries. Except for topographical features associated with coastlines, the boundaries of the OCS planning areas are artificial administrative boundaries on the open oceans (Figure 3.2-1) drawn with no intended relationship to underlying ecologic, oceanographic, or other processes affecting environmental conditions on the OCS and in adjacent coastal areas. Many natural resources, as well as physical features such as currents, freely cross the boundaries of adjacent planning areas, the boundaries between the OCS and adjacent marine waters seaward of the United States Exclusive Economic Zone (EEZ), and the boundaries between coastal waters shoreward of the administrative boundary that separates State and Federal jurisdiction. As a consequence, it would be too restrictive to describe many of the natural and physical resources, or to discuss the potential effects of oil and gas development on those resources, solely on a one-by-one planning area basis. Instead, the PEIS uses marine and coastal ecoregions as a spatial framework to incorporate the areas potentially affected directly by

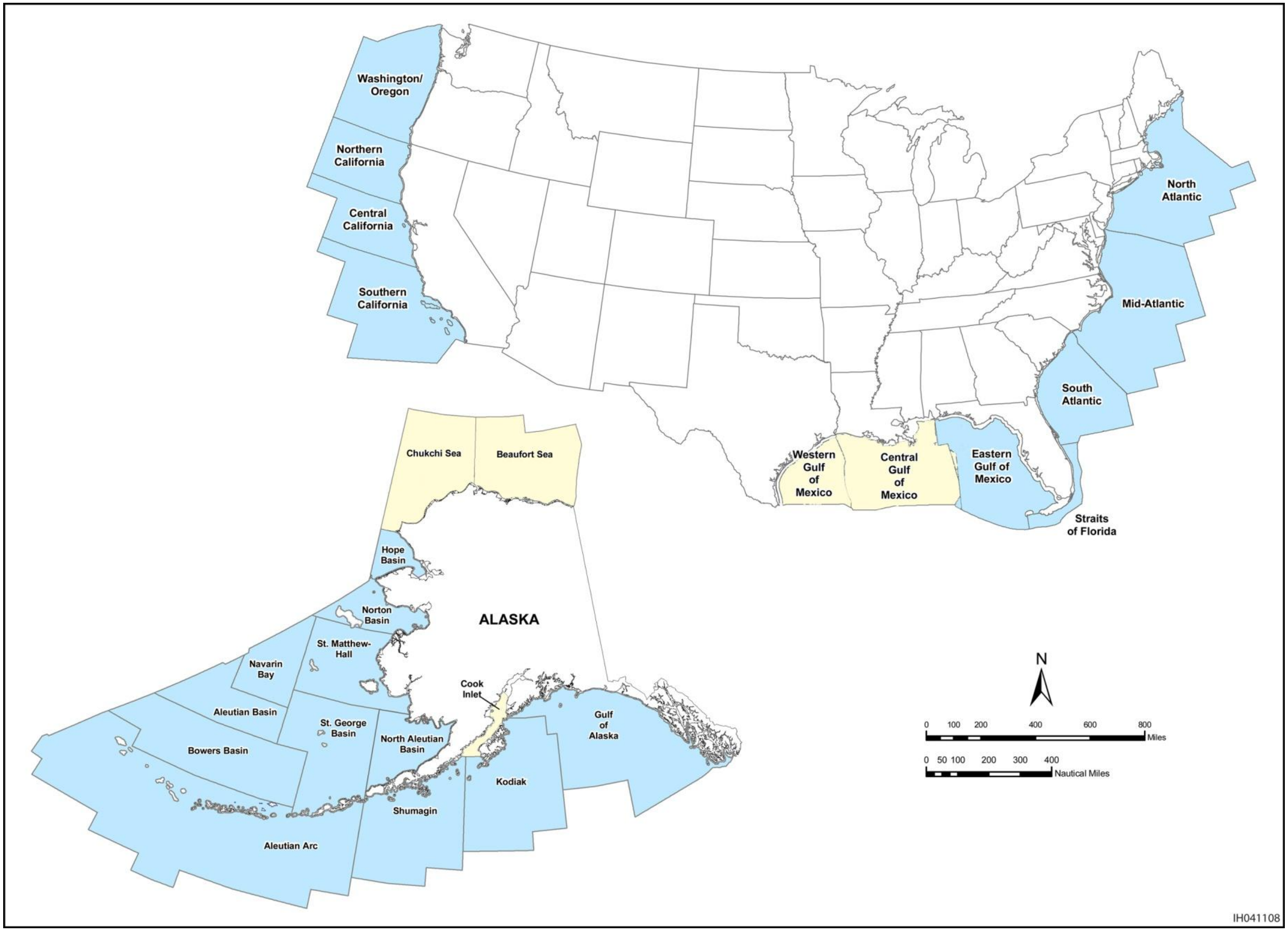

FIGURE 3.2-1 OCS Planning Areas

OCS activities within planning area boundaries as well as areas beyond the planning areas that could be affected by OCS impacts through the action of ecological and physical processes that operate at an ecoregional scale.

An ecoregion is an ecologically and geographically defined area that contains characteristic geographically distinct assemblages of natural communities and species which tend to be distinct from those in other ecoregions (McMahon et al. 2001; Omernik 2004; Bailey 2005). In terrestrial systems, individual ecoregions are associated with characteristic combinations of land forms and geologic, hydrologic, and climatic conditions (Omernik 1987, 2004). Many Federal agencies and private organizations manage terrestrial resources using land classifications based on the ecoregion concept (e.g., see http://www.fs.fed.us/rm/ecoregions).

The PEIS uses marine and coastal ecoregions to define areas being considered in this and subsequent chapters. Marine ecoregions are defined according to the boundaries of Large Marine Ecosystems (LMEs) developed by the National Oceanic and Atmospheric Administration (NOAA) (LMEW 2009). In particular, this PEIS uses the boundaries of the GOM, Chukchi Sea, Beaufort Sea, and Gulf of Alaska LMEs to define the marine areas that include the OCS Planning Areas considered in Chapters 3 and 4. NOAA developed the LME concept and established the LME program in 1984 as a tool for enabling an ecosystem-based approach to transboundary ecosystem-based science and management. The PEIS uses the LME boundaries to define the areas of analytic interest in the document based on ecologically important distinctions rather than political or administrative boundaries. The PEIS also uses the marine and coastal ecoregions developed by the Commission for Environmental Cooperation (CEC) for North America (Wilkenson et al. 2009) to subdivide the areas defined by the LME boundaries into more localized regional distinctions, where appropriate. The coastal ecoregions are also used to characterize coastal and nearshore areas.

For many environmental resources addressed in this PEIS, the descriptions of the affected environment, as well as the evaluations of possible environmental consequences associated with oil and gas activities, use locations within ecoregions rather than individual OCS planning areas as a spatial reference. The PEIS adopts this approach to facilitate a broader scale ecosystem perspective on the analysis of potential environmental effects of oil and gas activities on the OCS following lease sales under the Proposed Action Alternative. A narrowed planning area perspective is more appropriate for an EIS prepared at the lease sale or project development stages of oil and gas activities on the OCS. Adoption of a broader ecoregional perspective is intended to facilitate the National Environmental Policy Act of 1969 (NEPA) process of tiering by which programmatic analyses are intended to inform and provide context for the more geographically focused and detailed environmental analyses and reviews that will occur later under the Program.

The coastal and marine ecoregions identified in this section make up areas of interest for this PEIS. The evaluations and analyses in this and subsequent chapters will consider the potential effects of oil and gas activities on the OCS within these broad areas. The geographic scope of these analyses will vary depending on the issues being considered. Examples of specific areas of interest that could be applied to different analyses include:

1. Individual OCS Planning Areas and nearby coastal and marine areas where program-related activities could occur and directly affect local natural resource.
   – *Example Issue*: The effects of OCS-related bottom-disturbing activities (such as pipeline trenching) on benthic habitats.

2. Areas outside of OCS Planning Areas where environmental impacts may extend beyond program area boundaries through the action of ecoregion-scale physical and ecological processes.
   – *Example Issue*: Population effects on marine fauna from a very large oil spill as it is transported from a release location by ocean currents and winds.

3. Areas outside the OCS Planning Areas that contribute to and affect marine and coastal environmental baseline conditions and would need to be considered in the analysis of cumulative effects.
   – *Example Issue*: The influence of the Mississippi River drainage basin and discharge on water quality and coastal and marine habitats in the GOM.

3.2.1 Large Marine Ecosystems

LMEs are relatively large regions of coastal oceans of approximately 200,000 km^2 (77,220 mi^2) that include waters from river basins and estuaries to the seaward boundaries of continental shelves and/or seaward margins of coastal currents and water masses. They are characterized on the basis of ecological (as opposed to political) criteria, including bathymetry, hydrography, productivity, and trophic relationships. Sixty-four distinct LMEs have been delineated around the coastal margins of the Atlantic, Pacific, Arctic, and Indian Oceans (Sherman et al. 2007; LMEW 2009).

The OCS Planning Areas being considered for leasing under the Program addressed in this PEIS occur within four LMEs. The Cook Inlet Planning Area occurs in the Gulf of Alaska LME #2 (Figure 3.2.1-1); the Beaufort Sea Planning Area occurs within the Beaufort Sea LME #55; and the Chukchi Sea Planning Area occurs within the Chukchi Sea LME #54 (Figure 3.2.1-2). The Western, Central, and Eastern GOM Planning Areas occur within the GOM LME #5 (Figure 3.2.1-3). For the purposes of this PEIS, the LMEs are used solely to provide a spatial context for the planning areas considered for leasing in the Program. The following sections provide brief summary descriptions of these LMEs.

3.2.1.1 Gulf of Alaska Large Marine Ecosystem

The Gulf of Alaska LME lies along the southern coast of Alaska and the western coast of Canada (Figure 3.2.1-1), and has an area of approximately 1.5 million km^2 (569,450 mi^2), of which about 1.5% (22,500 km^2 [8,540 mi^2]) is protected (Aquarone and Adams 2009). The Cook Inlet Planning Area occupies about 1.5% of the Gulf of Alaska LME. This LME is

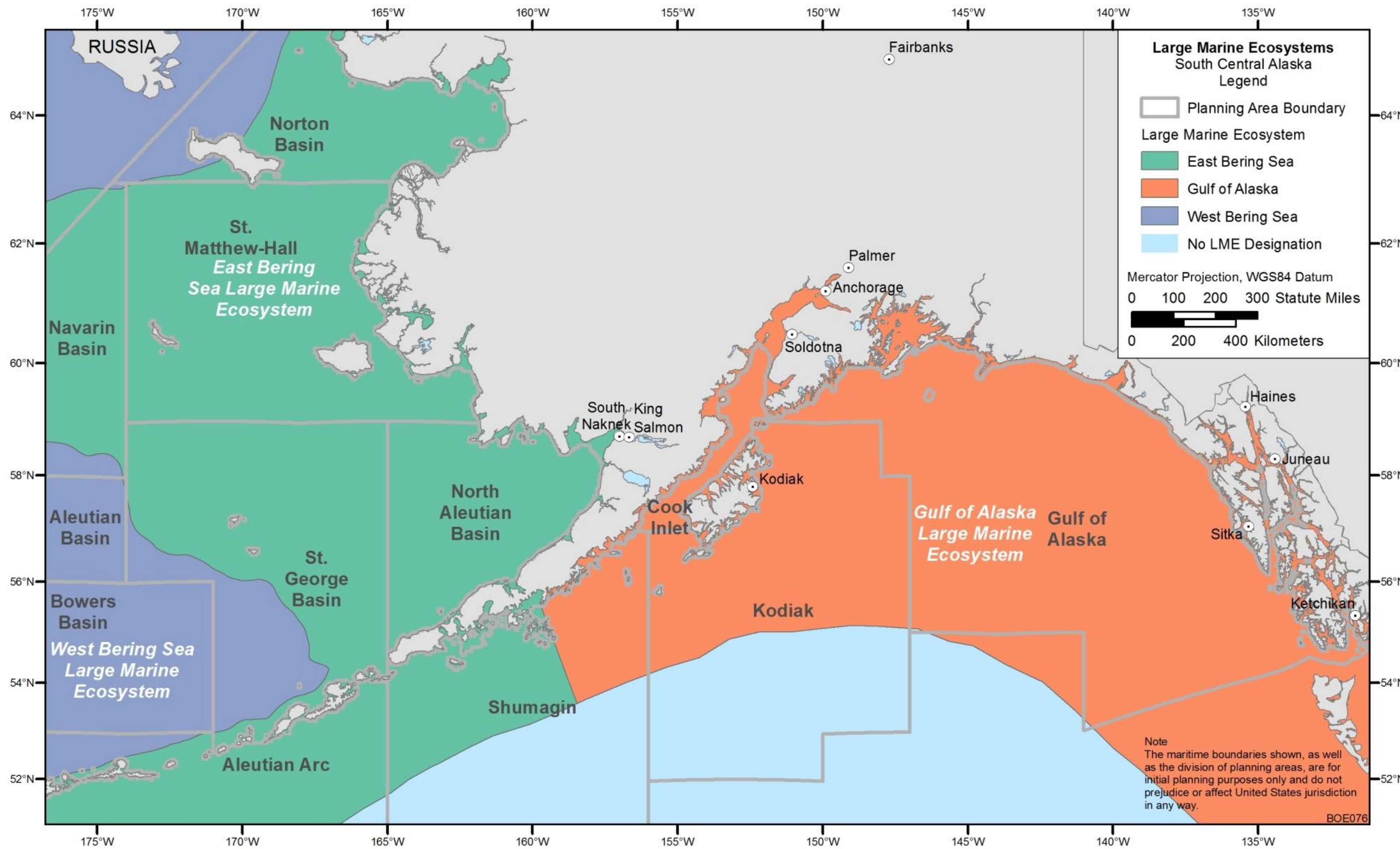

FIGURE 3.2.1-1 Large Marine Ecosystems for Southern Alaska (modified from Wilkenson et al. 2009)

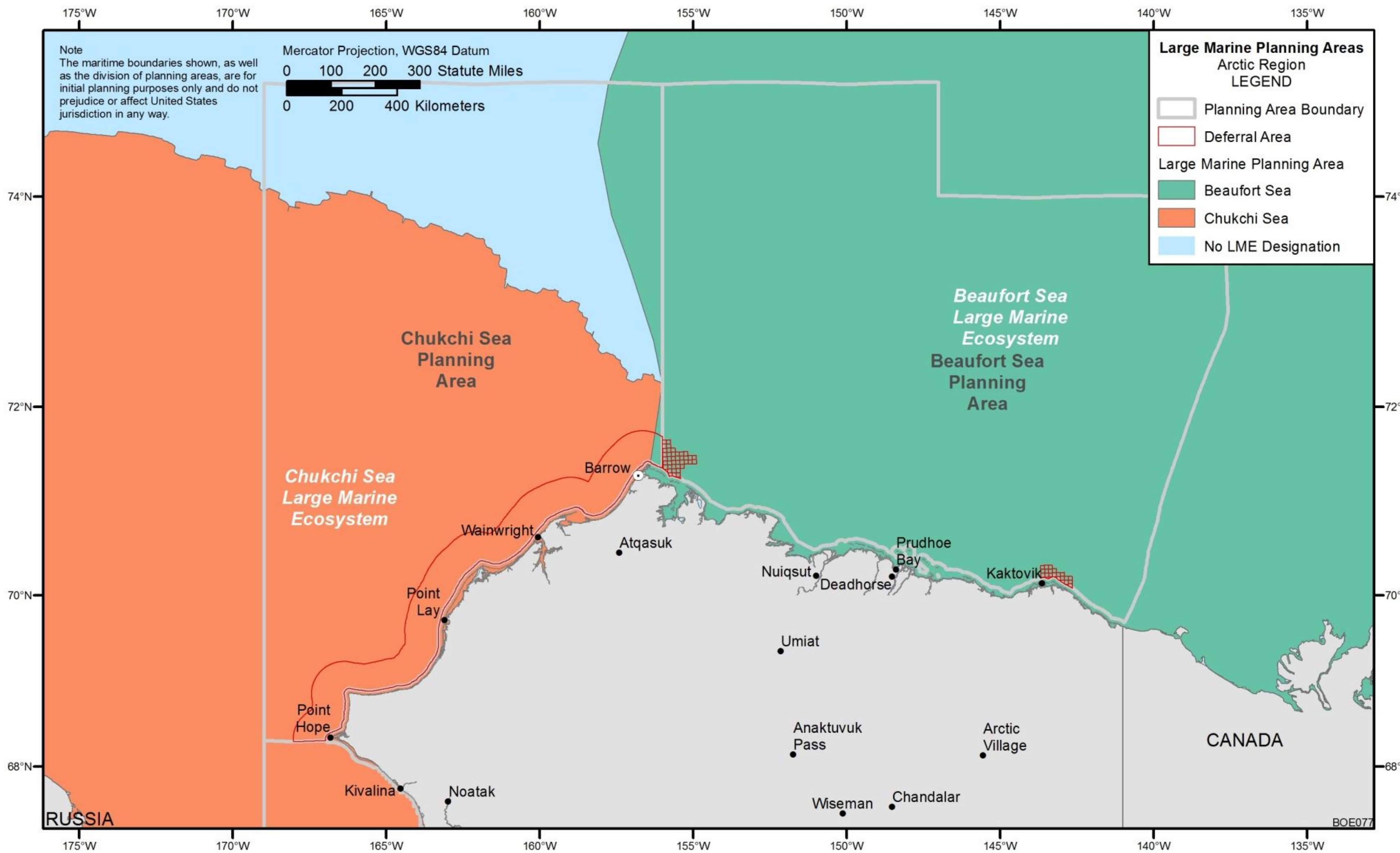

FIGURE 3.2.1-2 Large Marine Ecosystems for Arctic Alaska (modified from Wilkenson et al. 2009)

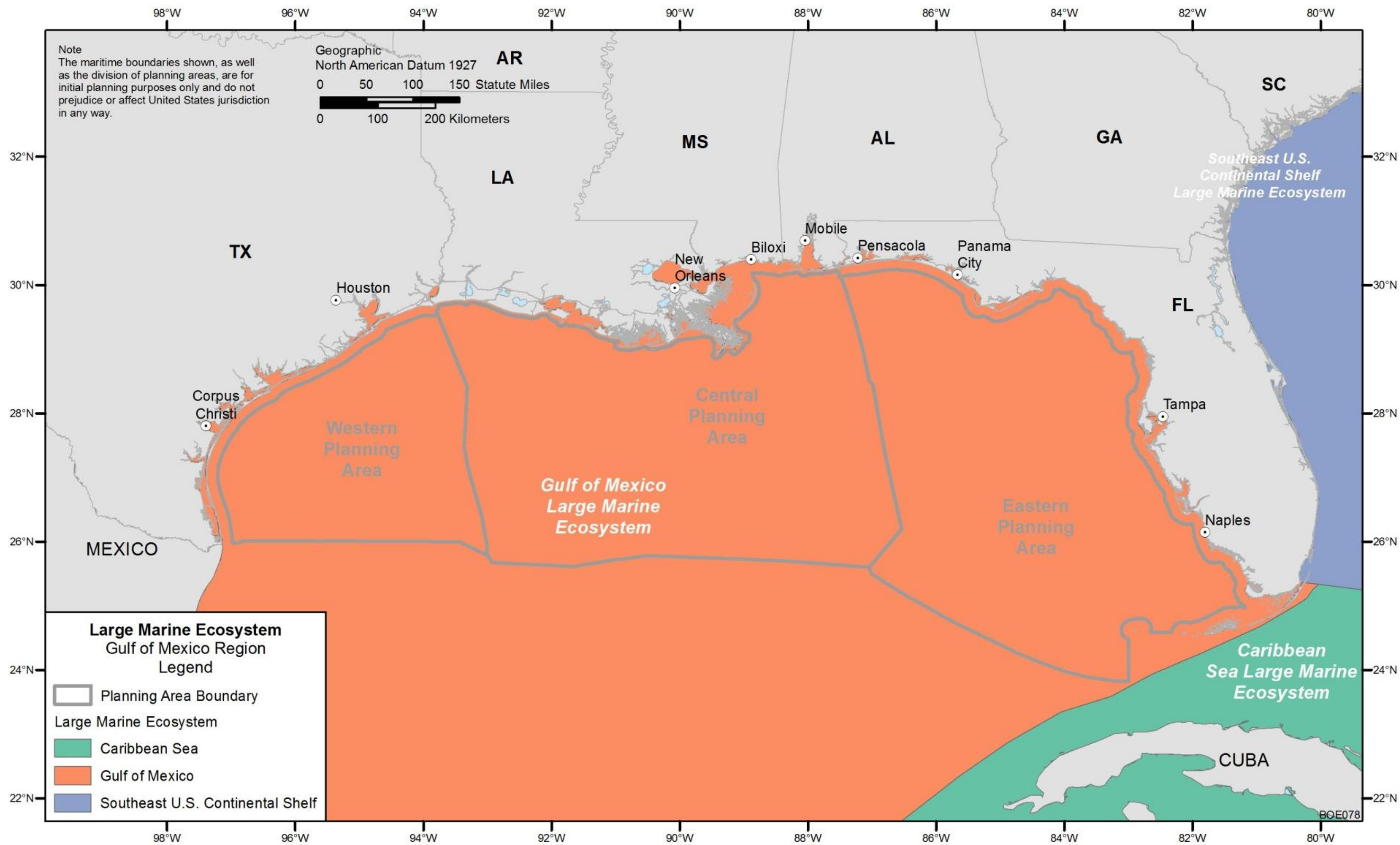

FIGURE 3.2.1-3 Large Marine Ecosystems for the GOM (modified from Wilkenson et al. 2009)

separated to the west from the East Bering Sea LME by the Alaska Peninsula and to the south borders the California Current LME. There are 14 estuaries and river systems, including the Stikine and Copper Rivers, Cook Inlet, and Prince William Sound in the Gulf of Alaska LME.

3.2.1.2 Beaufort Sea Large Marine Ecosystem

The Beaufort Sea LME occurs along the Arctic coast of Alaska and northwestern Canada (Figure 3.2.1-2) and covers about 770,000 km^2 (297,300 mi^2), of which about 0.02% (154 km^2 [59 mi^2]) is protected (Belkin et al. 2009). The Beaufort Sea Planning Area occupies about 34% of the Beaufort Sea LME, and future oil and gas leasing activities are anticipated to be restricted to the coastal shelf areas of this LME. The Beaufort Sea LME is characterized by an Arctic climate with major annual and seasonal changes, and historically is ice-covered much of the year.

3.2.1.3 Chukchi Sea Large Marine Ecosystem

The Chukchi Sea LME is located off of Russia's East Siberian coast and the northwestern coast of Alaska (Figure 3.2.1-2). This LME is a relatively shallow marginal sea with a surface area of about 776,643 km^2 (299,820 mi^2), of which about 5.4% (42,000 km^2 [16,190 mi^2]) is protected (Heileman and Belkin 2009). The Chukchi Sea Planning Area occupies about 33% of this LME. This LME is characterized by an Arctic climate with major seasonal and annual changes, in particular, the annual formation and deformation of sea ice.

3.2.1.4 Gulf of Mexico Large Marine Ecosystem

The GOM LME is a deep marginal sea bordered by Cuba, Mexico, and the United States (Figure 3.2.1-3). The GOM is the largest semi-enclosed coastal sea in the western Atlantic, encompassing about 1,500,000 km^2 (579,150 mi^2) (Heileman and Rabalais 2009). The Central GOM Planning Area comprises about 18%, the Western GOM Planning Area about 8%, and the Eastern GOM Planning Area about 17% of the total area of this LME. About 1.6% (24,000 km^2 [9,090 mi^2]) of the GOM LME is protected, and it contains about 0.5% of the world's coral reefs. The continental shelf comprises about 30% of this LME, and the coastal areas contain more than 750 estuaries, bays, and sub-estuaries that are associated with 47 major estuaries (USEPA 2008; Heileman and Rabalais 2009). This LME is strongly influenced by freshwater input from rivers (especially the Mississippi River), which accounts for about two-thirds of the flows into the GOM (Figure 3.2.1-4), and tropical storms (i.e., hurricanes) (Figure 3.2.1-5) are a major climatological feature of the area (Heileman and Rabalais 2009). Important hydrocarbon seeps occur in the southernmost and northern portions of the LME.

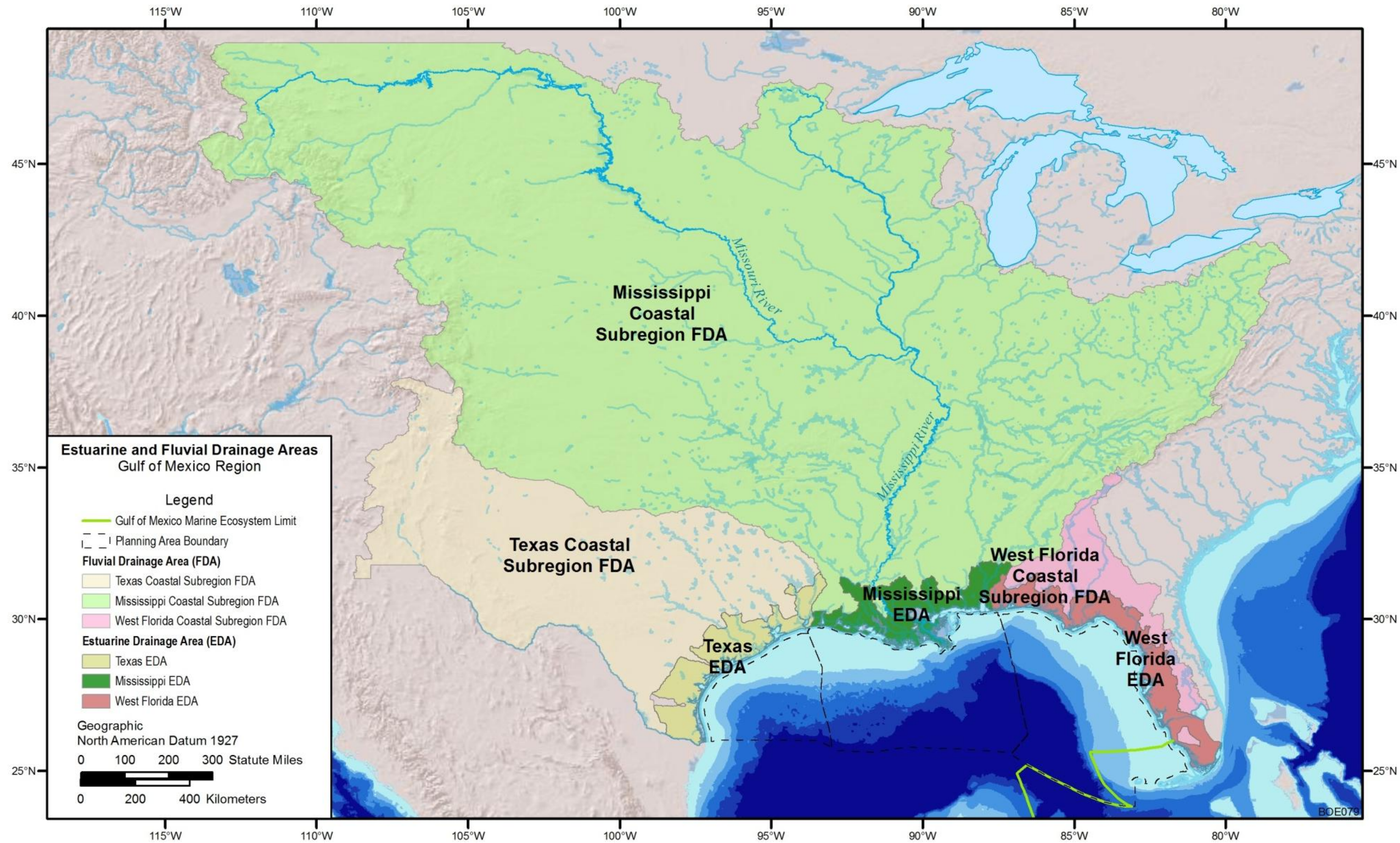

FIGURE 3.2.1-4 Estuarine and Fluvial Drainage Areas of the Northern GOM

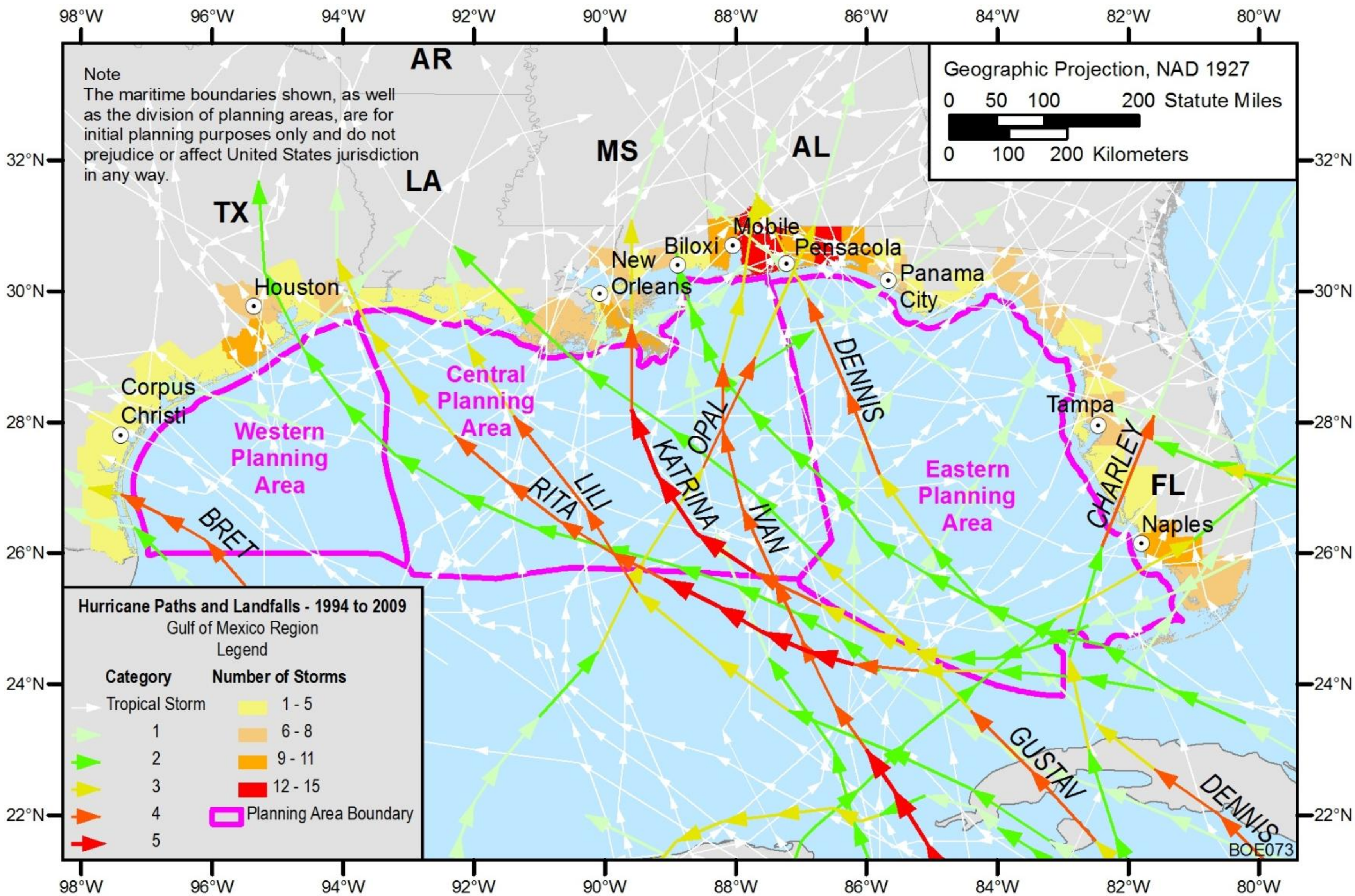

FIGURE 3.2.1-5 Tropical Storm Paths in the Northern GOM

3.2.2 Marine and Coastal Ecoregions of North America

As shown in Figures 3.2.1-1, 3.2.1-2, and 3.2.1-3, the four LMEs that encompass the OCS Planning Areas addressed in this PEIS are very large, and reflect marine ecosystem differences at their largest scale. Thus, their use in assessing the potential effects of oil and gas development activities to marine resources within individual LMEs would be similarly restricted to very large scale evaluations. The LMEs may be further examined on finer scales that distinguish ecosystems on the basis of larger physiographic features (e.g., continental slope, shelf, and abyssal plain) as well as on more locally significant conditions (such as local water characteristics, regional landforms, and biological communities). One such sub-LME classification has been developed by the CEC, a tri-national partnership comprised of government agencies, organizations, and researchers from the United States, Canada, and Mexico (see http://www.cec.org). The CEC has classified North American oceanic and coastal waters into 24 marine ecoregions according to oceanographic features and geographically distinct assemblages of species (Wilkinson et al. 2009). The Level II and Level III marine ecoregions developed by the CEC for North America are used in this PEIS to help identify and describe the marine ecosystems and resources that occur in the OCS Planning Areas that may be affected by OCS oil and gas activities under the Program.

Level II ecoregions capture the division between neritic (coastal areas out to a depth of about 200 m [600 ft]) and oceanic areas, and are determined by large-scale physiography (continental shelf, slope, and abyssal plain and also areas of islands and major trenches, ridges, and straits). The Level II classifications reflect the importance of depth as a determinant of benthic marine communities as well as the importance of major physiographic features in determining current flows and areas of upwelling. The Level III ecoregions reflect differences within the neritic areas, and are based on more locally significant variables such as local characteristics of the water mass, regional landforms, and biological community type. The Level III ecoregions are limited to the continental shelf, as only these areas have sufficient information to support finer-scale ecoregion delineations (Wilkinson et al. 2009). The CEC Level II and III marine ecoregions relevant to this PEIS are shown in Figure 3.2.2-1 for the GOM Planning Areas, Figure 3.2.2-2 for the Cook Inlet Planning Area, and Figure 3.2.2-3 for the Chukchi and Beaufort Seas Planning Areas, and are discussed below.

Other efforts have been directed toward developing ecoregions for coastal areas within LMEs (e.g., Yanez-Arancibia and Day 2004). The coastal ecoregions of Yanez-Arancibia and Day (2004) and the CEC marine ecoregions are used together in this PEIS to present an integrated ecosystem-based view of the areas that could be affected by oil and gas activities on the OCS.

The following sections identify the CEC ecoregions associated with each of the OCS Planning Areas addressed in this PEIS. Descriptions of the physical environment and ecological resources in these ecoregions are discussed in the subsequent resource-specific descriptions of the affected environment later in this chapter.

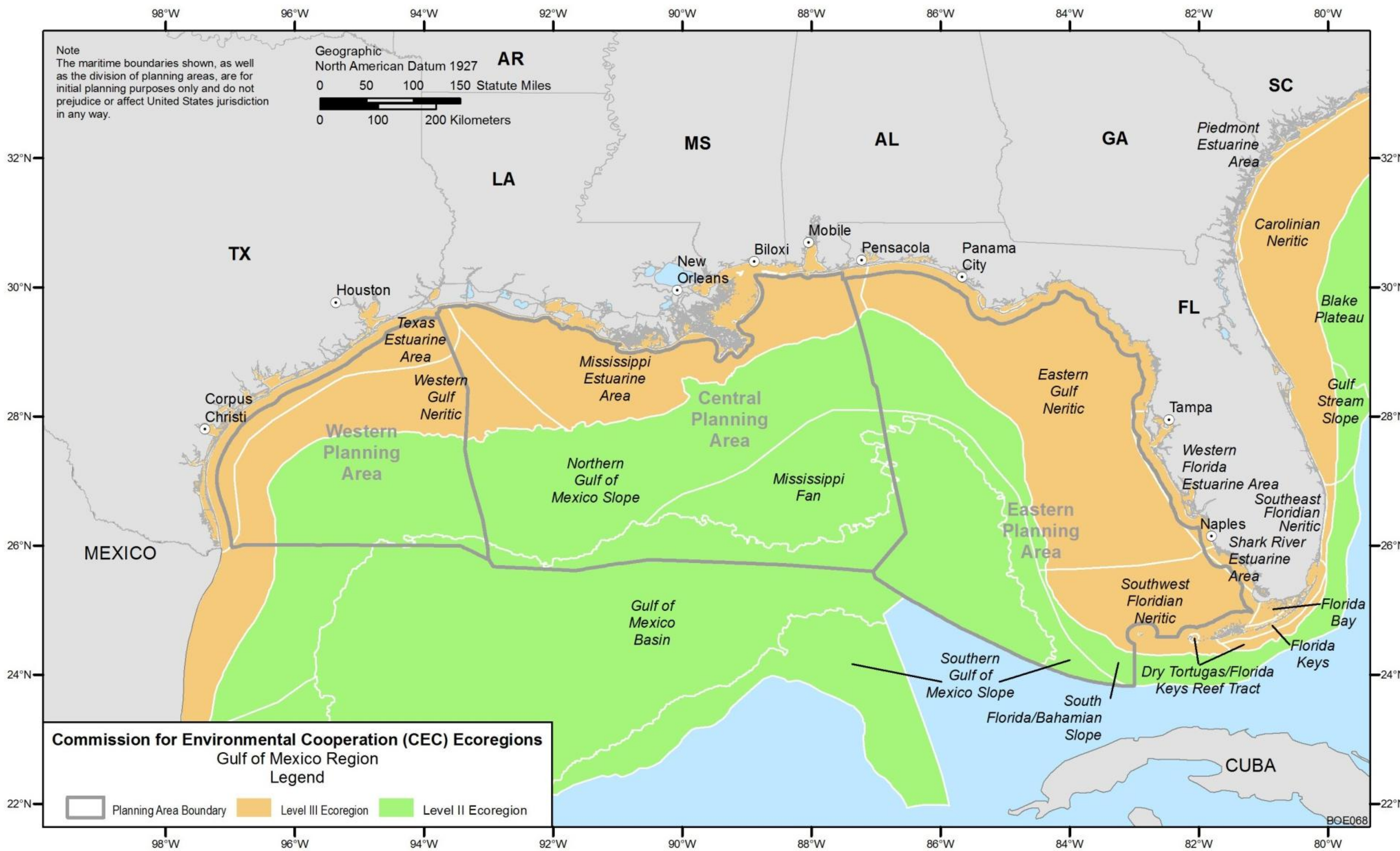

FIGURE 3.2.2-1 CEC Level II and III Marine Ecoregions of the Northern GOM

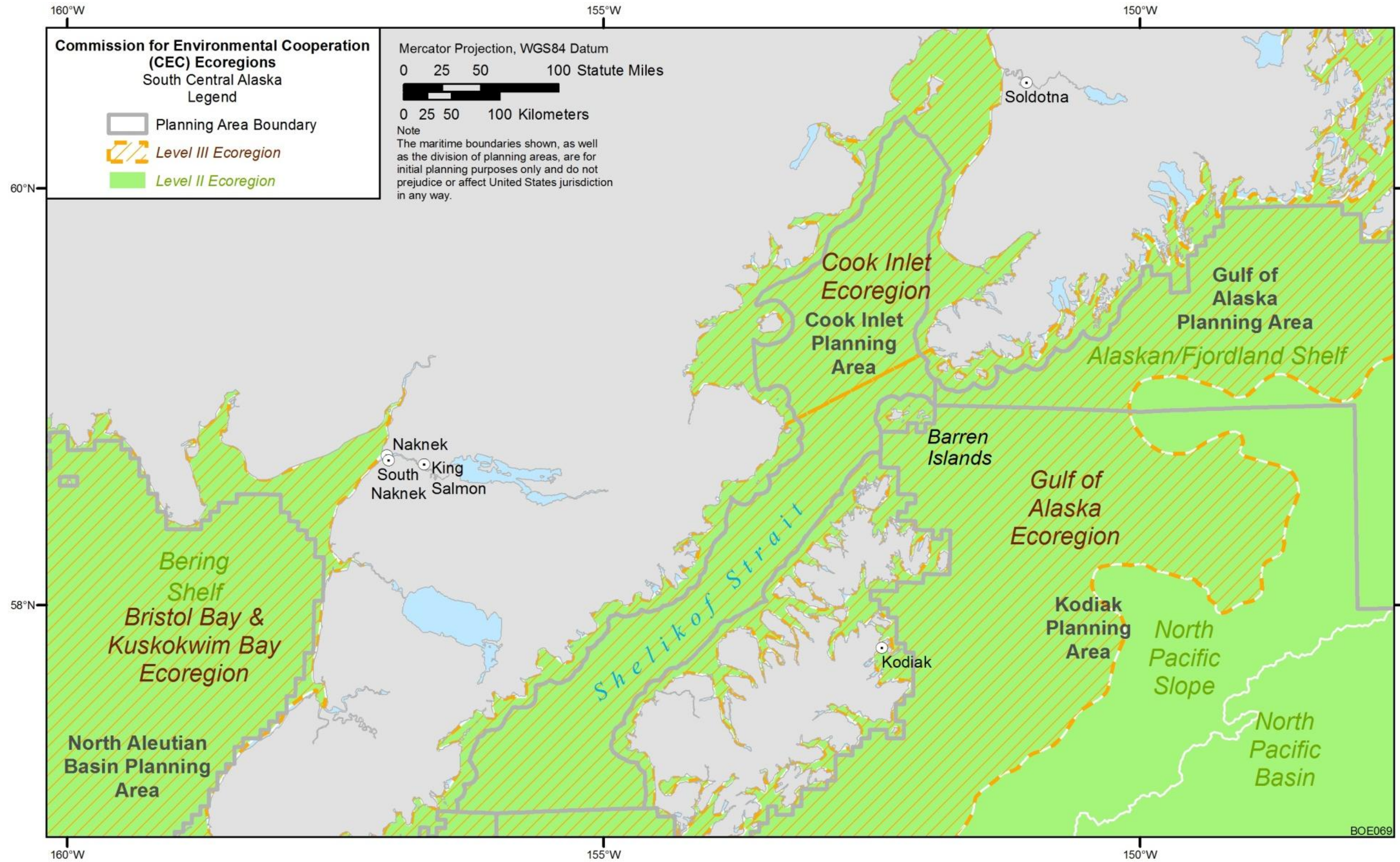

FIGURE 3.2.2-2 CEC Level II and III Marine Ecoregions of South Central Alaska

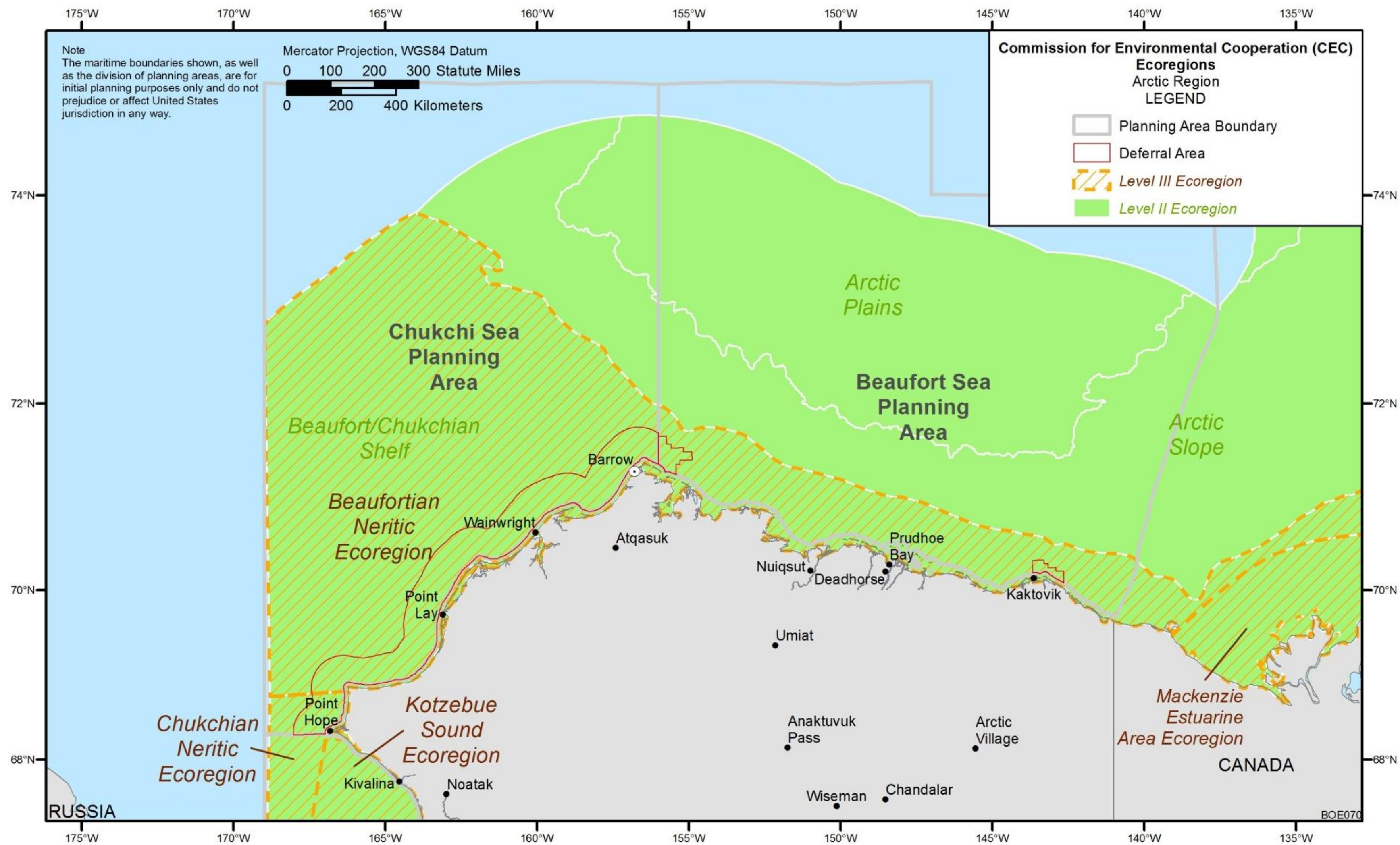

FIGURE 3.2.2-3 CEC Level II and III Marine Ecoregions of Northern Alaska

3.2.3 Ecoregions of the Northern Gulf of Mexico

As previously discussed, the GOM Planning Areas addressed in this PEIS occur within the GOM LME (see Section 3.2.2), which can be subdivided into finer-scale marine ecoregions as described by the CEC and others (Wilkenson et al. 2009). On a geomorphological basis, the GOM Planning Areas include the Northern GOM Shelf and Slope, the Mississippi Fan, and the GOM Basin Ecoregions (Figure 3.2.2-1) (Wilkinson et al. 2009). The following sections present brief overviews of these ecoregions, with more detailed discussions of physical and biological conditions and resources discussed in later sections.

3.2.3.1 Northern Gulf of Mexico Shelf Ecoregion

As indicated by its name, this ecoregion encompasses the continental shelf of the northern GOM and includes about half of the Western, Central, and Eastern GOM Planning Areas (Figure 3.2.2-1). This ecoregion varies in width across the three planning areas, extending as much as 250 km (155 mi) from the coastline in some areas, being narrowest in the vicinity of the Mississippi River Delta eastward to the Florida Panhandle. Water depth extends down to about 200 m (660 ft). Coastal areas of this ecoregion may be further delineated into three estuarine areas, the Texas, Mississippi, and Western Florida Estuarine Areas, and three neritic areas, the Western GOM, Eastern GOM, and Southwest Florida Neritic Areas (Figure 3.2.2-1). These estuarine areas contain as much as 60% of the tidal marshes of the United States and receive inputs from 37 major rivers. Freshwater input (with associated sediment loads) from three major estuarine drainage areas (Figure 3.2.1-4) strongly influences the nature and distribution of habitats and associated biota along the GOM coast.

The physiological and ecological conditions of the shelf in the central portion of the northern GOM are strongly influenced by the Mississippi River and its tributary, the Atchafalaya River (Wilkenson et al. 2009). Drainage from more than 55% of the conterminous United States enters the GOM from the Mississippi River, affecting water quality and substrates of this and other ecoregions (see Section 3.4.1). Increased nutrient and sediment loads from the Mississippi River result in the annual appearance of a large “dead zone” — an area of extremely low oxygen concentration.

Habitats include coastal lagoons and estuaries, tidal freshwater grasses, salt marsh, tidal freshwater marsh flats, intertidal scrub forest, beaches, and barrier islands. The nature and extent of these habitats and the biota they support vary, depending upon location (e.g., western Texas coastline vs. the Chenier Plain, Louisiana, vs. the west coast of central Florida).

3.2.3.2 Northern Gulf of Mexico Slope Ecoregion

This ecoregion extends from the edge of the Northern GOM Shelf Ecoregion to the start of the GOM Basin, with depths ranging from 200 to 3,000 m (660 to 9,800 ft) (Figure 3.2.2-1). This ecoregion extends through all three planning areas, comprising more than half of the

Western and Central GOM Planning Areas and about a quarter of the Eastern GOM Planning Area.

3.2.3.3 Mississippi Fan Ecoregion

The Mississippi Fan Ecoregion extends from the Mississippi River Delta to the central abyssal plain (Figure 3.2.2-1), and is strongly influenced by the outflow of the Mississippi River. The upper part of the fan (to a water depth of about 2,500 m [8,200 ft]) has a complex and rugged topography attributed to salt diapirism,[1] slumping, and current scour; the lower part of the fan by contrast is smooth, with a gently sloping surface that merges with the abyssal plain to the southeast and southwest.

3.2.3.4 Gulf of Mexico Basin Ecoregion

The GOM Basin Ecoregion contains the deepest waters and habitats within the GOM LME. Water depths range from 3,000 to more than 4,300 m (9,800 to more than 14,100 ft). Only a very small portion of the Western GOM Planning Area overlies this ecoregion (Figure 3.2.2-1). In contrast, about a quarter of the Central GOM Planning Area (primarily in its southeastern portion) and about a third of the Eastern GOM Planning Area (primarily its southwestern portion) overlay the GOM Basin Ecoregion.

3.2.4 Ecoregions of the Gulf of Alaska

As discussed earlier, the Cook Inlet Planning Area is located within the Gulf of Alaska LME (Figure 3.2.1-1). Cook Inlet itself is associated with the Alaskan/Fjordland Pacific Level II Ecoregion, which extends from the westernmost end of the Aleutian Islands southward to the northern end of Vancouver Island (Wilkinson et al. 2009). The Cook Inlet Planning Area includes two Level III ecoregions: the Cook Inlet Ecoregion in the upper portion of the planning area and the Gulf of Alaska Level III ecoregion in the lower portion of the planning area (Figure 3.2.2-2). These ecoregions are strongly influenced by the Alaska Current and the Alaska Coastal Current.

3.2.4.1 Alaskan/Fjordland Shelf Level II Ecoregion

The Alaskan/Fjordland Shelf Level II Ecoregion includes fjords, islands, and straits along the Pacific coast from the north end of Vancouver Island to the end of the Alaska Peninsula. The

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1 Salt diapirism refers to a process by which natural salt (mainly halite but also including anhydrite and gypsum) in the subsurface deforms and flows in response to loading pressures from overlying sediments. Because of its low density, salt tends to flow upward from its source bed, forming intrusive bodies known a salt diapir. Salt diapirs are common features of sedimentary basins such as the GOM (Nelson 1991).

shelf is generally narrow, ranging from about 20 km (12 mi) at its southern end to about 160 km (96 mi) along portions of the Alaska Peninsula, and is very narrow in some areas (such as around the Queen Charlotte Islands). The shelf is widest in the vicinity of the Cook Inlet Planning Area. This ecoregion has one of the most productive marine ecosystems in the northern Pacific, primarily as a result of the upwelling of nutrients by the Alaska Gyre (Wilkenson et al. 2009).

3.2.4.2 Gulf of Alaska Level III Ecoregion

The Gulf of Alaska Level III Ecoregion extends about 1,860 km (1,160 mi) along the Gulf of Alaska coast from about the vicinity of Juneau westward to the end of the Alaskan Peninsula at Unimak Pass, and has a width of about 170 km (105 mi) in the vicinity of the Cook Inlet Planning Area. This ecoregion encompasses the lower portion (the Shelikof Strait) of the Cook Inlet Planning Area, from the approximate vicinity of the Barren Islands through the Shelikof Strait to the southern end of Kodiak Island (Figure 3.2.2-2). This ecoregion is strongly influenced by the Alaska Current. The Shelikof Strait portion of this ecoregion and the planning area is about 240 km (150 mi) in length with a width of about 40–50 km (25–30 mi). Physiography of the ecoregion includes rocky coastlines and numerous fjords, islands, and embayments.

3.2.4.3 Cook Inlet Level III Ecoregion

The Cook Inlet Level III Ecoregion includes the northern portion of the Cook Inlet Planning Area, northward from the mouth of Cook Inlet proper (Figure 3.2.2-2). The inlet is about 290 km (180 mi) in length, with a watershed of about 100,000 km^2 (39,000 mi^2). Major tributaries based upon size include the Susitna, Little Susitna, Kenai, Matanuska, Eagle, Crescent, and Johnson Rivers.

3.2.5 Ecoregions of the Alaska Arctic Coast

The Beaufort Sea and Chukchi Sea Planning Areas occur within the two LMEs that encompass the Arctic coast of Alaska (Figure 3.2.1-2). While the two planning areas occur within the similarly named LMEs, the Level II and III CEC ecoregions actually cross LME and planning area boundaries (Figure 3.2.2-3). The following sections identify and describe the CEC Level II and III ecoregions where OCS oil and gas leasing may occur under the proposed action.

3.2.5.1 Arctic Slope and Arctic Plains Level II Ecoregions

These two Level II ecoregions are characterized by relatively constant covers of ice sheets and ice packs (Wilkenson et al. 2009). Water depths on the Arctic Slope may range from 200 to 3,000 m (660 to 9,800 ft) and are deeper on the Arctic Plains. Most of these two ecoregions occur in the Beaufort Sea Planning Area (Figure 3.2.2-3). While ice may cover 90–100% of these ecoregions in any given year, ice cover throughout the year is not continuous;

numerous leads of open water occur and are very important to ecological resources of these ecoregions.

3.2.5.2 Beaufort/Chukchian Shelf Level II Ecoregion

Within the Arctic Planning Areas, this Level II ecoregion extends along the Arctic coast from the eastern boundary of the Beaufort Sea Planning Area westward almost to Point Hope (Figure 3.2.2-3). In the Beaufort Sea Planning Area, this ecoregion is relatively narrow (about 80 km [50 mi]), and widens considerably in the Chukchi Sea Planning Area to as much as 390 km (240 mi). Water depths may reach 100 m (330 ft) (Wilkenson et al. 2009). Coastal areas include barrier beaches, extensive deltas, lagoons, estuaries, tidal flats, and narrow sand and gravel beaches, with low coastal relief. From October to June, this ecoregion is covered by a combination of landfast ice (extending 20 to 80 km [12 to 50 mi]) and pack ice. In summer, there is a coastal ice-free zone that may be as much as 200 km (120 mi) in width.

3.2.5.3 Beaufortian and Chukchian Neritic Level III Ecoregions

These Level III ecoregions occur within and comprise all of the Beaufort/Chukchian Shelf Level II Ecoregion (discussed above) that occurs within the two Arctic Planning Areas considered in this PEIS (Figure 3.2.2-3). The Beaufortian Neritic Level II Ecoregion accounts for the vast majority of the Beaufort/Chukchian Shelf, while the Chukchian Neritic Level II Ecoregion occurs only along a small portion of the Chukchi Sea coast in the vicinity of Point Hope. Both ecoregions (and especially the Chukchi Neritic Ecoregion) are strongly influenced by circulation flowing from the Bering Sea (Wilkenson et al. 2009).

3.3 CONSIDERATIONS OF CLIMATE CHANGE AND THE BASELINE ENVIRONMENT

Several natural and anthropogenic factors affect climate variability, but scientific evidence has led to the conclusion that current climate warming trends are linked to human activities, which are predominantly associated with greenhouse gas emissions (e.g., NRC 2010). Climate change effects have been observed to be occurring on all continents and oceans, and these observations have provided insights on relationships among atmospheric concentrations of carbon dioxide and other greenhouse gases, mean global temperature increases, and observed effects on physical and biological systems (IPCC 2007a). There are many impacts associated with climate change processes that have been observed in U.S. coastal regions that include changing air and water temperatures, rising sea levels, more intense storms, ocean acidification, coastal erosion, sea ice loss, declining coral reef conditions, and loss of critical habitats such as estuaries, wetlands, barrier islands, and mangroves (e.g., Boesch et al. 2000; ACIA 2005; Titus et al. 2009; Morel et al. 2010; Pendleton et al. 2010; Blunden et al. 2011).

The global climate system is driven largely by incoming solar energy that is reflected, absorbed, and emitted within the Earth's atmosphere, and the resulting energy balance determines atmospheric temperatures (Solomon et al. 2007). Atmospheric concentrations of greenhouse gases (carbon dioxide, methane, nitrous oxide, and halocarbons) increase absorption and emission of energy, resulting in a positive radiative forcing to the climate system and warmer global mean temperatures; this process is often described in general terms as the greenhouse effect. Global concentrations of greenhouse gases in the atmosphere have increased from pre-industrial times and by 70% from 1970 to 2004; these emission increases are linked to human activity sectors such as energy, industry, transportation, and agriculture (IPCC 2007a; Rogner et al. 2007). The climate system response to this positive radiative forcing is complicated by a number of positive and negative feedback processes among atmospheric, terrestrial, and oceanic ecosystems, but overall the climate is warming, as is evident by observed increases in air and ocean temperatures, melting of snow and ice, and sea level rise (IPCC 2007a).

Global mean atmospheric temperatures have risen by 0.74 ± 0.18°C (1.33 ± 0.32°F) between 1905 and 2005, and the rate of warming for the past 50 yr has been almost double the rate for the past 100 yr (0.13°C [0.23°F] per decade) (Trenberth et al. 2007). Atmospheric warming has not been spatially uniform, and in particular Arctic temperatures have increased about twice as much as those in lower latitudes (ACIA 2005). Preferential warming in the Arctic is partially the result of the ice-albedo effect, which occurs when highly reflective ice is replaced by less reflective water and land surfaces, resulting in more heat being absorbed by the land and water rather than being reflected back to the atmosphere (Perovich et al. 2007). About 80% of the warmth caused by greenhouse gases has been absorbed in the oceans (NRC 2010). Long-term observations of oceanic temperatures have revealed considerable inter-annual and inter-decadal variability. Between 1961 and 2003, oceanic warming was widespread in the upper 700 m (2,300 ft) of oceans, where the global mean ocean temperature has risen by 0.10°C (0.18°F) (Bindoff et al. 2007).

The effects of climate change on ecosystems are complex and nonuniform across the globe and vary among atmospheric, terrestrial, and oceanic systems (e.g., IPCC 2007a; Blunden et al. 2011). Considerations of climate change effects in OCS planning areas focus on impacts on marine and coastal systems where environmental sensitivities are typically associated with increasing atmospheric and ocean temperatures, but they can also be categorized as responses to sea level rise, coastal erosion, and ocean acidification. These general categories of climate change responses are occurring in addition to human-induced pressures related to coastal population densities (e.g., land use changes, pollution, overfishing) and trends of increasing human use of coastal areas (Nicholls et al. 2007).

Environmental Sensitivity to Atmospheric and Oceanic Temperature Increases. Environmental responses to warming atmospheric and oceanic temperatures include changes to species composition, coral reef damage, permafrost thawing, increased occurrences of storm events, coastal erosion, loss of sea ice, and changes in ocean dynamics.

Species Composition. Effects of warming temperatures have already been seen in the form of changes in species location ranges, changes in migration patterns and timing, changes in location and timing of reproduction, and increases in disease (Perry et al. 2005; Rosenzweig et al. 2007; Simmonds and Isaac 2007). As species extend their spatial ranges, there can be negative consequences related to non-native and invasive species (Twilley et al. 2001). Climate change impacts on aquatic environments have the potential to affect species composition within an ecosystem according to species-specific thresholds, as well as species characteristics such as mobility, lifespan, and availability to use available resources (e.g., Chapin et al. 2000; Levinsky et al. 2007). These variations in species-specific thresholds and characteristics result in the breakup of existing ecosystems and the formation of new ones in response to climate change, with unknown consequences (Perry et al. 2005; Simmonds and Isaac 2007; Karl et al. 2009).

Coral Reef Damage. Warmer water temperatures or increases in ultraviolet light penetration cause coral to lose their symbiotic algae, a process called bleaching. Intensities and frequencies of bleaching events have increased substantially over the past 30 yr, resulting in the death of or severe damage to about one third of the world's shallow water corals (Karl et al. 2009). In addition to coral bleaching, there has been a rise in the occurrence of excessive algal growth on reefs, as well as the presence of predatory organisms and reports of diseases related to bacterial, fungal, and viral agents (Boesch et al. 2000; Twilley et al. 2001). Additional discussion of coral reef damage is presented in Section 3.7.2.1.7.

Permafrost Thawing. Permafrost degradation affects terrestrial and hydrologic conditions in Arctic regions where the temperature at the top of the permafrost layer has increased by up to 3°C (5.4°F) since the 1980s, and in the Alaskan Arctic the permafrost base has been thawing at a rate of up to 0.04 m/yr (0.13 ft/yr) (Lemke et al. 2007). Recent data collected in 2010 suggest that trends in permafrost warming have begun to propagate southward nearly 200 km (124 mi) inland from the North Slope region (Richter-Menge and Jeffries 2011). Thawing of permafrost near coastal regions is expected to result in more rapid rates of shore erosion, increases in stored-carbon releases (Schuur et al. 2009), and damage to infrastructure such as roads and pipelines (Karl et al. 2009). These effects are expected to be compounded by reduced duration and extent of shoreline protection provided by landfast ice and more exposure to ocean storms.

Increases in Major Storm Frequency and Intensity. Regional weather conditions are influenced by modal climatic variability patterns such as the El Niño–Southern Oscillation (ENSO), Arctic Oscillation (AO), North Atlantic Oscillation (NAO), and the Pacific Decadal Oscillation (PDO) that act as connection pathways between regional atmospheric conditions and the world's oceans (NRC 1998; Liu and Alexander 2007). Major storms in low- to mid-latitude regions (e.g., cyclones, hurricanes, and typhoons) are largely controlled by the ENSO phase (Trenberth et al. 2007). In the northern hemisphere, there is a general northward shift in cyclone activity that is correlated with AO and NAO phases (ACIA 2005). Climate change affects water temperatures and wind patterns that interact to either enhance or work against storm formation, making it difficult to predict climate change effects on major storm events (Karl et al. 2009). However, a number of studies have concluded that cyclonic activity has changed over the second half of the 20th century with evidence suggesting that since the 1970s there has been a substantial upward trend toward longer-lasting and more intense storms (Trenberth et al. 2007).

Sea Ice Biome. The presence of sea ice and landfast ice in the marine environment of the Arctic creates a productive marine ice biome essential for the survival and flourishing of marine animals and supports traditional subsistence communities (e.g., Berkes and Jolly 2001;

Simmonds and Isaac 2007; Arp et al. 2010). These environments provide hunting, resting, and birthing platforms along the ice-water interface, generate local upwelling responsible for high productivity in polynyas, and release large quantities of algae growing beneath the ice surface into the food chain at ice melt (ACIA 2005). Polar bear populations are strongly correlated with regional characteristics of sea ice and vary seasonally and with respect to specific requirements for reproduction (Durner et al. 2004). The Iñupiat Eskimos, Alaska Native people of coastal villages of northwestern Alaska and the North Slope, use sea ice for hunting and fishing grounds, as well as seasonal whaling camps that are vital to support their subsistence lifestyle (Braund and Kruse 2009). The greatest threat to the sea ice biome is the loss of sea ice due to climate change. Sea ice extent, as observed mainly by remote sensing methods, has decreased at a rate of approximately 3% per decade starting in the 1970s with larger decreases occurring in summer months (Parkinson 2000). Multi-year sea ice has decreased at a rate of nearly 9 to 12% per decade since the 1980s (Comiso 2002; Perovich et al. 2010), but more recent studies have shown a loss of multi-year ice area of 42% from 2005 to 2008 (Kwok and Cunningham 2010).

Ocean Dynamics. While large-scale trends in ocean salinity suggest certain regions have been experiencing changes in salinity that in combination with the warming of the atmosphere and oceans can change the dynamic properties of the ocean circulation patterns, there is currently no clear evidence for suggesting significant changes to major ocean circulation patterns as a result of climate change (Bindoff et al. 2007). However, there have been more regional studies that have suggested potential mechanistic changes to ocean circulations. For example, Bakun (1990) presented evidence on the effects of altered wind patterns that could enhance coastal upwelling along the western coast of the United States, which could increase productivity in these regions as nutrient-rich bottom water ascends to the ocean surface. There has also been interest in understanding the effect of increased freshwater inputs from the Greenland Ice Sheet on overturning the North Atlantic Current (Church 2007; Rabe et al. 2011). One of the largest obstacles for understanding climate change effects on ocean currents is the lack of long-term measurements, which makes it difficult to decipher climate change responses from inter-decadal variability (Bryden et al. 2003).

Environmental Sensitivity to Sea Level Rise and Coastal Erosion. The recent global sea level rise has been caused by warming-induced thermal expansion of the oceans and accelerated melting of glaciers and ice sheets. The global mean sea level has risen at a mean rate of 1.8 ± 0.5 mm/yr from 1961 to 2003 with considerable variability spatially, as well as considerable decadal time-scale variability (Bindoff et al. 2007). Predictions in sea level rise are as much as 0.6 m (2 ft) by 2100 (Nicholls et al. 2007). The amount of relative sea level rise along different parts of the U.S. coast depends not only on thermal expansion and ice sheet melting, but also on the changes in elevation of the land that occur as a result of subsidence or geologic uplift (Karl et al. 2009). Submergence hotspots can occur as a result of local subsidence in combination with sea level rise such that the rate of rise of sea level relative to the land is expected to be higher than in other parts of the area.

Certain areas along the Atlantic and GOM coasts are undergoing relatively rapid inundation and landscape changes because of the prevalence of low-lying coastal lands (Titus et al. 2009). Barrier islands in the northern GOM have been losing land areas and changing habitat conditions because of decreased sediment supplies from rivers, sea level rise, and intense storms (Lucas and Carter 2010). Coastal erosion rates over the past couple of decades averaged 3.7 m/yr (12 ft/yr), but storm events such as Hurricane Rita have caused erosion rates of 12 to 15 m (39 to 49 ft) in a single event (Park and Edge 2011). The coasts of the Beaufort and Chukchi Seas consist of river deltas, barrier islands, exposed bluffs, and large inlets and inland are characterized by low-relief lands underlain by permafrost (Jorgenson and Brown 2005). The combination of wind-driven waves, river erosion, sea level rise, and sea ice scour with highly erodible coastal lands creates the potential for high erosion rates along the Beaufort and Chukchi Sea coasts (Proshutinsky et al. 2001; Mars and Houseknecht 2007). In addition to coastal erosion along the Arctic coast, storm surge flooding has converted freshwater lakes into estuaries, affecting habitat conditions (Arp et al. 2010).

Environmental Sensitivity to Ocean Acidification. Ocean acidification refers to the decrease in the pH of the oceans and its buffering capacity caused by the uptake of carbon dioxide from the atmosphere that reacts with seawater to form carbonic acid, leading to decreasing pH values in the oceans. Predictions of future ocean water pH levels vary somewhat, but predicted decreases range from 0.14 to 0.4 pH units over the 21st century (Caldeira and Wickett 2005; Orr et al. 2005; IPCC 2007a). Factors such as water temperatures, salinity, sea ice, and ocean mixing processes affect the amount of carbon dioxide absorbed by oceans, so climate change effects on storms, river discharge, and precipitation patterns all affect ocean acidification (IPCC 2007). The mechanisms that lead to ocean acidification also affect estuarine and coastal waters, although their impacts on estuarine ecosystems are not well known because of the multitude of processes affecting pH levels in these systems (Feely et al. 2010).

Ocean acidification affects the ability of certain organisms to create shells or skeletons by calcification, which can be especially harmful to mollusks, corals, and certain plankton species that are important to oceanic food chains (Orr et al. 2005; Karl et al. 2009). However, several laboratory experiments conducted under elevated carbon dioxide conditions have shown mixed calcification rates in many organisms (including positive responses to ocean acidification), which suggests complex mechanisms by which organisms respond to ocean acidification (Doney et al. 2009; Ries et al. 2009). Coral reefs are highly dependent on calcified structures for survival and both warm-water and cold-water corals are negatively impacted by ocean acidification (Royal Society 2005). Ocean waters in Arctic regions are highly susceptible to ocean acidification resulting from increased carbon dioxide solubility, freshwater inputs, and increased primary productivity, and these factors relating to ocean acidification are enhanced by current climate change trends and loss of sea ice (Fabry et al. 2009; Steinacher et al. 2009).

Climate Change Predictions and Uncertainties. Climate change predictions are based on a variety of models that simulate all relevant physical processes affecting interactions among the atmosphere, oceans, and biosphere, which are driven by a variety of projected greenhouse gas emission scenarios. Global climate models generate projected changes in atmospheric, ocean, and land surface climate variables at scales on the order of one degree in latitude and longitude, which are not sufficient for making regional-scale climate assessments. Downscaling global climate models and coupling them with more localized regional climate models is an active area of current research (Christensen et al. 2007; Randall et al. 2007). The complexity of modeling global and regional climate systems is great, so it is important to consider measures of uncertainty, which is typically done using a multi-model ensemble approach

(Krishnamurti et al. 2000). It is important to recognize that despite new climate model developments, uncertainty in climate projections can never be entirely eliminated (McWilliams 2007).

The Intergovernmental Panel on Climate Change (IPCC) has summarized climate change predictions over the next two decades and over the 21st century, using climate model predictions and evidence from various scientific disciplines (IPCC 2007a). The IPCC uses a 10-fold likelihood scale ranging from virtually certain (>99% probability of occurrence) to exceptionally unlikely (<1% probability) to define consistent terminology for climate change projections where uncertainty can be assessed by statistical analyses, and a 10-point scale (10 being the most confident) for projections where uncertainty was qualitatively assessed by expert judgment. The most recent climate change projections summarized by the IPCC (2007a) include some of the following:

- An increase in atmospheric temperatures of approximately 0.2°C (0.4°F) per decade is predicted over a range in projected greenhouse gas emission scenarios;
- Warming is expected to be greatest over land and at higher latitudes;
- Model estimates of sea level rise vary from 0.18 to 0.59 m (0.6 to 2 ft) by the end of the 21st century, but information on important feedback processes to sea level rise do not allow for determining a best estimate;
- Polar regions are projected to have continued reductions in sea ice, glaciers, and ice sheets;
- Projection models suggest that ocean pH values decreasing between 0.14 and 0.35 over the 21st century;
- It is likely (>66%) that tropical cyclones will become more intense;
- Increased precipitation is very likely (>90%) to occur at high-latitudes;
- There is high confidence (8 out of 10) that annual river runoff will increase by 10 to 40% at high latitudes and decrease by 10 to 30% in dry regions of mid-latitudes;
- Net carbon uptake by terrestrial ecosystems is likely (>66%) to peak during this century as natural carbon sequestration mechanisms reach their capacity; and
- There is medium confidence (5 out of 10) that predicted temperature increases will result in approximately 20 to 30% of plant and animal species that have been assessed likely (>60%) being at an increased risk of extinction.

3.3.1 Gulf of Mexico

Climate change in the GOM is expected to affect coastal ecosystems, forests, air and water quality, fisheries, and business sectors such as industry and energy (Ning et al. 2003). The GOM region has experienced increasing atmospheric temperatures since the 1960s, and from 1900 to 1991 sea surface temperatures have increased in coastal areas and decreased in offshore regions (Twilley et al. 2001). In addition to temperature changes, the northern coast of the GOM is experiencing impacts associated with sea level rise that include the loss of coastal wetland and mangrove habitats, salt water intrusion into coastal aquifers and forests, and increases in shoreline erosion (Williams et al. 1999; Pendleton et al. 2010). Climate change associated sea level rise is occurring in combination with altered hydrology and land subsidence that has resulted in measures of relative sea level rise ranging between 0.002 m/yr (0.007 ft/yr) along Texas and up to 0.01 m/yr (0.03 ft/yr) along the Mississippi River Delta (Twilley et al. 2001).

Climate models generally predict a rise in temperatures in the GOM Coastal States this century; however, predictions of precipitation are more problematic due to model uncertainties (Karl et al. 2009). Predictions of precipitation among various modeling studies for the GOM region have generally predicted a slight decrease in precipitation in coastal areas, as well as more intense rainfall events and longer periods of drought, but models vary widely in upland areas, which affect river discharges (Mulholland et al. 1997; Boesch et al. 2000; Twilley et al. 2001).

Significant increases or decreases in precipitation and river runoff would affect salinity and water circulation, as well as water quality. Increased runoff would likely deliver increased amounts of nutrients (such as nitrogen and phosphorous) to estuaries, increase the stratification between warmer fresher and colder saltier water, and potentially lead to eutrophication of estuaries and increase the potential for harmful algal blooms that can deplete oxygen levels (Justic et al. 1996; Karl et al. 2009). Reductions of freshwater flows in rivers or prolonged drought periods could substantially reduce biological productivity in Mobile Bay, Apalachicola Bay, Tampa Bay, and the lagoons of Texas and could increase the salinity in coastal ecosystems, resulting in a decline in mangrove and sea grass habitats (Twilley et al. 2001). Decreased runoff could also diminish flushing of the estuaries, decrease the size of estuarine nursery zones, and allow an increase in predators and pathogens (Boesch et al. 2000).

Sea level rise along parts of the northern GOM coast are as high as 0.01 m/yr (0.03 ft/yr), which is much greater than globally averaged rates (Twilley et al. 2001; IPCC 2007a). The combination of sea level rise and land subsidence is resulting in the loss of coastal wetlands and mangroves, which is damaging to habitat functions to many important fish and shellfish populations. Future sea level rise is expected to cause additional saltwater intrusion into coastal aquifers of the GOM, potentially making some unsuitable as potable water supplies (Karl et al. 2009). Saltwater intrusion and sea level rise are damaging coastal bottomland forests (primarily along the western GOM coast) and mangroves through soil salinity poisoning, increased hydroperiods, and coastal erosion (Williams et al. 1999). Additionally, climate change model predictions suggest that there will be an increase in the intensity of hurricanes (IPCC 2007a), and coastal regions may potentially have fewer barrier islands, coastal wetlands, and mangrove forests to buffer the resulting storm surges as a result of sea level rise.

Marine biota in the GOM are influenced by changes in temperature, salinity, and ocean acidification, as well as their biological environment including predators, prey, species interactions, disease, and fishing pressure (Karl et al. 2009). Projected changes in physical oceanographic conditions can affect the growth, survival, reproduction, and spatial distribution of marine fish species and of the prey, competitors, and predators that influence the dynamics of these species. However, impacts on marine biota associated with climate change need to be considered against natural variation (Rosenzweig et al. 2007).

3.3.2 Alaska Region

The Arctic climate system is complex and has varied considerably over geologic time scales (ACIA 2005). Over the last 100 yr, mean Arctic temperatures have increased at a rate nearly double that of global mean temperatures (IPCC 2007a). The ice-albedo feedback mechanism has the potential to enhance the effects of warming trends as the loss of sea ice leads to more heat absorption by ocean waters, which affects both sea ice melt and regional atmospheric circulation patterns important to the global heat budget (ACIA 2005; Overland and Wang 2010). However, it is important to recognize that climate conditions in the Arctic experience strong decadal variability in relation to modal climatic variability patterns such as the AO, PDO, and NAO (ACIA 2005). A recent modeling study has suggested that Arctic regions are nearing a threshold, where amplified greenhouse effect warming is likely to overpass decadal climate variability patterns (Serreze and Francis 2006). The impacts of climate change on the Arctic include warming ocean temperatures, increasing ocean acidification, reductions in sea ice, permafrost thawing, and coastal erosion, which all affect terrestrial, coastal, and marine ecosystems (Hopcroft et al. 2008). In addition to ecosystem impacts, the loss of sea ice contributes to an ice-albedo feedback process that affects regional atmospheric circulation patterns and global heat budgets (ACIA 2005; Overland and Wang 2010).

Changes to the Arctic climate, as well as the sea ice and permafrost biomes, have been documented in several studies (Parkinson 2000; Comiso 2002; Rothrock and Zhang 2005; ACIA 2005; Anisimov et al. 2007; Hopcroft et al. 2008; Perovich et al. 2010; Richter-Menge and Jeffries 2011) and include:

- Atmospheric temperatures have increased by 1–2°C (2–4°F) since the 1960s;
- Atmospheric temperatures increasing at a rate of 1°C (2°F) per decade in winter and spring;
- Precipitation has increased by approximately 1% per decade;
- March sea ice extent has decreased at a rate of approximately 3% per decade starting in the 1970s;
- Multi-year sea ice has decreased at a rate of approximately 9 to 12% per decade since the 1980s;

- Sea ice volumes have decreased by 4% per decade since the 1950s;

- Temperatures at the top of the permafrost layer have increased by up to 3°C (5°F) since the 1980s;

- Permafrost base has been thawing at a rate of up to 0.04 m/yr (0.13 ft/yr).

Impacts of current and projected climate changes have the potential to affect sea ice (most importantly multi-year sea ice) and permafrost biomes, as well as coastal erosion rates, animal populations, and subsistence livelihoods. Retreat of sea ice would increase impacts on coastal areas from storms. Furthermore, coastlines where permafrost has thawed are more vulnerable to erosion from wave action, which can affect both erosion rates as well as change freshwater lakes into estuarine habitats (Mars and Houseknecht 2007; Arp et al. 2010). An aerial photo comparison has revealed total erosive losses up to 457 m (1,500 ft) over the past few decades along some stretches of the Alaskan coast (Alaska Regional Assessment Group 1999). At Barrow, Alaska, coastal erosion has been measured at the rate of 1–2.5 m/yr (3–8 ft/yr) since 1948 (ACIA 2005), and it has been causing severe impacts on the community. Maximum coastal erosion rates of up to 13.3 m/yr (43.6 ft/yr) have occurred near Cape Halkett and Cape Simpson during the time period of 1980–2000 (Ping et al. 2011).

Changes in permafrost have caused failure of buildings and costly increases in road damage and road maintenance in Alaska (Alaska Regional Assessment Group 1999; Hinzman et al. 2005). Present costs of thaw-related damage to structures and infrastructure in Alaska have been estimated at $35 million per year (NAST 2001). A continued warming of the permafrost is likely to increase the severity of permafrost thaw-related problems. Thawing of any permafrost increases groundwater mobility, reduces soil bearing strength, and increases the susceptibility to erosion and landslides. Thawing could disrupt petroleum exploration and production by shortening the availability of time for minimal-impact operations on ice roads and pads (ACIA 2005).

Loss of sea ice, especially multi-year ice that lasts through summer months, could cause large-scale changes in marine ecosystems and could threaten populations of marine mammals such as polar bears, walruses, and seals that depend on the ice for habitat, hunting, and transportation (Boesch et al. 2000; NAST 2001; Durner et al. 2004; Hopcroft et al. 2008; Karl et al. 2009). With studies examining the impacts of climate change on Arctic biota, there have been reported changes in abundance, range shifts, growth rates, behavior, and community dynamics for both terrestrial and marine species (Belkin 2009; Mueter et al. 2009; Wassmann et al. 2011). Seals and polar bears regularly use landfast sea ice as habitat, which is particularly susceptible to climate warming (Boesch et al. 2000). Ice edges are biologically productive systems in which ice algae form the base of the food chain, which has implications for higher trophic levels (Moline et al. 2008). The sea ice algae are crucial to Arctic cod, which is an important species to the diets of seabirds and marine animals in Arctic regions (Bradstreet and Cross 1982; Gradinger and Bluhm 2004). As ice melts, there is concern that there would be loss of prey species of marine mammals, such as Arctic cod and amphipods, which are associated with ice edges, and these impacts can propagate through food webs associated with the sea ice biome (ACIA 2005).

Ocean fisheries are highly vulnerable to changes in climatic conditions such as sea temperature and sea ice conditions (Karl et al. 2009), and fisheries in the Alaska region have experienced decadal-scale variability in climate due to modal patterns of oceanic and atmospheric interactions (Schwing et al. 2010). For example, Pacific salmon populations have shown decadal variability over the past 300 yr, which spans the timeframe of before and after commercial fishing, suggesting the strong coupling of ocean conditions and salmon populations (Finney et al. 2000). In 1977, warmer sea surface temperatures and reduced sea ice conditions generated a "regime shift" in the fisheries of the Gulf of Alaska that carried over into the 1980s, producing large salmon, pollock, and cod populations with a reduction in populations of forage fishes (Boesch et al. 2000; NAST 2001). Evidence of climate change warming effects on fisheries is difficult to detect with respect to decadal variability patterns. However, current trends of increased freshwater inputs, increased ultraviolet radiation, warmer sea surface temperatures, ocean acidification, and reduced sea ice are driving biodiversity changes across trophic levels for marine and freshwater fish of the Alaska region with both positive and negative effects depending on tolerance levels and the ability to adapt to changing habitats of the various fish populations (Reist et al. 2006; Anisimov et al. 2007; Bates and Mathis 2009). In addition to temperature and sea ice changes, permafrost thawing and alterations to terrestrial hydrology have the potential to increase sediment and nutrient availability in estuarine and nearshore habitats, which have a mixture of positive and negative impacts on marine and anadromous fish populations (ACIA 2005; Hopcroft et al. 2008).

Alaska Native subsistence communities have adapted to climate variability in the past, but current warming trends may produce uncharacteristic and extreme environmental conditions that can adversely affect these communities (Berkes and Jolly 2001; Anisimov et al. 2007). Climate change effects such as multi-year sea ice loss, permafrost loss, and sea level rise may alter traditional hunting locations and cause shifts in game patterns and quality, travel routes, and inter-community trading and social mechanisms (Alaska Regional Assessment Group 1999; ACIA 2005). In addition to climate change impacts, Alaska Native subsistence communities have been adapting to economic development and modernization occurring in Arctic regions (ACIA 2005; Braund and Kruse 2009). Alaska Native subsistence communities have experienced and are currently experiencing impacts on subsistence activities caused by a combination of environmental, social, and cultural changes. The Alaska Native subsistence communities will find it more difficult to adapt or relocate than they did in the past because most now live in established communities, which will make adaptation to climate change effects problematic in the future (ACIA 2005).

3.4 WATER QUALITY

3.4.1 Gulf of Mexico

The term water quality describes the overall condition of water, reflecting its particular biological, chemical, and physical characteristics. It is an important measure for both ecological and human health. Water quality is most often discussed in reference to a particular purpose or use of the water, such as recreation, drinking, or ecosystem health. This usage divides the analysis area into coastal and marine waters and includes human uses of water for recreation and food harvest along with industrial and domestic uses. Coastal waters include all bays and estuaries from the Rio Grande River to the Florida Bay. Marine water includes both State offshore water and Federal Outer Continental Shelf (OCS) waters extending from outside the barrier islands to the Exclusive Economic Zone. The inland extent is defined by the Coastal Zone Management Act. A further distinction within the marine water areas is between continental shelf water and deep water. Figure 3.4.1-1 illustrates this distinction within marine water areas and the OCS Planning Areas for the GOM.

In general, coastal water quality is influenced by the rivers that drain into the area, the quantity and composition of wet and dry atmospheric deposition, and the influx of constituents from sediments. Human activities influence the waters closest to the land. Circulation or mixing of the water may either improve the water quality through dilution or degrade the quality by introducing factors that contribute to water quality decline.

Marine water composition in the GOM has two primary influences. These are the configuration of the GOM Basin, which controls the oceanic waters that enter and leave the GOM, and runoff from the land masses, which controls the quantity of freshwater input into the GOM. The GOM receives oceanic water from the Caribbean Sea through the Yucatan Channel and freshwater from major continental drainage systems such as the Mississippi River system. Estuarine and fluvial drainage areas in the GOM region are shown in Figure 3.2.1-4. The three major fluvial drainage areas (FDAs) drain a total of 4.1 million km^2 (1.6 million mi^2) of the inland continental United States, and have a large influence on water quality in the GOM. The large amount of freshwater runoff mixes into the GOM surface water, producing a different composition on the continental shelf from that in the open ocean.

3.4.1.1 Coastal Waters

The GOM coast contains one of the most extensive estuary systems in the world. This system extends from the Rio Grande River in Texas eastward to Florida Bay in Florida. Estuaries, semi-enclosed basins within which the freshwater of rivers and the higher salinity waters offshore mix, are influenced by both freshwater and sediment influx from rivers and the tidal actions of the oceans. The primary variables that influence coastal water quality are water temperature, total dissolved solids (salinity), suspended solids (turbidity), and nutrients. An estuary's salinity and temperature structure are determined by hydrodynamic mechanisms governed by the interaction of marine and terrestrial influences. Hydrodynamic influences include tides, nearshore circulation, freshwater discharges from rivers, and local precipitation. Tidal mixing within GOM estuaries is limited by the small tidal ranges that occur along the GOM coast. The shallowness of most GOM estuaries, however, tends to amplify the mixing effect of the small tidal range. GOM coast estuaries exhibit a general east-to-west trend in selected attributes of water quality associated with changes in regional geology, sediment loading, and freshwater inflow. For example, the estuarine waters in Florida generally have greater clarity and lower nutrient concentrations than those in the central and western areas of the GOM coast.

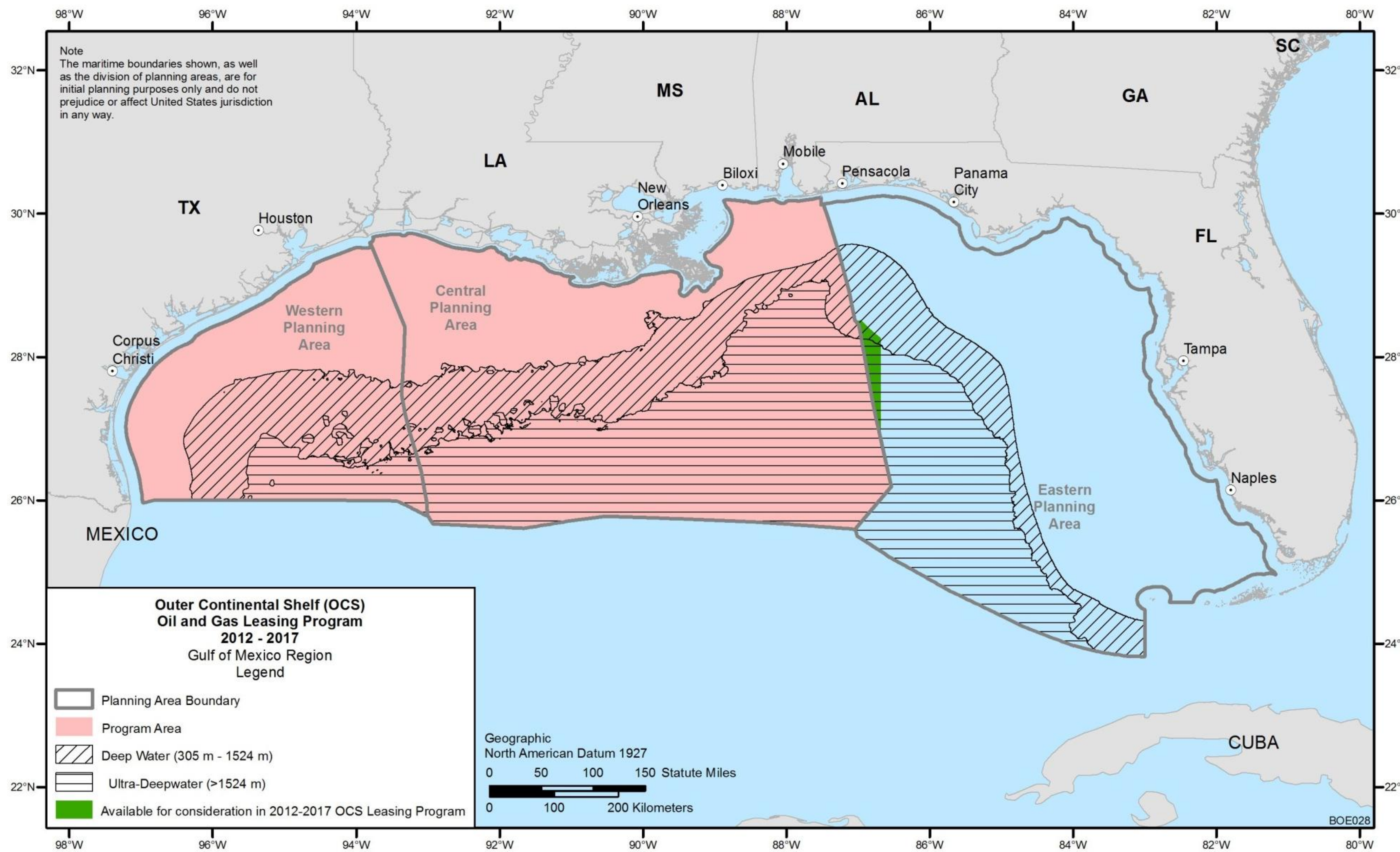

FIGURE 3.4.1-1 Depth Zones within GOM Planning Areas and Program Areas for the OCS Oil and Gas Leasing Program 2012-2017

The primary factors that affect estuarine water quality include upstream withdrawals of water for agricultural, industrial, and domestic purposes; contamination by industrial and sewage discharges; agricultural runoff carrying fertilizer, pesticides, and herbicides; upstream land use; redirected water flows; and habitat alterations (e.g., construction and dredge-and-fill operations). Because drainage from more than 55% of the conterminous United States enters the GOM primarily from the Mississippi River, a large area of the nation contributes to coastal water quality conditions in the GOM (see Figure 3.2.1-4). There are also three major estuarine drainage areas (EDAs) that drain approximately 250,000 km^2 (95,000 mi^2) of coastal areas along the GOM, strongly influencing water quality in the estuarine environments (NOAA 1999).

Population growth results in additional clearing of the land, excavation, construction, expansion of paved surface areas, and drainage controls. These activities alter the quantity, quality, and timing of freshwater runoff. Stormwater runoff that flows across impervious surfaces is more likely to transport contaminants associated with urbanization including suspended solids, heavy metals and pesticides, oil and grease, and nutrients (U.S. Commission on Ocean Policy 2004). Additional information on factors that contribute to coastal water quality can be found in the sociocultural systems section of this chapter.

Coastal water quality is also affected by the loss of wetlands, which is discussed in detail in Section 3.7.1. Wetlands improve water quality through filtration of runoff water and provision of valuable habitat. Suspended particulate material is trapped and removed from the water, resulting in greater water clarity. Nutrients may also be incorporated into vegetation and wetland sediments and removed from the water that passes through the wetlands.

The first USEPA National Coastal Condition Report summarized coastal conditions with data collected from 1990 to 1996 (USEPA 2001). The USEPA updated this information in a third report (USEPA 2008). The first report rated the overall condition of the GOM coastal region as fair to poor. The third report ranked the water quality index fair and the overall condition fair to poor (USEPA 2008). The water quality ranking used five factors: (1) dissolved oxygen, (2) dissolved inorganic nitrogen, (3) dissolved inorganic phosphorus, (4) chlorophyll *a*, and (5) water clarity. Contaminated sediments pose an immediate threat to benthic organisms and an eventual threat to estuarine ecosystems as a whole. Contaminants in sediments may be re-suspended into the water by anthropogenic activities, storms, or other natural events, where they can expose organisms in the water column and can accumulate and move up the food chain, eventually posing health risks to humans (USEPA 2011g). The sediment quality index of the GOM coast region was ranked as poor (USEPA 2008). Sediments in the GOM coast region have been found to contain pesticides, metals, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs) (USEPA 2008).

Hurricanes Katrina and Rita resulted in a number of impacts on water quality conditions in the GOM as a result of storm damage to pipelines, refineries, manufacturing and storage facilities, sewage treatment facilities, and other facilities and infrastructure. For example, Katrina damaged 100 pipelines, which resulted in approximately 211 minor pollution reports to the former Minerals Management Service (MMS) (now BOEM), while Rita damaged 83 pipelines, resulting in 207 minor pollution reports (MMS 2006a). Flood waters pumped into Lake Pontchartrain contained a mixture of contaminants, including sewage, bacteria, heavy metals, pesticides, and other toxic chemicals, and as much as 24,600 m^3 (6.5 million gal) of oil (Sheikh 2006). Sources of these contaminants include damaged sewage treatment plants, refineries, manufacturing and storage facilities, and other industrial and agricultural facilities and infrastructure (Sheikh 2006). The flood waters of New Orleans were oxygen depleted and contained elevated bacterial levels, but the pollutants occurred at about the same concentrations as typical stormwater runoff (Pardue et al. 2005). Testing following the storm identified low levels of fecal coliform in Mississippi Sound and Louisiana coastal waters. Very few toxics resulting from the hurricanes were detected in estuarine or coastal waters (USEPA 2010).

The heavy rainfall associated with Katrina increased agricultural runoff of nutrients into the GOM and decreased salinity of nearshore waters (NOAA and NMFS 2007). Storm surges as a result of the hurricanes caused temporary saltwater intrusion in some estuarine areas (NOAA and NMFS 2007). The release of contaminated Lake Pontchartrain waters into the GOM, as well as releases from damaged pipelines, caused short-term impacts on water quality in the GOM. Tidal action and normal current patterns in the GOM resulted in the dilution and dispersal of any heavily contaminated waters, potentially limiting any long-term effects on GOM water quality (Congressional Research Service 2005). Levels of contamination in oyster populations in coastal Louisiana and Mississippi after hurricane Katrina were measured and compared to the 20-yr record of contamination. Levels of organochlorine compounds and PAHs were found to be below normal, and levels of metals/trace elements were found to be elevated at most sites, compared to the historical record (NCCOS 2006).

3.4.1.2 Marine Waters

Within the GOM, marine waters occur in three regions: (1) the continental shelf west of the Mississippi River (primarily the Western GOM Planning Area and the western half of the Central GOM Planning Area), (2) the continental shelf east of the Mississippi River (the eastern half of the Central GOM Planning Area and the Eastern GOM Planning Area), and (3) deep water (>310 m). Figure 3.4.1-1 illustrates the marine water areas and the OCS Planning Areas for the GOM.

3.4.1.2.1 Continental Shelf West of the Mississippi River. The water quality in this area is highly influenced by input of sediment and nutrients from the Mississippi and Atchafalaya Rivers (Murray 1997). The Mississippi-Atchafalaya River Basin drains about 41% of the conterminous United States (see Mississippi Coastal Subregion FDA in Figure 3.2.1-4). A turbid surface layer of suspended particles is associated with the freshwater plume from these rivers. The river system supplies nitrate, phosphate, and silicate to the shelf. During summer months, the low-salinity water from the Mississippi River spreads out over the shelf, resulting in a stratified water column. While surface oxygen concentrations are at or near saturation, hypoxia, defined as oxygen concentrations less than 2 milligrams per liter (mg/L), is observed in bottom waters during the summer months in waters of the continental shelf west of the Mississippi River.

The Hypoxic Zone. Hypoxic, or low-oxygen, conditions occur on the continental shelf in the northern part of the GOM in areas where the dissolved oxygen level is below 2 mg/L. Hypoxia in the GOM is attributed to large nutrient influxes from the rivers draining the continental United States and stratification of GOM waters from differences in temperature and density (Mississippi River/GOM Watershed Nutrient Task Force 2009). The average size of the hypoxic zone over the period of measurement (1985–2011) is 13,600 km^2 (5,300 mi^2) (LUMCON 2011). Over the 5-yr period between 2006 and 2010, the hypoxic zone had an average size of 17,300 km^2 (6,700 mi^2), and in 2010, the hypoxic zone was measured to be 17,520 km^2 (6,765 mi^2) (USEPA 2011h). The hypoxic zone increased from an average size of 8,300 km^2 (3,200 mi^2) in the 1985−1992 period to more than 16,000 km^2 (6,200 mi^2) in the 1993−1997 period (Rabalais et al. 2002), and it reached a record 22,000 km^2 (8,500 mi^2) in 2002. The size of the hypoxic zone is directly correlated with the flux of nitrogen from the Mississippi River and river discharge (Scavia et al. 2003). Veil et al. (2005) evaluated the loading of nutrients and other oxygen-demanding materials in produced water discharged from offshore oil and gas platforms located in the hypoxic zone. Veil et al. (2005) found that the nitrogen and phosphorus loading in produced water discharges were about 0.16% and 0.013%, respectively, of the nutrient loading entering the GOM from the Mississippi and Atchafalaya Rivers.

Pollutant Sources. Analysis of shelf sediments off the coast of Louisiana has found trace organic pollutants including PAHs, herbicides such as Atrazine, chlorinated pesticides, PCBs, and trace inorganic (metal) pollutants (Turner et al. 2003). The detection of organochlorine pesticides and PAHs in sediment cores collected in water depths of 10 to 100 m (33 to 330 ft) off the southwest pass of the Mississippi River increased in sediments deposited after the 1940s (Turner et al. 2003). The river was identified as the primary source of both organochlorine and the pyrogenic PAHs, which are associated with the burning of fossil fuels; however, higher concentrations of petrogenic PAHs, associated with natural seeps and/or oil and gas exploration, were found farther from the mouth of the river (Turner et al. 2003).

The offshore oil and gas industry operates hundreds of platforms throughout this portion of the GOM. Many platforms have discharges of drilling wastes, produced water, and other industrial wastewater streams that have adverse impacts on water quality. The USEPA regulates the discharge of these wastes through an NPDES permit. Except in shallow waters, the effects of these discharges are generally localized near individual points of discharge (Neff 2005).

3.4.1.2.2 Continental Shelf East of the Mississippi River. Water quality on the continental shelf from the Mississippi River Delta to Tampa Bay is influenced by river discharge, runoff from the coast, and eddies from the Loop Current. The Mississippi River accounts for 72% of the total discharge onto the shelf (SUSIO 1975). The outflow of the Mississippi River generally extends 75 km (45 mi) to the east of the river mouth (Barry A. Vittor & Associates, Inc. 1985), except under extreme flow conditions. Mobile Bay and several smaller rivers east of the Mississippi River including the Apalachicola and Suwannee Rivers also contribute runoff to the area (Jochens et al. 2002). The Loop Current intrudes in irregular intervals onto the shelf, and the water column can change from well mixed to highly stratified very rapidly. Discharges from the Mississippi River can be easily entrained in the Loop Current.

Hypoxia is rarely observed on the Mississippi-Alabama shelf, although near-hypoxic conditions have been observed in the spring and summer during research cruises in 1987 through 1989 (Brooks and Giammona 1991) and 1998 through 2000 (Jochens et al. 2002).

The Mississippi-Alabama shelf sediments are strongly influenced by fine sediments discharged from the Mississippi River. The shelf area is characterized by a bottom nepheloid layer and surface lenses of suspended particulates that originate from river outflow. The West Florida Shelf receives very little sediment input. The water clarity is higher toward Florida, where the influence of the Mississippi River outflow is rarely observed.

Pollutant Sources. Analysis of water, sediments, and biota for hydrocarbons between 1974 and 1977 indicated that the Mississippi, Alabama, and Florida (MAFLA) area is pristine, with some influence of anthropogenic and petrogenic hydrocarbons from river sources (SUSIO 1977; Dames and Moore, Inc. 1979). Analysis of trace metal contamination for the nine trace metals analyzed (barium, cadmium, chromium, copper, iron, lead, nickel, vanadium, and zinc) also indicated no contamination sources (SUSIO 1977; Dames and Moore, Inc. 1979). A study done between 1987 and 1989 indicated that high molecular-weight hydrocarbons can come from natural petroleum seeps at the seafloor or recent biological production as well as input from anthropogenic sources (Brooks and Giammona 1991). The primary source of petroleum hydrocarbons and terrestrial plant material on the Mississippi-Alabama shelf is the Mississippi River. Higher levels of hydrocarbons were observed in late spring, coinciding with increased river influx. The sediments, however, are washed away later in the year, as evidenced by low hydrocarbon values in winter months. Contamination from trace metals was not observed (Brooks and Giammona 1991).

Several small rivers and the Loop Current are the primary influences on water quality on the shelf from DeSoto Canyon to Tarpon Springs and from the coast to a 200-m (656-ft) water depth (SAIC 1997). Because there is very little onshore development in this area, the waters and surface sediments are uncontaminated. The Loop Current flushes the area with clear, low-nutrient water (SAIC 1997).

3.4.1.2.3 Deep Water. Limited information is available on the deepwater environment of the GOM. Water at depths greater than 1,400 m (4,600 ft) is generally relatively homogeneous with respect to temperature, salinity, and oxygen (Nowlin 1972; Pequegnat 1983; Gallaway and Kennicutt 1988). A dissolved-oxygen low appears to occur at water depths of between 250 and 750 m (820 and 2,460 ft), depending upon the location within the GOM (Nowlin 1972). Pequegnat (1983) has pointed out the importance of the flushing time of the GOM. Jochens et al. (2005) provided a summary of estimated flushing rates presented in the literature, which range from 3 to 270 yr for different areas of the GOM. The waters of the western and southwestern GOM are estimated to have longer flushing times than the rest of the GOM; however, flushing rates are uncertain and are not well understood in the deepwater zone (Jochens et al. 2005). Investigations of historical oxygen data for the GOM and modeling of the distribution indicate that oxygen levels in the deep GOM would suffer only localized impacts from activities, but basin-wide decreases in oxygen would not occur (Jochens et al. 2005).

Limited analyses of trace metals and hydrocarbons for sediments exist, and water column measurements are primarily limited to salinity, temperature, and nutrients (Trefry 1981; Gallaway and Kennicutt 1988; CSA 2006; Rowe and Kennicutt 2009). Between 2000 and 2002, MMS completed two studies to measure concentrations of organics, metals, and nutrients in sediments in the deepwater zone (CSA 2006; Rowe and Kennicutt 2009). These studies helped to create a baseline of information related to the ecological function of these sediments, the extent of naturally occurring organics, and the impacts seen from OCS oil and gas activities. The study by Rowe and Kennicutt (2009) reported total PAH concentrations in deepwater sediments of between 0.02 and 1.0 mg/kg. Measurements of PAHs obtained by CSA (2006) in the vicinity of exploration and production wells mostly fell into the same range, with the exception of two samples within a 300-m (984-ft) radius of one of the well sites that had PAH concentrations of 3.5 and 23.8 mg/kg. The authors hypothesized that the source of the PAH was from some contaminant from the drilling or production activity (CSA 2006).

Hydrocarbon (oil) seeps are extensive throughout the continental slope and naturally contribute hydrocarbons to the sediments and water column (Sassen et al. 1993a). Remote sensing techniques have identified approximately 350 natural seeps in the northern half of the GOM (Kvenvolden and Cooper 2003). Estimates of the total volume of seeping oil in the northern half of the GOM vary widely from 29,000 barrels per year (bbl/yr) (MacDonald 1998) to 520,000 bbl/yr (Kvenvolden and Cooper 2003). When combined with estimates of oil seeping into the southern portion of the GOM, the estimated volume of oil seeping into the GOM is approximately 1.0 million bbl/yr (Kvenvolden and Cooper 2003). These estimates used satellite data and an assumed slick thickness. At hydrocarbon seeps, pore water of three different origins has been identified to leak out in addition to hydrocarbons: (1) seawater trapped during the settling of sediments, (2) briny fluid that is associated with the dissolution of underlying salt deposits, and (3) highly saline deep-seated formation waters (Fu and Aharon 1998; Aharon et al. 2001). The first two fluids leak out in the vicinity of carbonate deposits, while the third is rich in barium and is associated with barite deposits such as chimneys (Fu and Aharon 1998).

3.4.1.3 Climate Change Effects

Water quality in the GOM is expected to be affected by climate change (Ning et al. 2003). A thorough discussion of the impacts of climate change to the baseline environment can be found in Section 3.3. Anticipated sea-level rise would cause salinity increases in estuaries and lead to increases in coastal erosion (Nicholls et al. 2007). Changes in precipitation in the large fluvial drainage areas that contribute to the GOM (see Figure 3.2.1-4) are anticipated to change the quantity and timing of runoff that enters into the GOM. Significant changes in runoff would impact salinity in the coastal waters of the GOM, change coastal water circulation, and also impact the quantities of contaminants carried to the GOM, including suspended solids, heavy metals, pesticides, oil and grease, and nutrients. Increased runoff would likely deliver increased amounts of nutrients, increase the stratification between warmer fresher and colder saltier water, and potentially lead to eutrophication of estuaries and increase the potential for harmful algal blooms that can deplete oxygen levels (Justic et al. 1996; Karl et al. 2009). Reductions of freshwater flows in rivers or prolonged drought periods could increase the salinity in coastal ecosystems (Twilley et al. 2001). Ocean temperatures in the upper 700 m (2,300 ft) increased by 0.10°C (0.18°F) between 1961 and 2003 (Bindoff et al. 2007). Future sea surface temperature increases are anticipated and would affect chemical and microbial processes in coastal and marine environments. Rising temperatures are anticipated to lead to increased thermal stratification, increased coral bleaching and mortality, and increased algal blooms, but other impacts are difficult to predict, due to the complexity of ecological processes (Nicholls et al. 2007). In addition, ocean pH values are anticipated to decrease by up to 0.35 pH units over the 21st century, leading to ocean acidification (IPCC 2007a).

3.4.1.4 Deepwater Horizon Event

On April 20, 2010, the Deepwater Horizon drilling platform collapsed leading to the largest offshore oil spill in U.S. history, the Deepwater Horizon event (DWH event) (OSAT 2010). It is estimated that between April 22 and July 15, 2010, approximately 4.9 million barrels (with an uncertainty of plus or minus 10%) of oil were released from the well and 4.1 million barrels were released into the GOM from the DWH event (Lubchenco et al. 2010; TFISG 2010; McNutt et al. 2011). Hydrocarbon flow rates from the spill were independently verified using direct acoustic measurement methods (Camilli et al. 2011). A potential lower limit of fluids released into the GOM during the DWH event is presented by Ryerson et al. (2011). Analysis of event video footage led scientists to conclude that the majority of the volume of the release of the DWH event was hydrocarbon gases, and oil comprised 44% of the volume of the release (TFISG 2010). Reddy et al. (2011) estimated that the total quantity of gas released into the water column during the DWH event was 170 million kg (190,000 tons) of hydrocarbon gases and Joye et al. (2011) estimated that the DWH event released 450 million kg (500,000 tons) of hydrocarbon gases at depth. In addition, approximately 7,000 m^3 (1.84 million gal) of the chemical dispersants COREXIT 9500A and COREXIT 9527 were used on the DWH event (National Commission 2011a). Of the total volume, approximately 2,900 m^3 (771,000 gal) of chemical dispersants were applied directly to the DWH wellhead at a depth of about 1,500 m (4,900 ft) below the water surface, which was the first application of dispersants at the source of a subsea spill (Kujawinski et al. 2011).

An estimate of the fate of the oil (as of August 2010, when the well was capped) was released by the National Incident Command (NIC) in August 2010; findings were as follows: 25% of the oil was estimated to be removed by burning, skimming, and direct recovery from the wellhead; 25% was estimated to have evaporated or dissolved into the water column; 24% was estimated to be dispersed into the water column; and 26% was estimated to remain as oil on or near the water surface, onshore oil that remains or has been collected, and oil that is buried in sand and sediments (Lubchenco et al. 2010). As of August 2010, oil that was reported to be dissolved or was dispersed into the water column, and thus remaining in the environment, was estimated to be between 2.9 and 3.2 million bbl by a group of academics organized by the Georgia Sea Grant (Hopkinson 2010). It should be noted that the studies by Lubchenco et al. (2010) and Hopkinson (2010) had different methodologies; Hopkinson (2010) considered dissolved and dispersed oil to be residual oil remaining in the environment.

The principal impacting factors to GOM water quality from the DWH event were (1) the release of oil, (2) the release of gas, and (3) the use of chemical dispersants. Impacts of the DWH event on water quality have been monitored by various Federal and State agencies and by the academic community. The December 17, 2010, report released by the Operational Science Advisory Team of the Unified Area Command (OSAT) summarized water and sediment quality data measuring concentrations of oil- and dispersant-related chemicals collected from the start of the DWH event through October 23, 2010 (OSAT 2010). The OSAT is a group of Federal scientists and stakeholders that was put together by the Unified Area Command to collect data to inform cleanup operations, restoration activities, research, and the Natural Resources Damage Assessment (NRDA) process (OSAT 2010). As of January 20, 2011, a total of 13,677 water samples and 4,506 sediment samples had been taken to support the NRDA process (NOAA 2011g). Shoreline Cleanup Assessment Team (SCAT) observations indicated that oiling along barrier islands and coastal areas in Louisiana, Mississippi, Alabama, and Florida during and after the DWH event persisted on some shorelines as of January 2011 (Geoplatform 2011a,b). As of January 20, 2011, 134 km (83 mi) of shoreline were classified as heavily or moderately oiled (NOAA 2011c). SCAT observations in March 2012 indicated that oiling was still present in some areas along barrier islands and coastal areas in Louisiana, Mississippi, Alabama, and Florida (ERMA 2012a,b).

The oil that leaked during the DWH event is known as light sweet crude oil and has many chemical constituents. To evaluate the impacts of the DWH event on the environment, the USEPA selected “benchmark” concentrations of 41 hydrocarbon compounds and two metals found in the oil from the DWH event for human health, aquatic health, and sediment (OSAT 2010). The compounds include 7 volatile organic compounds (VOCs), 16 parent PAHs, and 18 derivative compounds of the PAHs (OSAT 2010). The composition of the oil from the DWH event varies with the state of weathering of the oil; lighter-end components are removed more quickly than the heavier-end components (Core and Technical Working Groups 2010). Some of the constituents released during the DWH event evaporated at the surface, some compounds underwent photo-oxidation at the surface, and some constituents rapidly dissolved into the GOM waters before the oil reached the surface. Evidence from the DWH event indicates that natural gas released from the well was rapidly broken down by bacterial action with little oxygen drawdown (Camilli et al. 2010; Kessler et al. 2011). Other constituents remained in the water column and bottom sediments for longer periods (OSAT 2010). In addition, the chemical dispersant used during the spill has been tracked in the GOM by measuring concentrations of 2-butoxyethanol, dipropylene glycol n-butyl ether (DPnB), propylene glycol, and dioctyl sulfosuccinate (DOSS) — four of its traceable constituents — and comparing those concentrations to water quality aquatic life benchmarks set by the USEPA (OSAT 2010). Areas contacted by the event were identified by tracking certain constituents. Other chemicals associated with the event include other surface washing agents, which are used to lift oil off of shoreline surfaces and further prevent those surfaces from becoming sources of pollution (NOAA 2011a).

Both short-term and long-term impacts from the DWH event on water quality in the GOM are currently being assessed. The current understanding of the status of water quality in coastal and marine areas as a result of the event will be discussed below.

3.4.1.4.1 Effects of Deepwater Horizon Event on Coastal Water Quality. As a result of the DWH event, oil was present on the surface as well as dispersed and in suspension below the surface in coastal areas (OSAT 2010). The NRDA process has collected a large amount of data, and as of December 1, 2010, approximately 6,400 linear km (4,000 linear mi) of shoreline had been assessed by NRDA teams for oil contamination (NOAA 2010a). Data from regional SCAT teams indicates that oil contamination persisted on some GOM shorelines as of March 2012. As of December 20, 2010, the Louisiana SCAT team observations indicated tar balls and varying degrees of oiling were still present on the shoreline, marshes, and barrier islands of Louisiana. As of January 5, 2011, Mississippi, Alabama, and Florida SCAT team observations indicated varying degrees of oiling were present on portions of the barrier islands and shoreline in Mississippi, Alabama, and western Florida (Geoplatform 2011a,b). Much of the oil residue from the DWH event has been removed by natural attenuation and, to some degree, cleanup efforts along the shoreline (OSAT-2 2011). As of January 20, 2011, 134 km (83 mi) of shoreline were classified as heavily or moderately oiled; 1,694 km [1,053 mi] of shoreline had been found to be oiled out of a total of 6,783 km [4,215 mi] of shoreline surveyed (NOAA 2011c). NOAA has not published an updated summary of surveyed versus oiled shoreline since the January 2011 summary. SCAT observations in March 2012 indicated that oiling still persisted in some areas along barrier islands and coastal areas in Louisiana, Mississippi, Alabama, and Florida (ERMA 2012a,b).

OSAT reported that all water samples collected after August 3, 2010 (in waters deeper than 10 ft), indicated that oil- and dispersant-related chemicals were below levels set by the USEPA to be chronically toxic to humans and aquatic life. The OSAT report also identified some residual contamination remaining in shallow waters in the form of tar mats, defined as “submerged sedimented oil,” located in the subtidal zone. The OSAT (2010) report indicated the need to further define the tar mats and evaluate them as a potential source of shoreline contamination through “re-oiling.” In February 2011, the OSAT published a second report focused on remnant oil along shorelines in the GOM (OSAT-2 2011). Supratidal buried oil, small surface residue balls, and submerged oil mats are three types of residual oil from the DWH spill in the nearshore zone that were identified as being more damaging to completely remove from coastal habitats than to let them remain and naturally attenuate (OSAT-2 2011). The OSAT-2 (2011) concluded that the residual oil had a relatively minor impact on resources when compared with the potential negative impact to those resources that could be sustained through prolonged cleanup activities. Hayworth et al. (2011) and Hayworth and Clement (2011) provide an evaluation of the effectiveness of beach cleanup activities in Alabama as of mid-2011. In these articles, the authors document the presence of residual oil in the beach system and note important steps to take to minimize the impacts and increase effective documentation of potential impacts in the future. Suggestions include creating a master sampling plan, examining more effective beach cleanup techniques, and creating baseline assessments of inhabitants of these beach ecosystems.

OSAT (2010) defined nearshore waters as those within 5.6 km (3 nautical mi; 3.5 linear mi) of the coastline, which are also defined as “State” waters in most cases. Visible oil was first found in nearshore waters on approximately May 15, 2010, in Louisiana and June 1, 2010, for Alabama, Mississippi, and Florida. Nearshore water and sediment quality were sampled before oil reached the nearshore zone, starting in late April, to create a baseline/

reference dataset (OSAT 2010). Concentrations of oil-indicator and dispersant chemicals were measured in samples to determine the presence or absence of impacts from the event. The concentrations of those chemicals were then compared with the human health and ecological health benchmarks set by the USEPA as indicators of health risks. Findings of indicator concentrations of oil- and dispersant-related chemicals were also compared to the composition of the oil from the DWH event to rule out samples that may have been contaminated by other sources (e.g., oil leaks from boats). Samples that were found to be of indeterminate origin were considered to be the oil from the DWH event. Results of the water and sediment quality sampling are detailed in Table 3.4.1-1 and indicate that there were very few exceedances of the benchmarks set by the USEPA. No exceedances of the human health benchmark for oil-related chemicals or the aquatic life benchmark for dispersant-related chemicals were measured in samples. Sampling after August 3, 2010, found traces of oil and dispersant remaining in the nearshore zone, but all samples that exceeded water and/or sediment quality benchmarks were not consistent with the oil from the DWH event (OSAT 2010).

Wong et al. (2011) found that sediments collected in October 2010 along GOM shorelines that were found to contain oil contamination likely from the DWH event were directly correlated with the location of the full extent of the surface oil slick. Ninety percent of the shoreline sediment samples collected contained at least a trace of oil (Nowell et al. 2011). The chemical signature of 39% of the sediment samples and tar balls collected along the shorelines of Louisiana, Alabama, Mississippi, and Florida matched that of the oil released during the DWH event (Nowell et al. 2011).

3.4.1.4.2 Effects of Deepwater Horizon Event on the Continental Shelf. The December 17, 2010, OSAT report summarized data collected measuring concentrations of oil- and dispersant-related chemicals in water and sediment from the start of the event through October 23, 2010. The OSAT (2010) report defined the offshore zone as those waters between 5.6 km (3 nautical mi) of the coastline (boundary of “State” waters) to the 200-m (656-ft) bathymetric contour. Concentrations of oil- and dispersant-indicator chemicals were measured in samples to determine the presence or absence of impacts from the event. The concentrations of those chemicals were then compared with the human health and ecological health benchmarks set by the USEPA as indicators of health risks. Findings of indicator concentrations of oil- and dispersant-related chemicals were also compared to the composition of the oil from the DWH event to rule out samples that may have been contaminated by other sources (e.g., oil leaks from boats, oil from natural seeps). Results of the water and sediment quality sampling are detailed in Table 3.4.1-1 and indicate that there were very few exceedances of the benchmarks set by the USEPA. No exceedances of the human health benchmark for oil-related chemicals or the aquatic life benchmark for dispersant-related chemicals were measured in water samples, and no exceedances of the aquatic life benchmark for oil-related chemicals were measured in sediment samples. Sampling after August 3, 2010, found traces of oil and dispersant remaining in the offshore zone, but no samples taken after this time had concentrations that exceeded water quality benchmarks (OSAT 2010). A summary of offshore water quality sampling data available by January 5, 2011 is presented by Boehm et al. (2011) and focuses on concentrations of total PAH through time and space after the DWH event. Edwards et al. (2011) reports high observed

TABLE 3.4.1-1 Summary of Results of Water and Sediment Quality Sampling from the Deepwater Horizon Event as of October 23, 2010[a]

Sample Type	Total Samples	Number of Detects	Samples Exceeding Benchmark[b]	Exceedances Consistent with Oil from DWH Event
Nearshore Zone[c]				
Oil-Related Chemicals				
Water quality sample compared to human health benchmark[b]	6,090	2,685	0	0
Water quality sample compared to aquatic life benchmark	5,773	395	41	22
Sediment quality sample compared to aquatic life benchmark	1,136	441	24	13
Dispersant-Related Chemicals				
Water quality sample compared to aquatic life benchmark	5,262	60	0	0
Sediment quality sample	412	6	NA[d]	NA
Offshore Zone[e]				
Oil-Related Chemicals				
Water quality sample compared to human health benchmark[b]	750	242	0	0
Water quality sample compared to aquatic life benchmark	481	283	6	6
Sediment quality sample compared to aquatic life benchmark	268	207	0	0
Dispersant-Related Chemicals				
Water quality sample compared to aquatic life benchmark	440	199	0	0
Sediment quality sample	242	1	NA	NA
Deepwater Zone[f]				
Oil-Related Chemicals				
Water quality sample compared to human health benchmark[b]	4,794	673	0	0
Water quality sample compared to aquatic life benchmark	3,612	821	70	63
Sediment quality sample compared to aquatic life benchmark	120	114	7	7
Dispersant-Related Chemicals				
Water quality sample compared to aquatic life benchmark	4,114	353	0	0
Sediment quality sample	120	1	NA	NA

a Data as presented in OSAT (2010).

b Values of the USEPA benchmarks are presented in the report by OSAT (2010).

c Nearshore zone is defined as coastal waters out to 5.6 km (3 nautical mi) from the shoreline (State waters).

d NA = No sediment quality benchmarks were established for dispersant-related chemicals.

e Offshore zone is defined as waters from 5.6 km (3 nautical mi) of the shoreline to a depth of 200 m (656 ft).

f Deepwater zone is defined as waters deeper than 200 m (656 ft).

rates of bacterial degradation within the surface oil slick, despite nutrient limitations thought to inhibit oil respiration.

3.4.1.4.3 Effects of Deepwater Horizon Event on Deep Water. The December 17, 2010, OSAT report summarized oil- and dispersant-related chemical concentrations in water and sediment from the start of the DWH event through October 23, 2010. The OSAT (2010) defined the deepwater zone as those waters beyond the 200-m (656-ft) bathymetric contour. Concentrations of oil- and dispersant-indicator chemicals were measured in samples to determine the presence or absence of impacts from the DWH event. The concentrations of those chemicals were then compared with the human health and ecological health benchmarks set by the USEPA as indicators of health risks. Findings of indicator concentrations of oil- and dispersant-related chemicals were also compared to the composition of the oil from the DWH event to rule out samples that may have been contaminated by other sources (e.g., oil leaks from boats, oil from natural seeps). Results of the water and sediment quality sampling (Table 3.4.1-1) indicate that there were very few exceedances of the benchmarks set by the USEPA. No exceedances of the human health benchmark for oil-related chemicals or the aquatic life benchmark for dispersant-related chemicals were measured in samples. Sampling after August 3, 2010, found traces of oil and dispersant remaining in the deepwater zone, and 7 out of 18 sediment samples taken within 3 km (2 mi) of the wellhead exceeded the aquatic life sediment quality benchmark and were consistent with the oil from the DWH event (OSAT 2010).

Camilli et al. (2010) conducted a subsurface hydrocarbon study two months after the start of the DWH event (depth 1,500 m [4,921 ft]) in the GOM while oil was still being released from the wellhead. They found a continuous plume of dispersed oil at a depth of approximately 1,100 m (3,609 ft) that extended for 35 km (22 mi) from the DWH event site. The plume consisted of droplets between 10 and 60 μm in size and contained monoaromatic hydrocarbons (benzene, toluene, ethyl benzene, and xylene) at concentrations greater than 50 micrograms per liter. The plume persisted for months at this depth with no substantial biodegradation. They also measured concentrations throughout the water column and found similarly high concentrations of aromatic hydrocarbons in the upper 100 m (328 ft). Polycyclic aromatic hydrocarbons were found at very high concentrations (reaching 189 micrograms per liter) by Diercks et al. (2010) after the DWH event at depths between 1,000 and 1,400 m (3,281 and 4,593 ft) extending as far as 13 km (8 mi) from the subsurface DWH event site.

Joye et al. (2011) estimated that the DWH event released 450 million kg (500,000 tons) of hydrocarbon gases at depth. During a research cruise in May/June 2010, Joye et al. (2011) found high concentrations of dissolved hydrocarbon gases (methane, ethane, propane, butane, and pentane) in a water layer between 1,000 and 1,300 m (3,281 and 4,265 ft) (Joye et al. 2011). These concentrations exceeded the background concentration of hydrocarbon gases by up to 75,000 times. Results from a study by Yvon-Lewis et al. (2011) showed that, beginning 53 days after the DWH event and for 7 days of continuous chemical analysis at sea, there was a low flux of methane from the DWH event to the atmosphere. Based on these methane measurements at the surface water and concurrent measurements at depth, they concluded that the majority of methane from the DWH event remained dissolved in the deep ocean waters (Yvon-Lewis et al. 2011). Valentine et al. (2010) reported that two months after the DWH event, propane and ethane gases at depth were the major gases driving rapid respiration by bacteria. They also found these gases at shallower depths but at concentrations that were orders of magnitude lower (Valentine et al. 2010).

Methane release in the DWH event and biodegradation by deepwater methanotrophs were studied by Kessler et al. (2011). They found that a deepwater bacterial bloom respired the majority of the methane in approximately 120 days. Similarly, Hazen et al. (2010) found indigenous bacteria at 17 deepwater stations biodegrading oil 2–3 months after the DWH event. Atlas and Hazen (2011) provide an overview of the biodegradation processes found in the dispersed plume of oil, surface water, and sediments in response to hydrocarbons released during the DWH event.

The fate of the estimated 771,000 gallons of chemical dispersants injected at the DWH wellhead near the seafloor (1,500 m [4,921 ft]) was studied by Kujawinski et al. (2011). Their results show that the anionic surfactant DOSS (dioctyl sodium sulfosuccinate) ingredient in the dispersants injected at the wellhead was concentrated in hydrocarbon plumes at 1,000–1,200 m (3,281–3,937 ft) depth 64 days after dispersant application was stopped and as far away as 300 km (186 mi). They concluded that the chemical dispersants at this depth underwent slow rates of biodegradation (Kujawinski et al. 2011). Kujawinski et al. (2011) did not draw conclusions as to the toxicity of the dispersant or dispersant-oil mixtures found at depth; the dispersant concentrations and dispersant-to-oil ratios measured were lower than those published in toxicology studies, and the authors identified a need for further studies assessing the impact of dispersant-oil mixtures on pelagic biota.

3.4.2 Alaska – Cook Inlet

The term water quality describes the overall condition of water, reflecting its particular biological, chemical, and physical characteristics. It is an important measure for both ecological and human health. Water quality is most often discussed in reference to a particular purpose or use of the water, such as recreation, drinking, or ecosystem health. Alaska State and Federal laws define the type of water quality that must be maintained for these purposes.

Alaska marine waters are a mixture of several sources — atmospheric (precipitation), rivers, streams, groundwater, snowmelt, glacier-melt, ice-melt, and oceanic sources such as vents on the deep seafloor. Constituents in marine waters come into the system naturally (biogenic) and are introduced by humans (anthropogenic). Climate change is affecting the sources and constituents of marine water as increasing carbon dioxide and increasing air temperatures force changes in seawater acidification, seawater temperature, and related water quality variables.

Precipitation, snowmelt, glaciers, and groundwater springs feed the many lakes, streams, ponds, and wetlands throughout Alaska. High tundra, muskeg, willow-alder habitats, and alpine bedrock feed constituents into these freshwater systems. Rivers originating in headwaters introduce and transport sediment into the drainage basins on a seasonal basis. Volcanic eruptions have also played an important role in contributing chemical constituents to the freshwater systems of Alaska.

In Alaska, there are several seasonal or occasional natural events that contribute to water quality and to which natural systems are adapted. Examples of these events include hydrocarbons from natural oil seeps, sediment from natural coastal erosion, sediment derived from glacial-fed rivers, natural levels of nutrients from river flooding, and metals from river sediments, volcanic eruptions, and rock erosion (AMAP 1997, 2002). Several metals, such as zinc and iron, in very low natural concentrations are essential for life processes in the marine environment (Ezoe et al. 2004).

The Alaska OCS water quality to date has received relatively little contribution from the more common land-based and marine anthropogenic pollution found in the Lower 48 States. The rivers that originate in Alaska and flow into coastal marine waters remain relatively unpolluted by human activities. Industrial and shipping impacts on water quality have been and are relatively low at this time, with some notable exceptions of events such as the *Exxon Valdez* oil spill and the *Selendang Ayu* and other ship groundings or accidents.

There are, however, several sources of anthropogenic contaminants in the Alaska marine environment. They travel through pathways to the arctic marine ecosystem including deposition from the atmosphere, discharges to the sea, drifting sea ice, or directly from accidental or intentional dumping of pollutants. Water quality pollutants arrive in Alaska from sources both within and outside the circumpolar environment. The types of pollutants that come from these near and distant sources include oil-based hydrocarbons, manufactured chemicals, metals (e.g., mercury, lead, cadmium), nutrients loads, high sediment loads (nonpoint runoff of disturbed lands), organic waste (e.g., seafood processing), and radionuclides (from radioactive materials).

Persistent organic pollutants (POPs) are a category of anthropogenic pollutants that are particularly resistant to degradation in the environment. POPs have a potential for long-range transport, and they accumulate in concentrations in aquatic species. Polyaromatic hydrocarbons (PAHs), a byproduct of burning hydrocarbon fuel, and polychlorinated biphenyls (PCBs), used in manufacturing products, are two persistent organic pollutants found in the Alaska (AMAP 2004).

Many of these pollutants concentrate in animals and bioaccumulate as they move through the food web. Contaminated animals can then transport the pollutant into or away from the Arctic (AMAP 2004). Migratory whales, migratory seabirds, and salmon species are examples of pollutant transporters through the marine aquatic system.

Human society sometimes discharges into the environment constituents that also occur naturally in the ecosystem. These anthropogenic discharges, however, are different than the biogenic sources because they occur in greater concentrations and often suddenly; the chemical bondings are different than what is found in the natural system; the discharges occur outside the area that they would naturally occur; or they occur out of phase of the natural cycle of the same biogenic contributions to the system. Examples of anthropogenic constituents include sediment, metals, and hydrocarbons.

The Cook Inlet Planning Area is located in south central Alaska and has a watershed of approximately 100,000 km^2 (38,600 m^2) (Saupe et al. 2005). The continental shelf off of south central Alaska supports a productive ecosystem that includes numerous species of fishes, marine mammals, sea birds, and invertebrates. The Cook Inlet watershed is home to two thirds of the population of the State of Alaska; therefore, runoff in the watershed is influenced by human activity more than in any other region in Alaska (Saupe et al. 2005). The principal point sources of anthropogenic contaminants in Cook Inlet are discharges from municipalities, seafood processors, and the petroleum industry (MMS 1996b). Point source pollution is rapidly diluted by the energetic tidal currents in the Cook Inlet, and it is estimated that 90% of the water in the Cook Inlet is flushed every 10 months (MMS 2003a). The State of Alaska has identified several coastal impaired water bodies throughout the south central coastal area that have total maximum daily load (TMDL) restrictions implemented or remain on the Clean Water Act 303(d) list of impaired water bodies with TMDLs planned to be implemented by 2013 (ADEC 2010a). The impaired areas are all relatively small and are mainly affected by urban runoff, timber harvest, or seafood processing (ADEC 2010a). These small impaired areas would not have an appreciable effect on marine water quality. The coastal waters of south central Alaska have recently been assessed to be in good condition by the USEPA National Coastal Condition Report, and were deemed to be in better condition than any other U.S. coastal waters assessed for the report (USEPA 2008).

Cook Inlet waters are influenced by riverine and marine inputs. During summer and fall, surface salinity varies from 32% at the entrance to lower Cook Inlet to approximately 26% at the West Forelands (Rosenberg et al. 1967; Kinney et al. 1970; Wright et al. 1973; Gatto 1976; Muench et al. 1978). Oxygen levels measured in May 1968 in the surface waters of Cook Inlet ranged from about 7.2 to 11.0 mL/L (Kinney et al. 1970). None of the waters in the inlet were found to be oxygen depleted, because of the strong tidal currents in the inlet that mix the entire water column (Kinney et al. 1970).

The distribution of suspended particulate matter in Cook Inlet shows horizontal gradients in both the longitudinal and cross-inlet directions (Feely and Massoth 1982). The suspended particulate matter concentrations are higher (up to 2,000 parts per million [ppm]) in the northeastern end of upper Cook Inlet and decrease through the lower inlet (up to 100 ppm) depending on inputs from rivers at the time of measurement (Kinney et al. 1970; Wright et al. 1973; Sharma 1979; Feely and Massoth 1982; Saupe et al. 2005).

The activities associated with petroleum exploitation in State waters that are most likely to affect water quality in the Cook Inlet are (1) the permitted discharges from exploration drilling units and production platforms and (2) petrochemical plant operations. The USEPA compared pollutant concentrations resulting from an estimated Cook Inlet discharge of cuttings generated while drilling with synthetic-based fluid to both Federal criteria and State water quality standards (because the projected discharges occur in State waters). There was no predicted exceedance of the Federal criteria or State water quality standards in the Cook Inlet (USEPA 2000). The National Research Council (NRC 2003b) estimated that the total amount of produced water being released into Cook Inlet waters was 45.7 million bbl/yr in the 1990s. Produced water can contain hydrocarbons, salts, and metals at levels toxic to marine organisms. Before being discharged into the ocean, produced water is typically treated and must meet

NPDES requirements regarding discharge rate, contaminant concentration, and toxicity, thereby reducing the potential for water column and sediment contamination.

Sediment sampling for sediment quality was conducted in depositional areas in the outer portion of Cook Inlet in 1997 and 1998 (Boehm et al. 2001a). Analysis of dated sediment cores demonstrated that the concentration of hydrocarbons has not increased appreciably over the past few decades (since before State offshore oil exploration and production in Cook Inlet). The concentrations of total PAHs found by Boehm et al. (2001a) in the outer portion of Cook Inlet range from less than 120 to 490 parts per billion (ppb). The highest concentrations tend to occur in the southeast corner of Cook Inlet. These concentrations are the result of a combination of eroded coal and oil sources, plus seep oil being deposited in sediments by the coastal current entering Cook Inlet from the eastern Gulf of Alaska (Boehm et al. 2001a). The concentrations down current of Cook Inlet are actually diluted up to several-fold by Cook Inlet discharges. This results in the highest concentrations of hydrocarbons existing in coastal sediments where the influence of estuarine Cook Inlet discharges is smallest, particularly in eastern lower Cook Inlet (Boehm 2001). Water and sediment quality were also sampled in 2002 by the USEPA and the Alaska Department of Environmental Conservation (ADEC) for the National Coastal Assessment Program (Saupe et al. 2005). Total PAH concentrations in sediments of Cook Inlet ranged from less than 10 ppb to 840 ppb, with the majority of samples having concentrations less than 150 ppb (Saupe et al. 2005). No persistent organic contaminants, such as PCBs or dichlorodiphenyltrichloroethanes (DDTs) were detected in sediments during sampling in 2002 (Saupe et al. 2005). Sampling for metals concentrations in sediment indicate that levels of most metals are below a range to produce effects (as defined by the ADEC); however, concentrations of nickel and chromium in sediments were found to exceed the threshold for effects at three stations and one station, respectively, within the Cook Inlet (Saupe et al. 2005). Measurements of sediment total organic carbon taken in 1971 were found to be low and suggestive of an unpolluted environment (MMS 2003a).

Hydrocarbons are found throughout the waters of Cook Inlet in generally low concentrations. Natural oil seeps occur on the west side of the Cook Inlet, which release hydrocarbons from biogenic sources (Saupe et al. 2005). Concentrations generally are similar to those found in other unpolluted coastal areas.

3.4.2.1 Climate Change Effects

Climate change is anticipated to impact water quality of the Cook Inlet. A thorough discussion of the impacts of climate change to the baseline environment can be found in Section 3.3. Anticipated sea-level rise would cause salinity increases in estuaries and lead to increases in coastal erosion (Nicholls et al. 2007). Increases in precipitation are anticipated to increase the quantity of runoff that enters into Cook Inlet (IPCC 2007a). Significant changes in runoff would impact salinity in Cook Inlet, change water circulation and stratification in Cook Inlet, and also impact the quantities of suspended solids and nutrients delivered to Cook Inlet (ACIA 2005). In addition, anticipated thaw of permafrost would increase susceptibility to erosion and landslides, which could lead to increased input of suspended solids to Cook Inlet (ACIA 2005). Ocean temperatures in the upper 700 m (2,300 ft) increased by 0.10°C (0.18°F) between 1961 and 2003 (Bindoff et al. 2007). Future sea surface temperature increases are anticipated and would affect chemical and microbial processes in coastal and marine environments (Nicholls et al. 2007). Coastal erosion is anticipated to increase due to climate change (Alaska Regional Assessment Group 1999). In addition, ocean pH values are anticipated to decrease by up to 0.35 pH units over the 21st century, leading to ocean acidification (IPCC 2007a).

3.4.3 Alaska – Arctic

The term water quality describes the overall condition of water, reflecting its particular biological, chemical, and physical characteristics. It is an important measure for both ecological and human health. Water quality is most often discussed in reference to a particular purpose or use of the water, such as recreation, drinking, or ecosystem health. Alaska State and Federal laws define the type of water quality that must be maintained for these purposes. General characteristics of water quality in Alaskan waters are presented above in Section 3.4.2.

Because of limited municipal and industrial activity around the Arctic Ocean coast, most pollutants occur at low levels in the Arctic. The rivers that flow into the Alaskan arctic marine environment remain relatively unpolluted by human activities, but they carry into the marine environment natural loads of suspended sediment particles with trace metals and hydrocarbons. Winds and drifting sea ice may play a role in the long-range redistribution of pollutants in the Arctic Ocean. The broad arctic distribution of pollutants is described in a report by the Arctic Monitoring and Assessment Program (AMAP 1997) entitled *Arctic Pollution Issues: A State of the Arctic Environmental Report*.

The areas of the Arctic region in the proposed action are in the Beaufort Sea and Chukchi Sea Planning Areas (Figure 3.4.3-1). Under Alternatives 5 and 6, leasing activity would be deferred in the Beaufort Sea and Chukchi Sea, respectively. In both seas, the water quality is relatively pristine. Degradation of water quality, where it occurs in the Arctic, is largely related to aerosol deposition and localized anthropogenic pollution from, for example, mining facilities and former military facilities (ADEC 2010a).

Water quality in the nearshore Arctic Ocean (landward of the 40-m [131-ft] water depth line) may be slightly affected locally by both anthropogenic and natural sources. Most detectable pollutants occur at very low levels in the arctic waters and/or sediments and do not pose an ecological risk to marine organisms (MMS 2003a). The State of Alaska does not identify any Clean Water Act Section 303(d) impaired water bodies within the Arctic region (ADEC 2010a). However, some annual water quality monitoring (temperature and total dissolved solids) is required for the Nearshore Beaufort Lagoons as a condition for oil and gas operations. The Nearshore Beaufort Lagoons were on the Clean Water Act 303(d) list for impaired water bodies between 1996 and 1998 for temperature and salinity, but mitigation measures have brought water quality into compliance with Alaska standards since 2002 (ADEC 2010a).

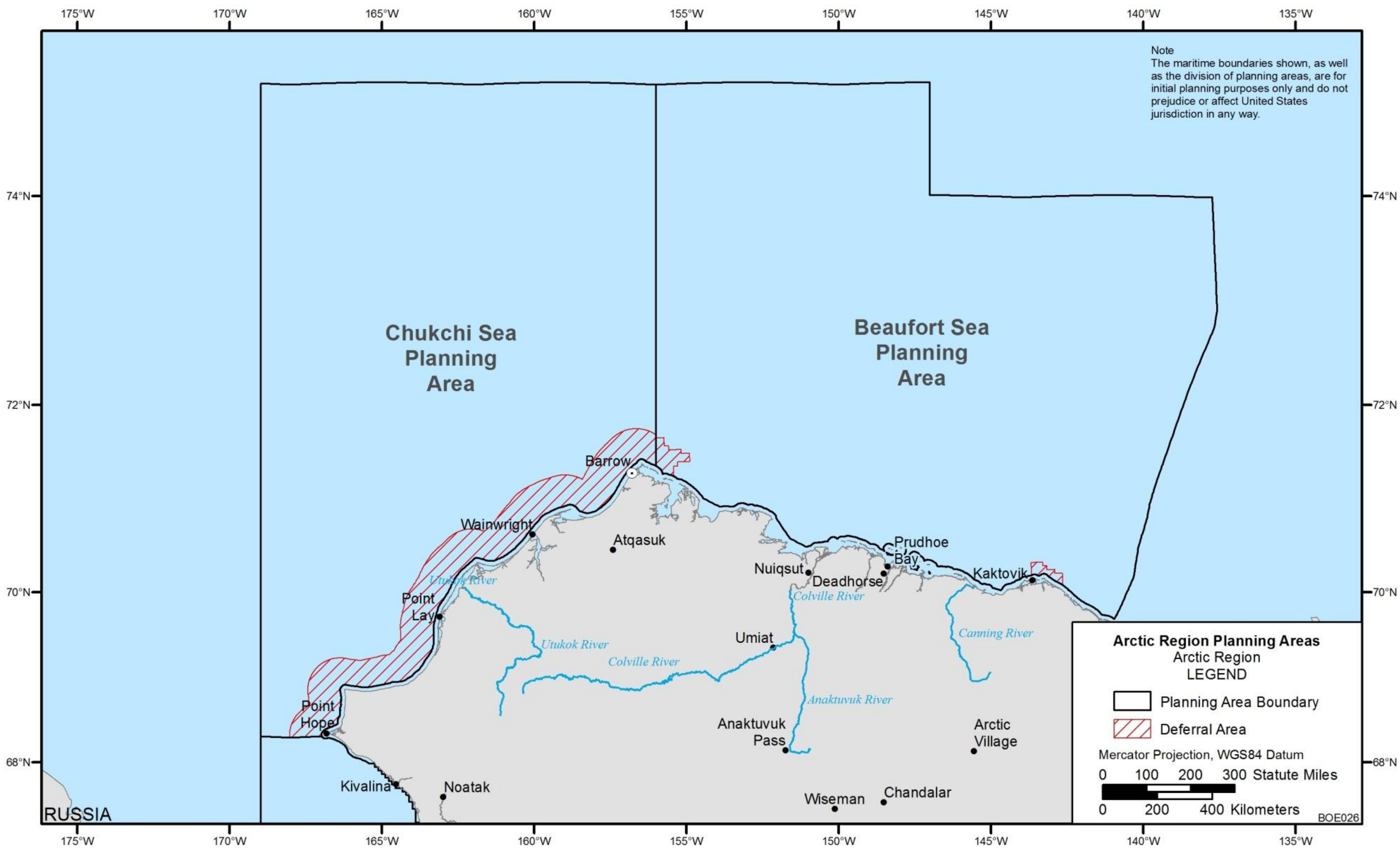

FIGURE 3.4.3-1 Beaufort Sea and Chukchi Sea Planning Areas

The primary rivers that flow into the arctic marine environment remain relatively unpolluted by human activities. They do, however, carry into the marine environment suspended sediment particles with some trace metals, hydrocarbons, and other pollutants. Suspended sediment concentrations are highest during the spring runoff, when rivers flow into the Arctic under landfast ice (Alkire and Trefry 2006). Plumes of river water can extend to 20 km (12.4 mi) under the ice, as mixing and wave action are low under the seasonal ice (Alkire and Trefry 2006).

Suspended sediment concentrations in the Beaufort Sea under summer conditions are usually low, but can be elevated by wind-wave activity in shallow waters closer to shore (less than 10 m [33 ft] deep) (Boehm et al. 2001b). Suspended sediment concentrations in the Beaufort Sea are estimated to be at background levels (Trefry et al. 2009). Water quality also is affected by natural erosion of organic material along the shorelines. The Chukchi is a high-energy shore once the ice is gone (MMS 2008b). Erosion and flooding occur with autumn and spring storms and ice movement (MMS 2008b). The increased oxygen demand of these inputs may marginally lower oxygen levels and locally increase turbidity. These effects usually occur in waters less than 5 m (16.4 ft) deep and do not generally extend seaward of the barrier islands. Another cause of altered water quality is sea ice cover (MMS 2008b). As sea ice forms during the fall, particulates are removed from the water column by ice crystals and are locked into the ice cover. The result is very low turbidity levels during the winter.

Dissolved and particulate trace metal concentrations in sediments of the Beaufort nearshore do not show evidence of significant impact from the nearby oil and gas activities in Prudhoe Bay (Naidu et al. 2001, 2005; Trefry et al. 2009). However, elevated concentrations of copper, lead, cadmium, silver, arsenic, antimony, nickel, mercury, and cobalt have been measured at a monitoring station near the West Dock in Prudhoe Bay and are assumed to be related to construction activity in the area (Boehm et al. 2001b). Results of monitoring activities around the Northstar site and the original proposed Liberty site also indicate that hydrocarbon and metals concentrations in sediments are not significantly influenced by anthropogenic input (Brown 2003). Trace-metal concentrations in the Chukchi are elevated compared to those in the eastern portions of the Arctic Ocean. The higher concentrations are thought to come from Bering Sea water that passes first through the Chukchi Sea and then through the Beaufort Sea (MMS 2008b). These waters, however, are considerably lower in trace-metal concentrations than the USEPA criteria for the protection of marine life (MMS 2008b). One potential source of anthropogenic input of trace metals is the Red Dog Mine. A study for the National Park Service (Hasselbach et al. 2005) showed extensive airborne transport of cadmium and lead; although the study was focused only on the Cape Krusenstern National Monument, these contaminants are probably carried out into the Chukchi Sea (Hasselbach et al. 2005).

Background hydrocarbon concentrations in Beaufort Sea waters appear to be biogenic and on the order of less than 1 ppb (Trefry et al. 2004). No seafloor oil seeps have been identified in the Beaufort or Chukchi Sea (Becker and Manen 1988). However, naturally occurring oil seeps have been identified onshore above the low-tide line along the coast of the Beaufort Sea (Becker and Manen 1988). Recent studies of sediments in Beaufort Lagoon, located in the eastern portion of the Alaskan arctic coast, have indicated that no anthropogenic hydrocarbon or metals contamination exists (Naidu et al. 2005). These sediment data will serve as a baseline against which to evaluate impacts to nearshore sediments from anthropogenic activities (Naidu et al. 2005). Hydrocarbon concentrations in sediments of the Beaufort Sea are relatively high compared with other nonpolluted marine areas (Steinhauer and Boehm 1992). Total saturated hydrocarbon concentrations in sampled sediments ranged from 2.5 to 36 mg/kg (Steinhauer and Boehm 1992; Brown 2003). PAH concentrations in the sediments ranged from 0.04 to 2.2 mg/kg, which are well below levels that have detrimental effects on the environment (Brown 2003; Naidu et al. 2001). Examination of sediment cores gives little indication that oil and gas activities in the area have measurably contaminated the sediments (Brown 2003), and molecular markers do not indicate input from oil and gas industrial activities (Naidu et al. 2001). However, concentrations of PAHs at a sampling site near West Dock in Prudhoe Bay show signs of elevated hydrocarbons when compared to the other sampling stations (Boehm et al. 2001b). Considering the limited sources of anthropogenic input to the area, concentrations of hydrocarbons in the Chukchi Sea are expected to be at background levels.

3.4.3.1 Climate Change Effects

Climate change is anticipated to impact water quality of the Beaufort and Chukchi Seas. A thorough discussion of the impacts of climate change to the baseline environment can be found in Section 3.3. Anticipated sea-level rise would cause salinity increases in estuaries and lead to increases in coastal erosion (Nicholls et al. 2007). Increases in precipitation are anticipated to increase the quantity of runoff that enters arctic waters (IPCC 2007a). Significant changes in runoff would impact salinity and also impact the quantities of suspended solids and nutrients delivered to the Beaufort and Chukchi Seas (ACIA 2005). In addition, anticipated thaw of permafrost would increase the susceptibility to erosion and landslides, which could lead to increased input of suspended solids to arctic waters (ACIA 2005). Ocean temperatures in the upper 700 m (2,300 ft) increased by 0.10°C (0.18°F) between 1961 and 2003 (Bindoff et al. 2007). Future sea surface temperature increases are anticipated and would affect chemical and microbial processes in coastal and marine environments (Nichols et al. 2007). Coastal erosion is anticipated to increase due to climate change, due to permafrost thaw (Alaska Regional Assessment Group 1999). Retreat of sea ice would increase impacts to coastal areas from storms, change the sea surface temperature and salinity, and alter ocean stratification (ACIA 2005). In addition, ocean pH values are anticipated to decrease by up to 0.35 pH units over the 21st century, leading to ocean acidification (IPCC 2007a).

3.5 METEOROLOGY AND AIR QUALITY

3.5.1 Climate

3.5.1.1 Gulf of Mexico

Most of the southern States, including the coastal areas along the GOM, have humid subtropical climates characterized by hot summers and mild winters, with high humidity in all seasons. These climates are classified as Cfa under the Köppen-Geiger climate classification system (Peel et al. 2007). The GOM is influenced by a maritime subtropical climate controlled mainly by the clockwise wind circulation around a semipermanent, high barometric pressure area alternating between the Azores and Bermuda Islands. The circulation around the western edge of the high pressure cell results in the predominance of moist southeasterly wind flow in the region. However, winter weather is quite variable. During the winter months, December through March, cold fronts associated with outbreaks of cold, dry continental air masses influence mainly the northern coastal areas of the GOM. Tropical cyclones may develop or migrate into the GOM during the warmer season, especially in the months of August through October. In coastal areas, the land-sea breeze is frequently the primary circulation feature in the months of May through October. Note that the following discussion is limited to the Western and Central Planning Areas and westernmost part of the Eastern Planning Area. Meteorological data summaries are based on two primary references: (1) local climatological data (NCDC 1995, 2011a) for coastal cities along the GOM and (2) meteorological data collected from the shoreline stations and buoy stations over open waters of the GOM (NDBC 2011).

For the coastal areas along the GOM, prevailing wind directions are generally from the southeast and the south, except for the coastal areas stretching from Alabama to the Florida Panhandle, where the prevailing wind is from the north (NCDC 1995, 2011a). Along the southern tip of Texas, southerly and southeasterly winds prevail throughout the year. Along the eastern coastal area (e.g., Pensacola, Florida), these wind components are limited to spring and early summer, and more northerly winds prevail during the rest of the year. Based on the National Data Buoy Center (NDBC) data in the Western and Central Planning Areas, southeasterly winds prevail (NDBC 2011). However, easterly winds are more frequent in the Eastern Planning Area. Near the coastal area in Alabama and the Florida Panhandle, the prevailing wind direction is from the north, the same as that for coastal cities (NCDC 2011a). Average wind speeds from the shoreline and buoy stations are relatively uniform, ranging from 5.2 to 6.4 m/s (11.6 to 14.3 mph), although anemometer heights vary from 5.0 to 30.5 m (16.4 to 100.1 ft). In general, wind speeds are highest in the winter months and lowest in the summer months, except for the shoreline stations in Texas where they are highest in May.

Ambient temperatures in the coastal areas and open waters of the GOM depend primarily on latitude and secondarily on proximity to the coastline. In the warmest month in the summer, average temperatures in the GOM coastal cities are relatively uniform, ranging from about 28 to 29 degrees Celsius (°C) (82 to 85 degrees Fahrenheit [°F]) (NCDC 1995, 2011a). During the warm months, there is little diurnal or spatial variation in temperature. Average temperatures for the coldest month in winter range from about 11°C (51°F) in the northern coastal cities to about 16°C (61°F) in the southernmost city in Texas. Ambient temperatures over the open GOM exhibit much smaller daily and seasonal variations due to the moderating effects of large bodies of water. Annual average temperatures range from 20°C (69°F) at the shoreline stations to 25°C (77°F) at open water buoy stations (NDBC 2011). Irrespective of the locations of NDBC stations, highest monthly temperatures, which occur mostly in August, are relatively uniform, ranging from about 28 to 29°C (82 to 84°F), which are similar to those in the coastal cities (NCDC 1995, 2011a). The lowest monthly temperatures occur mostly in January and vary depending on the location, ranging from 11°C (52°F) at the shoreline stations to 21°C (71°F) at open water buoy stations.

Humid subtropical climates exhibit abundant and fairly well-distributed precipitation throughout the year. Precipitation in the coastal cities along the GOM tends to peak in the summer months; lowest precipitation can occur in any of non-summer seasons. Annual mean precipitation tends to be heavier to the east than to the west of the GOM (NCDC 1995, 2011a). Annual precipitation ranges from 70.0 cm (27.55 in.) in Brownsville, Texas, to 168.4 cm (66.29 in.) in Mobile, Alabama. Rainfall in the warmer months is usually associated with convective cloud systems that produce showers and thunderstorms. Winter rains are associated with the passage of frontal systems through the area. Snowfall along the GOM is uncommon: highest annual snowfall along the coastal cities is about 1.0 cm (0.4 in.) (NCDC 1995, 2011a).

Due to the proximity of the GOM, the relative humidity over the coastal areas is high, especially for the northern coastal areas during the warmer months. Lower humidities in the winter season are associated with outbreaks of cool, dry continental air from the interior. Annual average relative humidities range from 75 to 79% for the coastal cities along the GOM (NCDC 1995, 2011a). Typically, the highest relative humidity occurs during the coolest part of the day (around sunrise), while the lowest relative humidity occurs during the warmest part of the afternoon.

Fog occurs occasionally in the cooler season as a result of warm, moist GOM air blowing over cool land or water surfaces. The days with heavy fog (visibility of 0.4 km [0.25 mi] or less) occur from 21 to 47 days per year along the GOM coastal cities (NCDC 1995, 2011a). The poorest visibility conditions occur from November through April. During air stagnation, industrial pollution and agricultural burning can also impact visibility.

Atmospheric stability plays an important role in dispersing gases or particulates emitted into the atmosphere. Vertical motion and pollution dispersion are enhanced in an unstable atmosphere and are suppressed in a stable atmosphere. Over land, the atmospheric stability is more variable, depending on the time of day, cloud cover, and wind speed. Under calm to low winds, the atmosphere tends to be unstable during the daytime due to surface heating by solar insolation and stable at night due to radiative cooling. Under higher wind speeds and/or greater cloud cover, the atmosphere tends to be neutral irrespective of time of day. For coastal areas along the GOM, unstable conditions occur about 20% of the time, while neutral and stable conditions each occur about 40% of the time (Doty et al. 1976). Different from overland behavior, there is no large sensible heat flux driven by solar radiation over water. In addition, heating and cooling of the water surface takes place slowly due to its high heat capacity. In general, the atmosphere over water tends to be neutral to slightly unstable, since there are usually positive heat and moisture fluxes.

The mixing height is the height above the surface through which relatively vigorous vertical mixing occurs, primarily through the action of atmospheric turbulence. When the mixing height is low (i.e., very little vertical motion), ground-level concentrations of pollutants will be relatively high because the pollutants are prevented from dispersing upward. Mixing heights commonly go through large diurnal variations due to solar heating and surface cooling. Mixing heights are generally lowest around sunrise and highest during mid- to late afternoon. By season, mixing heights are typically the highest in summer and the lowest in winter. Near large water bodies (e.g., the GOM), diurnal and seasonal variations in mixing heights are relatively small compared with those at inland stations due to the moderating effects of the water. For coastal areas along the GOM, the mean annual morning mixing heights range from 500 to 900 m (1,640 to 2,950 ft), while the mean afternoon mixing heights range from 1,000 to 1,400 m (3,280 to 4,590 ft) (Holzworth 1972). Over water, the absence of a strong sensible heat flux to drive the marine mixed layer and the small surface roughness of sea results in relatively low mixing heights. LeMone (1978) indicated that typical marine mixing height is about 500 m (1640 ft) over low-latitude oceans.

In the GOM region, severe weather events such as thunderstorms, lightning, floods, tornadoes, and tropical cyclones are common. Thunderstorms occur from 26 days per year in Brownsville, Texas, to 80 days per year in Mobile, Alabama (NCDC 1995, 2011a). Thunderstorms occur most frequently in summer months and are least frequent in winter months. The number of lightning strikes per km^2-yr is as low as one at the southern tip of Texas and as high as 14 (NOAA 2011b). During the 1980–1999 period, tornadoes occurred from about 0.2 days per year[2] at the southern tip of Texas up to 1.2 days per year in the southeastern Texas, Louisiana, and Mississippi along the GOM (NSSL 2003). While tornadoes and floods are the primary weather hazards in the southern States, the GOM coastal zone is most vulnerable to hurricanes and their accompanying impacts such as storm surges.

Tropical cyclones affecting the GOM originate over the tropical portions of the Atlantic basin, including the Atlantic Ocean, the Caribbean Sea, and the GOM. Tropical cyclones occur as early as May and as late as December, but most frequently from mid-August to late October (NHC 2011a). On average, about 11 tropical cyclones occur in the Atlantic Basin, many of which remain over the ocean and never impact the U.S. coastlines. About six of these storms become hurricanes each year (NHC 2011b). Coastal counties adjacent to the Western and Central Planning Areas could expect return periods, ranging from 3.6 to 7.0 yr, for hurricanes passing within 139 km (86 mi) of a given location (NHC 2011a). Figure 3.5.1-1 shows landfalling hurricanes in the continental U.S. for the period 1994–2009. Tropical cyclones cause damage to physical, economic, biological, and social systems in the GOM, but the severest effects tend to be highly localized. The GOM is also periodically affected by wintertime extratropical cyclones generated when continental, cold air outbreaks interact with the warm GOM waters. These storms can produce gale force winds and high seas, and are hazardous to shipping due to their sudden onset and rapid formation. For a discussion of the effects of tropical cyclones and severe storms on OCS oil operations in the GOM, see previous EISs prepared for OCS oil and gas activities in the GOM (MMS 2007a, 2008a).

3.5.1.2 Alaska – Cook Inlet

Climate in Alaska depends primarily on three factors: latitude, continentality, and elevation (ACRC 2011). The climate of the southern coastal Alaska including the Cook Inlet Planning Area is marine, characterized by short and cool summers and mild winters. The climate is moderated due to marine influences; however, the upper reaches of the Cook Inlet see

2 The mean number of days with one or more events occurring within 40 km (25 mi) of a point.

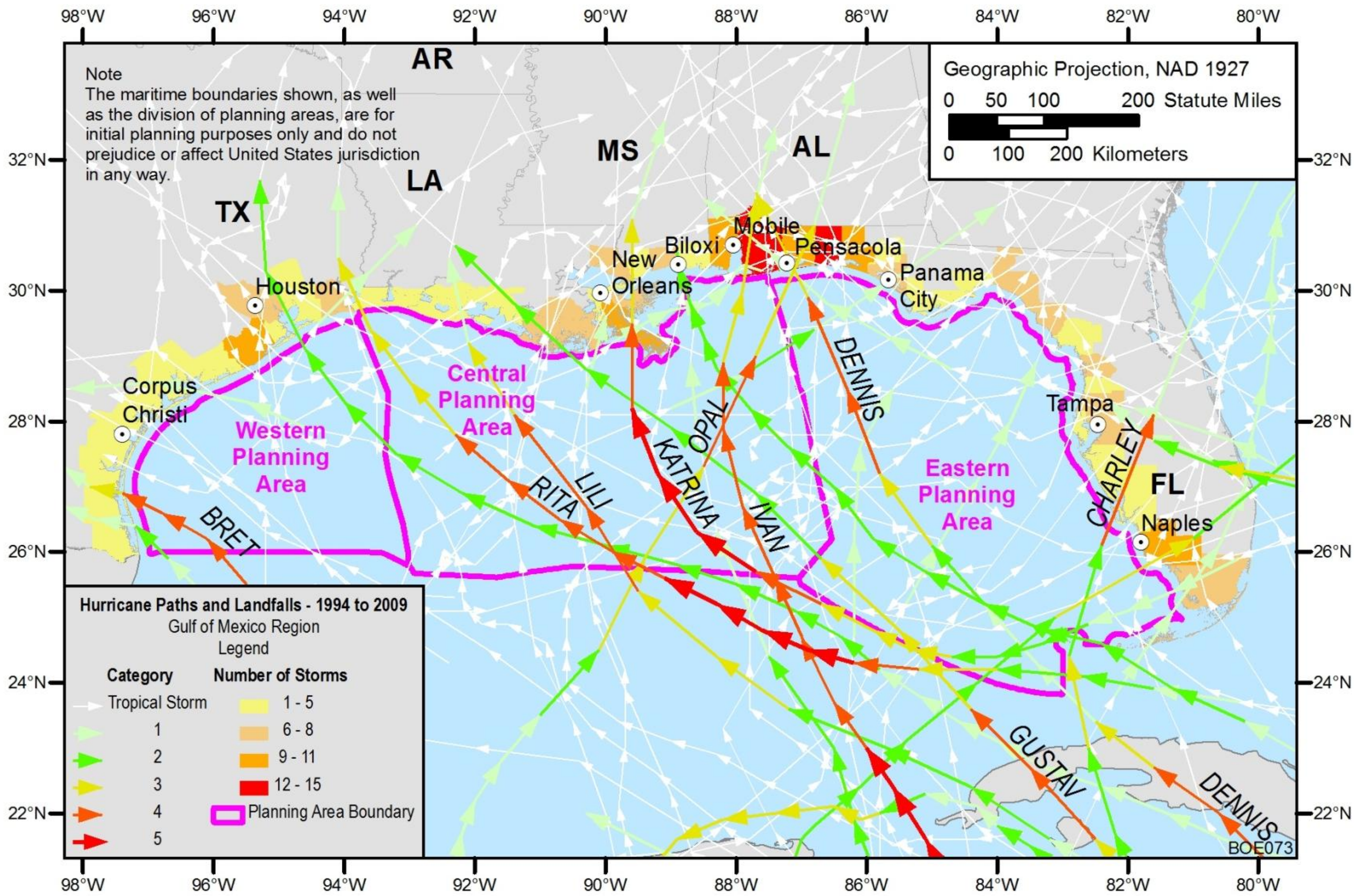

FIGURE 3.5.1-1 U.S. Landfalling Hurricanes, 1994–2009 (NHC 2011a)

more continental effects. Although the Cook Inlet Planning Area is relatively small compared to the other two planning areas, weather patterns significantly vary over a relatively short distance due to nearby complex terrains. The following discussion for wind, ambient temperature, and precipitation is based on data from primarily two National Weather Service (NWS) first-order stations: Homer, which is located on the southwest side of the Kenai Peninsula, and Kodiak, which is located on the east side of Kodiak Island. Homer and Kodiak are located in the upper and lower portions of the Cook Inlet Planning Area, which represent a wide spectrum of variations in climate around the area.

Winds are strongly influenced by local topography and mostly blow parallel to nearby mountain ranges. In Cook Inlet, the general prevailing wind direction is from the northeast. However, wind direction and speed at any location in Cook Inlet vary greatly depending on the orientation and elevation of and proximity to nearby mountain ranges/valleys and the openness to the Gulf of Alaska. At Homer, the prevailing wind direction is from the northeast during September through March, while winds blow more frequently from the west during April through August (NCDC 2011b). The average wind speed at Homer is about 3.3 m/s (7.3 mph), with a slightly higher value in spring and a slightly lower value in summer. At Kodiak, the prevailing wind direction is from the northwest throughout the year, except in June and July when east-northeast winds blow more frequently (NCDC 2011b). The average wind speed at Kodiak is about 5.0 m/s (11.1 mph), with the highest reading in winter and the lowest in summer. At the NDBC buoy and coastal stations scattered within the Cook Inlet Planning Area, prevailing wind directions vary clockwise from the west to the northeast (NDBC 2011). Average wind speeds from NDBC stations range from 4.4 to 7.4 m/s (9.9 to 19.6 mph), with the highest reading in winter and the lowest in summer.

During the normal period (1970–2000), the average temperature at Homer was about 3.4°C (38.1°F) (NCDC 2011b). January was the coldest month, with a mean daily minimum of –8.1°C (17.5°F); August was the warmest month, with a mean daily maximum of 16.1°C (61.0°F). In summer, maximum temperatures go over 21.1°C (70°F) about 2 days per year, while about 178 and 10 days have minimum temperatures at or below freezing and at –17.8°C (0°F) or below, respectively (NCDC 2011b). The highest temperature, 27.2°C (81°F), was reached in July 1993, and the lowest, –31.1°C (–24°F), in January 1989. For the same period, the average temperature at Kodiak was about 4.7°C (40.5°F), with the lowest mean daily minimum of –4.3°C (24.3°F) in February and the highest mean daily maximum of 16.3°C (61.4°F) in August (NCDC 2011b). About 8 days annually exceed 21.1°C (70°F), while about 131 days and 1 day have minimum temperatures at or below freezing and at –17.8°C (0°F) or below, respectively. Extreme temperatures at Kodiak range from –26.7°C (–16°F) to 30.0°C (86°F). Temperature patterns from NDBC stations are similar to those at Homer and Kodiak, except for a little higher annual average temperature range of about 0.5°C (0.9°F) at NDBC stations (NDBC 2011).

The amount of precipitation depends strongly on the surrounding topographic features. During the normal period (1970–2000), annual precipitation at Homer averaged about 64.6 cm (25.45 in.) (NCDC 2011b). An annual average of 148 days have measurable precipitation (0.025 cm [0.01 in.] or higher). Precipitation is recorded throughout the year but is the highest in fall, followed by winter, and lowest in spring. Snow starts as early as October and continues as late as May. Most of the snow falls from November through March. The annual average snowfall at Homer is about 158.2 cm (62.3 in.). For the same period, annual precipitation at Kodiak averages about 191.4 cm (75.35 in.), and an annual average of 201 days have measurable precipitation (NCDC 2011b). By season, precipitation is the highest in fall, followed by winter, and lowest total in summer. Snow starts as early as October and continues as late as May. Most of the snow falls from November through April. The annual average snowfall at Kodiak is about 181.6 cm (71.5 in.).

Severe weather events, such as floods, hail, high winds, and winter events (such as heavy snow, ice storms, winter storms, blizzards), have been reported in the area surrounding Cook Inlet (NCDC 2011c). A normal storm track along the Aleutian chain, the Alaska Peninsula, and all of the coastal area of the Gulf of Alaska exposes these parts of the State to a large majority of the storms crossing the North Pacific, resulting in a variety of wind-related issues (NCDC 2011d). Wind velocities exceeding 45 m/s (100 mph) are not common but do occur, usually associated with mountainous terrain and narrow passes. In 2006, Kodiak experienced a wind gust estimated at 59 m/s (131 mph) that caused minor property damage. Intense coastal winds occur as a result of atmospheric pressure differentials between interior Alaska and the Gulf of Alaska. Higher interior atmospheric pressure also promotes periodic, local offshore winds that are orographically funneled, attaining velocities up to 42 m/s (93 mph) and extending up to 30 km (19 mi) offshore (Lackmann 1988).

Atmospheric stability provides a measure of the amount of vertical mixing and dispersion of air pollutants. Along the Gulf of Alaska, atmospheric stability is predominantly neutral. This is due to the frequent occurrence of relatively high wind speeds and cloud cover. Stable conditions are found about 15–25% of the time, while unstable conditions occur less than 10% of the time. Neutral conditions prevail for the rest of the time. The stable conditions are associated with clear, calm conditions at night. Over open water in the wintertime, unstable conditions are expected to be more frequent. More stable conditions are expected over water in the summer season because of the relatively colder temperature of the sea surface in relation to the ambient air.

3.5.1.3 Alaska – Arctic

As discussed above, climate in Alaska depends primarily on three factors: latitude, continentality, and elevation (ACRC 2011). The climate of the land mass bordering the Beaufort and Chukchi Seas is classified as tundra, characterized by a lack of warm summers (average temperature for the warmest month is less than 10°C (50°F) but above freezing (>0°C [32°F]), and scant (or trace) precipitation.

3.5.1.3.1 Winds. In general, wind patterns at the coastal stations along the Beaufort and Chukchi Sea Planning Areas are characterized by (1) relatively high average wind speeds, about 5.4 m/s (12.0 mph) at stations in the Beaufort Sea, ranging from 4.7 m/s (10.5 mph) at Point Lay to 6.5 m/s (14.6 mph) at Point Hope in the Chukchi Sea; (2) frequent extreme winds; and (3) higher easterly wind components (NCDC 2011e).

The eastern Beaufort Sea coastal winds are strongly influenced by channeling due to the Brooks Range to the south. In the eastern Beaufort Sea around Barter Island, westerly and west-northwesterly winds become more frequent in the winter months, with prevailing easterly and east-southeasterly winds in other months (NCDC 2011e). These bimodal wind direction patterns are also observed in central Beaufort Sea around Prudhoe Bay, but prevailing and secondary wind directions are shifted to east-northeast and west-southwest, respectively.

Along the coast of the Chukchi Sea from Barrow to Cape Lisburne, surface winds commonly blow from the east-northeast and the east (NCDC 2011e). At these stations, northeasterly to east-southeasterly wind components prevail almost every month without any comparable westerly components. However, the prevailing wind direction at Point Hope (the westernmost coastal station of the Chukchi Sea) is from the north, but winds there blow from the southeast and south-southeast a considerable amount of the time. At this station, south-southeasterly winds prevail in June and July, while north-northwesterly to northeasterly winds prevail in all other months.

During the winter, northerly winds prevail in the Chukchi Sea, with directions ranging from northwest in the western part of the sea to northeast in the eastern part (Proshutinsky et al. 1999). During the summer, the Chukchi Sea exhibits a more complicated wind regime, with alternating northerly and southerly winds.

3.5.1.3.2 Ambient Temperature. Along the Beaufort Sea, the average temperature ranges from –12.3°C (9.8°F) at Barter Island to –11.2°C (11.8°F) at Kuparuk (WRCC 2011). February is the coldest month, with a mean monthly minimum temperature ranging from –31.2°C (–24.2°F) to –32.4°C (–26.3°F); July is the warmest month, with a mean monthly maximum ranging from 7.4°C (45.4°F) to 13.3°C (55.9°F). In summer, maximum temperatures seldom go over 21.1°C (70°F). Daily maxima above freezing have been recorded only one-third of the days. Freezing temperatures have been observed every month of the year (about 287–310 days per year); more than half of the days (about 163–167 days per year) have minimum temperatures of –17.8°C (0°F) or below (WRCC 2011). The highest temperature, 28.3°F (83°F), was reached at Kuparuk and Prudhoe Bay, and the lowest, –52.2°C (–62°F), at Prudhoe Bay.

Along the Chukchi Sea, the average temperature ranges from –12.0°C (10.4°F) at Barrow to –8.1°C (17.5°F) at Cape Lisburne (WRCC 2011). February is the coldest month, with a mean monthly minimum temperature ranging from –25.7°C (–14.3°F) to –34.7°C (–30.5°F), and July is the warmest month, with a mean monthly maximum ranging from 7.6°C (45.7°F) to 10.9°C (51.6°F). Freezing temperatures have been observed every month of the year (about 264–316 days per year); about half of the days (about 125–165 days per year) have minimum temperatures of –17.8°C (0°F) or below (WRCC 2011). Both the highest temperature of 26.7°F (80°F) and the lowest of –48.9°C (–56°F) were recorded at Wainwright.

3.5.1.3.3 Precipitation. Precipitation on the tundra is generally meager; thus the tundra is desert-like in terms of precipitation. Along the Beaufort Sea, the average annual precipitation ranges from 10.1 cm (3.97 in.) at Kuparuk to 15.7 cm (6.19 in.) at Barter Island (WRCC 2011). Annual average measurable precipitation (0.025 cm [0.01 in.] or higher) ranges from 62 days at Kuparuk to 87 days at Barter Island. Precipitation is recorded throughout the year, mostly as rainfall, with the lowest amounts in spring and the highest in late summer. Snow falls every month of the year but approximately half falls in fall months. The annual average snowfall ranges from 82.0 cm (32.3 in.) at Kuparuk to 106.2 cm (41.8 in.) at Barter Island (WRCC 2011).

Along the Chukchi Sea, the average annual precipitation ranges from 11.7 cm (4.62 in.) at Barrow to 28.8 cm (11.34 in.) at Cape Lisburne (WRCC 2011). The annual average measurable precipitation ranges from 66 days at Point Lay to 112 days at Cape Lisburne. The annual average snowfall ranges from 43.2 cm (17.0 in.) at Point Lay to 105.2 cm (41.4 in.) at Cape Lisburne (WRCC 2011).

3.5.1.3.4 Severe Weather. Storms (wind velocities of greater than 15 m/s [34 mph]) are observed more often in winter than in summer. In the Chukchi Sea, 6–10 storm days occur per month. The duration of storms ranges from 6 to 24 hours in 70–90% of cases, but stormy weather can last 8–14 days (Proshutinsky et al. 1999).

On October 3, 1963, an intense storm that hit Barrow with little warning and caused more damage than any other storm in Barrow's historical records is described in detail by Brunner et al. (2004). Wind gusts as high as 34–36 m/s (75–80 mph) may have been reached, and the highest official observation of sustained winds was 25 m/s (55 mph). The resulting storm surge (or rise in sea level) reached 3.0 m (10 ft), and may have been as high as 3.7 m (12 ft). The storm surge and wave action caused extensive flooding in coastal areas, and more than 150,000 m^3 (200,000 yd^3) of sediment transport caused bluffs in the Barrow area to retreat as much as 3.0 m (10 ft) (Brunner et al. 2004). Since this episode, at least 30 storms have produced severe winds at Barrow and along the Chukchi Sea coast. Lynch et al. (2001) document high-wind events at Barrow for the period 1960–2000 and concluded that high-wind events are common in fall and winter, but rare in summer. It remains uncertain whether the more frequent storms and the summer storms seen in the past few years are part of a new pattern.

Since 2001, severe weather events, such as floods, storm surges, hail, high winds, winter events (such as heavy snow, winter storms, extreme windchills, blizzards), have been reported in the coastal areas surrounding the Beaufort and Chukchi Seas (NCDC 2011c). In 2005, Cape Lisburne, (nearly the westernmost point of the Chukchi Sea Planning Area) experienced a wind gust estimated at 40 m/s (89 mph) that caused no property damage.

3.5.1.3.5 Atmospheric Stability. Atmospheric stability provides a measure of the amount of vertical mixing and dispersion of air pollutants. Along the Arctic Ocean, the atmosphere is predominantly neutral, due to the frequent occurrence of high wind speeds and cloud cover. Stable conditions are found about 15–25% of the time, while unstable conditions occur less than 10% of the time. Neutral conditions prevail for the rest of the time. Stable conditions are usually associated with clear, calm conditions at night. The presence of sea ice tends to result in more stable conditions, but also greater winds speeds, which could lead to a neutral atmosphere. Stable conditions also tend to be favored in the summertime due to the relatively colder temperatures of the sea surface in relation to the ambient air.

3.5.2 Air Quality

3.5.2.1 Gulf of Mexico

Under the Clean Air Act (CAA), which was last amended in 1990, the USEPA has set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment (USEPA 2011a). NAAQS have been established for six criteria pollutants — carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), particulate matter (PM; PM_{10}, PM with an aerodynamic diameter of 10 μm or less; and $PM_{2.5}$, PM with an aerodynamic diameter of 2.5 μm or less), ozone (O_3), and sulfur dioxide (SO_2), as shown in Table 3.5.2-1. The CAA established two types of NAAQS: primary standards to protect public health including sensitive populations (e.g., asthmatics, children, and the elderly) and secondary standards to protect public welfare, including protection against degraded visibility and damage to animals, crops, vegetation, and buildings. Any individual State can have its own State Ambient Air Quality Standards (SAAQS) but SAAQS must be at least as stringent as the NAAQS. If a State has no standard corresponding to one of the NAAQS or the SAAQS is not as stringent as the NAAQS, then the NAAQS apply. Currently, all GOM States have adopted NAAQS.

Areas considered to have air quality as good as or better than NAAQS are designated by the USEPA as attainment areas. Areas where air quality does not meet the NAAQS are designated by the USEPA as nonattainment areas. Nonattainment areas where air quality has improved to meet the NAAQS are redesignated as maintenance area and are subject to an air quality maintenance plan. The CAA requires each State to develop and regularly update a State Implementation Plan (SIP) to demonstrate how it will attain and maintain the NAAQS. SIPs include the regulations, programs, and schedules that a State will impose on sources and must demonstrate to the USEPA that the NAAQS will be attained and maintained.

In general, ambient air quality on coastal counties along the GOM is relatively good. Currently, all of the coastal counties along the GOM are in attainment for all criteria pollutants except lead and 8-hour ozone (USEPA 2011b). A portion of Hillsborough County, Florida, around the EnviroFocus Technologies Facility is in nonattainment for lead. For 8-hour ozone, all coastal counties in Mississippi, Alabama, and Florida are classified as in attainment, but a number of counties in Texas and Louisiana are designated as nonattainment or maintenance areas. Eight counties in the Houston-Galveston-Brazoria designated area in southeast Texas are classified as severe (maximum attainment date no later than June 2019) nonattainment areas, while three counties in the Beaumont/Port Arthur designated area are classified as moderate maintenance areas. In Louisiana, five parishes in the Baton Rouge designated area are classified as moderate (maximum attainment date no later than June 2010) nonattainment areas. For the Houston-Galveston-Brazoria and Baton Rouge nonattainment areas, 8-hour ozone concentrations have had a general downward trend since 1998 but ozone concentrations frequently exceed the NAAQS (USEPA 2011c). During the 2004–2008 period, the highest of the annual

TABLE 3.5.2-1 National Ambient Air Quality Standards (NAAQS) and Maximum Allowable Prevention of Significant Deterioration (PSD) Increments

		NAAQS[b]		PSD Increment ($\mu g/m^3$)[d]		
Pollutant[a]	Averaging Time	Value	Type[c]	Class I	Class II	Class III
CO	8-hour	9 ppm	P	–[e]	–	–
	1-hour	35 ppm	P	–	–	–
Pb	Rolling 3-month average	0.15 $\mu g/m^3$	P, S	–	–	–
NO_2	Annual	53 ppb	P, S	2.5	25	50
	1-hour	100 ppb	P	–	–	–
PM_{10}	Annual	–	–	4	17	34
	24-hour	150 $\mu g/m^3$	P, S	8	30	60
$PM_{2.5}$	Annual	15 $\mu g/m^3$	P, S	1	4	8
	24-hour	35 $\mu g/m^3$	P, S	2	9	18
O_3	8-hour	0.075 ppm	P, S	–	–	–
SO_2	Annual	–	–	2	20	40
	24-hour	–	–	5	91	182
	3-hour	0.5 ppm	S	25	512	700
	1-hour	75 ppb	P	–	–	–

a CO = carbon monoxide; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; $PM_{2.5}$ = particulate matter ≤2.5 µm; PM_{10} = particulate matter ≤10 µm; and SO_2 = sulfur dioxide.

b Refer to 40 CFR Part 50 for detailed information on the attainment determination and reference method for monitoring.

c P = primary standards, which set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly; S = secondary standards, which set limits to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

d The final rule for PSD increments for $PM_{2.5}$ is effective on December 20, 2010 (75 FR 64864).

e A dash denotes that no standard exists.

Sources: 40 CFR 52.21; 75 FR 64864; USEPA 2011a.

fourth-highest daily maximum 8-hour ozone concentrations were 0.106 ppm and 0.097 ppm, recorded in the Houston-Galveston-Brazoria and Baton Rouge nonattainment areas, respectively.

This region has several favorable conditions for the photochemical production of ozone. Precursor emissions of ozone, such as nitrogen oxides (NO_x) and VOCs, are abundant in the region due to a huge population, the oil and gas industry, and the petrochemical industry, including electricity generating facilities, chemical plants, petroleum refining facilities, oil and gas storage and transportation industries, and associated onroad vehicles and nonroad equipment. In addition, considerable emissions of biogenic VOCs are widespread and ubiquitous in the region. The subtropical climate of the region (characterized by relatively high temperature and intense solar radiation, despite frequent occurrences of precipitation) plays a role in establishing conditions conducive to high ozone episodes.

In recent years, four revisions to NAAQS have been promulgated. Effective May 27, 2008, the USEPA revised the 8-hour ozone standards from 0.08 ppm to 0.075 ppm (73 FR 16436). Effective January 12, 2009, the USEPA revised the Pb standard from a calendar-quarter average of 1.5 $\mu g/m^3$ to a rolling 3-month average of 0.15 $\mu g/m^3$ (73 FR 66964). Effective April 12, 2010, the USEPA established a new 1-hour primary NAAQS for NO_2 at 100 ppb (75 FR 6474), while, effective August 23, 2010, the USEPA established a new 1-hour primary NAAQS for SO_2 at 75 ppb (75 FR 35520). It takes several years to establish monitoring plans and collect data to determine whether an area is in compliance with a new standard.

The Prevention of Significant Deterioration (PSD) regulations (see 40 CFR 52.21), which are designed to limit the growth of air pollution in clean areas, apply to major new sources or modifications of existing major sources within an attainment or unclassified area. While the NAAQS (and SAAQS) place upper limits on the levels of air pollution, PSD regulations place limits on the total increase in ambient pollution levels above established baseline levels for NO_2, PM_{10}, $PM_{2.5}$, and SO_2, thus preventing "polluting up to the standard" (see Table 3.5.2-1). All State air quality jurisdictions are divided into three classes of air quality protection. These allowable increases are smallest in Class I areas, special areas of natural wonder and scenic beauty, such as National Parks (NPs), National Monuments, and Wilderness Areas (WAs), where air quality and air quality-related values (such as visibility and acid deposition) should be given special protection. The rest of the country is subject to larger Class II increments. States can choose a less stringent set of Class III increments, but none have done so. Major (large) new and modified stationary sources must meet the requirements for the area in which they are locating and any areas they impact. Thus, a source locating in a Class II area near a Class I area would need to meet the more stringent Class I increment in the Class I area and the Class II increment elsewhere, as well as any other applicable requirements.

As a matter of policy, the USEPA recommends that the permitting authority notify the Federal land managers (FLMs) when a proposed PSD source would locate within 100 km (62 mi) of a Federal Class I area. If the source's emissions are considered large, the USEPA recommends that sources beyond 100 km (62 mi) of a Federal Class I area be brought to attention of the FLM. There are several Class I areas in the GOM coastal zones, in Louisiana and Florida, as shown in Figure 3.5.2-1. In Louisiana, there is one Federal Class I area, while Florida has four. The Federal Class I area offshore of Louisiana consists of the Breton Wildlife Refuges, located on Breton Island and on many of the Chandeleur Islands (40 CFR 81.412). Federal Class I areas in Florida, such as Bradwell Bay WA,[3] Everglades NP, Chassahowitzka WA, and St. Marks WA (40 CFR 81.407), are located more than 250 km (155 mi) from the eastern boundary of the Central Planning Area. In addition, these Class I areas are not located downwind of prevailing winds in the Western and Central Planning Areas, and thus are not much affected by any current activities occurring in the Western or Central Planning Areas.

[3] In 1980, Bradwell Bay WA along with Rainbow Lake in Wisconsin were excluded for purposes of visibility protection as Federal Class I areas.

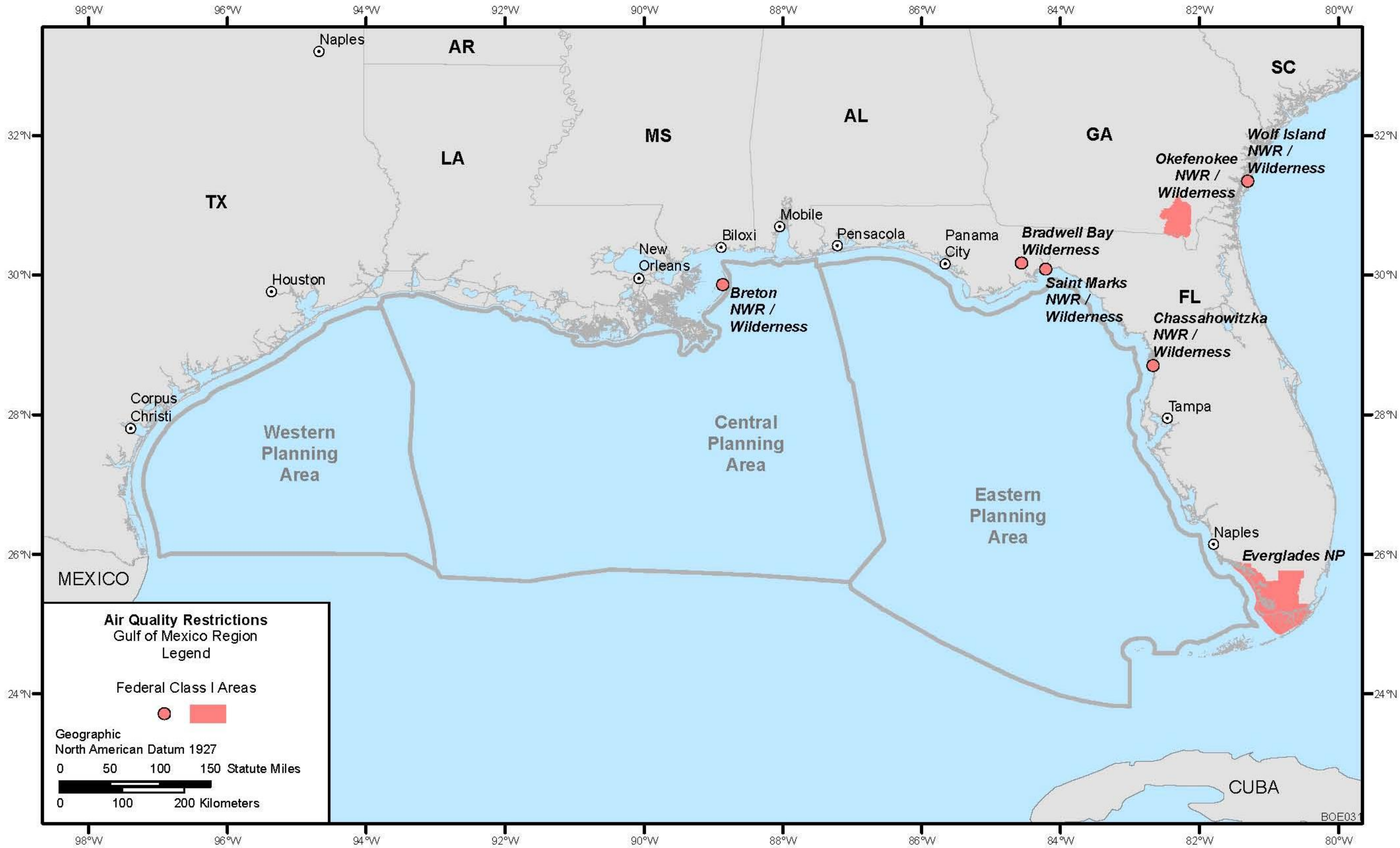

FIGURE 3.5.2-1 Mandatory Class I Federal Areas along the GOM

3.5.2.1.1 Deepwater Horizon Event. On April 20, 2010, the explosion and subsequent fire of the British Petroleum (BP) DWH platform in the GOM caused estimated 4.9 million barrels (Mbbl) of oil to be released into the GOM until July 15, 2010, when the wellhead was capped. The BP spill is by far the world's largest accidental release of oil into marine waters. It is estimated that burning, skimming, and direct recovery from the wellhead removed one quarter (25%) of the oil released from the wellhead (Lubchenco et al. 2010). One quarter (25%) of the total oil naturally evaporated or dissolved, and slightly less than one quarter (24%) was dispersed (either naturally or chemically) as microscopic droplets into GOM waters. The residual amount — just over one quarter (26%) — is either on or just below the surface as light sheen and weathered tar balls, has washed ashore or been collected from the shore, or is buried in sand and sediments. In summary, a third (33%) of the total leaked oil in the BP spill was captured or mitigated by the unified command recovery operations, including burning, skimming, direct recovery from the wellhead, and chemical dispersion. Half of the total leaked oil (naturally and chemically dispersed and residual) is currently being degraded naturally.

Evaporation from the oil spill itself resulted in VOCs in the atmosphere. If the spill is a subsurface spill, the lighter fractions of the released oil dissolve more easily in the water than the heavier fractions before reaching the surface (Ryerson et al. 2011), but this consideration would not apply to releases directly onto the surface. The VOC concentrations would occur anywhere there is an oil slick, and downwind of the slick. VOC concentrations would decrease with downwind distance. The lighter portions of VOCs would be most abundant in the immediate vicinity of the spill site. The heavier compounds would be emitted over a longer period of time and over a larger area. The formation of large concentrations of secondary organic aerosol (SOA), which affects air quality and climate change, was observed by measuring concentrations of groups of organic compounds downwind from the DWH oil spill (de Gouw et al. 2011). This SOA plume was formed from unmeasured, less volatile hydrocarbons that were emitted from a wider area around DWH. Other work measured individual compounds including BTEX, some of which could be hazardous to workers in the vicinity of the spill site. The hazard to workers can be reduced by monitoring and using protective gear, including respirators. During the DWH incident, air samples collected by individual offshore workers by BP, the Occupational Safety and Health Administration (OSHA), and the USCG showed levels of BTEX that were mostly under detection levels. All samples had concentrations below the OSHA Occupational Permissible Exposure Limits (PELs) and the more stringent American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) (BOEMRE 2011a).

At present, a number of scientists, physicians, and health care experts are concerned with potential public health effects as a result of DWH event in the GOM; they found that the VOC benzene, a cancer-causing agent, has been found to be above Louisiana's ambient air quality standards (BOEMRE 2011a). However, the Louisiana benzene standard is an annual average of short-term samples, and while benzene in several samples related to the DWH event was indeed above the Louisiana annual standard value of 12 $\mu g/m^3$ (or 3.76 ppb), the long-term average in the monitoring period was well below the standard; that is, the Louisiana benzene standard was not exceeded (Louisiana Department of Environmental Quality 2010, 2011). The sources causing the elevated short-term levels could include not only the DWH event but also onshore sources such as vehicle traffic and refineries.

3.5.2.1.2 Climate Change Effects. Climate changes are under way in the United States and globally, and are projected to continue to grow substantially over next several decades unless intense, concerted measures are taken to reverse this trend. Climate-related changes include rising temperature and sea level, increased frequency and intensity of extreme weathers (e.g., heavy downpours, floods, and droughts), earlier snowmelts and associated frequent wildfires, and reduced snow cover, glaciers, permafrost, and sea ice. A thorough discussion of the impacts of climate change to the baseline environment can be found in Section 3.3. In this section, potential impacts of climate change on meteorology and air quality specific to the GOM are discussed based on the report released by U.S. Global Change Research Program (USGCRP) in June 2009 titled, *Global Climate Change Impacts in the United States* (USGCRP 2009), unless otherwise noted.

Overall, the annual average temperature in the Southeast, which encompass the GOM coastal areas, did not change significantly over the past century. However, since 1970, the annual average temperature has risen about 1.6°F (0.9°C), with the highest seasonal increase of 2.7°F (1.5°F) in winters. Recently, heat waves and extreme temperatures have been common, especially in the southern States. For example, the average temperature for the summer in Texas at 86.8°F (30.4°C) exceeded the previous seasonal statewide average temperature record for any State during any season (NCDC 2011f). In summer of 2011, persistent heat engulfed the nation and the number of daily maximum temperatures over 100°F (37.8°C) were recorded to range from 10 days to more than 70 days in most of Texas, with a maximum of 90 days at Laredo Airport located in the southernmost Texas. In the near term (2010–2029) and mid-century (2040–2059), projected average temperature changes along the GOM coastal areas range 1–3°F (0.6–1.7°C) and 2–4°F (1.1–2.2°C), respectively, from 1961–1979 baseline.

Over the century, precipitation in the Southeast has increased by an average of 6% but has decreased by about 8% since 1970, with a maximum decrease of about 29% in spring. Model predictions indicated that, due to the northward shift of storm tracks, northern areas will become wetter and southern areas, especially in the West, will become drier. Accordingly, most of the GOM coastal area is predicted to experience reductions in precipitation and increases in drought severity and duration in the future. The destructive potential of Atlantic hurricanes has increased since 1970 and is correlated with the increase in sea surface temperature. Anticipated future changes for the U.S. and surrounding coastal waters include more intense hurricanes with related increases in wind, rain, and storm surges, but the frequency of landfalling hurricanes has not been established.

The two criteria air pollutants of most concern for public health and the environment are surface ozone and particulate matter. Air quality in the GOM is anticipated to be affected by climate change. While the Clean Air Act has improved air quality, higher temperatures and associated stagnant air masses due to a weaker global circulation and a decreasing frequency of mid-latitude cyclones (Jacob and Winner 2009) are expected to make it more challenging to meet air quality standards, particularly for ground-level ozone (a component of smog). A warmer climate is projected to increase the natural emissions of VOCs, accelerate ozone formation, and increase the frequency and duration of stagnant air masses that allow air pollutants to accumulate. This will worsen air quality, exacerbate respiratory diseases, and cause decreased crop yields.

Wildfires in the U.S. are already increasing due to warming. In GOM coastal areas, rising temperature and less precipitation (and thus prolonged droughts) have caused drying of soils and vegetation, which increase the potential for wildfires. More wildfires would result in air emissions, including criteria pollutants and toxic air pollutants, which could adversely impact air quality, visibility, and human health. In addition, greenhouse gas (GHG) emissions released from wildfires and associated loss of vegetation acting as a GHG sink could accelerate climate changes.

3.5.2.2 Alaska – Cook Inlet

For more detailed information on Federal air regulations and programs, please see Section 3.5.2.1.

The Alaska SAAQS are identical to the NAAQS (18 AAC 50.010). In addition, Alaska has set standards for some pollutants that are not addressed by the NAAQS, that is, reduced sulfur compounds and ammonia.

Except for a few population centers such as Anchorage, Fairbanks, and Juneau, the existing air quality in Alaska is relatively pristine with pollutant concentrations that are well within the ambient standards. However, in rural areas and communities, road dust, windblown dust, and wildfires can cause particulate concentrations to exceed NAAQS levels during certain seasons of the year. For example, PM_{10} levels at Butte exceeded the 24-hour NAAQS of 150 $\mu g/m^3$ nine times between April 1998 and December 2010 due to road dust, but $PM_{2.5}$ NAAQS levels were not exceeded (ADEC 2011a). Fugitive dust from roads in villages in the Northwest Arctic Borough has also been found to cause particulate levels to exceed the NAAQS values (ADEC 2011b). Currently, Kenai Peninsula and Kodiak Island Boroughs, which surround the Cook Inlet Planning Area, have no air monitoring stations for criteria pollutants but are in unclassifiable/attainment for all criteria pollutants (40 CFR 81.302).

Eagle River in the Municipality Anchorage and Juneau are currently in nonattainment for the PM_{10} NAAQS, while Fairbanks is in nonattainment for $PM_{2.5}$ NAAQS. Although $PM_{2.5}$ is still a problem, recent air monitoring data indicated that neither Eagle River nor Juneau continues to violate the PM_{10} standard. The Alaska Department of Environmental Conservation (ADEC), together with the USEPA and related boroughs, are currently in the process of changing the status from nonattainment to maintenance. The most important sources of particulate matter in Alaska include volcanic ash, windblown dust from dry glacial riverbeds, wildfires during summertime, fugitive dust from unpaved roads, re-entrainment of winter sanding materials from paved roads, and wood smoke as well as fuel combustion (ADEC 2010b). In particular, increased exposure to particulate matter occurs during extended wintertime temperature inversions. In addition, Anchorage and Fairbanks are designated as maintenance areas for CO NAAQS.

Data for 2006–2010 shows concentrations above the 24-hour $PM_{2.5}$ NAAQS level in four years and above the annual $PM_{2.5}$ NAAQS level for one year in Fairbanks. Concentrations above the 24-hour $PM_{2.5}$ level were also recorded for one year in Juneau and for two years in

Butte. The 24-hour PM_{10} NAAQS level was exceeded in one year in Eagle River and in two years in Butte. No data was reported above the CO or ozone standard levels (USEPA 2012).

There are four PSD Class I areas in Alaska (40 CFR 81.402): the Bering Sea WA in the St. Mathew Island group off southwestern Alaska; the Denali NP in south central Alaska; the Simeonof WA in the Shumagin Islands off the Alaska Peninsula; and the Tuxedni WA in Cook Inlet. All WAs are administered by the U.S. Fish and Wildlife Service (USFWS), while the Denali NP is administered by the National Park Service. The Tuxedni WA is the only Class I area that is located in close proximity to the northern portion of Cook Inlet Planning Area (about 10 km [6 mi] away), as shown in Figure 3.5.2-2. All other Class I areas in Alaska are located beyond 100 km (61 mi) from the Cook Inlet Planning Area.

3.5.2.2.1 Climate Change Effects. Climate changes are under way in the U.S. and globally, and are projected to continue to grow substantially over next several decades unless intense concerted measures are taken to reverse this trend. Climate-related changes include rising temperature and sea level, increased frequency and intensity of extreme weathers (e.g., heavy downpours, floods, and droughts), earlier snowmelts and associated frequent wildfires, and reduced snow cover, glaciers, permafrost, and sea ice. A thorough discussion of the impacts of climate change to the baseline environment can be found in Section 3.3. In this section, potential impacts of climate change on meteorology and air quality specific to the Cook Inlet are discussed based on the report released by U.S. Global Change Research Program (USGCRP) in June 2009 titled, *Global Climate Change Impacts in the United States* (USGCRP 2009).

In particular, Alaska has many resources vulnerable to climate change, such as sea ice, glaciers, permafrost, and thus may be subject to more pronounced potential impacts than any other parts of U.S. Over the past 50 yr, Alaska experienced more temperature increases than the rest of U.S. Its annual average temperature has increased by 3.4°F (1.9°C), with the highest seasonal increase of 6.3°F (3.5°C) in winters. By the middle of the century, the annual average temperature in Alaska is projected to rise about 3.5 to 7°F (1.9 to 3.9°C). The higher temperatures are already contributing to earlier snowmelt, reduced sea ice, widespread glacier retreat, and permafrost warming. This warming could produce benefits in some sectors, such as longer growing season, a longer period of outdoor and commercial activity such as tourism, increased shipping, and resource extraction, and detriments in others, such as increased likelihood of summer drought and wildfires due to longer summers and higher temperatures, coastal erosion, and flooding associated with coastal storms, and major shifts of biota habitats. Open water with a lower albedo absorbs sunlight better than the reflective surface of ice with a higher albedo. Albeit limited to northern Cook Inlet, any decrease in sea ice due to warming could lead to an decrease in albedo and thus an increase in ocean surface temperature, which causes sea ice to melt more, the so-called ice-albedo positive feedback.

Over the past 50 yr, precipitation has increased an average of 5% in the U.S. Model predictions indicate that, due to northward shift of storm tracks, northern areas will become wetter and southern areas, especially in the West, will become drier. Over this century, the

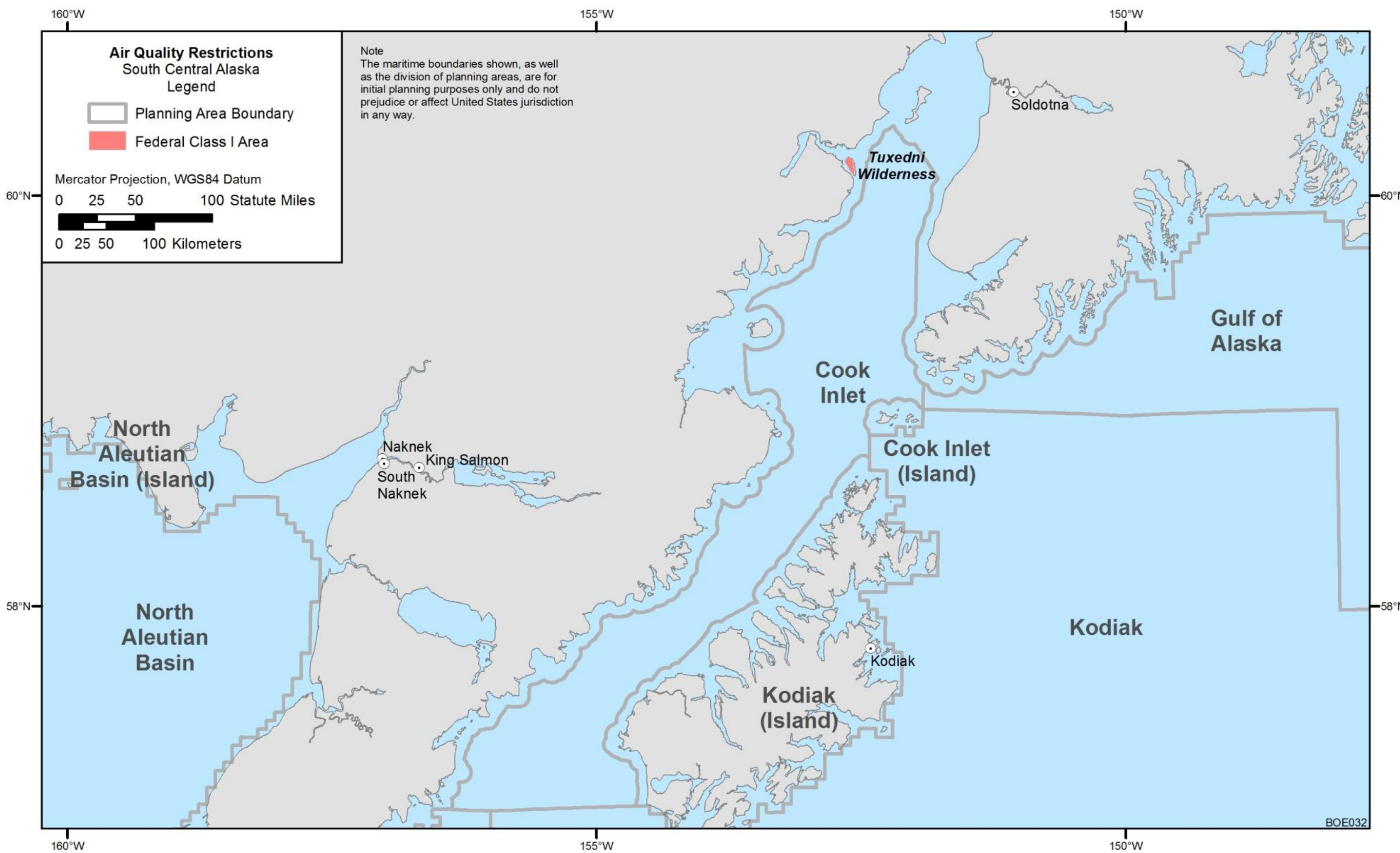

FIGURE 3.5.2-2 Mandatory Class I Federal Area in Cook Inlet, Alaska

temperature rise in sea surface temperature and reduced ice cover are likely to lead to northward shifts in Pacific storm tracks and increased impacts on Alaskan coastlines, many of which are low in elevation.

Two criteria air pollutants of most concern for public health and the environment are surface ozone and particulate matter. Air quality in the Cook Inlet is anticipated to be affected by climate change. Associated with climate change, more wildfires would result in air emissions, including criteria pollutants and toxic air pollutants, which could adversely impact air quality, visibility, and human health. In addition, greenhouse gas (GHG) emissions released from wildfires and associated loss of vegetation as a GHG sink could accelerate climate changes. To some degree, higher temperatures could increase ground-level ozone levels, which are primarily related to ambient temperature. Ozone level increases can worsen air quality, exacerbate respiratory diseases, and cause decreased crop yields. However, this minimal increase in ozone due to climate change is not anticipated to be high enough to contribute to exceeding the NAAQS.

3.5.2.3 Alaska – Arctic

Please see Section 3.5.2.1 for more detailed information on Federal air regulations and programs and 3.5.2.2 for Alaska-specific information.

Alaska has low air emissions. There are few industrial emission sources and, outside of Anchorage and Fairbanks, no sizable population centers. Barrow with a year 2010 population of about 4,600 is the largest city in North Slope Borough (USCB 2011i). The primary industrial emissions are associated with oil and gas production, power generation, small refineries, paper mills, and mining. The existing air quality in Alaska is considered to be relatively pristine, with pollutant concentrations in most areas that are well within the NAAQS. Currently, North Slope Borough, which borders the Beaufort Sea and Chukchi Sea Planning Areas, has no continuous air government-operated monitoring stations for criteria pollutants but is designated as an unclassifiable/attainment area for all criteria pollutants (40 CFR 81.302). There are monitors operated by the oil and gas industries as part of their permit conditions, the data from which is submitted to ADEC. Although data were not processed to provide the statistics required for comparison with the NAAQS, one $PM_{2.5}$ sample of 35.6 $\mu g/m^3$ exceeded the NAAQS level and four 1-hr NO_2 values exceeded the corresponding NAAQS level of 188 $\mu g/m^3$ (ADEC 2011c).

All four Class I areas in Alaska are located more than 690 km (430 mi) from the Beaufort Sea and Chukchi Sea Planning Areas (40 CFR 81.402). The entire Arctic region is classified Class II under Federal PSD regulations.

Over most of the onshore areas bordering the Arctic Ocean, there are only a few small, widely scattered emission sources. The only major local sources of industrial emissions are in the Prudhoe Bay-Kuparuk-Endicott oil production complex. The offshore Northstar facility located on an artificial island was the greatest single source of vented/flared gas on the North Slope in 2002 (Alaska Department of Administration 2004). However, repairs during 2004 resulted in a significant decrease of flaring at Northstar Island. This area was the subject of monitoring programs during 1986–1987 (MMS 2002b; Environmental Science and Engineering, Inc. 1987) and from 1990 through 1996 (ENSR Consulting and Engineering 1996). Five monitoring sites were selected — three were considered subject to maximum air pollutant concentrations, and two were considered more representative of the air quality of the general Prudhoe Bay area. The more recent observations are summarized in Table III.A-6 in MMS (2003b). All the values meet the NAAQS and SAAQS. The results demonstrate that ambient pollutant concentrations meet the ambient standards, even for sites subject to maximum concentrations.

Aside from notable warming trends and their associated impacts, the Arctic region experiences air pollution problems due to long-range transport of air pollutants from industrial northern Eurasia and North America, including Arctic haze followed by acidic depositions, tropospheric ozone, and buildup of toxic substances such as mercury or persistent organic compounds (Law and Stohl 2007). Local shipping emissions and summertime boreal forest fires may also be important pollution sources in the Arctic. In addition, large haze events in the Arctic can be caused by Asian dust originating from the Gobi and Taklamakan Deserts in Mongolia and northern China in springtime, as identified in Rahn et al. (1977).

During the winter and spring, winds transport pollutants to Arctic region across the Arctic Ocean from industrial Europe and Asia (Rahn 1982). These pollutants, primarily from coal burning and metal smelting, cause a phenomenon known as Arctic haze, a visible reddish-brown haze. The composition of aerosols producing regional haze consists of approximately 90% sulfate aerosols and 10% soot (Wilcox and Cahill 2003). Pollutant sulfate due to Arctic haze in the air in Barrow (that in excess of natural background) averages 1.5 $\mu g/m^3$. The concentration of vanadium, one of signature elements that fingerprint fossil fuel combustion, averages up to 20 times the background levels in the air and snowpack. Observations of the chemistry of the snowpack in the Canadian Arctic also provide evidence of long-range transport of small concentrations of organochlorine pesticides (Gregor and Gummer 1989). Concentrations of Arctic haze during winter and spring at Barrow are similar to those over large portions of the continental United States, but they are considerably higher than levels south of the Brooks Range in Alaska. Any ground-level effects of Arctic haze on the concentrations of regulated air pollutants in the Prudhoe Bay area are included in the monitoring data given in Table III.A-6 in MMS (2003b). Model calculations indicate that less than 10% of the pollutants emitted in the major source regions are deposited in the Arctic (Pacyna 1995). Maximum concentrations of some pollutants, sulfates and fine particles, were observed during the early 1980s and decreases in concentrations were observed at select stations at the end of the 1980s due to emissions decreases in some source regions and a meteorological shift. However, the decline in emissions from Russia may be reversing as a consequence of economic revitalization and an increasing reliance on coal, as natural gas becomes more valuable for export (Wilcox and Cahill 2003). Despite this seasonal, long-distance transport of pollutants into the Arctic, regional air quality still is far better than ambient air quality standards.

3.5.2.3.1 Climate Change Effects. Climate changes are underway in the U.S. and globally, and are projected to continue to grow substantially over next several decades unless intense concerted measures are taken to reverse this trend. Climate-related changes include rising temperature and sea level, increased frequency and intensity of extreme weathers (e.g., heavy downpours, floods, and droughts), earlier snowmelts and associated frequent wildfires, and reduced snow cover, glaciers, permafrost, and sea ice. A thorough discussion of the impacts of climate change to the baseline environment can be found in Section 3.3. In this section, potential impacts of climate change on meteorology and air quality specific to the Arctic are discussed based on the report released by U.S. Global Change Research Program (USGCRP) in June 2009 titled, *Global Climate Change Impacts in the United States* (USGCRP 2009).

In particular, Alaska has many resources vulnerable to climate change, such as sea ice, glaciers, permafrost, and thus may be subject to more pronounced potential impacts than any other parts of U.S. Over the past 50 yr, Alaska experienced more temperature increase than the rest of U.S. Its annual average temperature has increased by 3.4°F (1.9°C), with highest seasonal increase of 6.3°F (3.5°C) in winters. By the middle of the century, annual average temperature in Alaska is projected to rise about 3.5 to 7°F (1.9 to 3.9°C). The higher temperatures are already contributing to earlier snowmelt, reduced sea ice, widespread glacier retreat, and permafrost warming. This warming could produce benefits in some sectors, such as longer growing season, a longer period of outdoor and commercial activity such as tourism, increased shipping, and resource extraction, and detriments in others, such as increased likelihood of summer drought and wildfires due to longer summers and higher temperatures, coastal erosion, and flooding associated with coastal storms, and major shifts of biota habitats. Open water with a lower albedo absorbs sunlight better than the reflective surface of ice with a higher albedo. Any decrease in Arctic sea ice due to warming could lead to a decrease in albedo and thus an increase in ocean surface temperature, which causes sea ice to melt more, the so-called ice-albedo positive feedback.

Over the past 50 yr, precipitation has increased an average of 5% in the U.S. Model predictions indicate that, due to northward shift of storm tracks, northern areas will become wetter and southern areas, especially in the West, will become drier. Over this century, temperature rise in sea surface temperature and reduced ice cover are likely to lead to northward shifts in Pacific storm tracks and increased impacts on Alaskan coastlines, many of which are low in elevation.

Two criteria air pollutants of most concern for public health and the environment are surface ozone and particulate matter. Air quality in the Beaufort and Chukchi Seas is anticipated to be affected by climate change. Associated with climate change, more wildfires would result in air emissions, including criteria pollutants and toxic air pollutants, which could adversely impact air quality, visibility, and human health. In addition, greenhouse gas (GHG) emissions released from wildfires and associated loss of vegetation as a GHG sink could accelerate climate changes. To some degree, higher temperatures could increase ground-level ozone levels, which are primarily related to ambient temperature. Ozone level increases can worsen air quality, exacerbate respiratory diseases, and cause decreased crop yields. However, this minimal increase in ozone due to climate change is not anticipated to be high enough to contribute to exceeding the NAAQS.

3.6 ACOUSTIC ENVIRONMENT

3.6.1 Gulf of Mexico

For a more detailed discussion on the acoustic environment of the GOM, please see MMS (2004), which is incorporated here for reference.

3.6.1.1 Sound Fundamentals

Light does not travel far in the ocean due to its absorption and scattering. Even in the clearest water most light is absorbed within a few tens of meters, and visual communication among marine species is very limited in water, especially in deep or murky water, and/or at night. Accordingly, auditory capabilities have evolved to overcome this limitation of visual communication for many marine animals. Sound, which is mostly used by marine animals for such basic activities as finding food or a mate, navigating, and communicating, plays a crucial role in their survival in the marine environment. The same advantages of sound in water have led humans to deliberately introduce sound into the ocean for many valuable purposes, e.g., communication (e.g., submarine-to-submarine), feeding (e.g., fish-finding sonar), and navigation (e.g., depth-finders and geological and geophysical surveys for minerals) (Hatch and Wright 2007). However, some sounds, such as the noise generated by ships and by offshore industrial activities, including oil and gas activities, are also introduced into the ocean as a byproduct.

Any pressure variation that the human ear can detect is considered as sound, and noise is defined as unwanted sound. Sound is described in terms of amplitude (perceived as loudness) and frequency (perceived as pitch). The ear can detect pressure fluctuations changing over seven orders of magnitude. The ear has a protective mechanism in that it responds logarithmically, rather than lineally. To deal with these two realities (wide range of pressure fluctuations and the response of the ear), sound pressure levels[4] are typically expressed as a logarithmic ratio of the measured value to a reference pressure, called a decibel (dB). By convention, the reference pressures are 20 micropascal (µPa) for airborne sound, which corresponds to the average person's threshold of hearing at 1000 Hz, and 1 µPa for underwater sound. Accordingly, sound intensity in dB in water is not directly comparable to that in dB in air.

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[4] There are two primary but different metrics for sound measurements: sound pressure level (SPL) and sound exposure level (SEL). SPL is the root mean square of the sound pressure over a given interval of time, given as dB re 1 µPa for underwater sound. In contrast, SEL is the total noise energy from a single event and is the integration of all the acoustic energy contained within the event. SEL takes into account both the intensity and the duration of a noise event, given as dB re 1 $\mu Pa^2 \times s$ for underwater sound. In consequence, SEL is similar to SPL in that total sound energy is integrated over the measurement period, but instead of averaged over the entire measurement period, a reference duration of 1 s is used.

There are primarily three ways to characterize the intensity of a sound signal (OMP 2010). The "zero-to-peak pressure" denotes the range between zero and the greatest pressure of the signal, while "peak-to-peak pressure" denotes the range between negative and positive extremes of the signal. The "root-mean-square (rms) pressure" is the square root of the average of the square of the pressures of the sound signal over a given duration. Due to the sensitivity of marine animals to sound intensity, the rms pressure is most widely used to characterize underwater sound waves. However, for impulsive sounds, rms pressure is not appropriate to use because it can vary considerably depending on the duration over which the signal is averaged. In this case, peak pressure of impulsive sound, which could be associated with the risk of causing physical damage in auditory systems of marine animals, is more appropriately used (Coles et al. 1968). Unless otherwise noted, *source levels* of underwater sounds are typically expressed in the notation "dB re 1 µPa-m," which is defined as the pressure level that would be measured at a reference distance of 1 m from a source. In addition, zero-to-peak and peak-to-peak sound pressure levels are denoted as $dB_{0\text{-}p}$ and $dB_{p\text{-}p}$ re 1 µPa-m, respectively. In addition, the *received levels* (estimated at the receptor locations) are presented as "dB re 1 µPa" at a given location (e.g., 5 km [3 mi]).

3.6.1.2 Sound Propagation

Understanding the impact of sound on a receptor requires a basic understanding of how sound propagates from its source. Underwater sound spreads out in space, is reflected, refracted, and absorbed. Sound propagates with different geometries under water, especially in relatively shallow nearshore environments. Vertical gradients of temperature, pressure, and salinity in the water as well as wave and current actions can also be expected to constrain or distort sound propagation geometries. Several important factors affecting sound propagation in water include spreading loss, absorption loss, scattering loss, and boundary effects of the ocean surface and the bottom (Malme 1995).

Among these, spreading loss, which does not depend on frequency, is the major contributor to sound attenuation. As propagation of sound continues, its energy is distributed over an ever-larger surface area. The surface of the water and the ocean floor are effective boundaries to sound propagation, acting either as sound reflective or absorptive surfaces. Spherical and cylindrical spreading are two simple approximations used to describe the sound levels associated with sound propagations away from a source. In spherical propagation, sound from a source at mid-depth in the ocean (i.e., far from the sea surface or sea bottom) propagates in all directions with a 6-dB drop per doubling of distance from the source. In cylindrical spreading, sound propagates uniformly over the surface of a cylinder, with sound radiating horizontally away from the source, and sound levels dropping 3 dB per doubling of distance. The surface of the water and the ocean floor are effective boundaries to sound propagation, acting either as sound reflective or absorptive surfaces. Consequently, some underwater sound originating as a point source will initially propagate spherically over some distance until the sound pressure wave reaches these boundary layers; thereafter, the sound will propagate cylindrically. Therefore, some sound levels tend to diminish rapidly near the source (spherical propagation) but slowly with increasing distances (cylindrical propagation).

Directionality refers to the direction in which the signal is projected. Many underwater noises are generally considered to be omnidirectional (e.g., construction, dredging, explosives). However, geophysical surveys, such as seismic airgun arrays, are focuses downward, while some geological surveys are fanned. Although airgun arrays are designed to direct a high proportion of the sound energy downward, some portion of the sound pulses can propagate horizontally in the water, depending on array geometry and aspect relative to the long axis of the array (Greene and Moore 1995). In any case, sound attenuation of directional sound with distance is lower than the spreading loss for omnidirectional sources discussed above.

As sound travels, some sound energy is absorbed by the medium such as air or water (absorption losses) which represents conversion of acoustic energy to heat energy. Absorption losses depend strongly on frequency, becoming greater with increasing frequencies, and vary linearly with increasing distance, and are given as dB/km. Sound scattering is affected by bubbles, suspended particles, organisms, or other floating materials. Like absorption losses, scattering losses vary linearly with distance, and are given as dB/km.

Whenever sound hits the ocean surface or seafloor, it is reflected, scattered, and absorbed and mostly loses a portion of its sound energy. Hard materials (like rocks) will reflect or scatter more sound energy, while soft materials (like mud) will absorb more sound energy. Accordingly, the seafloor plays a significant role in sound propagation, particularly in shallow waters.

Typically, a high-frequency sound cannot travel as far as a low-frequency sound in water because higher frequencies are absorbed more quickly. An exception is the rapid attenuation of low frequencies in shallow waters (Malme 1995). Shallow water acts as a waveguide bounded on the top by the air and on the bottom by the ocean bottom. The depth of the water represents the thickness of the waveguide. Sound at long wavelengths (low frequencies) does not fit in the waveguide and is attenuated rapidly by the effects of interference at the boundaries.

3.6.1.3 Ambient Noise

Ambient noise is defined as typical or persistent environmental background noise lacking a single source or point. In the ocean, there are numerous sources of ambient noise, both natural and anthropogenic, which are variable with respect to season, time of day, location, and noise characteristics (e.g., frequency). Natural sources include wind and waves, seismic noise from volcanic and tectonic activity, precipitation, marine biological activities, and sea ice (Greene 1995) while anthropogenic sources include transportation, dredging and construction, oil and gas drilling and production, geophysical surveys, sonar, explosions, and ocean scientific studies (Greene and Moore 1995). Depending on the ambient noise levels and their frequency distributions, basic activities by marine animals or specific human activities could be significantly hampered. As the ambient noise level increases, sounds from a specific source disappear below the ambient level and become undetectable due to loss of prominence of the signal at shorter ranges. In particular, anthropogenic sound could have effects on marine life, including behavior changes, masking, hearing loss, and strandings. Due to its importance to the sensitivity of instrumentation for research and military applications, ambient noise has been of considerable interest to oceanographers and naval forces. Recent concerns over potential impacts of strong sources of sound from scientific and military activities have driven considerable public and political interest in the issue of noise in the marine environment (NRC 2003a; Greene 1995).

For most of the world oceans, shipping and seismic exploration noise dominate the low-frequency portion of the spectrum (Hildebrand 2009). In particular, noise generated by shipping has increased as the number of ships on the high seas has increased Along the west coast of North America, long-term monitoring data suggest an average increase of about 3 dB per decade in low-frequency ambient noise (Andrew et al. 2002; McDonald et al. 2006, 2008).

Various activities and processes, both natural and anthropogenic, combine to form the sound profile within the ocean. Except for sounds generated by some marine animals using active acoustics, most ambient noise is broadband (composed of a spectrum of numerous frequencies without a differentiating pitch). Virtually the entire frequency spectrum is represented by ambient noise sources.

According to the Office of Marine Programs (OMP 2010) of the University of Rhode Island, distant shipping is the primary source of ambient noise in the 20- to 500-Hz range. Spray and bubbles associated with breaking waves are the major contributions to ambient noise in the 500- to 100,000-Hz range. At frequencies greater than 100,000 Hz, “thermal noise” caused by the random motion of water molecules is the primary source. Ambient noise sources, especially noise from wave and tidal action, can cause coastal environments to have particularly high ambient noise levels. Ice movements are a large source of noise in the Arctic and in Cook Inlet.

Per classical Wenz curves (Wenz 1962), which are plots of average ambient noise spectra, seismic background and turbulent-pressure fluctuations are prevailing noises in the frequency range of 1 to 100 Hz. Ocean traffic has noise between 10 and 1,000 Hz. Bubble and spray resulting from sea surface agitation (such as breaking waves, spray, bubble formation and collapse, and rainfall), whose noise increases with wind speed, accounts for the frequency range of 100 to 20,000 Hz. With peaks ranging between 100 and 1,000 Hz, Wenz curves provided noise spectrum level distributions for varying sea states.[5] At frequencies greater than 10,000 Hz, thermal noise contributes increasingly to ambient levels with frequency, but absolute levels are much lower than those below these frequencies. As intermittent and local effects, earthquakes and explosions consist of noise signals from 1 to 100 Hz. Volcanic and tectonic noise generated by earthquakes on land or in water propagates as low-frequency, locally generated “T-phase” waves, with energy levels generally below 100 Hz (Greene 1995). Biota, such as fishes, certain shrimps, and marine mammals, can produce signals ranging from less than 10 Hz to well over 100,000 Hz. Shipping and industrial activities along with sea ice have signals between 10 and 10,000 Hz. In addition to noise caused by breakup, sea ice makes noise when temperature changes result in cracking. Underpressure from wind and currents also results in significant

[5] Sea state is a measure of the intensity of the ocean’s movement and is characterized by such parameters as wind speed, wave height, wave periodicity, and wave length. Sea states vary from “0,” which represents calm conditions, to “9,” which is characterized by wind speeds of more than 33 m/sec (108 ft/sec) and wave heights of more than 14 m (46 ft).

low-frequency noise, and iceberg melting results in "seltzer" noise. Precipitation covers the frequency range of 100 to 25,000 Hz.

Sources of ambient noise in the OCS include wind and wave activity, including surf noise near the land-sea interface; precipitation noise from rain and hail; lightning; biological noise from marine mammals, fishes, and crustaceans; and distant shipping traffic (Greene 1995). Several of these sources may contribute significantly to the total ambient noise at any one place and time, although ambient noise levels above 500 Hz are usually dominated by wind and wave noise. Consequently, ambient noise levels at a given frequency and location may vary widely on a daily basis. A wider range of ambient noise levels occurs in water depths less than 200 m (shallow water) than in deeper water. Ambient noise levels in shallow waters are directly related to wind speed and indirectly to sea state (Wille and Geyer 1984).

3.6.1.4 Anthropogenic Noise

Table 3.6.1-1 summarizes the various types of man-made noises in the ocean. Sources include transportation, dredging, construction, hydrocarbon and mineral exploration, geophysical surveys, sonar, explosions, and ocean science studies. Noise levels from most human activities are greatest at relatively low frequencies (<500 Hz).

3.6.1.4.1 Transportation. Transportation-related noise sources include aircraft (both helicopters and fixed-wing aircraft) and surface and subsurface vessels. While icebreakers, snowmobiles (snowmachine traffic), and hovercrafts are operating in the Arctic region, of these three, only hovercrafts are used in Cook Inlet, and none are used in the GOM.

Aircraft. The primary sources of aircraft noise are their engine(s) (either reciprocating or turbine) and propellers or rotors. Sound energy from both helicopters and propeller-driven aircraft concentrates at relatively low frequencies (usually below 500 Hz) due to dominant tones, which are harmonics of the blade rates[6] of the propellers and rotors (Hubbard 1995). Sounds from jets (i.e., turbojet or turbofan) that do not drive propellers or rotors do not include prominent tones at low frequencies but broadband noise across a wide range of frequencies.

In general, large, multi-engine aircraft tend to be noisier than small aircraft. Broadband (45–7,070 Hz) source levels from aircraft flyovers range from 156 dB re 1 μPa-m for Twin Otter with two turboprops to 175 dB re 1 μPa-m for C-130 military transport aircraft with four turboprops. A four-engine P-3 Orion with multi-bladed propellers has estimated source levels of 160–162 dB re 1 μPa-m in the 56–80 Hz band and 148–158 dB re 1 μPa-m in the 890–1,120 Hz band. A Twin Otter generates source levels of 147–150 dB re 1 μPa-m at the 82 Hz tone. Helicopters are typically noisier and produce a larger number of acoustic tones and higher broadband noise levels than do fixed-wing aircraft of similar size. Estimated source levels

[6] The blade rate is defined as the number of turns of a propeller or turbine per second multiplied by the number of blades.

TABLE 3.6.1-1 General Types of Anthropogenic Sound in the Ocean and Estimated Levels of Maritime Activity

Activity	Sources	Source Level[a] (dB re 1 µPa-m)	Frequency Range (Hz)[b]	Gulf of Mexico Level of Activity
Transportation	Aircraft (fixed-wing and helicopters)	156–175	45–7,070	Moderate flight activity, estimated to be in the range of several hundred flights annually (most low-level flights for oil and gas support, aerial surveys)
	Small vessels (boats, ships)	145–170	37–6,300	High activity level; hundreds to thousands of fishing vessels, pleasure craft, small ships daily; millions of angler trips per year (MMS 2004: Appendix F, Section II.B); oil and gas support vessel activity, estimated to be 304,807 to 319,921 trips per year, with most concentrated in the Central Planning Area.
	Large vessels (commercial vessels, supertankers)	169–198	6.8–428	In the U.S. GOM in 1999, tankers and other freight vessels completed a total of approximately 279,000 vessel trips in the GOM and Gulf Intracoastal Waterway waters
	Ice breakers	171–191	10–1,000	None
	Hovercraft and vehicles on ice	130	224–7,070	None; related watercraft would include “jet skis,” whose numbers are estimated to range into the thousands
Dredging and construction	Dredging	150–180	10–1,000	Precise levels unknown, although harbor maintenance activity is very common for major GOM ports; very limited in shipping channels
	Tunnel boring	Low	10–500	Unknown; expected to be rare in the GOM
	Other construction operations	Low	<1000	Unknown; expected to be limited in the GOM
	Pile driving	228	Broadband (peak at 100–500 Hz)	Precise levels unknown; used to set platforms

TABLE 3.6.1-1 (Cont.)

Activity	Sources	Source Level[a] (dB re 1 µPa-m)	Frequency Range (Hz)[b]	Gulf of Mexico Level of Activity
Oil and gas drilling and production	Drilling from islands and caissons	140–160	20–1,000	None in the GOM
	Drilling from bottom-founded platforms	119–127 (received)	5–1,200	Variable; may range from tens to hundreds of wells drilled from GOM platforms annually; January 2001 drilling activity levels: 61 wells. MMS notes 40,361 approved applications to drill in the GOM Federal waters
	Drilling from vessels	154–191	10–10,000	Low level of activity, on the order of tens of drill ships operating in GOM waters annually
	Offshore oil and gas production	Low	50–500	4,019 production platforms on 7,564 active leases in Federal waters of the GOM, as of July 31, 2001; as of September 2, 2003, there were 3,476 active offshore production platforms in the GOM Federal waters
	Support activity	See small vessels	See small vessels	304,807 to 319,921 trips per year, with most (~90%) concentrated in the Central Planning Area; ~10% of support vessel activity occurs in the Western Planning Area, while 0.2 to 0.3% is projected for the Eastern Planning Area
Geophysical surveys	Airguns	216–259[c]	<120	Tens to 30+ surveys per year, may have as many as five surveys running concurrently (MMS 2004: Appendix D, Section V)
	Sleeve guns	220–230	40–300	10–30 surveys per year usually limited to one OCS block (Brinkman 2012)

TABLE 3.6.1-1 (Cont.)

Activity	Sources	Source Level[a] (dB re 1 µPa-m)	Frequency Range (Hz)[b]	Gulf of Mexico Level of Activity
Geophysical surveys (Cont.)	Vibroseis	187 to 210[c] instantaneous level dependent upon sweep length (i.e., ~18–22 dB less than an airgun pulse)	10–70	Estimated to be rare (MMS 2004: Append D, Section II.D)
	Other techniques (sparkers, boomers)	212–221[c]	800–1,200	Less than 10 per year (Brinkman 2012)
Navigation and target detection (sonars, pingers)	Fathometers	180+	12,000+	Potentially high, given the presence of thousands of ships and boats in the GOM
	Military active sonars	230+	2,000–57,000	Unknown; expected to be periodic, infrequent (e.g., tens to 100 or more annually)
	Transponders	180–200	7,000–60,000	Unknown; expected to be periodic, infrequent (e.g., several hundred per year)
Explosions	Military ordinance	>279[c]	Peak	Low; live fire testing very limited in the GOM
	Ship and weapons testing	>294[c] (10,000 lb charge)	Broadband	Periodic, infrequent
	Offshore demolition (structure removals)	267–279[c] (based on charge weights)	Peak	53–130 removals per year

TABLE 3.6.1-1 (Cont.)

Activity	Sources	Source Level[a] (dB re 1 µPa-m)	Frequency Range (Hz)[b]	Gulf of Mexico Level of Activity
Ocean science studies	Seismology	Not applicable	Not applicable	Unknown, expected to be very limited study of earthquakes in the GOM, if any
	Acoustic propagation	220	50–64	Unknown, expected to be very limited
	Acoustic tomography	Not applicable	Not applicable	None expected
	Acoustic thermometry	195	57.5–92.5	None expected

[a] Root mean square pressure level unless otherwise noted.

[b] Frequency range represents the lowest and highest frequencies over which the estimated source level data (reported either for dominant tones or center frequency of the 1/3 octave bands) are available.

[c] Zero-to-peak pressure level.

Sources: Adapted from Greene and Moore (1995) and various sources including Brinkman (2012) and MMS (2004), as noted.

for a Bell 212 helicopter are about 149–151 dB re 1 μPa-m at the 22 Hz tone (Greene and Moore 1995).

Underwater sounds from passing aircraft are transient. Levels and durations of sounds received underwater from passing aircraft depend on the noise strength of the aircraft, the altitude and aspect of the aircraft, water depth, bottom conditions, the temperature-salinity profile of the water column, and receiver depth. The peak received noise level in water, as an aircraft passes directly overhead, decreases with increasing altitude and increasing receiver depth. At incident angles greater than 13° from the vertical, much of the incident noise from passing aircraft is reflected and does not penetrate the water with calm seas, deep water, or shallow water with a nonreflective bottom. However, some airborne sound may penetrate water at angles greater than 13° from the vertical when rough seas provide suitable angles for additional transmission, but only above certain frequencies (Lubard and Hurdle 1976).

Accordingly, the duration of audibility of a passing aircraft is far longer in air than in water. As explained previously, bottom type and water depth may strongly affect the level and frequency content of aircraft noise by either reflectivity or absorption of sound. Due to multiple reflections, lateral propagation underwater during aircraft flyover is better in shallow than in deep water, especially in the case of a reflective bottom (e.g., basalt); thus, its noise can be heard longer in shallow than in deep water.

Small and Large Vessels. Vessels are primary contributors to overall background noise in the sea, given their large numbers, wide distribution, and mobility (Greene and Moore 1995). Sound levels and frequency characteristics of vessel noises underwater are generally related to vessel size, speed, and mode of operation, although there exist wide variations among vessels of similar classes depending on vessel design. Larger vessels generally emit stronger and lower-frequency sounds than smaller vessels do because of their greater power, large drafts,[7] and slow-turning engines and propellers, and those underway with a full load or those pushing or towing a load are noisier than unladen vessels. The primary noise sources from all machine-powered vessels are related to propeller, propulsion, and other machinery. Propeller cavitation is usually the dominant underwater noise source of many vessels (Ross 1976). In general, propeller cavitation produces most of the broadband noise, with dominant tones resulting from the propeller blade rate. Propeller singing, typically a result of resonant vibration of the propeller blade(s) with a strong tone between 100 and 1,000 Hz, is an additional source of propeller noise. Cavitation bubbles absorb vibrational energy, so propeller singing ceases in case of strong cavitation. Noise from propulsion machinery is generated by engines, transmissions, rotating propeller shafts, and mechanical friction. These sources reach the water through the vessel hull. Other sources of vessel noise include a diverse array of auxiliary machinery, flow noise from water dragging along a vessel's hull, and bubbles breaking in the vessel's wake (Greene and Moore 1995).

Small boats produce noise of about 150–170 dB re 1 μPa-m at frequencies mostly below 1,000 Hz. At the 1/3 octave-band's center frequency of 1,000 Hz, a tug pulling a barge generates

[7] The draft denotes the vertical distance between the waterline and the bottom of the ship's hull.

164 dB re 1 μPa-m when empty and 170 dB re 1 μPa-m when loaded. A tug and barge underway at 18 km/hr (11 mph) can generate broadband (45–7,070 Hz) source levels of 171 dB re 1 μPa-m. A small crew boat produces 156 dB re 1 μPa-m at the 90 Hz tone. A small boat with an outboard engine generates 156 dB re 1 μPa-m at the 1/3 octave-band's center frequency of 630 Hz, with almost the same levels as that ranging from 400 to 800 Hz. An inflatable boat with a 25 horsepower outboard engine produces 152 dB re 1 μPa-m at the 1/3 octave-band's center frequency of 6,300 Hz (Greene and Moore 1995).

Fishing in coastal regions also contributes sound to the overall ambient noise. Sound produced by these smaller boats is typically at a higher frequency, around 300 Hz. A 12-m (39-ft) long fishing boat, underway at 7 knots, generates a broadband source level of 151 dB re 1 μPa-m in the 250–1,000 Hz range. Trawlers generate source levels of 158 dB re 1 μPa-m at the 1/3 octave-band's center frequency of 100 Hz, with almost the same levels as that ranging from 100 to 250 Hz (Greene and Moore 1995).

Few data on 1-m (3-ft) source levels are available for small ships, such as support and supply ships. A supply ship underway can generate broadband (45–7,070 Hz) source levels of 181 dB re 1 μPa-m. In general, broadband (20-1000 Hz) source levels for most small ships are about 170 to 180 dB re 1 μPa-m (Greene and Moore 1995), which is for ships between boats and large vessels.

Shipping traffic, including large commercial vessels and supertankers, is most significant at frequencies from 20 to 300 Hz. Source levels from a freighter can be 172 dB re 1 μPa-m in the dominant tone of 41 Hz. Large vessels such as tankers, bulk carriers, and container ships can range from 169 dB (at the 428 Hz tone) to 181 dB (at the 33 Hz tone) re 1 μPa-m, while a very large container ship generates as much as 181–198 dB re 1 μPa-m (at tones below 40 Hz). Supertankers generate peak source levels of 185–190 dB re 1 μPa-m at about a 7 Hz tone. Noise levels of supertankers are highest at the lowest frequency measured (near 2 Hz), while strong broadband components caused by propeller cavitation are centered at frequencies ranging from 40 to 100 Hz (Greene and Moore 1995).

In shallow water, shipping traffic located more than 10 km (6 mi) away from a receiver generally contributes only to background noise. However, in deep water, low-frequency components of traffic noise up to 4,000 km (2,485 mi) away may contribute to background noise levels (Greene 1995).

3.6.1.4.2 Dredging and Construction. Marine dredging and construction activities are common within the coastal waters of the OCS. Underwater noises from dredge vessels are typically continuous in duration (for periods of days or weeks at a time) and strongest at low frequencies. Marine dredging sound levels vary greatly, depending upon the type of dredge (such as transfer, hopper, and clamshell dredges), and hopper dredges were noisier than transfer dredges (Greene 1985a, 1987). Transfer dredges can generate broadband (45–890 Hz) source levels of 172 to 185 dB re 1 μPa-m, and 1/3 octave-band (between 10 and 1,000 Hz) source levels ranging from 150 to 180 dB re 1 μPa-m with peaks in the 100–200 Hz range (Greene and Moore 1995). A clamshell dredge generates broadband (20–1,000 Hz) source levels of about

167 dB re 1 μPa-m while pulling a loaded clamshell back to the surface. Because of rapid attenuation of low frequencies in shallow water, dredging noise can diminish below typical broadband ambient levels of about 100 dB re 1 μPa within 25 km (16 mi) of dredges, but stronger tones from some dredges can be detectable beyond 25 km (16 mi) under certain conditions (Greene and Moore 1995).

Sounds from various onshore construction activities vary greatly in levels and characteristics. These sounds are most likely within shallow waters. Onshore construction activities may also propagate into coastal waters, depending upon the source and ground material (Greene and Moore 1995).

Pile driving during construction activities is of special concern because it generates signals with a very high source level and broad bandwidth. In general, the source level and frequency content of the sounds produced by pile driving depend on a variety of factors, including the type and size of the impact hammer and the pile, the properties of the seafloor, and the depth of the water. Thus, the actual sounds produced would vary from location to location.

Pile driving is expected to generate sound levels in excess of 200 dB and to have a relatively broad bandwidth from 20 Hz to the ultrasonic range above 20 kHz, with peak energy between 100 and 500 Hz (Madsen et al. 2006; Thomsen et al. 2006). Due to the impulsive nature of the sound, the radiation pattern is assumed to be rather omnidirectional (Madsen et al. 2006). Measurements from offshore wind farms in German Bight indicated that the broadband peak sound pressure level during pile driving were 189 $dB_{0\text{-}p}$ re 1 μPa (SEL = 166 dB re 1 $\mu Pa^2 \cdot s$) at 400 m (1,300 ft) distance, resulting in a peak broadband source level of 228 $dB_{0\text{-}p}$ re 1 μPa-m (SEL = 206 dB re 1 $\mu Pa^2 \cdot s$-m) (Madsen et al. 2006). The 1/3 octave-band sound pressure level was highest at 315 Hz (peak = 218 $dB_{0\text{-}p}$ re 1 μPa-m) with considerable sound energy above 2 kHz.

Sound propagation modeling for three projects predicted underwater noise levels greater than 160 dB re 1 μPa (NMFS threshold for behavioral disturbance/harassment from a noncontinuous noise source) at distances ranging from 3.4 to 7.2 km (2.1 to 4.5 mi) (BOEMRE 2011b). Pile-driving noise can travel a long distance; even at 80 km (50 mi) distance, the sound pressure levels at frequencies below 4 kHz are well above background noise, about 40–50 dB (Thomsen et al. 2006).

3.6.1.4.3 Oil and Gas Drilling and Production. Offshore drilling and production involve a variety of activities that produce underwater noises. Offshore drilling can be, in large part, made from three types of facilities: (1) natural or man-made islands; (2) bottom-founded platforms; and (3) drilling vessels, including semisubmersibles and drillships. Irrespective of type of facilities, most noises associated with offshore oil drilling and gas production are generally below 1,000 Hz (Greene and Moore 1995).

Compared with other drilling facilities, underwater noise emanating from drilling on natural or manmade islands is generally low, primarily due to poor transmission of sound through the rock and fill islands. And thus noise is inaudible at ranges beyond a few kilometers.

During drilling operations at the Sandpiper Island, Miles et al. (1987) estimated the source level of 145 dB re 1 μPa-m at a predominant 40-Hz tone, which is presumed related to diesel electric generator operation.

Underwater noises emanating from drilling activities from fixed, metal-legged platforms are considered weak due to noise sources on decks well above the water and small surface areas in contact with water. The strongest tones are generally at very low frequencies, near 5 Hz, for which received levels of 119 to 127 dB re 1 μPa at near-field measurement locations were reported (Gales 1982).

Drillships show somewhat higher noise levels than semisubmersibles as a result of mechanical noises generated through the hull of a drillship that is well coupled to the water. The drillship *Canmar Explorer II* generated broadband (45–7,070 Hz) source levels of 174 dB re 1 μPa-m. The specialized ice-strengthened floating platform *Kulluk* is by far the noisiest among drillships, producing broadband (45–1,780 Hz) source levels of 185 dB re 1 μPa-m (Greene and Moore 1995). Across the 20 to 1,000 Hz range, its 1/3 octave-band source levels are higher than that for *Canmar Explorer II*, with a maximum difference of about 15 dB. Measurements from *Kulluk* operating in another area indicated that it produced broadband (10–10,000 Hz) source levels of 191 dB re 1 μPa-m while drilling and 179 dB re 1 μPa-m while tripping (extracting or lowering the drillstring) (Hall et al. 1994).

In the shallow waters, the overall noise (20 to 1,000 Hz band) from most drilling operations would be at levels below the median ambient noise (about 100 dB re 1 μPa) at ranges greater than 30 km (19 mi) (Greene 1987).

Offshore oil and gas production is made from natural/manmade islands or from bottom-standing metal platforms. Sounds from production on islands or platforms can attenuate rapidly due to the reasons explained above for platforms and islands. Underwater sound levels from these activities are relatively low compared with other manmade activities. In addition, support activities associated with oil and gas operations such as supply/anchor handling and crew boats and helicopters also contribute to the noise from offshore activities.

3.6.1.4.4 Geophysical Surveys. Marine geophysical (seismic) surveys are commonly conducted to delineate oil and gas reservoirs below the surface of the land and seafloor. These operations direct high-intensity, low-frequency sound waves through layers of subsurface, which are reflected at boundaries between geological layers with different physical and chemical properties. The reflected sound waves are recorded and processed to provide information about the structure and composition of subsurface geological formations (McCauley 1994). In an offshore seismic survey, a high-energy sound source is towed at a slow speed behind a survey vessel. Until the mid-1960s, explosive charges were the standard sources for marine seismic exploration, but nonexplosive seismic survey sources, such as airguns, smaller sleeve exploders, and boomers, are currently in use, among which airguns are commonly used (Greene and Moore 1995, Brinkman 2012). An airgun is a pneumatic device that produces acoustic output through the rapid release of a volume of compressed air, which forms bubbles. The airgun is designed to direct the high-energy pulses of low-frequency sound (termed a "shot") downward toward the seafloor. Airguns are usually used in sets, or arrays, rather than singly (McCauley 1994). Reflected sounds from below the seafloor are received by an array of sensitive hydrophones on cables (collectively termed "streamers") that are towed behind a survey vessel or attached to cables placed on or anchored to the seafloor.

Airgun arrays are the most common source of seismic survey noise. Airguns produce energy primarily at 10–120 Hz, with some energy up to 500–1,000 Hz, which is lower than low-frequency energy but much higher than ambient noise levels. A typical full-scale airgun array produces a broadband source level of 248–255 $dB_{0\text{-}p}$[8] re 1 μPa-m (Johnston and Cain 1981; Greene 1985b), with the most powerful airgun array producing 259 $dB_{0\text{-}p}$ re 1 μPa-m (Greene and Moore 1995). Typical seismic arrays being used in the GOM produce source levels (sound pressure levels) of approximately 240 $dB_{0\text{-}p}$ re 1 μPa-m. Despite downward focusing of the seismic airgun pulses toward the ocean bottom, portions of their energy propagate horizontally, which is of greater concern. In waters 25–50 m (82–164 ft) deep, sound produced by airguns can be detected 50–75 km (31–47 mi) away, and these detection ranges can exceed 100 km (62 mi) during quiet times with efficient propagation, or in deeper water (Greene and Moore 1995).

3.6.1.4.5 Navigation and Target Detection. Active sonar systems are used for the detection of objects underwater. These range from depth-finding sonars (fathometers), found on most ships and boats, to powerful and sophisticated units used by the military. Sonars emit transient, and often intense, sounds that vary widely in intensity and frequency. Unlike most other manmade noises, sonar sounds are mainly at moderate to high frequencies, ranging from a few hundred hertz for long-range search sonar to several hundred kilohertz for side-scan sonars and military sonars, which attenuate much more rapidly than lower frequencies (Greene and Moore 1995). Acoustic pingers used for locating and positioning of oceanographic and geophysical equipment also generate noise at high frequencies.

Source levels of depth sounders are over 180 dB re 1 μPa-m at over 12 kHz, while those of bottom profilers are about 200–230 dB re 1 μPa-m in the 0.4–30 kHz range. Military sonars for search and surveillance operate at 2–57 kHz, with source levels of over 230 dB re 1 μPa-m (Greene and Moore 1995).

3.6.1.4.6 Explosions. Underwater explosions in open waters are the strongest point sources of anthropogenic sound in the sea. Sources of explosions include both military testing and non-military activities, such as offshore structure removals. Explosives produce rapid onset pulses (shock waves) followed by a succession of oscillating low-frequency bubble pulses, if the explosion occurs sufficiently deep from the surface (Staal 1985). Shock waves change to conventional acoustic pulses as they propagate.

High-explosive detonations have velocities of 5,000–10,000 m/s with pulse rise times of about 20 μsec and short-pulse durations of 0.2–0.5 ms. Although the wave is initially

8 For an ideal sinusoid, the zero-to-peak value is about 6 dB lower than peak-to-peak value and about 3 dB higher than the rms value.

supersonic, it is quickly reduced to a normal acoustic wave. Bubble-pulse frequency decreases as charge mass increases and as charge depth decreases. The spectra are dominated by a broad peak over a lower frequency band (<100 Hz), with strong infrasonic (<20 Hz) energy. Even a small 0.5-kg (1-lb) charge of TNT generates source levels of 267 $dB_{0\text{-}p}$ re 1 μPa-m, while a 20-kg (44-lb) charge of TNT produces 279 $dB_{0\text{-}p}$ re 1 μPa-m, with dominant frequencies below 50 Hz. Detonation of very large charges during ship shock tests with a 4,536-kg (10,000-lb) charge produces source levels of more than 294 $dB_{0\text{-}p}$ re 1 μPa-m (Greene and Moore 1995; MMS 2005a).

3.6.1.4.7 Ocean Science Studies. Ocean science studies examine characteristics of the water masses and ocean bottom layer. In addition to the seismic surveys that are mentioned above, these include investigating sound transmission and the properties of ocean water masses (acoustic oceanography), the latter of which include tomographic studies.

Two notable closely related ocean science studies are presented to describe typical source levels. In January 1991, the Heard Island Feasibility Test (HIFT) in the southern Indian Ocean was carried out to establish the limits of usable, long-range acoustic transmissions (Munk et al. 1994). In the study, a vertical array of five sources, centered at 57 Hz (bandwidth 14 Hz), generated broadband source levels of about 220–221 dB re 1 μPa-m. These signals were detected halfway around the world (at ranges of up to ~20,000 km [12,427 mi]). The Acoustic Thermometry of Ocean Climate (ATOC) study was made in the northern Pacific Ocean over the decade 1996–2006, and was designed to monitor long-term ocean temperature trends. The coded signals with a source level of 195 dB re 1 μPa-m transmitted broadband signals centered at 75 Hz (bandwidth 35 Hz) to receivers scattered in the northern Pacific Ocean at a maximum range of about 5,500 km (3,418 mi) (Dushaw et al. 2009).

3.6.1.5 Climate Change Effects

Potential impacts of climate change on the acoustic environment are relatively minor. Since the sound attenuation rate depends on seawater acidity, it has been suggested that increasing ocean acidification resulting from rising anthropogenic CO_2 emissions will result in decreased sound absorption (Hester et al. 2008). Increases in ambient low-frequency noise have already been reported, attributable largely to an overall increase in human activities, such as shipping that are unrelated to climate change (Andrew et al. 2002). Due to the combined effects of decreased absorption and anticipated increases in overall human activities, ambient noise levels will increase considerably within the auditory range of 10–10,000 Hz, which are critical for environmental, biota, military, and economic interests (Hester et al. 2008). There will also be changes in frequency spectrum distributions.

3.6.2 Alaska – Cook Inlet

For a more detailed discussion on the acoustic environment of Cook Inlet, please see MMS (2003a), which is incorporated here for reference.

General underwater noise sources are covered in detail in Section 3.6.1, Acoustic Environment: Gulf of Mexico, while those limited to Arctic Alaska are discussed in Section 3.6.3, Alaska – Arctic. In this section, noise sources specific to Cook Inlet will be presented.

3.6.2.1 Sources of Natural Sound

In Cook Inlet, underwater sound is generated by a variety of natural sources, such as ice, the action of wind, waves, and biological activity. Ambient noise levels and the acoustic environment in the Cook Inlet vary greatly among seasons and even daily. To a lesser degree than in the Arctic, ice plays a role in the ambient noise levels. In contrast to the Arctic environment, strong tidal fluctuations and currents function as additional sources of ambient noise in Cook Inlet. Cook Inlet has one of the largest tides in the North American continent, and thus tidal noises can be important contributors to ambient levels, especially at low frequencies. Wind and wave action also contribute to ambient noise. Measurements at several seaward locations around Anchorage that are removed from industrial activities indicated that the mean ambient underwater broadband (10–20,000 Hz) levels span a fairly wide range, from 95 to 120 dB re 1 μPa (Blackwell and Greene 2002).

Marine mammals in Cook Inlet also contribute to ambient noise. Echolocation clicks have the highest source levels among marine mammal sounds. The echolocation signals from beluga whales have source levels of about 206–225 dB re 1 μPa-m, with peak frequencies between 40 and 60 kHz and between 100 and 120 kHz (Au et al. 1985, 1987; Au 1993). Under controlled conditions, a trained beluga had good echolocation abilities at distances up to at least 80 m (262 ft) (Au et al. 1987). However, maximum distances at which echolocation pulses can be detectable by hydrophone (one-way travel) are much greater than the maximum target distance at which the emitting animal can detect echoes (two-way travel).

Humpback whales in southeast Alaskan waters produce five categories of sounds, with frequencies ranging between 20 and 2,000 Hz (Thompson et al. 1986). Source levels ranged from 162 (low-frequency pulse trains) to 192 dB re 1 μPa-m (surface impacts resulting from fluke or flipper slaps).

Fin whales typically produce calls around 20 Hz, which have source levels of about 160–186 dB re 1 μPa-m with extremes of 200 dB and ≤140 dB (Patterson and Hamilton 1964; Northrop et al. 1968, 1971; Watkins 1981; Watkins et al. 1987; Cummings and Thompson 1994). Calls at 20 Hz can be transmitted up to 185 km (115 mi) away (Cummings and Thompson 1971).

There are many other species of marine mammals in the marine environment of Cook Inlet whose vocalizations contribute to ambient sound. These include but are not limited to, other whales (such as gray whales), dolphins, sea lions, sea otters, and seals (see Section 3.8.1.2). Sea lions, sea otters, seals, and marine and coastal birds all produce sound that can be heard above water.

3.6.2.2 Sources of Anthropogenic Sound

The primary sources of anthropogenic sounds in the Cook Inlet include aircraft overflights, vessel activities and traffic, oil and gas activities, including seismic surveys and production operations and other miscellaneous human activities such as construction of pipelines and production facilities, pile driving for a new dock at Anchorage port, and possibly new bridge construction. Port of Anchorage and Anchorage International Airport, which are important transportation and distribution hubs, and Elmendorf Air Force Base are located more than 145 km (90 mi) northeast of the Cook Inlet Planning Area (see Figure 3.2.1-1). Cook Inlet experiences considerable aircraft traffic throughout the year, including commercial passenger, cargo, private, and military aircraft (Moore et al. 2000c). In particular, Kenai and Homer airports, located east of the planning area, processed about 114,000 flight operations in 2001, about half of which were attributable to air-taxi operations. More than 10 helicopters are also based at these two airports. In Cook Inlet, significant noise originates from heavy vessel traffic, including cargo vessels, freighters, tankers, supply ships, support vessels, tugboats, barges, seismic-survey vessels, and fishing boats (for recreational, commercial, subsistence, and personal use). As for natural sound, anthropogenic sound varies spatially and temporally within the Cook Inlet.

Considering the size and/or traffic volume of vessels, noise from boat traffic associated with oil and gas activities is likely less than that from the fishing and commercial traffic occurring within the Cook Inlet. However, shipping traffic is more pronounced in Cook Inlet than in the Arctic Ocean. Shipping traffic dominates the spectra of ambient noise between 20 and 300 Hz. Fishing vessels produce high-frequency sound peaking at 300 Hz, whereas larger cargo vessels produce more lower frequency sounds (Greene and Moore 1995).

Blackwell and Greene (2002) measured underwater noise levels at six locations 0.3–19 km (0.2–12 mi) from the Phillips A oil platform in Cook Inlet. The highest broadband noise level was 119 dB re 1 µPa at 1.2 km (0.75 mi) from the platform. Background levels were reached by the farthest measuring location (19 km [12 mi]). Several tones at frequencies of 60–105 Hz were likely due to the platform. Other work found that drilling platforms and combined drilling/production platforms in California produce little underwater sound because of the small surface area in contact with the water and the placement of machinery on decks well above the water (Gales 1982).

3.6.2.3 Climate Change Effects

Potential impacts of climate change on the acoustic environment are relatively minor. Since the sound attenuation rate depends on seawater acidity, it has been suggested that increasing ocean acidification resulting from rising anthropogenic CO_2 emissions will result in decreased sound absorption (Hester et al. 2008). Increases in underwater low-frequency noise have already been reported, attributable largely to an overall increase in human activities, such as shipping that are unrelated to climate change (Andrew et al. 2002). Although sea ice is limited to northern Cook Inlet during winter through early spring, reduced sea ice associated with climate change could provide a longer open water season for shipping and resource extraction, which could increase sound levels in Cook Inlet. Due to the combined effects of decreased absorption, the anticipated increase in overall human activities, and the longer open water season, ambient noise levels will increase considerably within the auditory range of 10–10,000 Hz, which are critical for environmental, biota, military, and economic interests (Hester et al. 2008). There will also be changes in frequency spectrum distributions.

3.6.3 Alaska – Arctic

For a more detailed discussion on the acoustic environment of the Arctic region, please see MMS (2008b) and MMS (2006c), which are incorporated here for reference.

General underwater noise sources are covered in detail in Section 3.6.1, Acoustic Environment: Gulf of Mexico, while those limited to Cook Inlet are discussed in Section 3.6.2, Acoustic Environment: Alaska – Cook Inlet. In this section, noise sources specific to Arctic Alaska will be presented.

In the Arctic Project Areas including the Beaufort and Chukchi Seas, underwater sound is generated by a variety of natural and anthropogenic sources. The Arctic waters are a unique acoustic environment mainly due to the presence of ice, which can contribute significantly to ambient sound levels and affects sound propagation.

3.6.3.1 Sources of Natural Sound

Natural sound in the Alaskan Arctic predominantly originates from ice and the action of wind, waves, and biological activity (Greene 1995). Ambient levels of natural sound can vary dramatically between and within seasons at a particular location and can vary from location to location. As an example, MMS (2006c) found that ambient sound in the Beaufort Sea in September 1998 ranged widely, between about 63 and 133 dB re 1 μPa. The presence, thickness, and movement of sea ice significantly influence the ice's contribution to ambient sound levels, as does the period of open water when wind and waves contribute to ambient sound levels. Richardson 2011 found broadband (10–450 Hz) background levels of 90–110 dB re 1 μPa about 430 m (1,410 ft) from Northstar Island in the Beaufort Sea. The background levels were correlated with wind speed.

3.6.3.1.1 Sea Ice. The Arctic waters are a unique acoustic environment mainly due to the presence of ice, which can contribute significantly to ambient sound levels and affects sound propagation. Ice cracking due to thermal stresses caused by temperature changes generates noise, and ice deformation under pressure from wind and currents produces significant low-frequency noise (Greene 1995). Data are limited, but in at least one instance it has been shown that ice-deformation sounds had frequencies of 4–200 Hz (Greene 1981). While sea ice can produce significant sound, it also can also function to dampen ambient sound.

Ambient noise levels in the project area can vary drastically between seasons and can also vary with sea ice conditions. In winter and spring, shore-fast ice produces significant thermal cracking sounds (Milne and Ganton 1964). The spectrum of cracking noise typically displays a broad range from 100 to 1000 Hz, and the spectrum level has been observed to vary as much as 15 dB within 24 hours due to the diurnal change of air temperature. The NRC (2003a; citing Urick 1984) reported that variability in air temperature over the course of the day can change received sound levels by 30 dB between 300 and 500 Hz. Spring noise spectra peaked at about 90 dB re 1 μPa^2/Hz at infrasonic frequencies (0.5–2 Hz) (Milne and Ganton 1964). In the 2–20 Hz range, noise spectra decrease with increasing frequency, while in the 20–8,000 Hz range, the levels of 50 dB re 1 μPa^2/Hz remain constant. Winter noises include wind-induced noise as well as thermal cracking sounds. Winter noise, equivalent to Knudsen spectrum for sea state three, is higher than during any other season. For late summer ice, relative motion of the floes is the primary factor for ambient sound. As icebergs melt, they produce additional background noise with a spectrum level flat at about 62 dB re 1 μPa^2/Hz at a range of 180 m from an iceberg, decreasing to about 58 dB at 10 kHz (Urick 1971). In addition to noise caused by breakup, sea ice makes noise when temperature changes result in cracking. Underpressure from wind and currents also results in significant low-frequency noise, and iceberg melting results in “seltzer” noise.

The Arctic Ocean is almost uniformly cold from top to bottom, and pressure always increases with depth. Thus, sound speed is the lowest at or near the surface. All sound rays in the Arctic surface channel are refracted upward and are then reflected from the under-ice surface (Malme 1995). Low-frequency noise loses its energy by conversion of acoustic waves into flexural waves of the ice sheet. At higher frequencies, under-ice roughness plays a primary role in sound propagation. Smooth annual ice may enhance propagation as compared with open water conditions. However, increased cracking, ridging, and other forms of roughness generally cause more transmission losses than under open water conditions. As ice forms, especially in very shallow water, the sound propagation properties of the underlying water are affected in a way that can reduce the transmission efficiency of low-frequency sound (Blackwell and Greene 2002). At frequencies less than 500 Hz, where most acoustic energy from aircraft and surface vehicles is concentrated, the ice layer is acoustically thin and causes little attenuation of sound (Malme 1995).

The presence of sea ice also affects the timing, nature, and possible locations of human activities such as shipping; research; barging; whale hunting; oil- and gas-related exploration (e.g., seismic surveys and drilling); military activities; and other activities that introduce noise into the marine environment. Because of sea ice and its effects on human activities, ambient sound levels in the Beaufort and Chukchi Seas can vary dramatically between seasons and with sea ice conditions. The presence of ice also impacts which marine species are present, another factor that influences ambient sound levels.

There is some concern that climate change will alter the acoustic environment in the Arctic drastically. Arctic sea ice is declining rapidly. Its extent has fallen at a rate of 3 to 4% per decade over the last three decades, and this trend is very likely to continue (USGCRP 2009). If Arctic warming continues, it is likely that changes in the acoustic environment also will occur in many parts of the waters off Alaska (Tynan and DeMaster 1997; Brigham and Ellis 2004).

Climate warming potentially could: (1) increase noise and disturbance related to increased shipping and other vessel traffic and possibly increased seismic exploration and development; (2) expand commercial fishing and/or cause a change in areas where intensive fishing occurs; (3) decrease year-round ice cover; (4) change subsistence-hunting practices; and (5) change the distribution of marine mammal species (MacLeod et al. 2005).

3.6.3.1.2 Wind and Waves. During the open water season in the Arctic, wind and waves are important interrelated sources of ambient sounds with levels tending to increase with increased wind (and thus sea state) and wave height, all other factors being equal (Greene 1995). Areas of water with 100% sea ice cover can reduce or completely eliminate sounds from waves or surf. However, the marginal ice zone in the area near the edge of large sheets of ice usually is characterized by quite high levels of ambient sound compared to other areas, in large part due to the impact of waves against the ice edges and the breaking up and rafting of ice flows (Milne and Ganton 1964).

3.6.3.1.3 Marine Mammals (and Birds). Marine mammals can contribute significantly to the background sounds in the acoustic environment of the Beaufort and Chukchi Seas; however, frequencies and levels depend highly on seasons. For example, bearded seal sounds dominate ambient noise in many Arctic areas during spring; source levels of bearded seal songs have been estimated to be up to 178 dB re 1 μPa-m, with dominant frequencies of 1–2 kHz (Cummings et al. 1983). Parts of some calls were recorded up to a distance of 25 km (16 mi) underwater (Cleator et al. 1989). Ringed seal calls have a source level of 95–130 dB re 1 μPa-m, with the most energy below 5 kHz (Thomson and Richardson 1995). Its source levels are low compared with those of other marine mammals and the detection range may not exceed 1 km (0.6 mi) (Cummings et al. 1984). Bowhead whales, which are present in the Arctic region from early spring to mid- to late fall, produce sounds with estimated source levels ranging 128 to 189 dB re 1 μPa-m in frequency ranges from 20 to 3,500 Hz. Thomson and Richardson (1995) summarized that most bowhead whale calls are "tonal frequency modulated (FM)" sounds at 50–400 Hz. A few callings of bowhead whales are detectable up to 20 km (12 mi) away, although most localizable whales are $\leq$ 10 km (6.2 mi) away (Cummings and Holliday 1985; Clark et al. 1986; LGL and Greeneridge 1987). Based on monitoring near BP's Northstar Island in the Beaufort Sea, some whale calls were detected at up to 40 km (25 mi) (Aerts and Richardson 2008).

There are many other species of marine mammals in the Arctic marine environment whose vocalizations contribute to ambient sound including, but not limited to, the gray whale, walrus, beluga whale, spotted seal, fin whale (in the southwestern areas), and, potentially but less likely, the humpback whale. Walruses, seals, and seabirds (especially in the Chukchi Sea near colonies) all produce sound that can be heard above water.

3.6.3.2 Sources of Anthropogenic Sound

The primary sources of anthropogenic sounds in the Arctic include vessel activities and traffic, oil and gas activities, including seismic surveys, production, and other miscellaneous activities. During much of the year in many marine areas, there are few near-field marine noise sources of human origin and limited, but increasing, land-based and nearshore-based sources of noise.

Anthropogenic sources of sound in the project area include vessels; navigation and scientific research equipment; airplanes and helicopters; human settlements; military activities; and marine development, including those sounds from the oil and gas activities. Ambient sound levels from anthropogenic sources can also fluctuate temporally and spatially as much as variations in natural sounds. Table 3.6.1-1 provides a comparison of man-made sound levels from various sources and their typical source levels associated with the marine environment.

3.6.3.2.1 Vessel Activities and Traffic. The types of vessels that typically produce noise in the Beaufort and Chukchi Seas include barges, skiffs with outboard motors, icebreakers, tourism and scientific research vessels, and vessels associated with oil and gas exploration, development, and production. In the Beaufort and Chukchi Seas, vessel traffic and associated noise presently is limited primarily to open water season between late spring and early autumn.

In shallow water, vessels more than 10 km (6.2 mi) away from a receiver generally contribute only to background noise levels (Greene 1995). In deep water, traffic noise up to 4,000 km (2,485 mi) away may contribute to background noise levels. Shipping traffic is most significant at frequencies from 20 to 300 Hz (Greene 1995). Barging associated with activities such as onshore and limited offshore oil and gas activities, fuel and supply shipments, and other activities contributes to overall ambient noise levels in some regions of the Arctic. Smaller boats, such as aluminum skiffs with outboard motors during fall subsistence whaling and fishing also generate noise, typically at a higher frequency around 300 Hz (Greene and Moore 1995).

Icebreaking vessels used in the Arctic for activities including research and oil and gas activities produce louder, but also more variable, sounds than those associated with other vessels of similar power and size (Greene and Moore 1995). Icebreaking noise is up to 15 dB higher than when the same ship is underway in open water, primarily due to strong propeller cavitation. However, physical crushing of ice contributes little to the overall increase in noise. In general, spectra of icebreaker noise are wide and highly variable over time. Icebreaking generates broadband (10–1,000 Hz) source levels of 184 and 191 dB re 1 μPa-m during movement ahead and astern, respectively (Greene and Moore 1995). Even with rapid attenuation of sound under heavy ice conditions, the elevation in noise levels attributed to icebreaking can be substantial out to at least 5 km (3 mi). In some instances, icebreaking sounds are detectable from more than 50 km (31 mi) away.

Hovercraft can operate on open water or ice, and tracked or standard vehicles can often operate on shore-fast ice. Recordings indicated that the hovercraft operating around the Northstar Island generate strong in-air sounds, but were considerably quieter underwater than conventional vessels of similar size (Blackwell and Greene 2005). Hovercraft have replaced much of the helicopter traffic to the Northstar facility. At the closest point of approach (6.5 m [21 ft]), underwater broadband (10–10,000 Hz) levels reached 133 and 131 dB re 1 µPa at depths of 1 and 7 m (3 and 23 ft), respectively, with the peak near 87 Hz, which corresponds to the blade rate of the thrust propeller.

In general, noise generated on ice is transmitted into the water directly below but does not propagate well laterally (Greene and Moore 1995). For sources on ice, sound levels are affected by ice conditions (temperature, snow cover) and are generally much lower than those generated by vessels on water. Snow absorbs sound, and thus transmits less sound energy to water, and water depth also affects sound transmission from sources on ice.

Northstar is the first offshore oil production island in the Beaufort Sea, which is located about 19 km (12 mi) northwest of the Prudhoe Bay. Around the Northstar Island, vessels were the main contributors to the underwater sound field. During both the ice-covered and the open water seasons, helicopters and a hovercraft were used to transport personnel and equipment to and from the Northstar Island (Richardson 2011). During the ice-covered season, tracked vehicles and standard vehicles were additional modes of transportation over an ice road to the Northstar Island. During the open water season, vessels such as tugs, self-propelled barges, crew boats, and other vessel operations (e.g., oil spill-response training) were additional modes of transportation. Broadband sounds from vessel traffic were often detectable as much as 30 km offshore. Sound measurements for the entire 2001–2010 late summer/early fall seasons indicated that broadband (10–450 Hz) ambient levels ranged from 81 to 141 dB re 1 µPa at about 450 m (1,476 ft) north to northeast of Northstar.

3.6.3.2.2 Seismic Noise. The oil and gas industry in Alaska conducts marine (open water) surveys (e.g., airgun array) in the summer and fall, and on-ice seismic surveys (e.g., Vibroseis) in the winter to locate geological structures potentially capable of containing petroleum accumulations and to better characterize ocean substrates or sub-sea terrain.

Airgun arrays are the most common source of seismic survey noise. Airguns produce energy primarily at 10–120 Hz, with some energy up to 500–1,000 Hz, which is lower than low-frequency energy but much higher than ambient noise levels. A typical full-scale airgun array produces a broadband source level of 248–255 $dB_{0\text{-}p}$ re 1 µPa-m (Johnston and Cain 1981; Greene 1985b), with the most powerful airgun array of 259 $dB_{0\text{-}p}$ re 1 µPa-m (Greene and Moore 1995). Typical seismic arrays being used in the Arctic produce source levels (sound pressure levels) as high as 248 $dB_{0\text{-}p}$ re 1 µPa-m (Greene and Richardson 1988).

While the seismic airgun pulses are directed toward the ocean bottom, sound propagates horizontally for several kilometers (Greene and Richardson 1988; Hall et al. 1994). However, depending on the source and other factors, seismic noise could be detected much farther away from the source. In waters 25–50 m (82–164 ft) deep, sound produced by airguns can be detected 50–75 km (31–47 mi) away, and these detection ranges can exceed 100 km (62 mi) under favorable propagation conditions or in deeper water (Greene and Moore 1995) and, particularly during summer, over 3,000 km (1,864 mi) in the open ocean (Nieukirk et al. 2004).

Vibroseis is a method of seismic profiling on shore-fast ice, usually over shallow water, which propagates energy into the earth over an extended period of time, in contrast to the near-instantaneous energy provided by impulsive sources. In this activity, hydraulically driven pads mounted beneath a line of trucks are used to vibrate, and thereby energize, the ice. Noise incidental to the activity is introduced by the vehicles associated with this activity. Greene and Moore (1995) summarized that typical signals associated with the vibroseis sound source used for an on-ice seismic survey sweep from 10 to 70 Hz, but harmonics extend to about 1.5 kHz. Vibroseis produces source levels of about 187–210 $dB_{0\text{-}p}$ re 1 µPa-m and would reduce to the ambient level at distances of 3.5–5 km (2–3 mi) (Holliday et al. 1984).

3.6.3.2.3 Noise from Other Oil and Gas Activities. Offshore exploration and production drilling platforms (freestanding or drill ships) use machinery and equipment that emit noise into the marine environment. While most of this noise is relatively localized, organisms can be attracted to or be displaced away from these sites.

Onshore oil production facilities (and associated buildings, pipelines, roads, etc.) have equipment (machinery and vehicles) or people that generate noise. As of the end of 2011, there are no oil production facilities in the Chukchi Sea. There is one operating oil production facility on an artificial island and several others in planning and construction stages in the Beaufort Sea. There are two other developments on causeways. While sounds originating from drilling activities on islands can reach the marine environment, noise typically propagates poorly from artificial islands, as it must pass through gravel into the water (Greene and Moore 1995). During unusually quiet periods, drilling noise from icebound islands with a low source level and low frequency would be audible at a range of about 10 km (6 mi), when the usual audible range would be about 2 km (1 mi). Broadband noise reduced to ambient levels within about 1.5 km (0.9 mi), and low-frequency tones were measurable to about 9.5 km (6 mi) under low ambient noise conditions, but were essentially undetectable beyond about 1.5 km (0.9 mi) with high ambient noise. Much of the production noise from oil and gas operations on gravel islands is substantially attenuated within 4 km (2.5 mi) and often not detectable beyond 9.3 km (6 mi) away.

Based on measurements of noise from Northstar obtained during March 2001 and February–March 2002 (during the ice-covered season), Blackwell et al. (2004) found that background levels were reached underwater at 9.4 km (6 mi) during drilling and at 3–4 km (2–2.5 mi) without. Depending on the wind but irrespective of drilling, in-air background levels were reached at 5–10 km (3–6 mi) from Northstar. Without vessels and under calm sea (sea state ≤ 1), median underwater sound from a gravel island like Northstar generally reached background levels at about 2–4 km (1.2–2.5 mi) from Northstar (Richardson 2011).

3.6.3.2.4 Snowmachines and Ice Roads. The two principal sources of transportation activity on the North Slope are the oil industry and the Iñupiat communities (MMS 2008b). Small snowmobiles have high-speed two-cycle engines. These are noisy in air and create sounds at higher frequencies than larger, slower machinery. The amount of sound passing through ice into the water below is expected to vary greatly depending on snow, ice, and temperature conditions. The spectrum of snowmobile sound as received under the ice includes much energy near 1–1.25 kHz, but levels vary widely: spectrum levels about 90 dB re 1 μPa^2/Hz at 148 m (486 ft) in one study, versus only 55–60 dB at about 200 m (656 ft) in another (Greene and Moore 1995).

The oil industry builds ice roads in winter to access areas that otherwise would be inaccessible to large equipment. Fresh water from local lakes is used to build a thick, flat road surface capable of supporting large machinery. Ice-road construction begins as early as December and is usually completed by mid-winter. Water may be used for maintenance throughout the useful life of the ice road (BLM 2012).

3.6.3.2.5 Miscellaneous Sources. Acoustical systems are associated with some research, military, commercial, or other vessel use of the Beaufort or Chukchi Seas. Such systems include multi-beam sonar, sub-bottom profilers, and acoustic Doppler current profilers. Active sonar is used for the detection of objects underwater. These systems range from depth-finding sonar, found on most ships and boats, to powerful and sophisticated units used by the military. Sonar emits transient, and often intense, sounds that vary widely in intensity and frequency. Although not commonly used in the Arctic, acoustic pingers used for locating and positioning oceanographic and geophysical equipment also generate noise at frequencies greater than about 10–20 kHz. LGL Ltd. (2005) describes many examples of acoustic navigational equipment.

Small snowmobiles are used for transportation on the North Slope (MMS 2008b). These are noisy in air and create sounds at higher frequencies than larger, slower machinery. The amount of sound passing through ice into the water below is expected to vary greatly depending on snow, ice, and temperature conditions (Greene and Moore 1995).

The oil industry builds ice roads in winter to access areas that otherwise would be inaccessible to large equipment. Ice-road construction begins after freezeup and is built over tundra and shorefast ice to facilitate exploration and development while minimizing impacts (MMS 2008b).

3.6.3.3 Climate Change Effects

Potential impacts of climate change on acoustic environment are relatively minor. Since the sound attenuation rate depends on seawater acidity, it has been suggested that increasing ocean acidification resulting from rising anthropogenic CO_2 emissions will result in decreased sound absorption (Hester et al. 2008). Increases in underwater low-frequency noise have already been reported, attributable largely to an overall increase in human activities, such as shipping, that are unrelated to climate change (Andrew et al. 2002). In addition, reduced sea ice associated with climate change could provide a longer open water season for shipping and resource extraction, which could increase sound levels in the Beaufort and Chukchi Seas. Due to the combined effects of decreased absorption, the anticipated increase in overall human activities, and the longer open water season, ambient noise levels will increase considerably within the auditory range of 10–10,000 Hz, which are critical for environmental, biota, military, and economic interests (Hester et al. 2008). There will also be changes in frequency spectrum distributions.

3.7 MARINE, COASTAL, AND OTHER ADJACENT HABITATS

A habitat is defined as an area or environment where an organism or ecological community normally lives. Marine and coastal habitats occur as characteristic arrangements of geologic, hydrologic, oceanographic, and biologic features and processes that create environments favorable for the establishment, flourishing, and continued survival of the flora and fauna of marine and coastal areas. This section focuses on the geologic, biologic, and oceanographic features that define marine and coastal habitats of particular concern. Habitats of particular concern are so designated because of their ecosystem importance, their association with high productivity and/or faunal populations, and/or their high scientific interest. These habitats will be evaluated within an ecoregional geographic framework, as shown for the GOM in Figure 3.7-1, and discussed in Section 3.2.

3.7.1 Coastal and Estuarine Habitats

3.7.1.1 Gulf of Mexico

Habitats are divided into coastal and marine categories. Coastal habitats occur in estuarine areas along virtually the entire U.S. GOM coast. The EIS uses the EDAs from NOAA's Coastal Assessment Framework (http://coastalgeospatial.noaa.gov) database to show the areas where the coastal habitats that are considered in the EIS are located (Figure 3.7-1). Marine habitats occur seaward of the coastal habitats that occur within estuarine watersheds. While a convenient boundary between coastal and marine habitats is the most seaward coastal feature, which typically would be barrier islands or beaches in the GOM, the actual boundary between predominantly coastal and predominantly marine habitats is a transition zone blurred by the influence of estuarine discharges onto the continental shelf. Figure 3.7-1 shows that the central coastal ecoregion estuarine influence extends to the edge of the continental shelf as a result of the discharge of the Mississippi River, while it is much more restricted on the continental shelf offshore Florida and Texas.

GOM coastal habitats are associated with a nearly continuous estuarine ecosystem that is made up of 31 major estuarine watersheds that extend across the coastal waters of the northern GOM. Coastal and nearshore habitats of concern within these areas include barrier islands and beaches, wetlands (marsh, bottomland swamp, mangrove, and scrub/shrub communities), and seagrasses. These habitats occur within estuarine watersheds in and around bays, lagoons, and river mouths where marine and fresh waters intermix, as well as extending further offshore in some areas but commonly to depths of about 30 m (98 ft). Coastal and nearshore habitats of the GOM can be subdivided into three GOM Estuarine Ecoregions (Figure 3.7.1-1), each with distinguishing characteristics, arrangements of habitat components, and freshwater inflows with

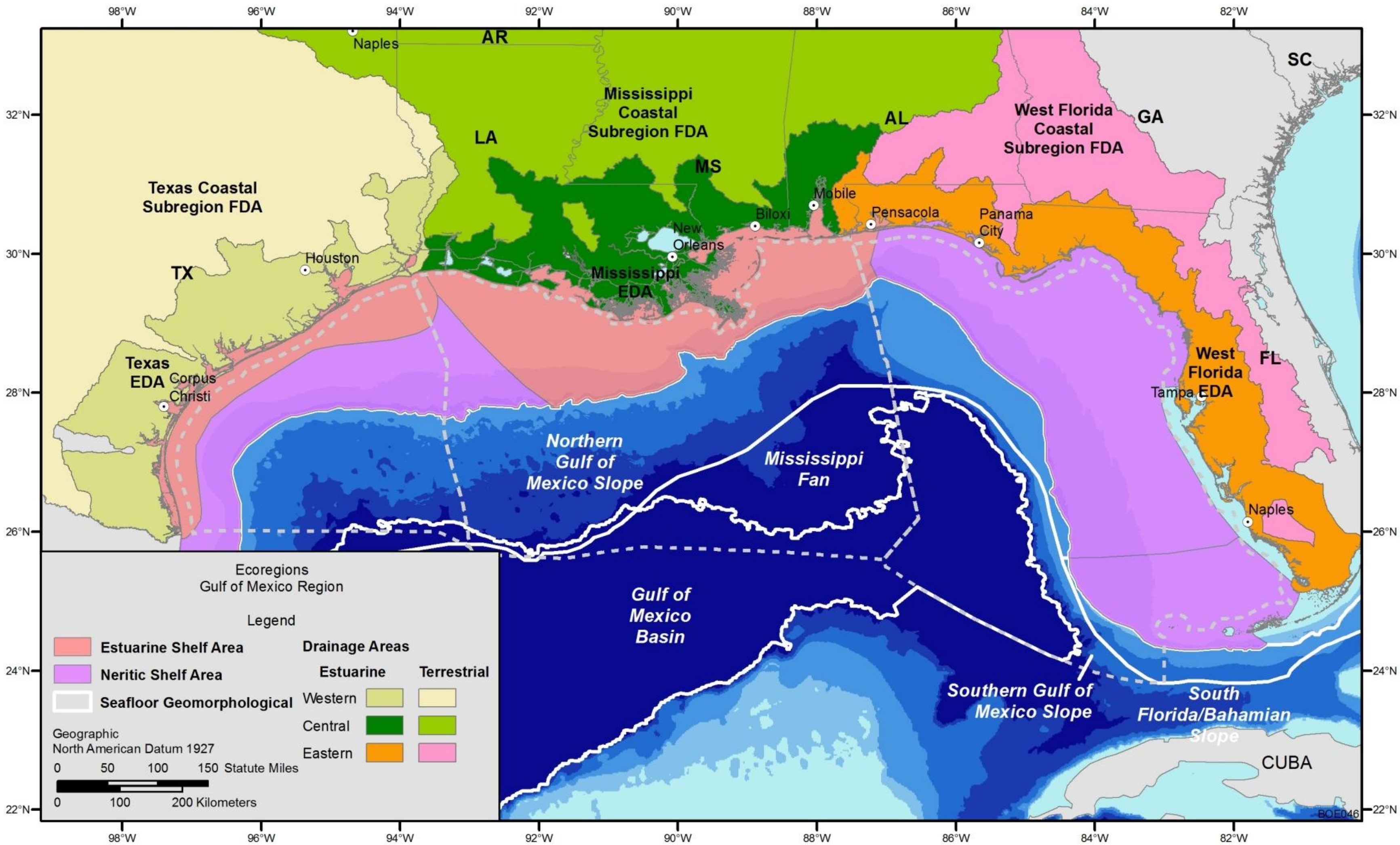

FIGURE 3.7-1 Ecoregions of the GOM Region

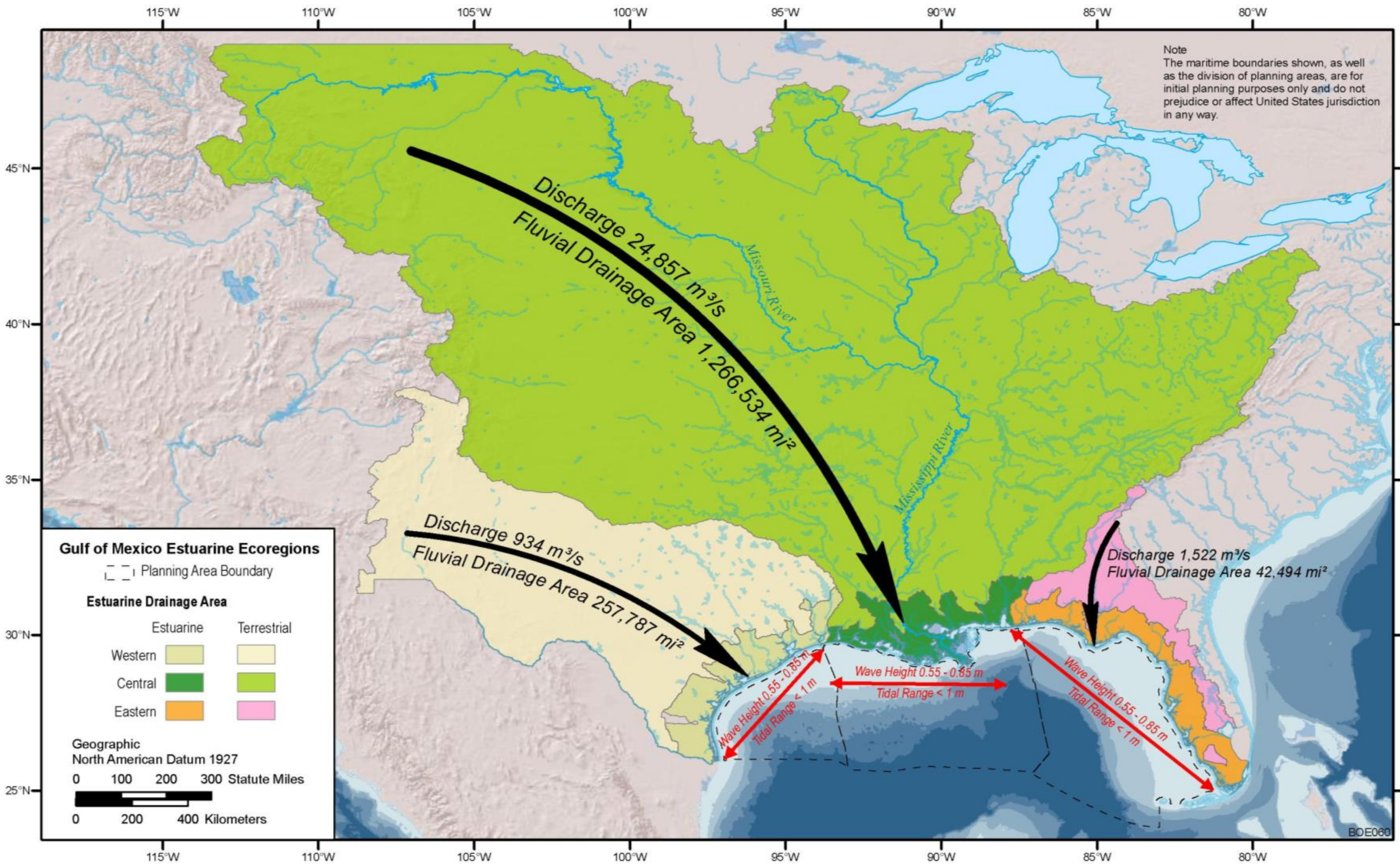

FIGURE 3.7.1-1 Estuarine and Fluvial Drainage Areas of the Gulf of Mexico Region

associated nutrient and sediment loads: a western coastal ecoregion, extending from near the Mexico–Texas border to just east of the Louisiana border; the Central GOM Estuarine Region, extending to just east of the Florida border; and the Eastern GOM Estuarine Region, extending to the southern tip of Florida. These ecoregions are similar to the geographic/hydrologic regions of Yanez-Arancibia and Day (2004) and are consistent with estuarine influenced zones identified on the GOM continental shelf in the Marine Ecoregions of North America (CEC 2008).

Figure 3.7.1-1 emphasizes coastal habitats. It shows terrestrial, estuarine, and continental shelf estuarine areas and values for fluvial and marine processes/quantities. Fluvial drainage areas are shown because they depict the land area that drains into the estuarine portion of the watershed. The estuarine drainage areas show where coastal habitats potentially affected by OCS oil and gas activities occur. While OCS activities would not be expected to extend upstream into the terrestrial portion of the watershed, the terrestrial watershed characteristics have important influences on estuarine habitats. Terrestrial discharges introduce dissolved and suspended materials into estuarine and marine waters that can serve either as nutrients that enrich marine and coastal productivity or as pollutants that degrade habitat quality. The terrestrial discharges also carry suspended and bed load sediments from the land into estuarine areas where they are redistributed through the coastal zone to provide the substrate for many coastal habitats. Marine processes are also at work on the seaward side of estuarine areas through the action of waves, tides, and currents. These processes affect the redistribution of terrestrial sediments in the coastal zone, coastal erosion and deposition patterns, and mixing of fresh and salt water within the coastal zone and onto the continental shelf. To a large degree, the variations in the interactions among these terrestrial and marine processes and properties within the GOM explain the distinctions among the three coastal ecoregions that characterize the northern GOM.

Figure 3.7.1-1 indicates that marine processes affecting estuarine habitats, such as tidal range, wave height, and longshore sediment transport, are fairly uniform across the GOM coast. In contrast, there is substantial variation in terrestrial drainage properties among the coastal ecoregions. Fluvial discharge, for example, varies by a factor of over 25 across the three coastal ecoregions. The effect of the amount of fresh water discharged through the central GOM estuarine costal ecoregion is apparent on Figure 3.7.1-1, which shows the entire continental shelf area offshore of the Mississippi River Delta as being estuarine influenced compared to smaller estuarine areas on the continental shelf offshore of the eastern and western coastal ecoregions.

The sizes and configurations of the fluvial drainage areas also affect governance issues that would apply to managing coastal environments and habitats and present and future programs for mitigating and restoring coastal habitats there. The central coastal fluvial drainage area is sub-continental in size and under the jurisdiction and regulatory authority of numerous State governments, Federal agencies, and interagency programs. Furthermore, the hydrology of the Mississippi River system in the central GOM fluvial drainage area supports numerous navigational, agricultural, recreational, and industrial activities and enterprises that together create a complex set of governance and trade-off issues that would affect the management of coastal and marine habitats there. The western and eastern fluvial drainage areas, in contrast, are nearly contained within the boundaries of a single State, which would act to simplify governance issues affecting coastal habitat management there.

3.7.1.1.1 Barriers. Coastal barrier landforms consist of barrier islands, major bars, sand spits, and beaches that extend across the nearshore waters from the Texas–Mexico border to southern Florida. These elongated, narrow landforms are composed of sand and other unconsolidated, predominantly coarse sediments that have been transported to their present locations by rivers, waves, currents, storm surges, and winds.

Coastal landforms are transitory in nature and are constantly being modified by the same forces that led to their original deposition. The GOM coast shoreline is constantly changing as a result of the action of wind-driven waves and longshore currents that cause sediment transport. The coastline has a narrow tidal range, and energy forces tend to be storm dominated, with episodic high wave energy. These landforms are continually modified by waves, currents, storm surges, and winds. Coastal currents in the GOM transport sediments in a counter-clockwise direction from east to west, and contribute to sediment accretion as well as erosion of coastal landforms. Over extended periods of time, landforms may move landward (transgressive), seaward (regressive), or laterally along the coast. Sediments are also transported to coastal areas from rivers that discharge to the GOM. Barrier islands and sand spits protect wetlands and other estuarine habitats located behind them from the direct impacts of the open ocean, and slow the dispersal of freshwater into the GOM, thus contributing to the total area and diversity of estuarine habitat.

On barrier landforms, the nonvegetated foreshore slopes up from the low-tide line to the beach berm-crest. The backshore is found between the beach berm-crest and the dunes, and it may be sparsely vegetated. The berm-crest and backshore may occasionally be absent because of storm activity. The dune zone of a barrier landform consists of one or more low dune ridges that may be stabilized by vegetation such as grasses and scrubby woody vegetation. During storms, waves can overwash lower barrier landforms, and vegetation communities on these are often sparse and in early successional stages. On higher, more stabilized landforms, vegetation behind the dunes consists of scrubby woody vegetation, marshes, and maritime forests. Fresh- and saltwater ponds may occur on landward flats or between dunes. On the landward side of islands and spits, low flats grade into intertidal wetlands or mudflats.

Barrier islands are prevalent along the Texas coast from the Bolivar Peninsula southward to the Mexican border. Barrier islands and sand spits present in this region of the Texas coast were formed from sediments supplied by major deltaic headlands. The barrier islands in this region are arranged symmetrically around old, eroding delta headlands, and tend to be narrow and sparsely vegetated, exhibiting a low profile with numerous washover channels. The barrier islands and beaches are moving generally to the southwest. Net coastal erosion has been occurring in some areas. Inland beaches of sand and shells are found along the shores of bays, lagoons, and tidal streams.

The Chenier Plain is transitional between the Central estuarine ecoregion, which is heavily influenced by the Mississippi River Delta building processes, and the Western estuarine ecoregion, where the river influence greatly diminishes. Most barrier shorelines of the Mississippi River Delta complex in Louisiana occur along the outward remains of a series of old abandoned river deltas and are transgressive. Only a minor portion of the sediments of the Mississippi River, now channelized, enter longshore currents and contribute to barrier landforms.

Most dune areas of the delta consist of low single-line dune ridges that are sparsely to heavily vegetated, depending on the length of time between major storms.

Short time intervals between storms can cause reductions in the size and resiliency of barrier islands and shorelines. Although barrier islands and shorelines have some capacity to regenerate over time, the process is very slow and often incomplete. The past decade has seen an increase in tropical storm activity for the project area. Figure 3.7.1-2 shows hurricane landfalls from 1994 to 2009. Hurricane Katrina in 2005 caused severe erosion and land loss for the coastal barrier islands of the Deltaic Plain. Hurricane Katrina was the fifth hurricane to impact the Chandeleur Island chain in 8 yr. The Chandeleur Islands were reduced by Hurricane Katrina from 14.6 km^2 (5.64 mi^2) to 6.5 km^2 (2.5 mi^2), and then to 5.2 km^2 (2.0 mi^2) by Hurricane Rita (Di Silvestro 2006).

The Mississippi River Delta in Louisiana has the most rapidly retreating beaches in North America. Most of the barrier beaches of southeast Louisiana are composed of medium to coarse sand. Mudflats occur in lower intertidal areas. Gentle slopes of subtidal substrates in much of the area reduce wave energies and erosion. The Statewide average shoreline retreat for 1956–1978 was 8.29 m/yr (27.2 ft/yr) (van Beek and Meyer-Arendt 1982). More recent analyses reveal that Louisiana shorelines are retreating at an average rate of 4.2 m/yr (13.8 ft/yr) and range from a gain of 3.4 m/yr (11.2 ft/yr) to a loss of 26.3 m/yr (86.2 ft/yr) (USGS 1988). In comparison, the average shoreline retreat rates for the GOM, Atlantic seaboard, and Pacific seaboard were reported at 1.8, 0.8, and 0.0 m/yr (5.9, 2.6, and 0.0 ft/yr), respectively. The highest reported rates of Louisiana’s coastal retreat have occurred along the coastal plain of the Mississippi River. Regressive shorelines occur, however, at the mouth of the Atchafalaya River, where sediment discharges from that river are forming new deltas.

Wide beaches and a large dune system are located on the Alabama coast. The Mississippi Sound barrier islands, along the coast of Mississippi and Alabama, have formed as a result of westward sand migration resulting in shoal and sand bar growth (Otvos 1980). The islands are separated from each other by fairly wide, deep channels, and are offset from the coast by as much as 16 km (10 mi). They are generally regressive and stable in size, and slowly migrating westward in response to the westward moving longshore current. These islands have high beach ridges and prominent sand dunes, and sand shoals typically occur adjacent to the islands. The dunes and margins of ponds on the islands are well vegetated, with mature southern maritime forests of pine and palmetto behind some dunes areas. Although some of these islands may experience washover during significant storms, washover channels are not common.

Exceptions include a number of barrier islands of Mobile Bay’s ebb-tidal delta, portions of which are low-profile transgressive islands frequently overwashed by storms. They continually change shape under storm and tidal pressures. Their sands generally move northwesterly into the longshore drift, nourishing beaches down drift. These sediments may also move landward during flood tides (Hummell 1990).

Barrier islands and sand beaches occur along the southwest Florida coastline, north of the Everglades, except in the Big Bend area. The Big Bend area, one of the lowest energy coastlines in the world, is devoid of typical barrier islands and beaches. Because of the low energy and

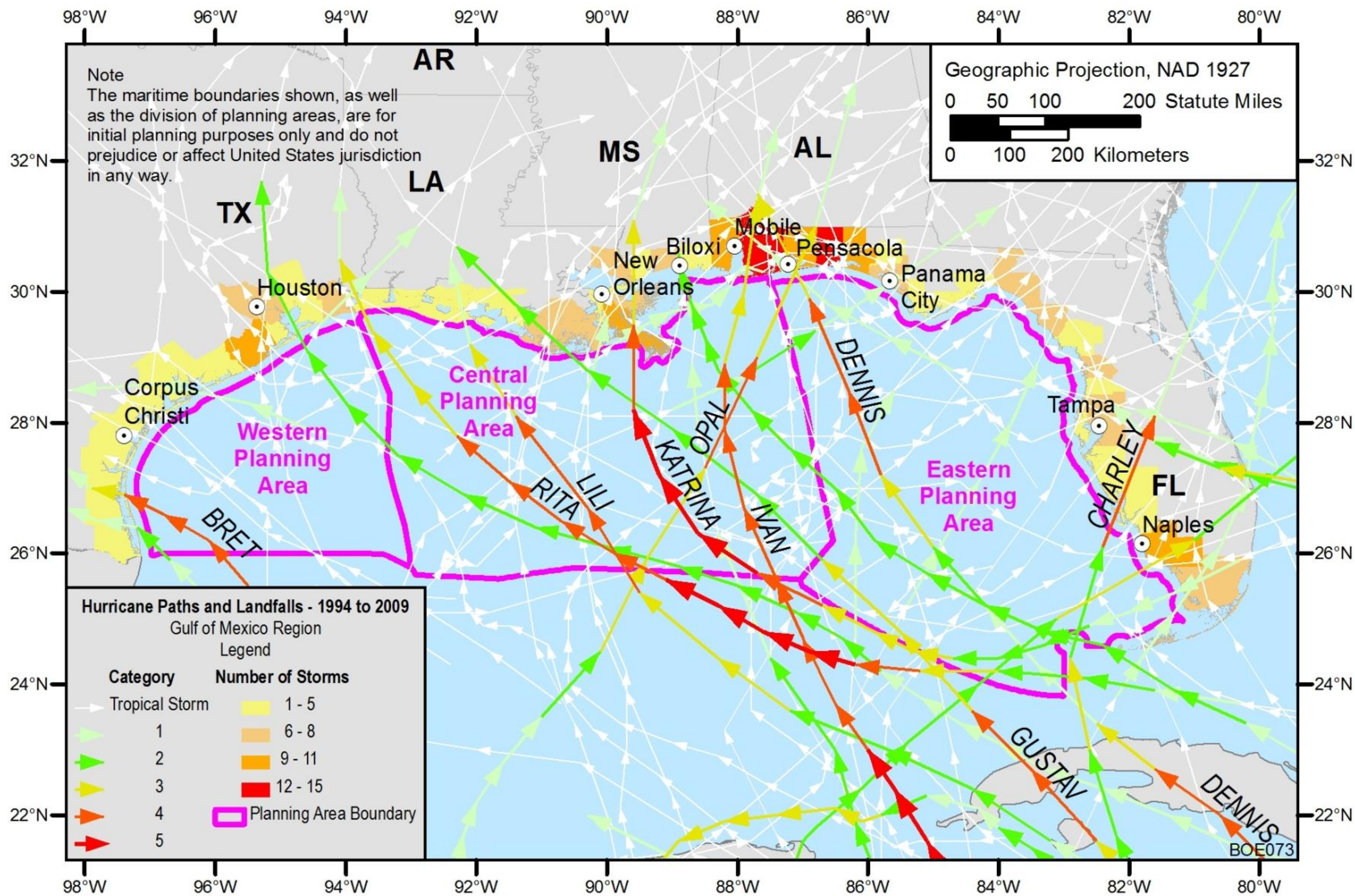

FIGURE 3.7.1-2 Hurricane Paths and Landfalls 1994–2009

minimal erosive forces, forested wetlands occur down to the water's edge. The barrier islands and mainland beaches of the Florida Panhandle typically are stable, with broad, high-profile beaches backed by high dunes. The Florida Keys, at the southern tip of Florida, are limestone islands, an unusual landform type that does not occur elsewhere in the GOM, and provide unique habitats in the region (MMS 1996a).

3.7.1.1.2 Wetlands. Wetland habitats along the coast of the GOM consist of fresh, brackish, and salt marshes; mudflats; forested wetlands of bottomland hardwoods, cypress tupelo swamps, and mangrove swamps. Wetland habitats may occupy only narrow bands along the shore, or they may cover vast expanses of the coastline. Marshes and mangrove swamps are primarily intertidal habitats. Forested wetlands are generally found inshore, above the tidal influence. Coastal wetland areas of the GOM States are given in Table 3.7.1-1 and wetland density is shown in Figure 3.7.1-3.

Coastal wetlands are characterized by high organic productivity, including the production and export of detritus, and efficient nutrient recycling. They provide habitat for numerous species of plants, invertebrates, fish, reptiles, birds, and mammals. Freshwater marshes generally support a greater diversity of plant and animal species than do brackish and salt marshes.

The coast of the Chenier Plain, which includes western Louisiana and eastern Texas from the Bolivar Peninsula just north of Galveston Bay, is composed of sand beaches and extensive intertidal mudflats. The mudflats are the result of mud and fine particles being transported from the Mississippi and the Atchafalaya Rivers. A subtidal mud bottom extends a great distance seaward in shallow water, reducing wave energy and resulting in minimal longshore sediment transport (USDOI and USGS 1988), and helping to protect coastal wetland communities. The shoreline is in a state of transgression (moving landward). Thin accumulations of sand, shell, and caliche nodules form beaches that are migrating landward over tidal marshes. These beaches have poorly developed dunes and numerous washover channels. Barrier beaches in the Chenier

TABLE 3.7.1-1 Gulf of Mexico Coastal Wetland Inventory

State	Marsh[a]	Estuarine Scrub-Shrub[a]	Forested Scrub-Shrub[a]	Total[a]	% Total
Texas	183,900	1,100	3,000	188,000	14
Louisiana	723,500	4,100	1,900	729,500	55
Mississippi	23,800	400	–	24,200	2
Alabama	10,400	1,100	800	12,300	1
Florida	108,100	255,100	13,100	363,900	28
Total	1,041,700	261,800	18,800	1,319,900	–

[a] Measured in ha.

Source: USEPA 1992.

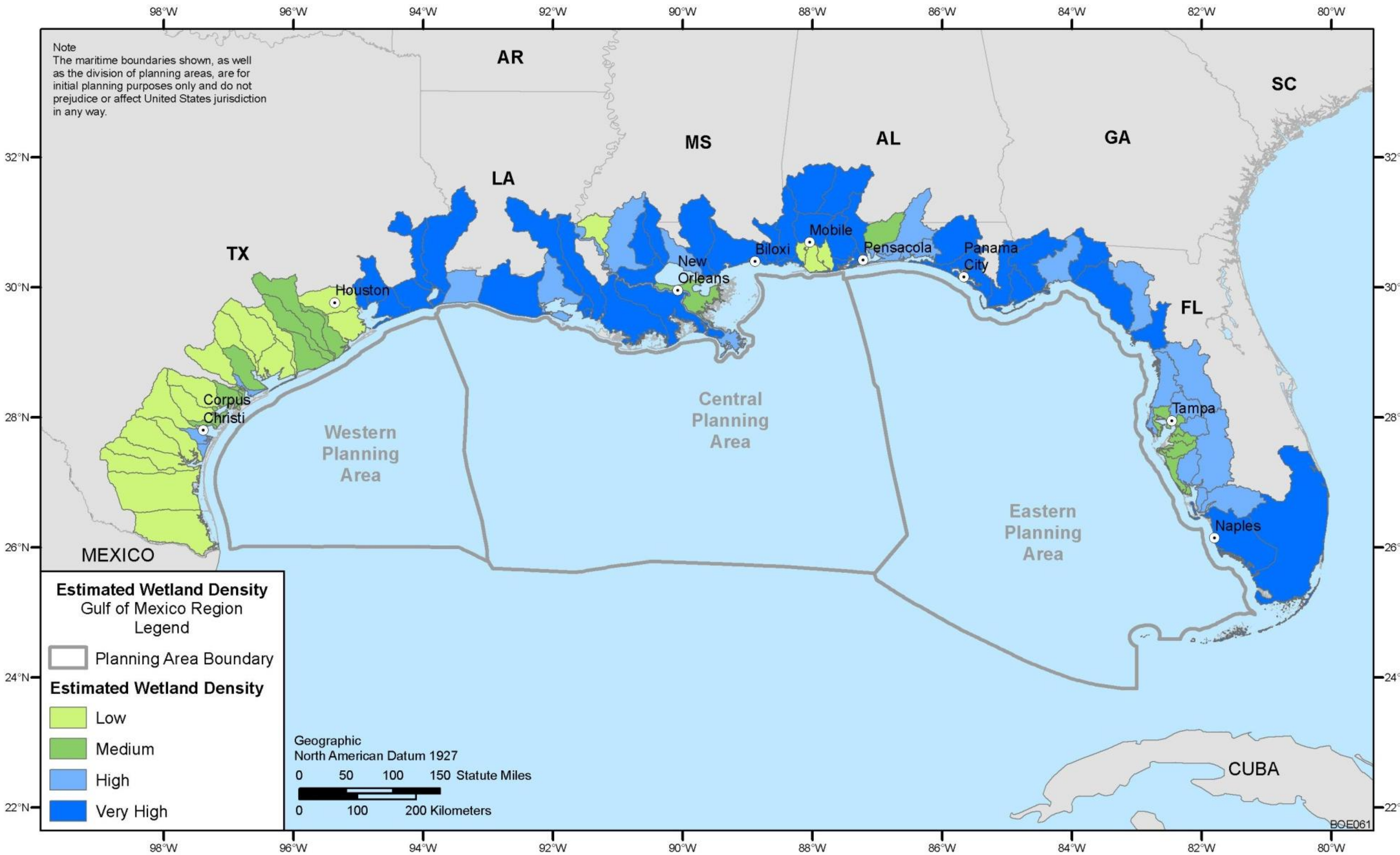

FIGURE 3.7.1-3 Estimated Wetland Density of the Gulf of Mexico Region (Stedman and Dahl 2008)

Plain area are narrow, low, thin sand deposits present along the seaward edge of the coastal marsh, and have poorly developed dunes and numerous washover channels. In some western areas of the Chenier Plain, the beach and subtidal substrates are composed of shelly sand (Fisher et al. 1973). Subtidal substrates in the eastern portions are mud and muddy sand. Most of the shoreline of the Chenier Plain is sediment starved and transgressive.

Along the Texas coast, from the Mexican border to the Bolivar Peninsula, estuarine marshes occur in discontinuous bands around bays and lagoons, on the inner sides of barrier islands, and in the deltas and tidally influenced reaches of rivers. Salt marshes, composed primarily of smooth cordgrass (*Spartina alterniflora*), are evident nearest the mouths of bays and lagoons in areas of higher salinities. Salt-tolerant species such as saltwort (*Batis maritima*) and glasswort (*Salicornia* spp.) are among the dominant species. Brackish water marshes, some of which are infrequently flooded, occur farther landward. Freshwater marshes occur along the major rivers and tributaries, lakes, and catchments (White et al. 1986). Broken bands of black mangroves (*Avicennia germinans*) also occur in this area (Brown et al. 1977; White et al. 1986). Mud and sand flats occur around shallow bay margins and near shoals, increasing toward the south as marshes decrease. Freshwater swamps and bottomland hardwoods are uncommon, and do not occur in the southern third of this coastal area.

Localized sedimentation conditions have favored deposition in the area of the Chenier Plain, which is a series of sand and shell ridges separated by progradational mudflats, marshes, and open water lakes. Few tidal passes are located along the Chenier Plain, and the tidal movement of saline water is reduced. Salt marshes are not widely distributed on the Chenier Plain. They are generally directly exposed to GOM waters and are frequently inundated. Brackish marshes are dominant in estuarine areas and are the most extensive and productive in the Louisiana portion of this coastal area. Marsh-hay cordgrass (*Spartina patens*) is generally the dominant species.

Freshwater wetlands are extensive on the Chenier Plain. While tidal influence is minimal, these wetlands may be inundated by strong storms. Some inland freshwater marshes, bottomland swamps, and hardwood forests were inundated by hurricane Rita with up to 1.5 m (4 ft) of saltwater. Detritus tends to collect in freshwater marshes and may form thick accumulations, sometimes forming floating marshes in very low energy areas. Forested wetlands of cypress-tupelo swamps, black willow stands, and bottomland hardwoods occur only in the floodplains of major streams.

Wetlands in the Mississippi Deltaic Plain are associated with a series of overlapping riverine deltas. These wetlands developed in shallow areas that received flow and sediments from the Mississippi River. The effects of sea-level rise and high, natural subsidence of these organically rich sediments are continually impacting these wetlands (van Beek and Meyer-Arendt 1982). Extensive salt and brackish marshes occur throughout the southern half of the plain and east of the Mississippi River. Farther landward, extensive intermediate and freshwater marshes are found. In freshwater areas, cypress-tupelo swamps occur along the natural levees and in areas that are impounded by dredged materials, levees, or roads. Bottomland hardwoods occur on natural levees and in drained levee areas. Extensive freshwater marshes, swamps, and hardwood forest also occur in Atchafalaya Bay in association with the delta sediments. Sparse stands of black mangrove are scattered in some high-salinity areas of the Mississippi Deltaic Plain.

Most marshes around Mississippi Sound and associated bays occur as discontinuous wetlands associated with estuarine environments. The more extensive coastal wetland areas in Mississippi are associated with the deltas of the Pearl River and Pascagoula River. The marshes in Mississippi are more stable than those of either Alabama or Louisiana, reflecting a more stable substrate and continued active sedimentation in the marsh areas. In Alabama, most of the wetlands are located in Mobile Bay and along the northern side of Mississippi Sound. Forested wetlands are the predominant wetland type along the coast of Alabama; large areas of estuarine marsh and smaller areas of freshwater marsh also occur (Wallace 1996). Major causes of marsh loss in Alabama have included industrial development, navigational dredging, natural succession, and erosion-subsidence (Roach et al. 1987).

From 1956 to 2006, the land loss rate for coastal Louisiana was 69.7 km^2/yr (26.9 mi^2/yr), for a total net loss of 3,494 km^2 (1,349 mi^2) (Barras et al. 2008). The net land loss rate has declined, however, from previous years: a loss of 562 km^2 (217 mi^2) from 2001 to 2006, at 16.4 km^2/yr (6.3 mi^2/yr) from 2001 to 2004, and 256.4 km^2/yr (99.0 mi^2/yr) from 2004 to 2006. Although the net land loss rate is expected to continue to decline from 2000 to 2050, averaging 26.7 km^2/yr (10.3 mi^2/yr), Louisiana can be expected to lose about 1,329–1,813 km^2 (513–700 mi^2) of coastal wetlands over that time period, in spite of predicted gains from natural processes and current restoration projects (USGS 2003; LCWCRTF 2003; USACE 2004). Historic and projected future land losses for coastal Louisiana (developed before hurricanes Katrina and Rita) are shown in Figure 3.7.1-4.

Losses of coastal wetlands have been occurring along the GOM coast for decades, resulting in the conversion of wetland habitats to open water. Coastal land loss is a particular problem in Louisiana. Many factors contribute to the coastal land loss problem there, including the effects of large storm events, subsidence, sea-level rise, saltwater intrusion, drainage and development, canal construction, herbivory, sediment deprivation, reduced flooding, and induced subsidence and fault reactivation. Upstream alterations of the Mississippi River drainage system are factors of particular importance because the construction of dams on upstream tributaries has resulted in approximately a 50% reduction in sediment load transported to the GOM (Turner and Cahoon 1988), and flood control levees constructed along the Mississippi River have prevented seasonal overbank flooding and sediment deposition in coastal marshes. Projects undertaken through the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA, or Breaux Act) program (LCWCRTF 2003), Coast 2050 Plan (LCWCRTF 1998), and Louisiana Coastal Area Plan (USACE 2004) are designed to contribute to ecosystem-scale restoration and sustainability.

Land losses along the Louisiana coast result from numerous factors, some of which are relatively recent in origin, while others have been ongoing for many years. Coastal wetlands are lost due to the effects of large storm events, and erosion of barrier islands reduces wetland protection (LCWCRTF 2001). In addition, hydrologic alterations have resulted in changes in salinity and inundation, causing a dieback of marsh vegetation and a subsequent loss of substrate (LCWCRTF 2001). The sediment load of the Mississippi River has been reduced by about 50%

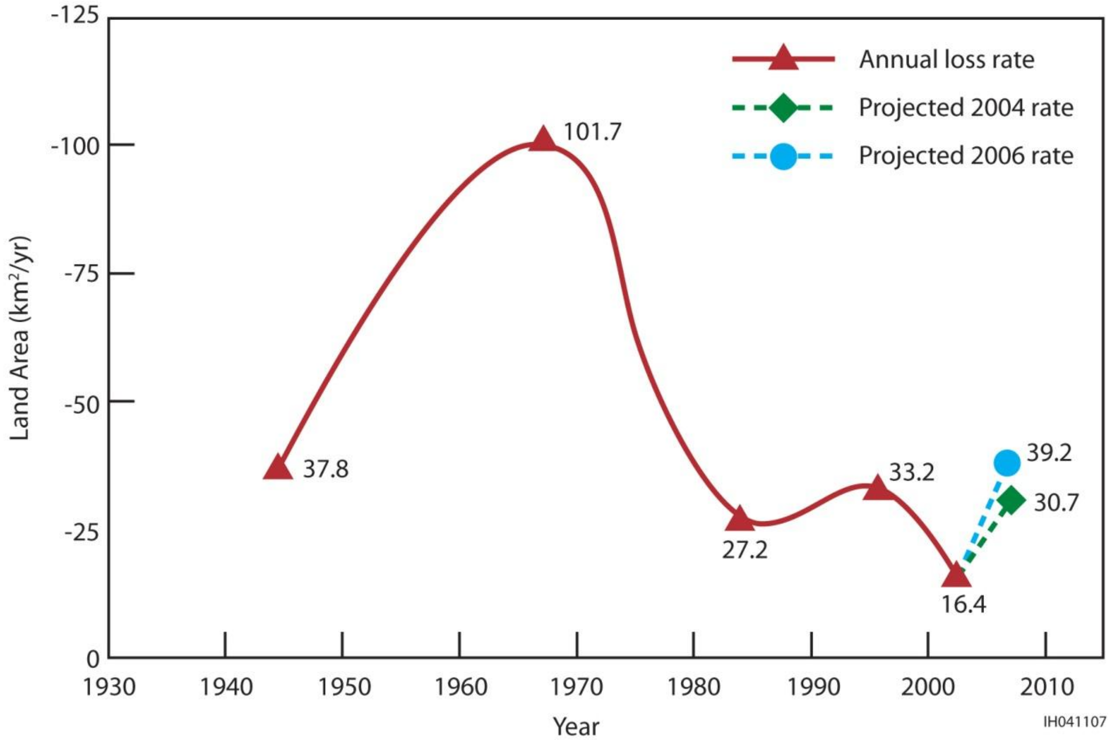

FIGURE 3.7.1-4 Annual Rates of Land Area Change in Coastal Louisiana (Barras et al. 2008)

since the 1950s as a result of upstream tributary dam construction and reduced soil erosion in the watershed. Furthermore, levees constructed along the Mississippi River have, for many years, prevented seasonal overbank flooding and the sediment deposition in coastal marshes. The Louisiana coastal marshes require an adequate addition of sediment annually to continue building vertically in pace with ongoing subsidence and sea level change (LCWCRTF 1998, 2003; USACE 2004). As a result, coastal marshes are being converted to open water.

Subsidence is a natural process resulting from the compaction of highly organic sediment deposits underlying the coastal marshes, and has been occurring for centuries. The rate of subsidence is 0.15–1.31 m (0.49–4.30 ft) per century in the delta area and 0.08–0.61 m (0.26–2.00 ft) per century on the western Louisiana Coast (USACE 2004). The rise in sea level is attributed to the melting of ice sheets and glaciers, and increased ocean temperatures, induced by global climate change. Sea levels have risen 0.12 cm/yr (0.05 in./yr) over the past century, and may rise as much as 20 cm (7.9 in.) by 2050 (LCWCRTF 1998, 2001; USACE 2004). Relative sea-level rise is a combination of the rise in sea level and local subsidence, and the average rate is currently estimated to be 1.03–1.19 m (3.38–3.90 ft) per century along the Louisiana Coast (USACE 2004). The rate of relative sea-level rise on the deltaic plain is occurring at a higher rate than in most coastal areas, and the rapid rise in relative sea level exacerbates the effects of reduced sedimentation in the wetlands.

Numerous canals have been constructed within the coastal marshes for navigation and shoreline access and, because of widening over time, contribute to the breakup of marsh (LCWCRTF 2003). Spoil banks along the canals cover wetland areas and prevent the effective draining of adjacent areas, resulting in higher water levels or more prolonged tidal inundation. Canals also create a means for salt water intrusion into brackish and freshwater wetlands and increased tidal processes, resulting in shifts in species composition, habitat deterioration, erosion, and wetland loss (LCWCRTF 1998, 2003).

Marsh loss in Louisiana has also resulted from sudden marsh dieback, or brown marsh. Large areas of coastal marsh vegetation have died, particularly in 2000 and 2009. Brown marsh results from a combination of factors related to extensive drought conditions, primarily reduced soil moisture combined with physical and chemical changes in the soil (Lindstedt and Swenson 2006). Most areas affected in 2000 have recovered.

Induced subsidence and fault reactivation attributed to oil and gas extraction below the coastal marshes have also been identified as causes of coastal wetland loss in some locations in Louisiana (USGS 2001; Morton et al. 2002, 2003). Large-volume extraction of hydrocarbon fluids and formation water has likely caused compaction of the overlying rock strata and downward displacement along nearby faults, resulting in land surface subsidence and conversion of marsh to open water, particularly during the years of high petroleum production.

In coastal Louisiana, it is difficult to establish possible linkages from deep onshore and nearshore hydrocarbon production to subsidence and wetland loss because wetland loss is ubiquitous and caused by numerous processes and conditions, both natural and anthropogenic (Morton et al. 2002). Thus, it is increasingly complex and difficult to establish the extent to which onshore subsidence and land loss is caused by hydrocarbon fluids and formation water extraction in offshore Federal waters.

A number of coastal habitat protection and restoration projects have been initiated along the GOM coast to address the issue of erosion and land losses. Many of these projects have focused on rebuilding barrier islands and coastal beaches for shoreline maintenance, as well as protection of coastal salt marshes. Modern techniques for navigation channel dredging and maintenance use the dredged sediments to nourish adjacent coastal landforms, minimizing potential erosion impacts. MMS, now BOEM, in cooperation with State and local agencies, has been involved in developing habitat restoration projects using OCS sand resources.

3.7.1.1.3 Seagrasses. Seagrasses are unique marine flowering plants of which there are approximately 60 species worldwide (den Hartog 1970; Phillips and Menez 1988). With the exception of some species that occur in rocky intertidal habitats (e.g., west coast of the United States), they grow in shallow, subtidal, or intertidal unconsolidated sediments. Overall the importance of seagrasses and their role in many coastal ecosystems has been extensively documented (see reviews by Phillips 1984; Zieman 1982a; Thayer et al. 1984; Zieman and Zieman 1989). As submerged wetlands, they form one of the most productive plant communities on the planet, providing a wide range of ecological services (e.g., water filtration, shoreline erosion protection, nursery grounds for recreationally and commercially valuable animals, carbon sequestration).

Field et al. (in prep.) has reviewed and compiled existing Geographic Information System (GIS) data for seagrasses from Maine to Texas, and the results for the GOM are summarized here. Seagrasses are distributed across all the GOM States, but the majority, 88% (727,096 ha), are found in Florida (Yarbro and Carlson 2011). This does not include the large amounts of paddle grass (*Halophila decipiens*) that exist on the West Florida shelf that cannot be mapped with any existing remote sensing technology. However, Iverson and Bittaker (1986) and Hale et al. (2004) conducted extensive surveys of this offshore (out to about the 30 m isobath), which totaled over 8,500 km^2 of seagrass beds (2.09×10^6 acres). Texas has extensive seagrass broad shallows, ranked second in the GOM with 11% of the total (92,854 ha), 74% of which are in the broad shallows of Laguana Madre. The remaining States have considerably less seagrass coverage: Louisiana with 0.5% of the GOM total (4,511 ha); Mississippi, 0.08% (622 ha); and Alabama, 0.06% (498 ha) (Field et al. in prep.).

Frequency of mapping techniques vary, making it difficult to evaluate Gulfwide seagrass resources. Long-term trends indicate that in many areas from Texas to Florida, seagrass habitats have decreased (Handley et al. 2007), although specific areas have shown gains in recent years (Yarbro and Carlson 2011).

Hurricane impacts, such as the influx of salt water in low salinity estuaries, can produce changes in seagrass community quality and composition. The distribution of seagrass beds in coastal waters of the Western and Central GOM has diminished during recent decades. Primary factors believed to be responsible include dredging, dredged material disposal, trawling, water quality degradation, hurricanes, and a combination of flood protection levees that have directed freshwater away from wetlands, saltwater intrusion that moved growing conditions closer inland, and infrequent freshwater diversions from the Mississippi River into coastal areas during the flood stage.

Primarily because of low salinity and high turbidity, robust seagrass beds are found only within a few scattered, protected locations in the Western and Central GOM, although seagrass meadows occur in nearly all bay systems along the Texas coast. Seagrasses in the Western GOM are widely scattered beds in shallow, high-salinity coastal lagoons and bays. Lower-salinity, submerged beds of aquatic vegetation are found inland and discontinuously in coastal lakes, rivers, and the most inland portions of some coastal bays. The distribution of seagrass beds in coastal waters of the Western and Central GOM has diminished during recent decades.

The turbid waters and soft, highly organic sediments of Louisiana's estuaries and offshore areas limit widespread distribution of higher salinity seagrass beds. Consequently, only a few areas in offshore Louisiana support seagrass beds. In Mississippi and Alabama, seagrasses occur within the Mississippi Sound. Widgeon grass (*Ruppia maritima*), an opportunistic species, is tolerant of low salinities and occurs in some estuaries.

3.7.1.1.4 Climate Change Effects. Coastal habitats would be affected by global climate change. Factors associated with global climate change include changes in temperature, rainfall, alteration in stream flow and river discharge, wetland loss, salinity, sea level rise, changes in hurricane frequency and strength, sediment yield, mass movement frequencies and coastal erosion, and subsidence (Yanez-Arancibia and Day 2004). Effects of sea level rise include damage from inundation, floods, and storms; erosion; saltwater intrusion; rising water tables/impeded drainage; and wetland loss and change (Nicholls et al. 2007). Effects of increased storm intensity include increases in extreme water levels and wave heights, and increases in episodic erosion, storm damage, risk of flooding, and defence failure (Nicholls et al. 2007). Patterns of erosion and accretion can also be altered along coastlines (Nicholls et al. 2007). The small tidal range of the GOM coast increases the vulnerability of coastal habitats to the effects of climate change. A study of coastal vulnerability along the entire U.S. GOM coast found that 42% of the shoreline mapped was classified as being at very high risk of coastal change due to factors associated with future sea level rise (Thieler and Hammar-Klose 2000). A revised coastal vulnerability index (CVI) study of the coast from Galveston, Texas, to Panama City, Florida, indicated that 61% of that mapped coastline was classified as being at very high vulnerability, with coastal Louisiana being the most vulnerable area of this coastline (Pendleton et al. 2010) (see Figure 3.7.1-5, which shows the CVIs of Pendleton et al. [2010] from Galveston to Panama City, and CVIs of Thieler and Hammar-Klose [2000] for the remainder of the coast).

Saltwater intrusion/increased salinity and sea level rise can result in mortality of salt-intolerant species, resulting in reductions in habitat area and changes in species composition of coastal habitats. Effects observed include declines in coastal bald cypress (*Taxodium disticum*) forests in Louisiana and migration of mangroves into adjacent wetland communities in Florida (Nicholls et al. 2007). In some areas, existing plant communities may be displaced farther inland (Nicholls et al. 2007). Enhanced coastal erosion, coastal flooding, and loss of coastal wetlands, particularly in Louisiana and Florida, are projected impacts of sea level rise and increased frequency of storm surges, both of which are associated with climate change (IPCC 2002).

Land losses would likely increase due to the effects of climate change. The acceleration of sea level rise and increases in storm intensity as a result of climate change would exacerbate the current level of coastal land loss in the Mississippi deltaic plain, an already expected additional loss of 1,300 km^2 (501.9 mi^2) if current global, regional, and local processes continue (Nicholls et al. 2007). Recent rates of sea level rise have been approximately 3 mm/yr (0.12 in./yr), but this rate may increase to 4 mm/yr (0.16 in./yr) by 2100 (Blum and Roberts 2009). Combined with potential rates of subsidence in the area of the Mississippi Delta Plain, relative sea level rise may range from 0.5 to 1.4 m (1.6 to 4.6 ft) by 2100 (Blum and Roberts 2009). In the absence of sediment input, resulting submergence in the delta region could range from 10,000 to 13,500 km^2/yr (3,861 to 5,212 mi^2/yr) by 2100 (Blum and Roberts 2009).

3.7.1.1.5 Effects of Deepwater Horizon Event. Oil released into coastal waters as a result of the DWH event, April–July, 2010, affected more than 1,046 km (650 mi) of the GOM coastal habitat, from the Mississippi River Delta to the Florida Panhandle, with the Louisiana, Mississippi, Alabama, and Florida coasts all affected (OSAT-2 2011; National

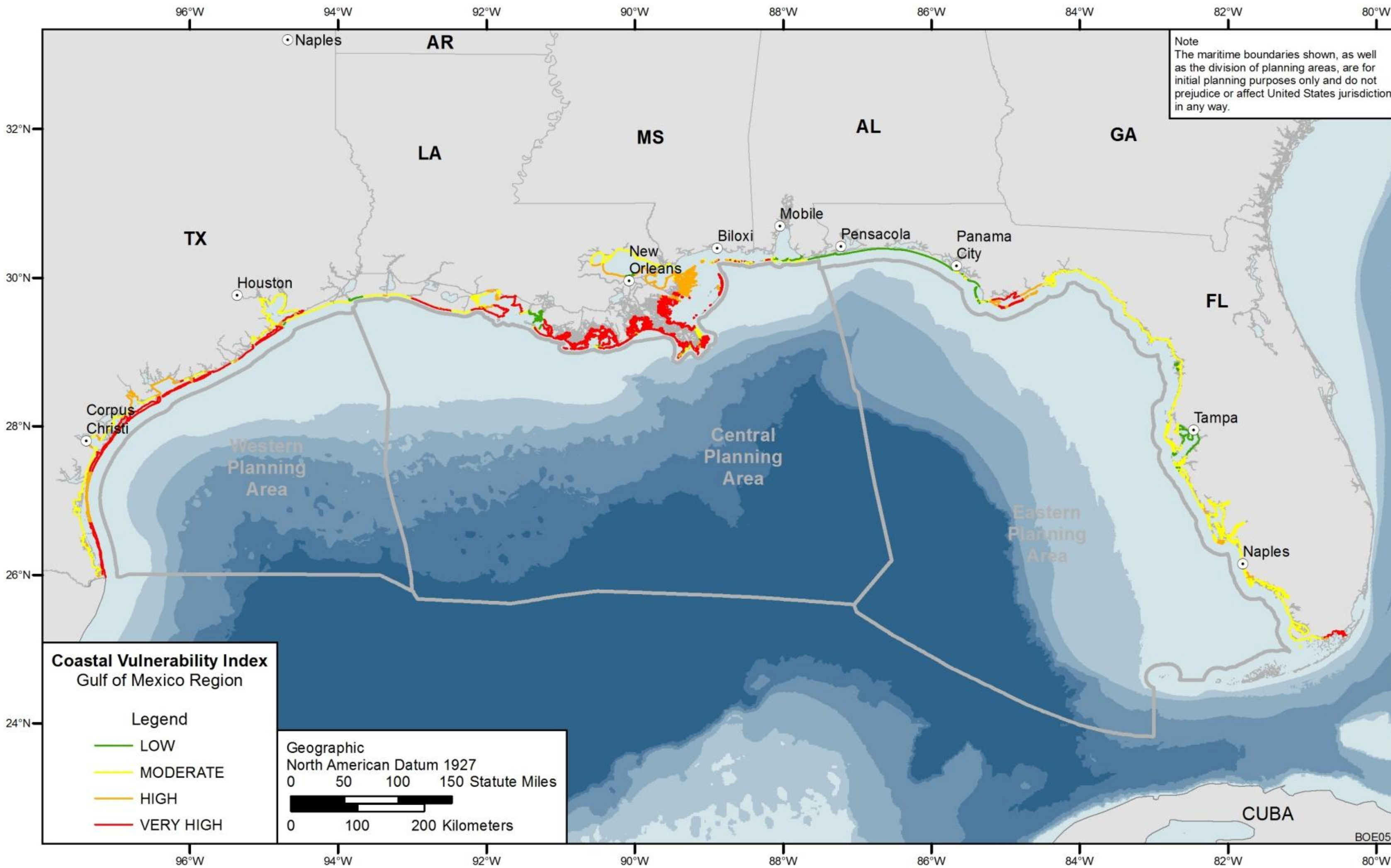

FIGURE 3.7.1-5 Coastal Vulnerability Index of the Gulf of Mexico Region (Pendleton et al. 2010; Thieler and Hammar-Klose 2000)

Commission 2011b). The greatest impacts were in Louisiana. More than 209 km (130 mi) of coastal habitat were moderately to heavily oiled, only 32 km (20 mi) of which occurred outside of Louisiana (National Commission 2011b). Little or no oil affected Texas coastal habitats. Heavy to moderate oiling occurred along a substantial number of Louisiana beaches, with the heaviest oiling on the Mississippi Delta, in Barataria Bay, and on the Chandeleur Islands (OSAT-2 2011). The majority of Mississippi barrier islands had light oiling to trace oil, although heavy to moderate oiling occurred in some areas. Some heavy to moderate oiling also occurred on beaches in Alabama and Florida, with the heaviest stretch of oiling extending from Dauphin Island, Alabama, to near Gulf Breeze, Florida (OSAT-2 2011). Light to trace oiling occurred from Gulf Breeze to Panama City, Florida. Deposition of oil occurred in the supratidal zone (above the high tide mark), deposited and buried during storm events; in the intertidal zone; and in the subtidal zone, remaining there as submerged oil mats (OSAT-2 2011). On Grand Isle, Louisiana, and Bon Secour, Alabama, oil was found up to 105 cm (41 in.) below the surface (OSAT-2 2011). Low molecular weight and volatile compounds were mostly depleted from oil that reached shorelines, due to weathering at sea (OSAT-2 2011). Although much of the oil remaining after cleanup is highly weathered, several constituents have the potential to cause toxicological effects (OSAT-2 2011). Remnant oil continued to be observed buried at various depths in some near-shore beaches in November 2011(Hayworth et al. 2011). Oil was also deposited along the coast in marshes such as those of the Mississippi River Delta and Chandeleur Sound, mudflats, and mangroves, oil contacted seagrass beds such as those behind the Chandeleur Island chain, and submerged aquatic vegetation communities such as those in Plaquemines and St. Bernard Parishes, Louisiana. These habitats also were also affected by prevention and cleanup efforts (National Commission 2011b; Martinez et al. 2011). Loss of marsh habitat along its edge as a result of oiling was observed. A full understanding of the effects of the spill is expected to take years but is not needed at the programmatic stage to make a reasoned choice among alternatives (see Section 1.4.2, Incomplete and Unavailable Information).

3.7.1.2 Cook Inlet

Coastal and nearshore habitats of concern within the Cook Inlet Planning Area include beaches, marshes, tidal flats, scarps, riverine mouths/deltas, and marine algae. Coastal habitats of Cook Inlet are given in Table 3.7.1-2. These habitats occur within estuarine watersheds in and around bays, lagoons, and river mouths where marine and fresh waters intermix. Coastal and nearshore habitats of Cook Inlet can be subdivided into two ecoregions (Figure 3.2.2-2), each with distinguishing characteristics, arrangements of habitat components, and freshwater inflows with associated nutrient and sediment loads: the Cook Inlet, extending from the northeastern Alaska Peninsula to the southern tip of the Kenai Peninsula, and the Gulf of Alaska, extending south along Kodiak Island and the Alaska Peninsula. These are based on the Level III Marine Ecoregions of the Commission for Environmental Cooperation (CEC 2008). Four terrestrial ecoregions are located along the coast of the Cook Inlet Planning Area: the Cook Inlet, the Alaska Range (along the southwestern coastline), Coastal Western Hemlock-Sitka Spruce Forests (on the southeastern coastline and northern Kodiak Island), and the Alaska Peninsula Mountains (along the Alaska Peninsula and southern Kodiak Island) (USEPA 2011e).

TABLE 3.7.1-2 Coastal Habitats of the Cook Inlet Planning Area

Habitat: ESI Rank	Habitat Area and Shoreline Length
Salt- and brackish-water marshes: 10A	11,338 mi^2; 672 mi
Sheltered tidal flats: 9A	104,977 mi^2; 356 mi
Sheltered scarps in mud or clay: 8A	279 mi
Exposed tidal flats: 7	280,010 mi^2; 426 mi
Gravel beaches: 6A	167 mi
Mixed sand and gravel beaches: 5	317 mi^2; 792 mi
Coarse-grained sand beaches: 4	36 mi
Fine- to medium-grained sand beaches: 3A	7 mi
Exposed wave-cut platforms in bedrock, mud, or clay: 2A	10,252 mi^2; 449 mi
Exposed, solid man-made structures: 1B	1 mi
Exposed rocky shores: 1A	25 mi^2; 284 mi

In Cook Inlet, the amount of sea ice varies annually. In general, sea ice forms in October to November, increases from October to February from the West Foreland to Cape Douglas, and melts in March to April. Sea-ice formation is controlled in upper Cook Inlet primarily by air temperature and in lower Cook Inlet by the temperature and inflow rate of the Alaska Coastal Current (Poole and Hufford 1982).

Coastal forest occurs along much of Alaska’s south central coast and on the coastal islands, and is predominantly evergreen forest composed of Sitka spruce and western hemlock (BLM 2002). Deciduous forest occurs primarily along floodplains, streams, and in disturbed areas. Many areas around Cook Inlet also support white spruce and black spruce forest, as well as wet tundra, referred to as “muskegs,” with sedges, mosses, and scattered shrubs (ADNR 1999). Also occurring along or near the shoreline are forested wetlands, wetlands with emergent vegetation, and shrub wetlands that are not tidally influenced but that have saturated soils or are flooded seasonally or continuously (BLM 2002).

Extensive freshwater marshes and salt marshes composed of sedge and grass wet meadow communities occur on river deltas along the coast. Coastal habitat in the Gulf of Alaska includes several large estuaries and wetlands (MMS 2002a).

In some areas of the south Alaskan coastline, numerous peninsulas and islands with irregular shorelines form bays, lagoons, and steep prominences (BLM 2002). Much of the shoreline consists of steep slopes with a narrow zone of tidal influence.

Coastal habitats throughout the Gulf of Alaska, including Cook Inlet, include intertidal and shallow subtidal communities (O’Clair and Zimmerman 1986). Intertidal wetlands include unvegetated rocky and soft sediment (sand or mud) shores, as well as coastal salt marshes with emergent vegetation and wetlands with submerged or floating vegetation (BLM 2002). These wetlands are all periodically inundated or exposed by tides. Large areas of soft-sediment shores are common in Cook Inlet (McCammon et al. 2002). Salt marshes and other wetlands occur throughout the coastal margins of the Cook Inlet (ADNR 1999).

Submerged or floating vegetation community types in estuaries include eelgrass communities and marine algae communities (BLM 2002). Eelgrass communities are common in protected bays, inlets, and lagoons with soft sediments (Viereck et al. 1992; McCammon et al. 2002). Marine algae communities often occur along exposed rocky shores on much of the coast (Viereck et al. 1992). Large kelps form dense communities in shallow subtidal areas along much of the Gulf of Alaska coast (McCammon et al. 2002). Marine algae communities dominate the low intertidal areas, to about 3 m (10 ft) in depth, and do not occur below about 5 m (16 ft) in depth (MMS 2003a).

Coastal salt marshes occur on soft sediments along low-energy shorelines. Coastal marshes may contain a number of vegetation community types that are tidally influenced, ranging from irregularly exposed to irregularly inundated (BLM 2002). The higher areas of coastal marshes may support sedge-scrub wet meadow communities (Viereck et al. 1992). These communities are not generally inundated by tides, but may be flooded during storm surges. Upper areas of coastal marshes may also support a hairgrass community (ADNR 1999).

The lower, outer areas of coastal salt marshes typically consist of sedge and grass communities (Viereck et al. 1992). The inland portion of these marshes often includes the taller and denser communities of salt-tolerant sedges. The seaward margin often adjoins a sparse community of salt-tolerant alkali grass, often associated with salt-tolerant forbs (Viereck et al. 1992). Halophytic herb wet meadow communities occur in early successional stages on seaward portions of beaches and coastal marshes where inundation occurs at least a few times per month (Viereck et al. 1992).

Brackish ponds occasionally occur within coastal marshes of deltas, tidal flats, and bays (BLM 2002; Viereck et al. 1992). These communities occur in shallow water and are periodically inundated by tides.

Coastal habitats along Cook Inlet are vulnerable to the effects of climate change. Sea level rise is expected to increase, inundating low-lying coastal habitats (Nicholls et al. 2007). Climate change is also expected to result in an increase in the incidence of pests and diseases, which could result in increased forest tree mortality (Anisimov et al. 2007).

Dynamic tidal currents in the inlet are related to the vulnerability of shoreline communities and their sensitivity to disturbance. The overall environmental sensitivity of Cook Inlet shorelines has been ranked independently by NOAA, the Alaska Regional Response Team, and recently by the *Exxon Valdez* Oil Spill Trustees/Cook Inlet Regional Citizens Advisory Council (Harper et al. 2004). In general, the vulnerability of shoreline habitats is rated as low if the shoreline substrate is impermeable (rock) and exposed to high wave energy or tidal currents, and is rated as high for vegetated wetlands and semipermeable substrates (mud) that are sheltered from wave energy and strong tidal currents. Sensitive shoreline habitats identified in lower Cook Inlet include marshes, sheltered tidal flats, sheltered rocky shores, and exposed tidal flats (NOAA 2002) (see Table 3.7.1-2). A study of the recovery rate of organisms on sheltered rocky shores in Cook Inlet concluded that 5–10 yr would be needed for full recolonization of rocky shorelines (Highsmith et al. 2001). Ongoing *Exxon Valdez* oil spill studies have shown that traces of spilled oil have persisted in Prince William Sound shoreline sediments and intertidal organisms for more than a decade (Short 2004; MMS 2003a).

3.7.1.3 Alaska – Arctic

Arctic coastal and nearshore habitats of concern include barrier islands and beaches, low tundra, marshes, tidal flats, scarps, peat shorelines, and marine algae. These habitats occur within estuarine watersheds along the coastline and in and around bays, lagoons, and river mouths where marine and fresh waters intermix. Coastal and nearshore habitats of the Arctic region can be subdivided into two ecoregions (Figure 3.2.2-3), each with distinguishing characteristics, arrangements of habitat components, and freshwater inflows with associated nutrient and sediment loads: the Chukchian Neritic Ecoregion, extending from near Point Hope to near Cape Lisburne, and the Beaufortian Neritic Ecoregion, extending from near Cape Lisburne to the border of Canada. These are based on the Level III Marine Ecoregions of the Commission for Environmental Cooperation (CEC 2008). Most of the coastline along the Chukchi Sea Planning Area, from near Cape Lisburne to near Point Barrow, lies within the Beaufortian Neritic Ecoregion. Two terrestrial ecoregions are located along the Arctic coast: the Arctic Foothills, from Kotzebue to near Cape Beaufort, and the Arctic Coastal Plain, from near Cape Beaufort to near the border of Canada (USEPA 2011e).

The fluvial discharge and freshwater flow into the Beaufortian ecoregion is much larger than the flow into Chukchian ecoregion. Fluvial discharge into the Chukchian ecoregion is relatively limited, with the Kukpuk River being the only major river system present, although there are numerous named and unnamed streams discharging into the Chukchi Sea. Numerous large rivers, such as the Kukpowruk River, Utukok River, and Kuk River along the Chukchi Sea, and the Colville River, Kuparuk River, Sagavanirktok River, and Canning River along the Beaufort Sea, discharge into the Beaufortian ecoregion.

Stream flows generally begin in late May or early June as a rapid flood event, with more than half of the annual discharge of a stream sometimes occurring over a period of several days to a few weeks (MMS 2008b). Fluvial discharges introduce dissolved and suspended materials into estuarine and marine waters that can serve either as nutrients that enrich marine and coastal productivity or as pollutants that can degrade habitat quality. Human society sometimes discharges into the environment constituents that also occur naturally in the ecosystem. These anthropogenic discharges, however, are different than the biogenic sources because they occur in greater concentrations and often suddenly; the chemical bondings are different than what is found in the natural system; the discharges occur outside the area where they would naturally occur; or they occur out of phase of the natural cycle of the same biogenic contributions to the system. Examples of anthropogenic constituents include sediment, metals, and hydrocarbons (see Section 3.4.3 for a further discussion of water quality). The fluvial discharges also carry suspended and bed load sediments that when deposited at the river mouths and redistributed through the coastal zone provide the substrate and foundation for many coastal habitats.

Arctic coastal habitats are greatly influenced by a short growing season and extremely cold winters. The onshore sediments are frozen during most of the year and are underlain by permafrost (permanently frozen soil). Growth and even biodegradation in coastal habitats are limited to only a few months per year (Prince et al. 2002).

Although differences exist in fluvial discharge, the coastal and estuarine habitats of both ecoregions are greatly affected by the dynamics of sea ice. The Arctic coastline is highly disturbed due to the movement of sea ice that frequently is pushed onshore, scouring and scraping the coastline. Sea ice dominates the coastal habitats during most of the year. Landfast ice, which is attached to the shore and freezes to the seafloor (grounded ice) in shallow water up to 2 m (7 ft) in depth, is relatively immobile (MMS 2010); however, landfast ice along the Chukchi Sea coast is not as stable as along the Beaufort Sea coast (MMS 2008b). Onshore pileups of ice often extend up to 20 m (66 ft) inland from the shoreline, while rideups of unbroken ice sheets over the ground surface occasionally extend more than 50 m (164 ft) and rarely beyond 100 m (328 ft) (MMS 2008b). Landfast ice begins forming in late October to late December along the Chukchi Sea, with breakup in late May to mid-June (MMS 2010); in the Beaufort Sea, landfast ice begins forming in September to October, with breakup beginning in early June to early July (MMS 2008b). The areal extent of sea ice in the Arctic has substantially decreased over the past several decades (MMS 2010). Decreases in ice cover can increase wave action and shoreline erosion. The duration of landfast ice has also decreased, with ice breaking up earlier in the spring (MMS 2008b).

Coastal habitats of the Arctic ecoregions are given in Table 3.7.1-3, with general characteristics in Table 3.7.1-4. The coastline of the Beaufort Sea includes eroding bluffs, sandy beaches, lower tundra areas with some saltwater intrusions, sand dunes, sandy spits, and estuarine areas where streams enter the Beaufort Sea (MMS 2002b, 2003b). The Chukchi Sea coastline consists of nearly continuous sea cliffs cut into permafrost (MMS 2010). While the cliffs are abutted by narrow beaches along most of the coastline, in some areas, barrier islands enclose shallow lagoons. Barrier islands occur along the Beaufort and Chukchi Sea coastlines and also support tundra communities. These islands are generally narrow (less than 250 m [820 ft] wide) and low-lying (less than 2 m [7 ft] in elevation) and are washed over in large storms (MMS 2003b). Deltas of the Colville, Sagavanirktok, Kadleroshilik, and Shaviovik Rivers support a complex mosaic of wet Arctic saltmarsh, dry coastal barrens, salt-killed tundra, typical moist and wet tundra, and dry, partially vegetated gravel bars.

Marine algae communities occur on hard bottom substrates in several areas along the Chukchi Sea coast, such as in Peard Bay, or southwest of Wainwright at a depth of 11–13 m (36–43 ft) (MMS 2010). The distribution and extent of these communities are likely limited by the presence of rock and other hard substrate (MMS 2010). Few known beds occur along the Beaufort Sea coast. These communities include many species of macroalgae (e.g., 15 species at the Stefansson Sound Boulder Patch); however, the community is dominated by a few common species (Iken 2009).

TABLE 3.7.1-3 Length of Coastal Habitats (mi) of the Alaskan Arctic Ecoregions

Habitat: ESI Rank	Chukchian Ecoregion[a]	Beaufortian Ecoregion
Salt- and brackish-water marshes: 10A	–	88
Inundated low-lying tundra: 10E	–	763
Sheltered tidal flats: 9A	–	24 mi^2[a]; 394
Sheltered, vegetated low banks: 9B	–	225
Peat shorelines: 8E	–	283
Sheltered scarps in mud or clay: 8A	–	1
Exposed tidal flats: 7	–	196
Riprap: 6B	<1	1
Gravel beaches: 6A	2	13
Mixed sand and gravel beaches: 5	76	488
Coarse-grained sand beaches: 4	–	72
Tundra cliffs: 3C	–	338
Fine- to medium-grained sand beaches: 3A	–	393
Exposed wave-cut platforms in bedrock, mud, or clay: 2A	–	–
Exposed, solid man-made structures: 1B	–	<1
Exposed rocky shores: 1A	18	19

[a] Square mileage represents total habitat area.

Several estuarine habitats within shallow bays, inlets, and lagoons occur along the Chukchi Sea coastline, including Kasegaluk Lagoon, Wainwright Inlet, Peard Bay, and Kugrua Bay (BLM and MMS 2003). These areas often have low-energy sand beaches and wetlands along their margins, and some support communities of marine algae, such as sea lettuce (*Ulva* spp.). Kasegaluk Lagoon is usually ice covered from mid-September through mid-July. During the summer, many animals concentrate around the passes between the ocean and the shallow lagoon.

Salt marshes occur along the Arctic coastline and support emergent vegetation communities. These coastal marshes are intertidal wetlands exposed at low tides and inundated by high tides and storm surges. The Arctic coastline experiences tides of small fluctuation, 6 to 10 cm (2.4 to 4 in.) along the Beaufort Sea (MMS 2003b); however, coastal water levels are driven primarily by wind stress and barometric pressure changes from the passage of storm centers and frontal passages (Gill et al. 2011). Storm surge and water level withdrawal on the coast can be considerable, about 1 m (3 ft) in amplitude (Gill et al. 2011). The Arctic coastline is subject to strong erosive forces (BLM 2002; MMS 2002a). Disturbance from sea ice action is common along the generally unstable and erosion-prone shoreline (MMS 2002a). Arctic coastal salt marshes are therefore smaller, often only a few meters in extent, and less common than on south Alaskan coasts (Macdonald 1977; Viereck et al. 1992). The most extensive salt marsh habitats along the coast occur in the deltas of the major rivers and a few protected bays.

TABLE 3.7.1-4 Characteristics of Coastal Habitats of the Alaskan Arctic Ecoregions

Habitat	Chukchian Ecoregion	Beaufortian Ecoregion
Barrier beaches and islands	Narrow beaches along coastline, predominantly fronting steep cliffs cut in bedrock, up to 260 m (853 ft) high at Cape Lisburne (MMS 2007c). Barrier islands occur only at Point Hope at Marryat Inlet/Kukpuk River delta and nearby Aiautak Lagoon; nearly continuous, composed of sand and gravel.	Narrow beaches along coastline; lower cliffs, where present, cut in bedrock (south of Utukok River) or perennially frozen ice-rich sediments (MMS 2007c). Barrier islands, typically enclosing lagoons, frequent along Chukchi and Beaufort Sea coasts, some, such as at Kasegaluk Lagoon, <3 m (10 ft) relief, and <2 m (7 ft) in Beaufort. Coastal relief along these marine depositional areas is generally <5 m (16 ft). Much of coast eroded by ice, waves, and currents, but active wave erosional coast is rare along Chukchi Sea where cliffs are generally <1 m (3 ft) high.
Wetlands	Little wetland occurrence along coastline except along Point Hope.	Estuarine wetland systems occur in enclosed and protected bays along the Chukchi Sea shoreline. Large estuarine wetland complexes in Chukchi Sea lagoons and other well protected areas, such as Omalik Lagoon, Kasegaluk Lagoon, Icy Cape, Peard Bay, Wainwright Inlet; include sand/silt flats and brackish-water sedge marshes. Few, scattered narrow marshes along remainder of coastline
Marine algae	–	Few known beds along coast, on hard bottom substrates; includes many species of macroalgae, e.g., 15 at the Stefansson Sound Boulder Patch; community dominated by a few common species (Iken 2009). Present along Chukchi Sea in Kasegaluk Lagoon, Peard Bay, near Skull Cliffs, and 25 km (16 mi) southwest of Wainright, in 11–13 m (36–443 ft) water.

Sources: MMS 2007c; Iken 2009.

The predominant community types of Arctic coastal salt marshes are dense halophytic (salt-tolerant) sedge wet meadow communities and sparse halophytic grass wet meadow communities (Meyers 1985; Viereck et al. 1992; Funk et al. 2004). The former occur where tidal inundation ranges from several times per month to once a summer, while the latter occur at lower elevations under regular or daily inundation from tides.

Halophytic sedge wet meadow communities often form the main body of the coastal marsh. Soils are fine-textured silts and clays, often overlying sand or gravel. The shoreward marsh community forms a broad transition zone with freshwater wetlands (Viereck et al. 1992). The substrate is typically peat. The seaward margin is often adjacent to a halophytic grass wet meadow community.

The seaward portions of beaches and areas of coastal marshes where inundation occurs at least a few times per month support halophytic herb wet meadow communities (Viereck et al. 1992). These also occur in brackish ponds within coastal marshes of deltas, tidal flats, and bays (Viereck et al. 1992).

The most important coastal estuarine wetlands along the Beaufort Sea coast include Elson Lagoon, just east of Point Barrow; Fish Creek Delta; Colville River Delta; Simpson Lagoon; Canning River Delta; Jago Lagoon–Hulahula River Delta; and Demarcation Bay. Along the Chukchi Sea coast, the primary estuaries include Peard Bay, Kasegaluk Lagoon, and Point Hope (MMS 2002a).

Nearshore areas of the Beaufort and Chukchi Seas are estuarine subtidal deepwater habitat and are generally unvegetated (BLM 2002). However, dense marine algae communities occasionally grow in shallow nearshore subtidal areas (less than about 11 m [36 ft) in depth) and generally in protected areas (such as behind barrier islands and shoals) with hard substrates (MMS 2003b).

Estuaries and coastal lagoons are characterized by large fluctuations in salinity and temperature. Salinity can range from 180 parts per trillion (ppt) in winter to 1–32 ppt in summer (Houghton et al. 1984). At ice breakup in spring, the large influx of freshwater from ice melt and terrestrial runoff can create hyposaline conditions approaching freshwater. Temperature also fluctuates widely and rapidly at breakup, ranging from 0°C to 14°C (Craig et al. 1984).

Effects of climate change on Alaskan Arctic habitats include decreases in sea ice cover, warming of permafrost, longer growing season, and changes in precipitation. Decreased sea ice has led to increased wave activity and accelerated coastal erosion and increases in shoreline erosion from storms, along with increased turbidity (MMS 2008b). Portions of the coast have experienced considerable erosive losses, up to 457 m (1,500 ft) over the past few decades (MMS 2008b). Coastal peat bluffs along the Chukchi Sea coast have experienced more rapid erosion. The erosion rate in areas of the Beaufort Sea coast has more than doubled between 1955 and 2005.

Increases in air temperature and precipitation have also occurred as a result of climate change, particularly in autumn and winter (MMS 2008b). Permafrost, occurring on much of the

Arctic Coastal Plain, creates an impermeable soil layer, limiting the water storage capability of the subsurface and, when near the surface, generally maintaining saturated soils above the permanently frozen layer, thereby maintaining lakes and wetland habitats. Permafrost is warming across the Arctic, with rapid warming in Alaska over the last 50 yr (Anisimov et al. 2007). Significant permafrost degradation has been observed in some areas. Increased permafrost temperatures at 15–20 m (49–66 ft) depths over the past 20 yr have been recorded (MMS 2008b). Increases in mean annual ground surface temperatures have been observed since the 1960s and, in some areas, discontinuous permafrost has begun thawing downward at a rate of 0.1 m/yr (0.3 ft/yr) (MMS 2008b). Thawing of permafrost tends to result in collapse of the soil structure of thaw-unstable soils and slumping of the soil surface, which may subsequently result in flooding. Deepening of the active layer, the upper soil layer that thaws each summer, and associated hydrologic change is accompanied by large changes in the plant community. Evaporation/precipitation ratios have also increased in the Arctic, resulting in the desiccation of some lakes (MMS 2008b). Earlier spring melt in the Arctic and later freeze-up has resulted in a longer growing season, along with changes in plant communities, such as an increased abundance of shrubs (Anisimov et al. 2007).

Projections for future climate change indicate continued increases in temperature and precipitation in the Arctic. The depth of the permafrost active layer is expected to increase by 15 to 25% on average by 2050, and 50% or more in the northernmost areas (Anisimov et al. 2007). Areas of continuous permafrost are likely to show increasing patchiness (Anisimov et al. 2007). An initial increase in the number and total area of wetlands and shallow lakes due to permafrost thawing may be followed over time by the loss of these habitats as permafrost continues to thaw, surface water increasingly drains into groundwater systems, and shallow groundwater tables continue to drop, resulting in the drying of wetland habitats and drainage of lakes (MMS 2008b; Anisimov et al. 2007). A longer growing season and warmer water temperatures of lakes that currently freeze to the bottom would likely change the chemical, mineral, and nutrient status. Arctic species may be at a competitive disadvantage as subarctic species ranges expand northward and changes in plant communities are likely to continue. Arctic tundra in Alaska may be replaced by boreal forest by 2100 (Anisimov et al. 2007).

Decreases in sea ice cover are also expected to continue. The Arctic sea ice is undergoing changes in extent, thickness, distribution, age, and melt duration (NSIDC 2010, 2011; Kwok and Cunningham 2010, 2011). The analysis of long-term datasets indicates substantial reductions in both the extent (area of ocean covered by ice) and thickness of the Arctic sea-ice cover during the past 20–40 yr. Generally, it is thought that the Arctic will become ice-free in the summer, but at this time there is considerable uncertainty about when that will happen (Stroeve et al. 2011; Tietsche et al. 2011; Zhang et al. 2010; Overland and Wang 2010). Changes in ice cover may affect primary and secondary productivity, thus influencing the structure of the biotic community in the Beaufort and Chukchi Seas. See also Section 3.3 for further discussion of sea ice. The suspended sediments associated with increased coastal erosion will likely affect marine algae communities. In addition, sea level is projected to rise an average of 0.73 m (2.4 ft) in the Arctic between 2000 and 2100, flooding low-lying coastal habitats (MMS 2008b). Coastal wetlands and estuaries would be threatened by inundation from rising sea levels, intensification of storms, and higher storm surges. Increased wave activity, relative sea level rise, and thawing of permafrost that binds coastal sediments lead to retreat of coastal habitats (Nicholls et al. 2007). Temperature, salinity, and oxygen levels of coastal estuaries would be affected by changes in rates and timing of river runoff. Seasonal ice cover on rivers and lakes is breaking up earlier each year, with a longer open water season (MMS 2008b). Observed changes in tundra habitats are expected to continue. Snow cover over tundra is expected to melt earlier and large-scale changes in permafrost are predicted to be likely.

No federally listed or candidate plant species occur in the Arctic region. Thirty-one species of rare vascular plants are known to occur on the North Slope (Cortes-Burns et al. 2009). Many of these species are found nowhere else in Alaska, and several are endemic to Alaska.

3.7.1.3.1 Chukchian Neritic. Habitats of the Chukchian ecoregion include narrow beaches along the coastline, predominantly fronting steep cliffs cut in bedrock, up to 260 m (853 ft) high at Cape Lisburne (MMS 2007c). Barrier islands occur only at Point Hope at the Marryat Inlet/Kukpuk River delta and nearby Aiautak Lagoon; the islands are nearly continuous, composed of sand and gravel. There is little or no wetland occurrence along the Chukchian ecoregion coastline other than the lagoon at Point Hope.

3.7.1.3.2 Beaufortian Neritic. Habitats of the Beaufortian ecoregion include narrow beaches along the coastline; lower cliffs, where present, are cut in bedrock (south of Utukok River) or perennially frozen ice-rich sediments (MMS 2007c). Barrier islands, typically enclosing lagoons, are frequent along Chukchi and Beaufort Sea coasts; some, such as at Kasegaluk Lagoon, have less than 3 m (10 ft) relief and less than 2 m (7 ft) in the Beaufort Sea. Beaufort islands are narrow, at less than 250 m (820 ft), and short (MMS 2008b). Coastal relief along these marine depositional areas is generally less than 5 m (16 ft). The Chukchi Sea coast is a high-energy shoreline when ice is absent. Erosion and flooding are associated with autumn and spring storms and ice movement (MMS 2008b). Much of the coast is eroded by ice, waves, and currents, but active wave erosional coast is rare along the Chukchi Sea, where cliffs are generally less than 1 m (3 ft) high (MMS 2007c).

Estuarine wetland systems occur in enclosed and protected bays along the Chukchi Sea shoreline. Large estuarine wetland complexes in Chukchi Sea lagoons and other well-protected areas, such as Omalik Lagoon, Kasegaluk Lagoon, Icy Cape, Peard Bay, and Wainwright Inlet, include sand/silt flats and brackish-water sedge marshes. A few scattered, narrow marshes occur along the remainder of the coastline. Beaufort Sea coastal waters are estuarine during a portion of the year, with freshwater inflows from numerous rivers and streams mixing with marine waters (MMS 2007c, 2008b). Maximum discharge is late May to early June, with melting of landfast ice in early June to July, initially near river deltas. The coastline includes bays and lagoons, as well as Stefansson Sound, enclosed by barrier islands.

3.7.1.3.3 Arctic Coastal Plain. The Arctic Coastal Plain (ACP) is relatively flat and borders the Beaufort Sea and the eastern portion of the Chukchi Sea, encompassing most of the Beaufortian ecoregion. The ACP includes a complex mosaic of vegetation types, the distribution and extent of which are strongly influenced by local soil characteristics, elevation, temperature, and moisture (BLM 2002). Freshwater wetlands, including a wide variety of vegetation types, cover nearly all of the coastal plain and foothills (ADNR 2008; BLM 2002; BLM and MMS 2003).

On the ACP, the presence of thick, continuous permafrost that is generally near the soil surface restricts soil drainage and results in saturated soils over most of the area (BLM 2002; BLM and MMS 2003). Wetland plant communities, characterized by sedges, grasses, dwarf shrubs, and mosses, are the predominant vegetation types of the ACP (BLM 2002; MMS 2002b, 2003b). Numerous small lakes and ponds are scattered across the landscape. Even small-scale variations in the land surface elevation alter patterns of species occurrence and influence the distribution of plant communities. These variations determine the occurrence of wet, moist, and dry tundra (BLM and MMS 2003). Flooded tundra and aquatic vegetation cover types also occur. Coastal plain soils generally consist of an organic mat over fine-textured mineral soil.

Over much of the near coastal area inland from Point Barrow, along the Beaufort Sea to the Canning River, wet graminoid moss communities, with moist communities on higher microsites, are the predominant plant communities (Raynolds et al. 2006). Wet sedge moss communities, with moist communities such as tussock-sedge and dwarf-shrub communities on higher microsites, extend over much of the ACP from near Point Lay on the Chukchi coast to the border of Canada. Non-tussock sedge, dwarf-shrub, moss tundra communities and Non-tussock sedge, dwarf-shrub, forb, moss tundra communities, both on mesic soils, occur at the margin of the ACP near the Arctic Foothills. Tussock-sedge, dwarf-shrub, moss tundra communities, occurring on sandy soils in complex with lakes and wet tundra, are the predominant community type over a large area south of Teshekpuk Lake, in the central portion of the ACP.

Ground patterns form polygons in much of the east-central portion of the ACP. Low polygons, enclosed by rims, are common and support wet sedge/moist sedge tundra in basins and dwarf shrub tundra on rims, with troughs between polygons (MMS 2002b). Near the coastline, high centered polygons bordered by deep troughs support moist sedge and dwarf shrub tundra.

Over much of the ACP, thaw lakes (typically 1–7 m [3–23 ft] in depth) shaped and oriented by wind direction cover 20–50% of the surface area (Gallant et al. 1995). Ponds are generally smaller and shallower. Lake margins and smaller ponds frequently support the fresh grass marsh vegetation type, generally in surface water depths of 0.2–2 m (0.7–7 ft) (Viereck et al. 1992).

Thaw lakes generally follow a cyclic pattern of draining and reforming (BLM 2002). Wet tundra communities, later becoming wet sedge meadow communities, commonly become established in drained basins (BLM 2002). Surface water in these areas may be present much of the growing season and may be up to 15 cm (0.5 ft) deep (Viereck et al. 1992).

Barren areas along major streams are composed of 60% barren peat, mineral soil, or gravel. These areas may have patches with sparse cover of forbs and dwarf shrubs. The margins of ACP rivers typically include gravel bars, sandbars, and sand dunes (BLM 2002). Active sand dunes support dunegrass communities, while floodplains support low willow shrub and seral herb communities. Large, braided rivers on the ACP, such as the Sagavanirktok River, include extensive areas that are predominantly unvegetated or sparsely vegetated. Some plant communities near the Sagavanirktok and Kadleroshilik Rivers are maintained in early and mid-successional stages by the deposition of windblown silt from the river channel (MMS 2002b; BLM 2002).

3.7.1.3.4 Arctic Foothills. Inland from the Chukchian ecoregion and southwestern Beaufortian ecoregion coast, the Arctic Foothills extend across northern Alaska between the ACP and the Brooks Range, reaching to the Beaufort Sea near the border of Canada. Thick permafrost extends over the hills and plateaus of the Arctic Foothills, and most soils are poorly drained with thick organic layers (BLM 2002). Although the foothills have more distinct drainage patterns and fewer lakes than the ACP, much of the landscape in the foothills consists of wetlands.

A wide variety of plant community types occurs on the foothills (Raynolds et al. 2006). Near the Chukchian ecoregion coast, the wet sedge moss communities (with moist communities on higher microsites), non-tussock sedge, dwarf-shrub, forb, moss communities (mesic soils), and prostrate dwarf-shrub, forb, lichen (dry limestone slopes) are the predominant community types. Farther inland, and extending along much of the southwestern Beaufortian ecoregion, the tussock-sedge, dwarf-shrub, moss community type, on mesic soils, is a predominant community type of the Arctic Foothills. Also occurring near the coast are erect dwarf-shrub, lichen communities on mesic sites and prostrate dwarf-shrub, lichen communities on dry granitic slopes. The foothills approach the Beaufort Sea along the northeastern coast of Alaska. Here, tussock-sedge, dwarf-shrub, moss (mesic soils); erect dwarf-shrub (mesic soils); and prostrate dwarf-shrub, sedge community types (dry limestone slopes) occur at or near the coast.

3.7.2 Marine Benthic Habitats

3.7.2.1 Gulf of Mexico

Marine benthic (bottom) habitats are areas of the seafloor used by organisms at some or all stages in their life for critical functions such as feeding, reproduction, and shelter. In the GOM Planning Areas, marine benthic habitats on the continental shelf and slope/deep sea habitats include soft sediments, hard bottom areas, chemosynthetic communities, warm-water coral reefs, and deepwater corals (Table 3.7.2-1).

3.7.2.1.1 Soft Sediments. Sediments of the Northern GOM are primarily composed of sand, silt, and clay. Thus soft bottom habitat is not a unique habitat of concern like the hard bottom, deepwater coral, and deepwater community habitats discussed below. However, soft sediments do provide habitat to most marine organisms in the GOM and are the site of fundamental ecosystem processes, such as the breakdown of organic matter, nutrient transformation and recycling, and the metabolization of natural and anthropogenic releases of

TABLE 3.7.2-1 Benthic and Pelagic Marine Habitat Types Found in the Northern Gulf of Mexico Shelf, Slope, Mississippi Fan, and Basin Marine Ecoregions within the Western and Central Planning Areas

Marine Habitat Type	Marine Ecoregion
Benthic	
Soft sediments	All ecoregions
Hard bottom areas	Shelf (Mississippi Estuarine Area, Western Gulf Neritic), Slope, and Basin
Coral reefs	Shelf (Western Gulf Neritic)
Deep/coldwater corals	Primarily Slope
Chemosynthetic communities	Primarily Slope
Man-made structures	Shelf (Mississippi Estuarine Area, Western Gulf Neritic), Slope
Pelagic	
Water column	All ecoregions
Sargassum	All ecoregions

hydrocarbons (Hazen et al. 2010). As the predominant sediment substrate type, soft sediment habitat will be most affected by oil and gas development and production activities.

Continental Shelf Soft Bottom Habitat. The Northern GOM Continental Shelf Marine Ecoregion extends from the coastline out to the shelf break at water depths ranging about 118 to 150 m (387 to 492 ft) and encompasses the Mississippi and Texas Estuarine Ecoregions and the Western Gulf Neritic Ecoregion. The major marine benthic habitat consists of soft muddy bottom. An exception is the sandy sediments along beaches and barrier islands.

Much of the organic matter in the upper water column is eventually deposited on the seafloor in seasonal pulses, following springtime peaks in river discharge and spring phytoplankton blooms. Once reaching the seafloor, organic matter is consumed by bacteria, meiofauna, and macrofauna. Consequently, soft sediments are important sites for detrital processing and the remineralization of critical elements like sulfur, nitrogen, and phosphate. Sediment-associated nutrients and organic matter may also be resuspended into the water column, where they support new water column primary and secondary production. This coupling between benthic and pelagic habitats is particularly strong in shallow areas of the continental shelf.

Biological interactions as well as physiochemical factors such as substrate, temperature, salinity, water depth, currents, oxygen, nutrient availability, and turbidity are critical in determining the distribution, composition, and abundance of continental shelf soft bottom communities. The major factor influencing the megafaunal distributions appears to be the differing substrates, with primarily carbonate sediments found east of DeSoto Canyon and along the west Florida shelf in the Eastern Planning Area and with more terrigenous muds found in the estuarine and neritic shelf sediments in the Eastern and Western Planning Areas (Defenbaugh 1976). Soft sediment infaunal communities on the GOM continental shelf are generally dominated, in both number of species and individuals, by surface-deposit-feeding polychaete worms, followed by crustaceans and mollusks (Continental Shelf Associates, Inc. 1992, 1996; Brooks and Giammona 1991; Baustian and Rabalais 2009). Common species on the sediment surface include sea anemones, brittle stars, portunid crabs, and penaid shrimp. These animals are typically distributed on the basis of water depth and sediment composition or grain size, with seasonal components also being present in shallower water areas.

Northern Gulf of Mexico Slope/Basin Ecoregion. Soft sediments of the continental slope and deep sea have a unique faunal community adapted to the cold, high-pressure, and low-productivity environment. Recent surveys from south Texas to the Florida panhandle revealed that echinoderms, sea anemones, nematodes, copepods, amphipod, polychaetes, and bivalves were common constituents of soft sediment assemblages in the deep sea. There were distinct faunal communities from east to west of the Mississippi River and from the upper slope to the abyssal plain (Rowe and Kennicutt 2009; Wei et al. 2010). The highest macroinvertebrate densities were found near the Mississippi River, followed by areas to the east. A general decrease in the abundance of fish, meiofauna, and macrofauna was observed from the upper continental slope to the abyssal areas in the GOM (Rowe and Kennicutt 2009). The number of invertebrate species was higher on the shelf/slope than the outer shelf, and the number of benthic invertebrate species was highest on the mid to upper slope. Overall, biomass, species number, and species composition were influenced by water depth, the proximity of locations to canyons and methane seeps, and the organic matter content of sediment (Rowe and Kennicutt 2009). Other physical and chemical parameters — such as oxygen concentration, temperature, salinity, and chemical contaminants within the sediments — did not appear to be related to community structure (Rowe and Kennicutt 2009).

The abundance patterns just described, such as the high density of macrofauna near the Mississippi River, are in large part attributable to food availability. The offshore GOM has low nutrient concentrations and surface water productivity. In such areas, most organic matter is therefore tightly recycled in the water column and much less is exported to sediment or higher trophic levels (Hagstrom et al. 1988; Buesseler 1998; Pomeroy et al. 2007; Hung et al. 2010). Organic matter that does fall below the photic zone breaks down as it sinks and reaches the seafloor in a highly degraded state. The continental slope/deep sea benthos is thus typically food starved; consequently, the size, biomass, and abundance of benthic consumers decline with depth as one goes from the continental shelf to the deep sea. Although much of the deep sea is relatively unproductive, deep sea cold seep communities are exceptions and will be discussed later in this section.

3.7.2.1.2 Warm Water Coral Reefs. Coral reefs are formed by reef-building coral species. Coral are suspension feeders, and their prey predominantly consist of planktonic organisms carried in the water column. Photosynthetic corals also harbor dinoflagellate algae that benefit the coral's physiology through products resulting from photosynthesis. Where they are present, coral reefs in the GOM serve ecological functions as important sites of primary productivity and as habitat for dense and diverse reef-associated communities.

Coral reefs are primarily concentrated on the west Florida shelf. Although not in the Western or Central Planning Areas, these reefs could be affected by accidental oil spills. Coral reefs are not found in the Central Planning Area and are relatively uncommon in the Western Planning Area, although individual corals are common in hard-bottom seafloor habitats in both areas. The East and West Flower Garden Banks in the FGBNMS, located in the Western Gulf Neritic Marine Ecoregion, are considered the only coral reefs present in the Western Planning Area (Figure 3.7.2-1). The East and West Banks are prominent topographic features covering approximately 50 and 74 km^2 (12,355 and 18,286 ac), respectively, and rising to a depth of 17 m (63 ft) below the water surface from surrounding water depths below 100 m (328 ft) (Hickerson et al. 2008). The banks formed over salt domes, which forced the overlying seabed upward, resulting in exposed carbonate that provided substrate for the colonization and growth of reef organisms. The crests of these features are carbonate rock formed by reef-building corals, coralline algae, and other lime-secreting creatures. The dominant community on these banks at water depths above 36 m (118 ft) is composed of reef-building corals (approximately 20 species), with an average cover of more than 50% (Bright et al. 1984; Dokken et al. 1999; Precht et al. 2008). In addition, more than 80 species of algae, approximately 250 species of macroinvertebrates, and more than 120 species of fishes are associated with these features (Dokken et al. 1999). Two Elkhorn coral (*Acropora palmata*) colonies have also been reported in the Flower Gardens. This species is primarily found in south Florida, the southern GOM, and the Caribbean, and is listed as threatened under the Endangered Species Act (Section 3.8.5.1). On the basis of data from 1978 to 2006, there do not appear to be any long-term trends in the percentage of coral cover at the FGBNMS (Hickerson et al. 2008; Robbart et al. 2009), and despite causing some physical damage to reef structure, recent hurricanes have not caused significant lasting damage to the FGBNMS (Robbart et al. 2009). Within a 6.4-km (4-mi) radius of the FGBNMS, there are currently 14 oil production platforms, and there is one gas production platform within the East Sanctuary boundary. Ongoing stressors on the FGBNMS include mechanical disturbance from anchors and discarded fishing gear, coastal runoff, and disease (Hickerson et al. 2008).

3.7.2.1.3 Deepwater Corals. Research from 2003 to the present has resulted in extensive data on the distribution of deepwater (or coldwater) corals and the compositions of their associated communities (CSA International, Inc. 2007). Deepwater corals are found on rock outcroppings in the Northern GOM Slope Ecoregion in waters typically deeper than 300 m (984 ft) (Figure 3.7.2-2). The primary deepwater species in the GOM is *Lophelia pertusa.* This highly branching species can develop from small bushes to thickets of hemispherical colonies. *Lophelia* aggregations typically develop on lithified outcroppings formed in the past by now-inactive hydrocarbon seeps. Although often located near cold hydrocarbon seeps, *Lophelia* corals and associated biota do not appear to use seep hydrocarbons as a food source; instead, they depend on plankton and organic matter falling from the upper water column (CSA International, Inc. 2007). *Lophelia* produce larvae whose dispersal ability is limited when compared with that of species that produce planktotrophic larvae. Consequently, gene flow appears to occur primarily within individual *Lophelia* thickets; nevertheless, enough long-distance dispersal occurs to maintain regional genetic distinctiveness (USGS 2008).

Lophelia beds provide complex benthic habitat that attracts deepwater fish and invertebrates in greater density than that found in the surrounding soft-bottom habitat. Surveys of *Lophelia* communities off the coast of Louisiana conducted in 2004 and 2005 indicated that polychaetes, brittle stars, sponges, and hydroids were the most common species (CSA

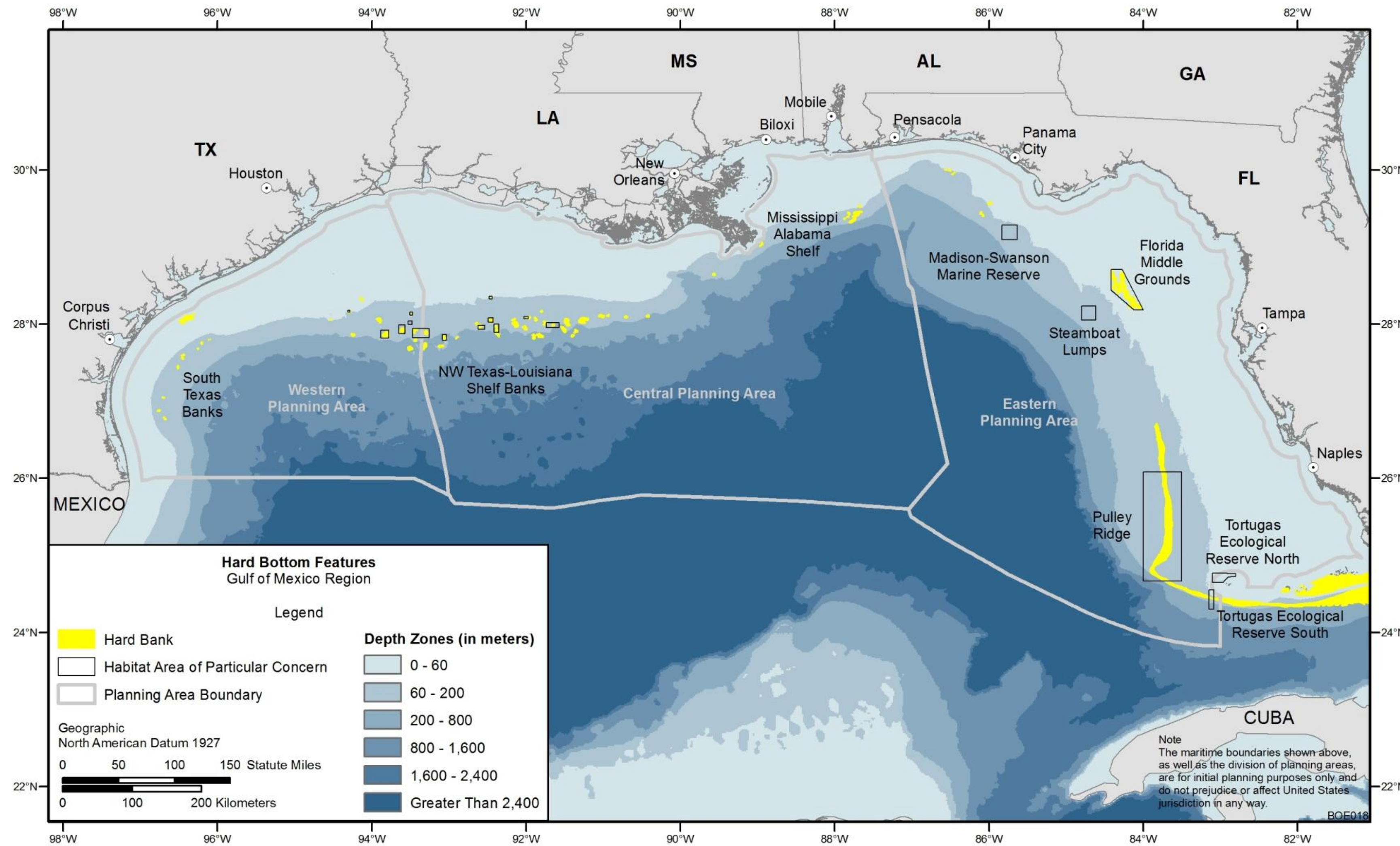

FIGURE 3.7.2-1 Location of Hard Bottom Features in the Western, Central, and Eastern Planning Areas

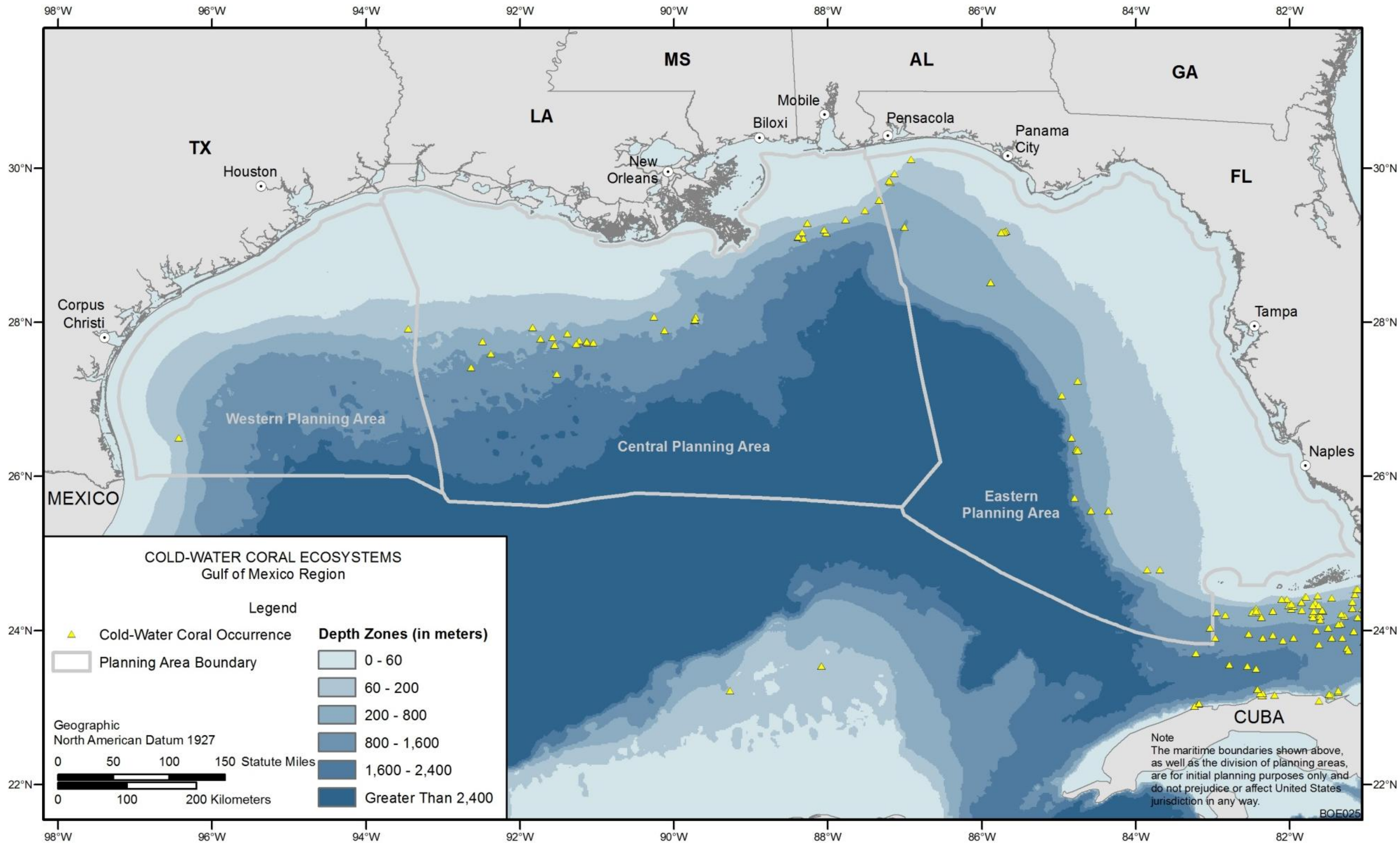

FIGURE 3.7.2-2 Location of Coldwater Coral System Features in the Western, Central, and Eastern Planning Areas

International, Inc. 2007). Predatory polychaetes and shrimp and crabs were also common. Overall, suspension feeders and predators were the dominant trophic guilds represented, but large scavengers were also present (CSA International, Inc. 2007). A study of the Viosca Knoll *Lophelia* communities found that fish communities differ according to depth, with communities found at 325 m (1,066 ft) being distinctly different than the deepwater fish species collected at 500 m (1,640 ft) (USGS 2008).

3.7.2.1.4 Hard Bottom. The term hard bottom (also referred to as live bottom) generally refers to exposed rock, but it can also refer to other substrata, such as coral and clay, or even artificial structures. Hard bottoms often support highly productive algal and animal communities. The sessile (nonmotile) biota typically growing on hard-bottom areas may include macroalgae, seagrasses, sponges, barnacles, hydroids, corals, cnidarians, bryozoans, and tunicates, which, in turn, provide shelter, food, and spawning sites for mobile fish and invertebrates. Within the Eastern and Western Gulf Neritic and the Mississippi Gulf Estuarine Ecoregions, major topographic features occur on the continental shelf and shelf edge across the west Florida shelf and in more restricted locations off Alabama, Mississippi, Louisiana, and Texas. The estimated areal extent of natural hard bottom in the GOM on the continental shelf is 4,772,600 ha (11,793,300 ac), with only 6% of this occurring in the Central and Western Planning Areas (GMFMC 1998). Authigenic carbonate exposed in deepwater areas below 300 m could total more than 200,000 ha (494,208 ac) as determined from 3D seismic remote sensing data (less than 1% of the total bottom area of the deep GOM).

Mississippi-Alabama Shelf. Within the Mississippi Estuarine Area, in inner-shelf and mid-shelf regions off Mobile Bay and the Alabama/Florida State line, there are small low-relief outcrops of rock, shell hash, and sandstone on areas with sand or shell bottom (Figure 3.7.2-1). This hard-bottom habitat, found in water depths of 18 to 40 m (59 to 131 ft), ranges from low-relief exposed rock in shallow depressions to rock outcrops with up to 5 m (16.4 ft) of vertical relief (Thomson et al. 1999). The dominant biota varies with location, but it can include barnacles, coralline algae, hydroids, sponges, octocorals, solitary hard corals, bryozoans, and ascidians (Schroeder et al. 1989; Thompson et al. 1999). These inner shelf outcrops also served as spawning grounds for a variety of fish, including the spot (*Leiostomus xanthurus*) and the Atlantic croaker (*Micropogonias undulates*).

Along the shelf edge between the Mississippi River and DeSoto Canyon, there are discontinuous carbonate reef structures called Pinnacle Trend regions; they fall primarily in two parallel bands along depth contours. BOEM (as MMS)-sponsored studies (Brooks and Giammona 1991; Continental Shelf Associates, Inc. 1992; Continental Shelf Associates, Inc., and Texas A&M University, Geochemical and Environmental Research Group 1999) have provided further information about these features, which consist of thousands of carbonate mounds ranging in size from less than a few meters to nearly a kilometer in diameter. The larger “pinnacle” features are found at depths of 74–82 m (243–269 ft) and 105–120 m (344–394 ft), and their vertical relief ranges from 2 to 20 m (6 to 66 ft), with the average being 9 m (30 ft). Linear ridges paralleling the isobaths were also mapped in the shallower depth zone. These ridges are typically about 20 to 250 m (66 to 820 ft) in width, are more than 1 km (0.6 mi) long, and have a relief of up to 8 m (26 ft). Shallow (generally less than 1 m, or 3 ft, deep) depressions, usually less than 15 m (49 ft) in diameter, were also found (Sager et al. 1992).

The pinnacle features provide a significant amount of hard substrate for colonization by suspension-feeding invertebrates, and they support relatively rich biological communities. Barnacles, worms, coralline algae, sponges, corals, and bryozoans are present at the tops of the shallowest features in water depths of less than about 70 m (230 ft) (GMFMC 2004). The diversity and abundance of the associated species appear to be related to the size and complexity of the features, with the low-relief rock outcrops (less than 1 m [3 ft] high) typically having low faunal densities, and the higher-relief features having the more diverse faunal communities. Although it is likely that little active reef building is occurring now, the Pinnacle Trend may serve as an important colonization site for hard-bottom species and allow cross-shelf gene flow between reef species in the western and eastern GOM (GMFMC 2004). In addition, pinnacles off Mobile Bay serve as aggregation sites and spawning grounds for fish and invertebrates during multiple life stages.

Louisiana-Texas Shelf Banks and South Texas Banks. Within the Mississippi Estuarine and Western Gulf Neritic Ecoregions, there are several low- to high-relief banks and ridges along the mid to outer Louisiana-Texas shelf in 22 to 200 m (72 to 656 ft) of water. Bank relief ranges from less than 1 to 150 m (3 to 492 ft) and can be as large as several hundred square meters in area. The major topographic features of the central and western GOM are shown in Figure 3.7.2-1. These features are elevated above the surrounding seafloor and are characterized as either mid-shelf bedrock banks or outer-shelf bedrock banks with carbonate caps (Rezak et al. 1983; Hickerson et al. 2008). Although these topographic features are small, the hard-bottom faunal assemblages associated with them often have high diversity, species richness, and biomass; they also provide habitat for important commercial and recreational fish species.

Benthic zones were described for the topographic features by Rezak et al. (1983). The zones were classified on the basis of their amount of reef-building activity and primary production (Rezak et al. 1983, 1985). The mid-shelf and shelf-edge banks along the Texas-Louisiana border contain a variety of zones, ranging from clear water high-productivity to low-productivity zones (Rezak et al. 1983). Several banks along the Louisiana-Texas mid shelf and shelf edge were near the storm track of Hurricane Rita in 2005. However, the long-term effects on these banks appear to have been minor (Robbart et al. 2009). Rezak et al. (1983) classifies the south Texas banks as low relief with turbidity-tolerant communities and little to no reef-building activity.

It appears that differences in the fish and invertebrate communities depend on the bank's structure, depth, and location. However, all areas have high fish and invertebrate densities and diversities, dominated by reef-associated species (Dennis and Bright 1988). Epibenthic biota that are colonizing the hard substrate include bryozoans, hard corals, octocorals, fire corals, sponges, sea whips, gastropods, hydroids, sea urchins, and spiny lobster (GMFMC 2004). Reef-associated fishes typical of the GOM congregate around these features, and many are of commercial and recreational importance (Section 3.8.4.1).

West Florida Shelf. Most of the hard-bottom habitat in the Northern GOM Shelf Marine Ecoregion is located on the west coast of Florida. Although not in the Western or Central Planning Areas, these areas could be affected by accidental oil spills and are therefore briefly described. The live-bottom communities on the west Florida shelf are tropical to temperate in nature, with the number of tropical species decreasing to the north. The communities are predominantly algal/sponge/coral assemblages, with the shallow-water octocorals and the hard corals significantly decreasing in abundance at depths deeper than about 40 m (161 ft). Most of the hard bottom on the west Florida shelf is low relief (less than 1 m [3 ft]), but it also includes ridges and pinnacles rising up to 30 m (98 ft) from the seafloor (Woodward-Clyde Consultants and Continental Shelf Associates, Inc. 1983; Continental Shelf Associates, Inc. 1987). Despite the relatively small amount of actual exposed rock outcrops across this shelf, dense sessile epifaunal assemblages are common. The primary topographic features on the west Florida shelf are the Florida Middle Ground (Figure 3.7.2-1), located about 160 km (99 mi) northwest of Tampa Bay, and Madison Swanson water, located south of Panama City at a depth of 60 to 100 m (197 to 328 ft). Steamboat Lumps, a low-relief area that measures 269 km^2 (104 mi^2) and is located west of Tarpon Springs, is another known spawning ground for reef fish. (Additional maps are available at http://oceanexplorer.noaa.gov/explorations/islands01/log/jun20/jun20.html).

Artificial hard-bottom sites, including sunken vessels, oil and gas platforms, and debris, represent only 1.3% of all hard-bottom sites in the GOM (GMFMC 1998); nevertheless, these structures support locally abundant fish populations in shelf waters of all GOM coast States (GMFMC 1998). Artificial reefs are placed in the GOM continental shelf to improve fishery production and recreational fishing opportunities.

Oil platforms also serve as artificial reef habitats. There are 3,315 active oil platforms now present in GOM Federal waters (Boudreaux 2011). After oil platforms are decommissioned, they can be converted to artificial reefs by being toppled or partially removed. Oil platforms represent a novel habitat when compared with the surrounding soft sediments, and they provide attachment sites for sessile reef invertebrates such as corals, bryozoans, and sponges. In this way, they allow the range of fish and invertebrate species to expand. In addition, by serving as "islands" of hard substrate, the platforms can also promote gene flow between the eastern and western portion of the GOM (Sammarco et al. 2004).

Although the algae growing on oil platforms provide food for some platform biota, plankton is the primary food source supporting the platform community. The attached platform community in turn provides food for many but not all structure-oriented fish and invertebrates living on or near the platform. Single offshore platforms of average size have been found to provide habitat for an average of 10,000 to 30,000 fish within 50 m (164 ft) of the structure (Stanley and Wilson 2000). The high densities of fish near the platform decline to background levels within 10 to 50 m (33 to 164 ft) of the platform. Jacks, amberjack, red snapper, gray snapper, and triggerfish dominate the oil platform fish assemblage (Stanley and Wilson 2000).

Although platforms undoubtedly have higher amounts of organismal biomass than do the surrounding soft sediments, their role in enhancing fish production is controversial. Initially it was argued that reef fish are habitat-limited because of the scarcity of hard bottom on the Gulf continental shelf. Consequently, it was thought that artificial reefs provide needed habitat (Brickhill et al. 2005). Others argued that reef fish are not habitat-limited, and artificial reefs such as oil platforms simply attract fish away from natural hard bottom. Thus, platforms may simply attract fish rather than increasing fish production and, at the same time, make them easier to harvest by commercial and recreational fisheries (Brickhill et al. 2005). The benefit or detriment of artificial reefs as habitat depends on how fisheries are managed on the reef and the individual life histories and habitat requirements of the species present.

3.7.2.1.5 Chemosynthetic (Seep) Communities. In deepwater areas where oil and natural gas compounds seep up through the sediments, chemosynthetic bacteria inhabit specialized cells in clam, mussel, and worm hosts; they form symbiotic relationships in which methane and/or hydrogen sulfide are used to produce basic organic compounds. In the Northern GOM Slope Marine Ecoregion, chemosynthetic communities are associated with hydrocarbon seeps in water depths ranging from less than 300 m (984 ft) to more than 2,700 m (8,858 ft; Brooks et al. 2008). Figure 3.7.2-3 shows known chemosynthetic community locations. In addition, maps of acoustic seafloor anomalies in the GOM have been developed over the last 13 yr that can be used to predict the location of deepwater corals (Section 3.7.2.1.3-1) and chemosynthetic communities (Figure 3.7.2-3). The anomalies are present in the form of positive anomalies, negative anomalies, and pockmark features. The positive anomalies are indicative of hard-bottom authigenic carbonate deposits or solid hydrate formations with which deepwater coral or chemosynthetic communities are often associated. Positive anomalies do not guarantee the presence of deepwater communities because there may be a lack of exposed hard substrate for corals and the hydrocarbon seep could be inactive and not capable of supporting chemosynthetic communities. The negative anomalies are areas of rapid gas expulsion where it is generally not possible for significant communities to develop, although suitable hard substrate may be nearby. Pockmarks may be caused by large, short-term gas expulsion events and may or may not have associated hard substrate. BOEM has successfully used the presence of positive anomalies to predict the location of exposed hard-bottom, chemosynthetic, and/or deepwater coral communities, which has allowed these sensitive features to be avoided by oil and gas activities. Sassen et al. (1993b) showed that at locations for which data were available, most significant oil fields in the deepwater GOM had associated chemosynthetic communities. Since there is extensive natural oil and gas seepage in the GOM, an extensive amount of habitat is thought to be available for these types of communities, although the amounts are small in individual areal extent. In addition, chemosynthetic communities not associated with oil and gas seepage have been found at the base of the Florida Escarpment in water at a depth of about 3,200 m (10,499 ft) (Paull et al. 1984; Hecker 1985).

Evidence indicates that fauna associated with chemosynthetic communities can be extremely slow-growing. For example, tubeworms are estimated to grow less than 1 cm (0.4 in.) per year and to live longer than 200 yr (Fisher et al. 1997; MacDonald 2000). The seep mussels also exhibit slow growth rates, with adults surviving up to 40 yr (Nix et al. 1995; MacDonald 2000). Chemosynthetic communities on the upper continental slope (<1,000 m [3,281 ft]) and the mid to lower continental slope (>1,000 m [3,281 ft]) have been studied. Although general groups of epifauna, such as galatheid crabs, decapod shrimp, mussels, and tubeworms, were present at upper and lower slope sites, differences were strong at the species

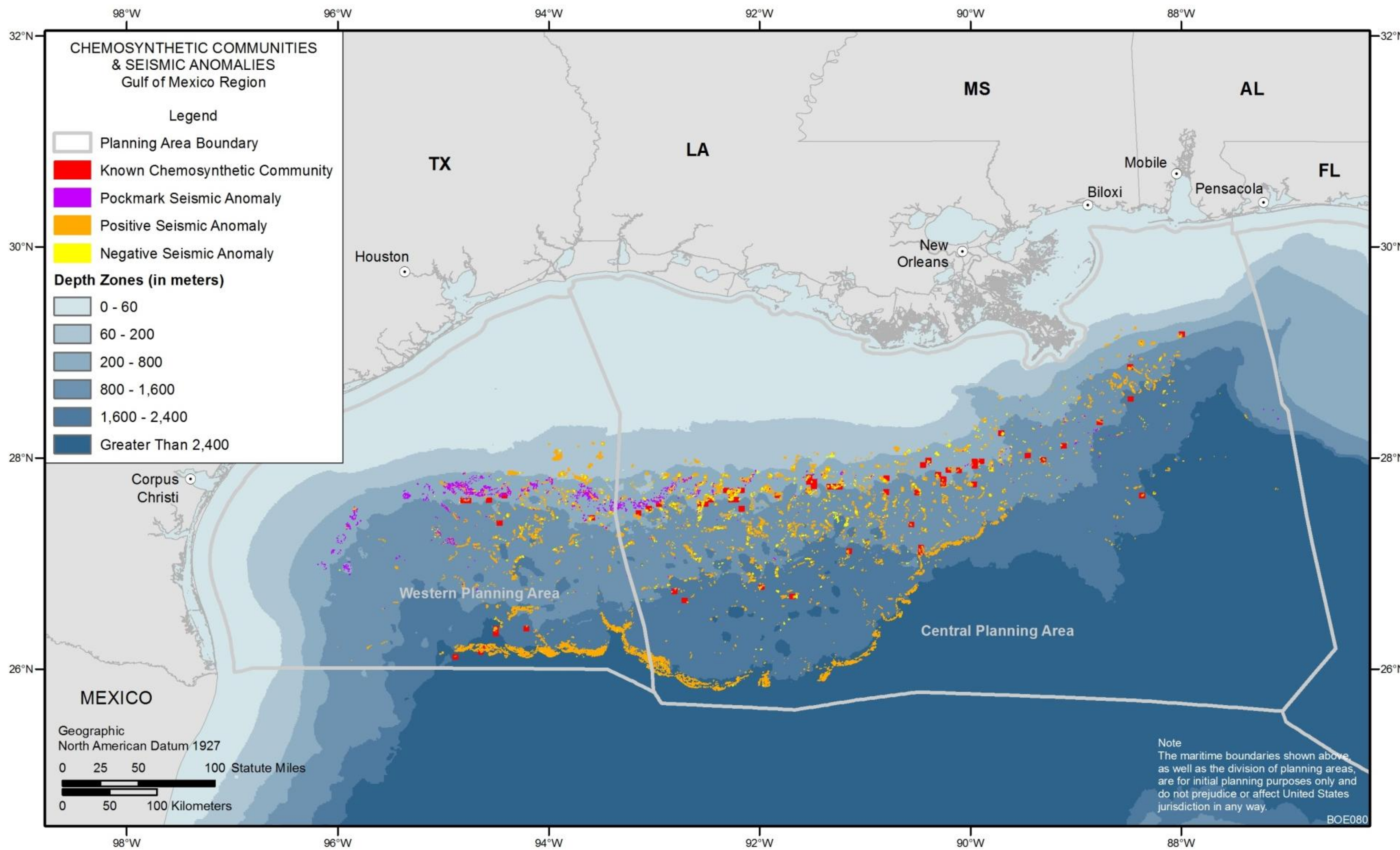

FIGURE 3.7.2-3 Location of Chemosynthetic Communities in the Western and Central Planning Areas

level (Brooks et al. 2008). There were differences in the invertebrate communities associated with mussel and tubeworm habitats although a single species of shrimp (*Alvinocaris muricola*) was typically numerically dominant at both habitat types. Depth, relative abundance of different mussel species in a bed, and the tubeworm size were important determinants of community composition (Cordes et al. 2010).

3.7.2.1.6 Climate Change Effects on GOM Marine Benthic Habitats. Climate change has the potential to profoundly affect marine benthic habitats and communities. One seafloor habitat likely to be affected is coral reefs. For example, as a stress response to warming water temperatures, coral reefs could suffer from an increased frequency of bleaching (Hoegh-Guldberg et al. 2007). Globally, bleaching appears to have increased in frequency and severity since the last quarter of the 20th century (Janetos et al. 2008), but on the basis of data from 1978 to 2006, there do not appear to be any long-term trends in the percentage of coral cover at the FGBNMS (Hickerson et al. 2008; Robbart et al. 2009). Recent surveys indicate that the FGBNMS appears to be healthy, with coral cover ranging from 50 to 70% on both banks and a low incidence of bleaching and other coral disease (Precht et al. 2008; Robbart et al. 2009). Much of this may be due to the distance of the coral reefs from land and the depth at which the reefs are located. However, the IPCC estimates that water temperatures could increase by 1.8 to 4.0°C by 2050 (IPCC 2007b), and with the rise in temperature, coral bleaching at the FGBNMS could increase.

In addition to coral bleaching, there are other challenges to coral reefs related to climate change. For example, there has been a rise in the occurrence of excessive algal growth on reefs and an increase in bacterial, fungal, and viral agents (Boesch et al. 2000; Twilley et al. 2001). There is also the potential for greater frequency of mechanical damage to corals from greater severity of tropical storms and hurricanes (Janetos et al. 2008).

In addition, the increase in atmospheric CO_2 has resulted in the formation of carbonic acid, at the expense of carbonates (aragonite and calcite), in seawater. The resulting decreases in the oceanic pH and carbonate concentration are expected to reduce the reef formation rate, weaken the existing reef structure, and alter the composition of coral communities (Janetos et al. 2008). The projected decrease in pH varies depending on the model and model assumptions used; nevertheless, by 2050, the ocean's carbonate saturation might drop below levels necessary for coral reef accretion, and the pH of surface oceans might drop by as much as 0.5 pH by the end of this century (Royal Society 2005; Hoegh-Guldberg et al. 2007). Recent work also suggests ecosystem respiration is higher in the GOM because eutrophication has increased dissolved CO_2 and reduced oceanic pH by 0.11 to 0.16 (Cai et al. 2010). The trend is expected to continue, potentially leading to carbonate undersaturation (Cai et al. 2010).

As climate change has the potential to affect warm water corals, it could also affect coldwater *Lophelia* habitats. The saturation depth of aragonite (the primary carbonate form used by hard corals) appears to be a primary determinant of deep water coral distribution, with reefs forming in areas of high aragonite solubility (Orr et al. 2005). The depth at which the water is saturated with aragonite is projected to become shallower over the coming century, and most coldwater corals may be in undersaturated waters by 2100 (Orr et al. 2005). Consequently, the spatial extent, density, and growth of deepwater corals may decrease, diminishing their associated ecosystem functions (Orr et al. 2005).

In nearshore and mid-shelf benthic habitats, climate change may cause the temporal variability of key physical parameters — particularly dissolved oxygen, salinity, and temperature — to change or increase, which could significantly alter the existing structure of the benthic community (Rabalais et al. 2010). For example, freshwater discharge into the GOM has been increasing and is expected to continue to increase as a result of the increased rainfall in the Mississippi River Basin (Dai et al. 2009). Such changes could result in severe long-term or short-term fluctuations in temperature and salinity that could reduce or eliminate sensitive species. Such changes are most likely to occur in the Mississippi Estuarine Ecoregion, where freshwater inputs are highest. Habitats most likely to be affected include inner-shelf and mid-shelf hard-bottom and soft-sediment habitats, although the benthos of deepwater areas affected by the Mississippi River, such as Mississippi and DeSoto Canyons, may also be affected. In addition, greater rainfall may increase inputs of nutrients into the GOM, potentially resulting in more intense phytoplankton blooms that could promote benthic hypoxia (Rabalais et al. 2010). The increased freshwater inputs and surface water temperature may also promote water column stratification, which is also conducive to the development and expansion of the existing GOM Dead Zone. Hypoxic or anoxic conditions can reduce or eliminate the suitability of benthic habitat for marine organisms.

3.7.2.1.7 Effects of DWH Event on Marine Benthic Habitats. In response to the DWH event, extensive nearshore and offshore sediment sampling was conducted in order to map contamination levels (OSAT 2010). Of the sediment samples collected throughout the 2010 sampling period, less than 6% of deepwater (>200 m) samples and less than 1% of offshore and nearshore samples (out to 3 nautical miles and 200 m depth) exceeded the USEPA chronic aquatic life benchmark for PAHs and were chemically determined to be contaminated with oil from the DWH event (OSAT 2010). Dispersants were only detected in 1 of the 243 sediment samples, and no samples had dispersant concentrations that exceeded the USEPA's dispersant benchmarks (OSAT 2010). More data are needed before characterizing the implications of the DWH event on soft sediment habitat. In heavily oiled areas, the recovery time is unknown, but sediments in deeper waters may take longer to recover because colder temperatures could reduce microbial activity. However, studies of deepwater plumes following the DWH event suggest bacterial productivity rapidly responds to the presence of oil and microbial reduction in oil concentrations occurred more quickly than expected, given the low temperatures and high pressure (Hazen et al. 2010). Whether the same rapid breakdown would occur along the seafloor is unknown. Overall, natural physical and bioremedial processes will break down the oil, and it is likely that soft sediment habitat affected by the DWH event will recover.

There is some evidence that the DWH event affected more sensitive benthic habitats. In November 2010, a survey of deepwater corals along the predicted trajectory of the DWH event in 1,400 m (4,593 ft) of water revealed a 15 × 40-m (49 × 131-ft) area of dead and dying deepwater corals covered in brown flocculent (http://www.boemre.gov/ooc/press/2010/press1104a.htm). Follow-up studies indicated that the flocculent contained oil from the DWH event located approximately 11 km (7 mi) to the northeast and almost half of the corals at the site had been impacted by exposure to oil (White et al. 2012). Surveys of 11 other deepwater coral sites in the GOM did not suggest they had been impacted by the DWH event (White et al. 2012). Investigations are ongoing. It is not known how many deepwater coral communities were affected or whether the affected corals will recover. The DWH event occurred more than 320 km (200 mi) from the FGBNMS, and there were no reports of oil from the spill reaching the FGBNMS (http://flowergarden.noaa.gov/education/oilspill.html). The FGBNMS is monitored as part of a regular program, and any changes related to the spill should be detected.

3.7.2.2 Alaska – Cook Inlet

The Cook Inlet Planning Area is located within the Alaska Fjordland Shelf Ecoregion (Wilkinson et al. 2009). The physical characteristics of the benthic habitats of Kachemak Bay, Shelikof Strait, and lower Cook Inlet are critical in determining habitat function. Several distinct benthic habitats have been identified based on tidal inundation and substrate, which can consist of rock, sand, silt, and/or shell debris. Plant and animal communities in rocky habitats have strong patterns of zonation with marked variation in species composition, community structure, and productivity. In the rocky intertidal habitat, benthic assemblages are concentrated below the seaweed zone, probably due to battering by waves and kelp (MMS 1996b). The Shelikof Strait is relatively ice free even in winter (MMS 2003a). However, seasonal ice is an important influence on habitat function in Cook Inlet. The western side of Cook Inlet experiences seasonal ice scour and has biological and physical characteristics that are more similar to Arctic habitats compared to the eastern side, which does not experience ice scour (MMS 1996b, 2003a). The Cook Inlet lease sale 149 EIS (MMS 1996b) and 191 and 199 lease sale EIS (MMS 2003a) contain a comprehensive description of the habitats and biota found in Cook Inlet. See Section 3.8.4.2 and Section 3.8.5.2 for a further description of fish and benthic invertebrate communities in Cook Inlet.

The Gulf of Alaska is located outside of the Cook Inlet Planning Area and therefore would not be directly disturbed by oil and gas infrastructure. However, it could be affected by an oil spill associated with OCS activities in Cook Inlet and therefore will be briefly described. In the Gulf of Alaska, sediment deposition and sediment grain size are important determinants of benthic communities. In areas of the Gulf of Alaska where sediments are fine and sedimentation rates are high (particularly in the north-central region), nearshore infauna consists mostly of mobile deposit-feeding organisms. Greater numbers of sessile and suspension feeding infauna occur west of Prince William Sound as sediment changes to sand/gravel. A relatively low biomass of deposit feeders occurs in the eastern Gulf of Alaska, an environment characterized by strong tidal currents and sediment of low organic content (Semenov 1965).

Strong benthic-pelagic coupling is present in the Gulf of Alaska. Studies of Prince William Sound indicate sediment habitat receive the greatest springtime inputs of phytoplankton in years when phytoplankton blooms are of short duration and high biomass (Eslinger et al. 2001). Soft sediment habitat also contributes to water column productivity when sediments are resuspended by wind and wave action.

3.7.2.2.1 Climate Change Effects on Cook Inlet Marine Benthic Habitats. Continuing trends in climate change are expected to result in chemical, physical, and hydrologic changes in Cook Inlet. For example, increased river discharge is expected to alter the salinity, temperature, and turbidity regimes in nearshore benthic habitat (Arctic Council 2005), potentially resulting in changes in the composition, abundance, and diversity of sessile benthic communities. See Sections 3.8.4.2 and 3.8.5.2 for a discussion of climate change and benthic fish and invertebrates. In addition to changes in hydrology, rising temperatures may reduce the extent and duration of landfast ice, resulting in a reduction in the scouring of intertidal and shallow subtidal habitats on the western side of Cook Inlet. A reduction in scour may allow more persistent and non-opportunistic invertebrate communities to develop. Warmer temperatures may also increase phytoplankton productivity, potentially resulting in greater food inputs to benthic habitats. Alternatively, the greater expected river discharge could increase stratification and reduce light and nutrients available for phytoplankton (Strom et al. 2010). Such a change could reduce organic matter inputs to the seafloor by decreasing phytoplankton productivity or shifting the phytoplankton community to smaller species, resulting in more of the primary productivity being consumed in the water column and less sinking to the seafloor.

3.7.2.3 Alaska – Arctic

The Beaufort and Chukchi Planning Areas include the Beaufort/Chukchian Shelf Marine Ecoregion and the Arctic Slope and Arctic Plains Marine Ecoregions. In both planning areas, oil and gas exploration and production activities will generally occur in water depths of less than 200 m (656 ft).

Most of the seafloor of the Beaufort/Chukchian Shelf Marine Ecoregion consists of a soft-bottom, featureless plain composed of silt, clay, and sand. Deposits of flocculated particles from plankton blooms, epontic organisms, and ice algae from ice retreat all contribute to the bottom sediments in these regions. Disturbance from sea ice scour is a dominant process affecting the seafloor of the Beaufort and Chukchi shelves. Deep keels of icebergs moving across the shelf scour sediments, causing chronic disturbance to benthic communities. Strudel (drainage of large volumes of freshwater through the ice at holes and cracks) scouring of the seafloor also occurs near the mouths of rivers during spring flood periods. Few species inhabit the seafloor in waters shallower than 2 m (6.6 ft) deep because of the bottom fast ice, which prohibits overwintering of most organisms. This nearshore benthic area is recolonized each summer, mainly by mobile, opportunistic, epifaunal crustaceans (amphipods, mysids, cumaceans, and isopods, which are fed on primarily by waterfowl and fishes). In slightly deeper water, the gouging of the seafloor by ice keels creates a habitat for opportunistic infauna (e.g., small clams and other invertebrates), which are fed on by seabirds, fishes, and walrus (Bluhm and Gradinger 2008). Surveys on the Chukchi Shelf revealed that tunicates, echinoderms, jellies, crabs, polychaetes, and sponges make up most of the benthic biomass (NPFMC 2009). Common fish on soft sediments included Arctic cod (*Boreogadus saida*), Pacific herring (*Clupea pallasii*), sculpins, and pollock (*Theragra chalcogramma*) (NPFMC 2009). See Sections 3.8.4.3 and 3.8.5.3 for descriptions of fish and invertebrate communities.

Food sources supporting soft-sediment habitat are highly seasonal and primarily derive from terrestrial sources and from water column primary and secondary production originating locally or advected from the Bering Sea. Data from the Northern Bering Sea and the Chukchi Sea suggests there is a strong coupling between phytoplankton biomass and benthic invertebrate biomass (also known as benthic-pelagic coupling), suggesting that communities on seafloor habitats rely strongly on organic matter originating from the water column. These benthic communities in turn support higher trophic levels such as benthic feeding birds and marine mammals (Dunton et al. 2005; Grebmeier et al. 2006). Thus, the fact that the biomass of benthic invertebrates in Chukchi Shelf sediments is higher than that in Beaufort Shelf sediments is thought to result from the higher phytoplankton and organic matter available on the former (Dunton et al. 2005). In contrast, benthic communities on the Beaufort Shelf do not appear to be related to phytoplankton biomass but rather to the availability of terrestrial organic matter from coastal erosion or riverine inputs (Dunton et al. 2006). Organic matter released from sea ice habitat is another food source that may be critical to benthic species in certain locations and seasons. For example, early life stages of benthic invertebrates are commonly found in the water column associated with sea ice (Gradinger and Bluhm 2005). In addition, much of the phytoplankton from ice-edge blooms associated with the spring sea ice melt is exported to the seafloor because of the low zooplankton density in the water column in the early spring (Bluhm and Gradinger 2008).

Hard-bottom seafloor habitat is also present, primarily in the form of cobble and boulders distributed sporadically along the inner Beaufort and Chukchi shelves and in the Barrow Canyon (MMS 2002a). Three such locations are in Stefansson Sound and western Camden Bay in the Beaufort Sea and in Peard Bay in the Chukchi Sea (MMS 2003b, Section III.B.1.b; BLM and MMS 2003b, Section III.A.2.c(3)). In addition, Peard Bay and the Stefansson Sound Boulder Patch have kelp communities, with the latter having the largest brown kelp (*Laminaria solidungula*) community in the Alaskan Arctic (Phillips et al. 1984; Dunton et al. 2004; Figure 3.7.2-4). The resident species are found at higher diversity, abundance, and biomass in boulder patches than in surrounding areas and are composed of a unique community of algae, bryozoans, hydroids, polychaetes, bivalves, crustaceans, and the soft coral associated with them (Iken 2009). Sediment inputs from rivers and ice scouring are primary controls on biological productivity in boulder habitat. Results of a recent study conducted under the BOEM Arctic Nearshore Impact Monitoring in the Development Area (ANIMIDA) Program demonstrated that suspended sediment can reduce the light available for kelp production during open-water periods of summer (Dunton et al. 2004) and that kelp productivity is significantly reduced in years where sediment loading is high (Aumack et al. 2007). The reduced photosynthesis can result from sediment coating kelp blades or reducing light penetration into the water column. Multiple studies have also demonstrated that boulder habitats are subject to frequent disturbance from the freezing and thawing of ice. If significantly scoured or overturned, communities associated with boulders are slow (2 or more years) to begin recovery, with full recovery taking a decade or more (Konar 2007 and references therein).

Although no drilling is proposed on the Beaufort or Chukchi slope, in recent investigations, “pock marks” were discovered on the Chukchi slope (MacDonald et al. 2005). These crater-like features are about 1 km (3,281 ft) in diameter and 40 m (131 ft) deep and are located between the 500-m and 1,000-m (1,640-ft and 3,280-ft) isobath. The abundance and

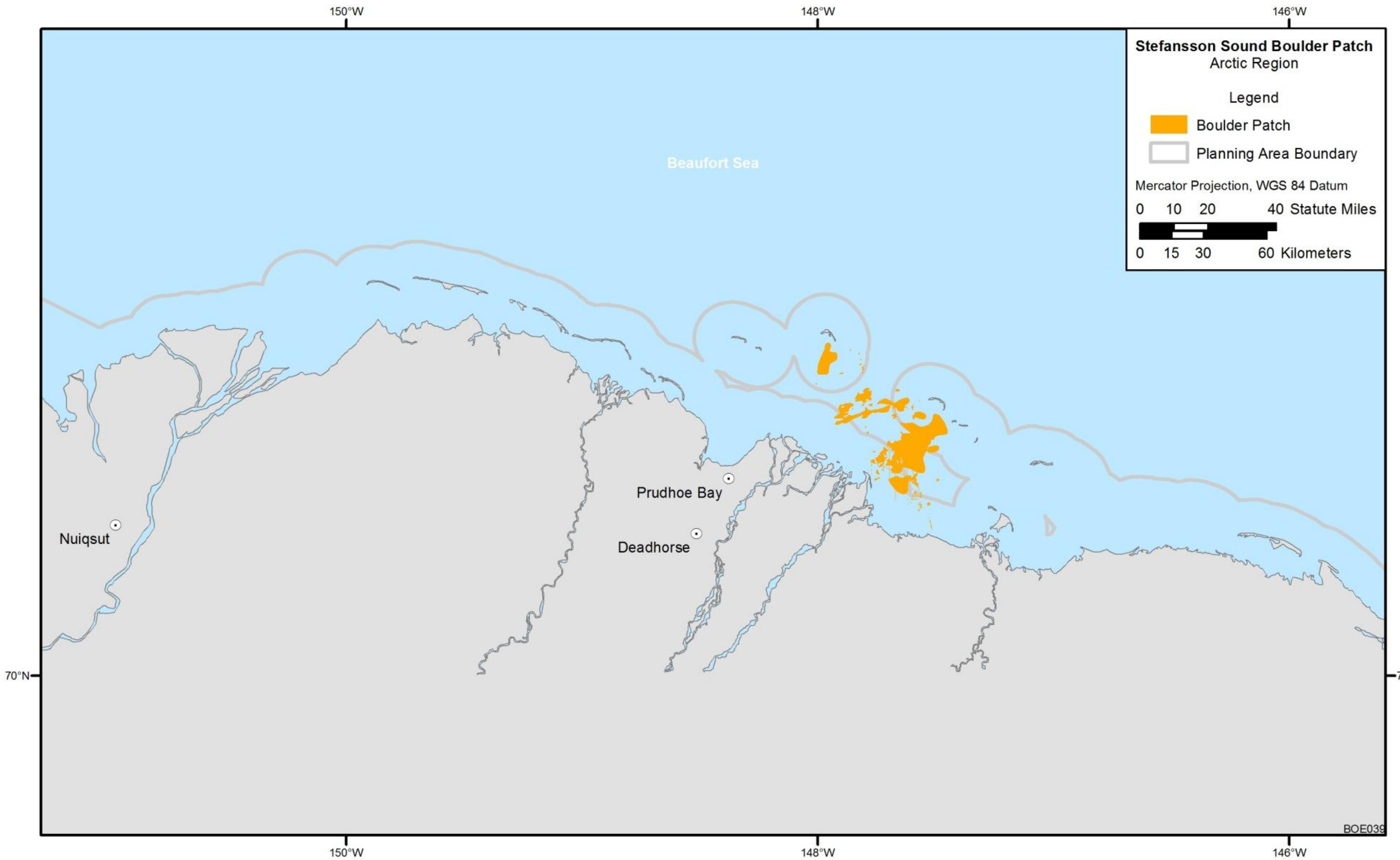

FIGURE 3.7.2-4 Location of the Stefansson Sound Boulder Patch in the Beaufort Sea Planning Area

diversity of invertebrates were higher in the pock marks than in the surrounding sediments. Brittle stars, various types of anemones, shrimps, eel pouts, stalked crinoids, benthic ctenophore, gooseneck barnacles, mysids, and holothurians were the most abundant epifauna. Polychaetes, foraminiferans, nemertineans, cnidarians, peanut worms, and clams were the most abundant infauna (MacDonald et al. 2005).

3.7.2.3.1 Climate Change Effects on Arctic Marine Benthic Habitats. Continuing trends in climate change are expected to result in chemical, physical, and hydrologic changes in the Alaska Fjordland Shelf and Beaufort/Chukchian Shelf Ecoregion. For example, increased river discharge is expected to alter the salinity, temperature, and turbidity regimes in nearshore benthic habitat (Arctic Council 2005; Hopcroft et al. 2008), potentially resulting in changes in the composition, abundance, and diversity of sessile benthic communities.

The predicted decrease in the extent and duration of sea ice also has implications for benthic habitat. The retreat of the summer sea-ice cover from the coastline during the last few decades (Arctic Council 2005) has created an unusually wide expanse of open water, which has led to the formation of large storm waves that cause shoreline erosion and consequent changes to the intertidal and shallow subtidal benthic habitats. A reduction in the extent of sea-ice cover may also reduce the intensity of benthic scouring. A decrease in the sea-ice cover will adversely affect sea-ice-dependent benthic biota and reduce the seasonally important pulse of sea-ice organic matter to the seafloor. Recent data also suggests that benthic-pelagic coupling could be weakened if the existing temperature increases and reductions in sea ice continue in the Arctic. A reduction in organic matter inputs to the benthos could reduce benthic productivity and shift the system from a benthic-dominated food web to a more pelagic-oriented system dominated by pelagic fishes (Grebmeier et al. 2006). Benthic feeding birds and marine mammals could suffer from the reduced benthic productivity (Grebmeier et al. 2006). Such changes are less likely to affect the Beaufort Sea than the Chukchi Sea which exhibits a high degree of benthic-pelagic coupling (Hopcroft et al. 2008). The loss of sea-ice organic-matter deposition may be made up for by higher open water phytoplankton productivity (Arrigo et al. 2008), some of which will settle to the seafloor. Alternatively, as Arctic waters warm, the flux of organic matter to the benthos may decrease if phytoplankton productivity decreases or shifts to smaller species due lower nutrient availability (Li et al. 2009) or if there is an increased consumption of phytoplankton by zooplankton (Arrigo et al. 2008).

Climate change also has several potential implications for hard-bottom habitat. The reduction in sea-ice cover may reduce the spatial and temporal extent of scouring, and it may also increase wave action, which could result in more frequent disturbance of slow-recovering Boulder Patch habitats. The increase in total suspended solids due to coastal erosion and the greater riverine sediment loading could increase turbidity in the water column and consequently decrease the penetration of photosynthetically active radiation available for kelp production (Hopcroft et al. 2008).

3.7.3 Marine Pelagic Habitats

Marine pelagic habitats exist in the water column rather than the seafloor, and include the water surface. The following sections focus on the water column as habitat for biota. See Section 3.4 for a discussion of water quality in the GOM, Cook Inlet Planning Area, and the Beaufort and Chukchi Sea Planning Areas.

3.7.3.1 Gulf of Mexico

3.7.3.1.1 Water Column. Pelagic habitats in the GOM include unique habitats such as drifting surface *Sargassum* and areas where dynamic ocean circulation processes result in high biological productivity. The Mississippi and Texas Estuarine Areas have high inputs of riverine nutrients, which promote phytoplankton productivity in the surface water; this, in turn, supports a high biomass of vertebrate and invertebrate consumers. Primary production is typically limited by nutrients whose concentrations are greatly reduced in the absence of riverine inputs. Therefore, primary production decreases to the west and east with distance from the Mississippi River, and it decreases from the Mississippi and Texas Estuarine Areas seaward to the neritic ecoregions, where the phytoplankton are dominated by small picophytoplankton, dinoflagellates, and cyanobacteria (Hulbert and Corwin 1972; Wawrik and Paul 2004). Oceanic waters beyond the continental shelf edge are similarly unproductive. Although most oceanic waters are relatively unproductive, there are areas of temporarily high productivity. For example, upwelling zones occur along the edge of the GOM shelf, where deepwater moves up the continental slope, bringing nutrients into the photic zone. The combination of high irradiance and high nutrient levels allows seasonally high primary and secondary production in upwelling zones. The DeSoto and Mississippi Canyons are important upwelling zones in the Central Planning Areas, and the south Texas shelf is an upwelling zone in the Western Planning Area (GMFMC 2004; Walker et al. 2005; Zavala-Hidalgo et al. 2006).

Most pelagic primary consumers are temporary or permanent zooplankton. Temporary zooplankton are larval stages of fish and invertebrates that mature in the marine environment or are transported into estuaries where they will reach their juvenile stage. Permanent zooplankton remain in a planktonic state for their entire life cycle. Zooplankton serve as critical food sources. They also play a key role in recycling nutrients within the water column and in transferring water column primary production to sediment consumers in the form of fecal pellets and carcasses.

Pelagic waters can be classified into zones on the basis of their depth (Bond 1996). Epipelagic habit is defined as the upper 200 m (656 ft) of the water column. Because of the high clarity of the water, light penetrates deeply enough to support limited primary production in water as deep as 200 m (656 ft). Below this euphotic zone, light levels and consequently primary production are limited or nonexistent. Below the epipelagic zone, the water column may be layered into the mesopelagic zone (200 to 1,000 m [656 to 3,281 ft]) and bathypelagic (>1,000 m [>3,281 ft]) zone. To overcome the low availability of food at depth, many mesopelagic fishes and megaplankton spend their days in depths of 200 to 1,000 m (656 to 3,281 ft) but migrate vertically at night into food-rich near-surface waters. Mesopelagic fish and zooplankton are important ecologically because they transfer significant amounts of energy between mesopelagic and epipelagic zones over each daily cycle. For example, the lanternfishes, which are abundant mid-water species in the GOM, are important prey for meso- and epipelagic predators like tuna (Hopkins et al. 1996).

The bathypelagic zone is an aphotic, food-poor habitat. Consequently, predators and scavengers dominate this zone. The base of the food web is relatively degraded particulate falling from the photic zone. This material can aggregate into larger particles called marine snow. Many organisms occupying the bathypelagic zone have evolved adaptations to the harsh physical and chemical conditions; these include a lowered metabolic rate and soft bodies with high water content to reduce the need for food and hypercephelization and large jaws to swallow a greater size range of prey (Miller 2004). Deeper-dwelling (bathypelagic) fishes are composed of strange, little-known species, such as snipe eels (family Nemichthyidae), slickheads (family Alepocephalidae), bigscales (family Melamphaidae), and whalefishes (family Cetomimidae) (McEachran and Fechhelm 1998). Most species are capable of producing and emitting light (bioluminescence) to aid communication in an environment devoid of sunlight.

The ecological effects of the DWH event are still being investigated. However, data collected from recent research cruises indicate that some tentative conclusions can be made about the effect of the spill on marine pelagic habitats. The spill released both oil and methane gas into the water column, some of which was entrained in bottom currents, forming a subsurface plume. Comprehensive sampling during and after the spill over a wide area and depth strata of the GOM reported less than 2% of water column samples taken from nearshore, offshore, and deepwater areas contained PAH concentrations exceeding USEPA toxicity benchmarks (OSAT 2010). Contamination related to oil from the DWH event was found within approximately 70 km (43 mi) of the wellhead in deep water. The toxicity of water samples decreased with distance from the wellhead (OSAT 2010). Surveys in late June 2010 indicated that there was a subsurface methane plume (as high as 180 m [591 ft]) in 800 to 1,200 m (2,625 to 3,937 ft) of water that extended from the DWH (Valentine et al. 2010; Kessler et al. 2011). However, the plume was not found in samples collected in August and September 2010, despite extensive areal sampling coverage (Kessler et al. 2011). Also in June 2010, clouds of oil trending southwest from the well were found at a depth of 1,100 m (3,609 ft); they extended 35 km (22 mi) from the wellhead (Camilli et al. 2010; Atlas and Hazen 2011). The dispersed oil was as thick as 200 m (656 ft) and up to 2 km (6,562 ft) in width (Camilli et al. 2010). Dispersants were also found in the subsurface oil clouds; their concentrations decreased significantly with time and distance from the well as a result of their dilution with seawater (Kujawinski et al. 2011). However, dispersant was still detectable at low, nontoxic levels up to 300 km (186 mi) away from the wellhead 64 days after the dispersant application ended, suggesting slow natural breakdown (Kujawinski et al. 2011).

The biological effects of the DWH event are still being investigated. Phytoplankton productivity has been found to increase, decrease, or remain unchanged following oil spills (Hu et al. 2011). PAH toxicity or lower solar irradiance could reduce phytoplankton productivity, while phytoplankton biomass could increase if zooplankton are suppressed. Jernelov and Linden (1981 cited in Hu et al. 2011) reported a phytoplankton bloom after the IXTOC-1 oil spill. Satellite imagery suggests that phytoplankton biomass increased in areas of the GOM following the DWH event, but there were not enough data to link the increase directly to the oil released by the DWH (Hu et al. 2011). The DWH event also changed pelagic microbial communities. The amount of menthanotropic and oil-eating bacteria increased greatly after the DWH event (Atlas and Hazen 2011; Kessler et al. 2011). However, the increase in microbial biomass did not result in significant oxygen depletion, even in deep water. In shallow coastal areas, the hydrocarbon appeared to be assimilated by bacteria and transferred up through the zooplankton food web (Graham et al. 2010). The carbon derived from the DWH event appeared to have been metabolized and assimilated into the food web within weeks (Graham et al. 2010; Atlas and Hazen 2011). These studies suggest the GOM has a tremendous natural capacity to assimilate accidental oil spills.

3.7.3.1.2 Pelagic *Sargassum* Habitat. Floating *Sargassum* mats are present in neritic and oceanic waters (Figure 3.7.3-1). *Sargassum* in the GOM consists of three species of brown algae: *Sargassum natans* (80%) *S. fluitans* (10%), and detached sessile *S. filapendula* (10%) (GMFMC 2004). Satellite maps indicate that *Sargassum* originates in the northwest GOM in the spring and is transported through the Florida Straits into the Atlantic Ocean via the Loop Current and Gulf Stream (Gower and King 2008). Its abundance is highest in the summer and decreases in the fall and winter (Figure 3.7.3-1). *Sargassum* is distributed over the entire GOM in shelf, basin, and slope waters.

As many as 54 fish species are closely associated with floating *Sargassum* at some point in their life cycle, but only two species spend their entire lives there: the *Sargassum* fish (*Histrio histrio*) and the *Sargassum* pipefish (*Syngnathus pelagicus*) (MMS 1999). Hydroids, anthozoans, flatworms, bryozoans, polychaetes, gastropods, nudibranchs, bivalves, cephalopods, pycnogonids, isopods, amphipods, copepods, decapod crustaceans, insects, and tunicates can all be found in the *Sargassum*-associated invertebrate community (GMFMC 2004). Most fish associated with *Sargassum* are temporary residents, such as juvenile stages of species that reside in shelf or coastal waters as adults (MMS 1999). *Sargassum* mats are also recognized as preferred habitat for hatchling sea turtles (Carr and Meylan 1980). These species subsist on the shrimp and crabs that dominate the invertebrate biomass within the *Sargassum* mat. Several large fish species of recreational or commercial importance — including dolphin fish, yellowfin tuna, blackfin tuna, skipjack tuna, Atlantic bonito, little tunny, and wahoo — feed on the small fishes and invertebrates attracted to *Sargassum* (Morgan et al. 1985; MMS 1999).

3.7.3.1.3 Climate Change Effects on GOM Marine Pelagic Habitats. See Water Quality, in Section 3.4.1, for a discussion of the potential effects of climate change on water quality in the GOM.

Climate change may affect water column productivity and ecosystem processes (Table 3.7.3-1). Surface water phytoplankton productivity in nearshore and mid-shelf areas is likely to increase during the spring because of the greater discharge of nutrient-rich river water into the GOM (Rabalais et al. 2010). The composition of the phytoplankton community may also change to reflect the new nutrient, salinity, and temperature regime, although the nature of the changes is unknown. Some have predicted that silica limitation in the face of greater nutrient

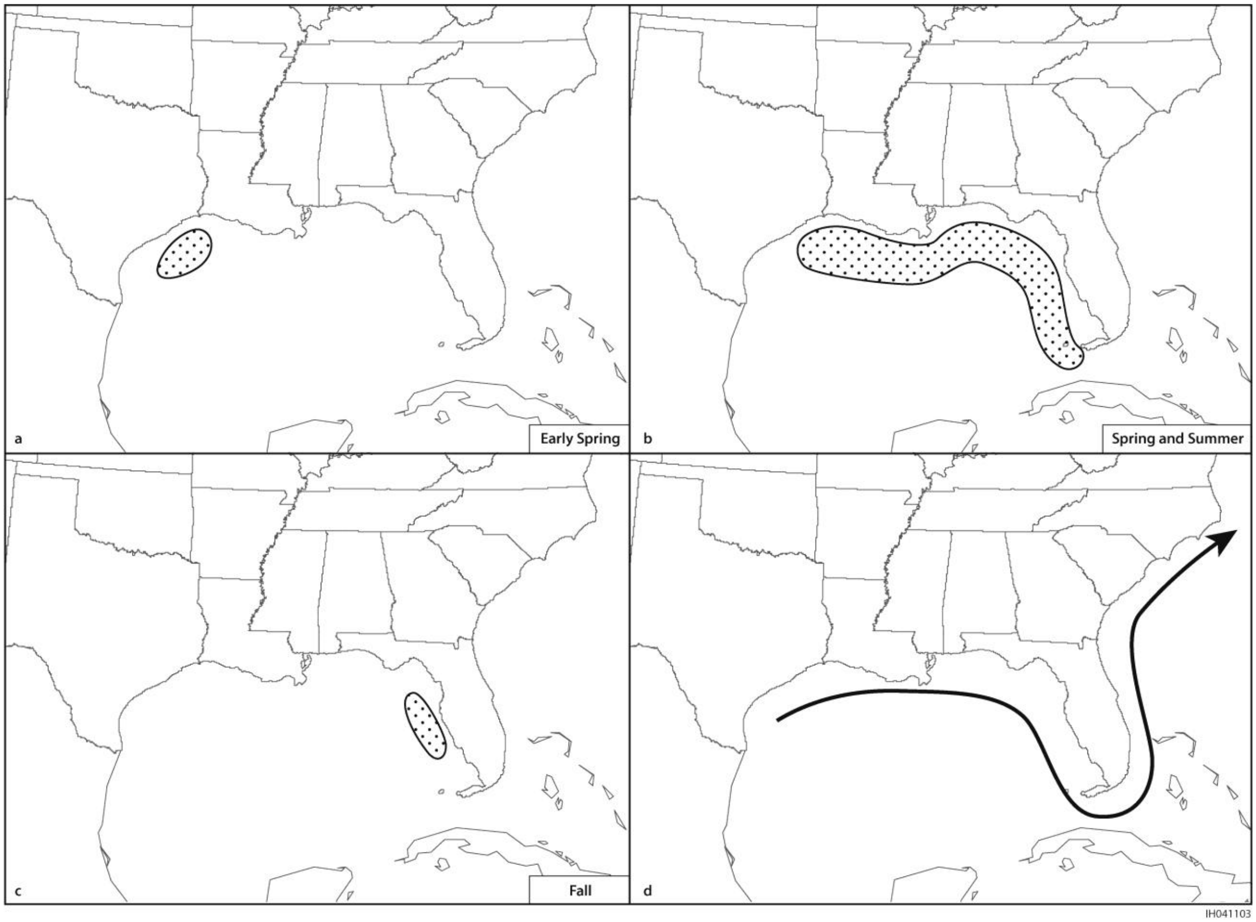

FIGURE 3.7.3-1 Areas of High Abundance of *Sargassum* in the GOM in (a) Early Spring, (b) Spring and Summer, and (c) Fall. General Trajectory of *Sargassum* Movement Is Shown in (d). (Map based on satellite data collected by Gower and King [2008].)

inputs may reduce the relative abundance of diatoms in favor of nuisance phytoplankton such as dinoflagellates (Turner 2001). If this were to occur, the traditional diatom-zooplankton food web could potentially shift to a microbial-based food web, resulting in a reduction in energy transfer to higher trophic levels. Along with increased primary production in the springtime, the greater freshwater inputs and surface water temperature may promote water column stratification; together, these could promote the development and expansion of the existing GOM Dead Zone (area of hypoxic or anoxic water that develops seasonally in the GOM). In the summer, the productivity of surface water phytoplankton may decrease because higher water temperatures may promote greater thermal stratification and reduce the transfer of nutrients to the upper water column. However, the expected increase in the frequency and severity of tropical storms may promote water column turnover and reduce the duration of hypoxic conditions (Rabalais et al. 2010).

The impact of increased atmospheric CO_2 on pelagic productivity is complicated and difficult to predict. Increased CO_2 could increase primary productivity by increasing the carbon available for photosynthesis. However, greater CO_2 has also resulted in the formation of

TABLE 3.7.3-1 Summary of Potential Changes in the Marine and Pelagic Habitats of the Northern GOM Marine Ecoregion That Could Result from Climate Change

Climate Change Impact Factor	Soft Sediment	Coral	Hard Bottom	Deepwater Coral	Chemosynthetic Communities	Pelagic Habitat
Sea level rise		Decrease in light availability				
Temperature increase	Changes in biogeochemical processes; changes in food inputs to the seafloor	Increase in coral bleaching	Changes in food inputs to the seafloor	Changes in food inputs to the seafloor		Greater water column stratification; changes in water column productivity
Ocean acidification		Decrease in growth and distribution	Decrease in coral growth	Decrease in growth and distribution	Decrease in growth of chemosynthetic mussels and clams	Changes in phytoplankton composition
Increased storm frequency	Increase in benthic disturbance	Physical damage to corals	Physical damage and scouring			Greater mixing of water column
Increased river discharge	Physiological stress on sessile organisms; changes in biogeochemical processes	Increased nutrients and turbidity may reduce light penetration	Physiological stress on sessile organisms	Could affect habitat in GOM canyons	Could affect habitat in GOM canyons	Greater water column stratification and variation in water chemistry; changes in water column productivity

carbonic acid at the expense of carbonates in seawater. Aside from affecting pelagic invertebrates (Section 3.8.5.1), ocean acidification could also negatively affect calcifying phytoplankton species such as the coccolithophores (Royal Society 2005), which are often a dominant primary producer found in low-nutrient waters over the outer continental shelf and slope. However, other research suggests coccolithophore productivity will increase with greater CO_2 concentrations (Royal Society 2005).

3.7.3.2 Alaska – Cook Inlet

See Section 3.4.2 for a discussion of water quality in Cook Inlet. Cook Inlet pelagic waters are influenced by riverine and marine inputs, resulting in salinity gradients and horizontal mixing near the inlet. In general, extensive areas of pack ice do not form in Cook Inlet because of the large tidal range and strong tidal currents. However, seasonal ice is observed during the winter (MMS 2003a). The Shelikof Strait is relatively ice free even in winter (MMS 2003a). Pelagic habitat in Cook Inlet is highly productive, with phytoplankton biomass peaking in the spring. The spring phytoplankton bloom begins as the water column stratifies and light levels increase. However, productivity remains high in summer because of the resuspension of nutrient-rich bottom sediments due to tidal flux and strong winds. There is spatial variation in productivity as well, with the west side of Cook Inlet having lower primary and secondary production due to greater sediment loading. Diatoms and microflagellates, many of them advected from the Gulf of Alaska, dominate the phytoplankton assemblage.

In Shelikof Strait, studies indicate that the densities of zooplankton and pollock eggs are higher than in the adjacent continental shelf, and interannual variation in both appears to be controlled primarily by physical factors such as currents, salinity, and temperature, which in turn influence biologically important variables such as phytoplankton production (Kendall et al. 1996; Napp et al. 1996; Incze et al. 1997; Bacheler et al. 2009). Zooplankton are dominated by copepods of estuarine, continental shelf, and marine origin (Incze et al. 1997; Speckman et al. 2005).

The fate of phytoplankton depends on the timing of the spring phytoplankton bloom. Zooplankton biomass in Cook Inlet tracks seasonal peaks in phytoplankton. Zooplankton can consume a high proportion of phytoplankton biomass in years with a prolonged lower density bloom (Eslinger et al. 2001). However, in years with a short high-density bloom, zooplankton consumption cannot keep up with phytoplankton production and much of the phytoplankton is exported to the seafloor.

3.7.3.2.1 Climate Change Effects on Cook Inlet Planning Area Pelagic Habitat. See Section 3.4.2 for a discussion of climate change and water resources in Cook Inlet. The effects of climate change on pelagic habitat in Cook Inlet are difficult to predict with certainty because of the complexity of the system. However, current and predicted trends suggest climate change will significantly alter the chemical, physical, and hydrologic properties of pelagic habitat, which will in turn alter biological communities. For example, the predicted increase in river discharge could change the salinity, temperature, and turbidity, and mixing regimes in nearshore areas and alter the composition of existing phytoplankton communities. Studies in the Gulf of Alaska suggest phytoplankton productivity is controlled by a number of factors, especially light, microzooplankton consumption, nutrients, and water column stratification (Strom et al. 2010). In the future, given the complicated regulation of primary productivity and how each of these factors may be affected by climate change, annual phytoplankton productivity may increase or decrease (Strom et al. 2010). The timing and duration of phytoplankton blooms, as well as seasonal species composition, are also likely to be altered. Such changes in phytoplankton productivity may increase or decrease net export of organic matter to the benthos. For example, if climate change decreases nutrient availability, smaller species may come to dominate the phytoplankton assemblage, resulting in more of the primary productivity being consumed in the water column and less sinking to the seafloor.

Ocean acidification from increasing CO_2 inputs into the ocean is also predicted to continue in Alaskan waters and may reduce the availability of calcite and aragonite to calcifying marine organisms. In the Gulf of Alaska, carbonate undersaturated water from the outer shelf and slope periodically moves inshore, potentially reducing the abundance of calcifying invertebrate prey for commercially important species such as salmon and pollock (Fabry et al. 2009).

3.7.3.3 Alaska – Arctic

Water depths in the Beaufort and Chukchi Sea Planning Areas range up to 3,800 m (12,467 ft). Section 3.4.3 has a detailed description of the physical and chemical characteristics of the water column. In both planning areas, oil and gas exploration and production activities would generally occur in the inner shelf in water depths up to 200 m (656 ft).

The Beaufort Sea and Chukchi Sea are characterized by distinct hydrographic and productivity regimes. Both systems undergo extended seasonal periods of frigid and harsh environmental conditions, reduced light, seasonal darkness, prolonged low temperatures, and ice cover. The lack of sunlight and extensive ice cover in Arctic latitudes during winter months greatly reduces primary and secondary productivity (Craig 1989).

Pelagic habitat in the Beaufort/Chukchi Marine Ecoregion consists of ice-free open water and high-productivity areas of open water surrounded by sea ice (polynyas). Productivity in the water column is primarily controlled by temperature, nutrients, light, and the amount of sea ice in a given year. Phytoplankton productivity is highest in the summer when temperatures are highest (Hopcroft et al. 2008) and when nutrient and solar irradiance are most conducive to productivity. Phytoplankton productivity gradually decreases from the southwestern Chukchi Sea to the east to the Beaufort Sea (especially east of Point Barrow) and from inshore to offshore areas, although there are isolated mid-shelf upwelling regions where productivity is higher than it is in the surrounding water. The east-to-west trend is thought to be caused by the import of nutrients, phytoplankton, and organic matter-rich water into the Chukchi Sea from the adjacent Bering Sea (Dunton et al. 2005) as well as the cold nutrient-poor water flowing into the Beaufort Sea from the Atlantic. Sea ice is also a primary influence on primary productivity, and nutrients from upwelling off the Barrow and Herald Canyons can also be delivered to the continental shelf

(Pickart et al. 2009). Phytoplankton productivity is highest in warmer years with less sea ice because of the higher areal extent of surface water solar irradiance and the longer growing season (Wang et al. 2005).

There are multiple fates for water column productivity, and they depend highly on the timing of phytoplankton and zooplankton activity. In the early spring when waters are still cold, zooplankton (primarily protozoans and copepods) are not as active, and much of the productivity may be exported to the seafloor, where it is a critical subsidy for the benthic food web. In late spring and summer, however, during periods of active zooplankton growth, much of the productivity may be consumed in the water column (Hopcroft et al. 2008). In general, the Chukchi exhibits strong benthic-pelagic coupling, with high flux of phytoplankton and organic matter from open water areas (including polynyas) to the sediment. The production may also be advected to deep waters of the Canada Basin (Cooper et al. 2002; Bates et al. 2005).

Pelagic habitats of the Arctic contain classes of organisms similar to those found in subarctic and temperate waters, such as protozoan microzooplankton, copepods, euphausiids, shrimp, larvaceans, cnidarians, ctenophores, pteropods, and squid. The pelagic fish assemblage is dominated by Arctic cod, whitefish (*Coregonus*), capelin (*Mallotus villosus*), and herring. All of these resources are important forage for marine mammals and birds. See Sections 3.8.4.3 and 3.8.5.3 for a discussion of Arctic fish and invertebrates.

3.7.3.3.1 Sea Ice. Sea ice is an important habitat in the northern Beaufort and Chukchi Seas; it exists for variable periods in the colder months of the year near the coastline and perennially closer to the shelf edge and basin. Sea ice is more extensive and lasts longer in the Beaufort Sea than the Chukchi Sea. Algae growing on the underside of sea ice can be the primary source of productivity in northern areas of the shelf with permanent ice cover, and sea ice algal productivity and biomass can exceed the productivity of the water column during the spring (Gradinger 2009). One primary control over the growth of sea ice algae is the availability of light under the ice, which is a function of snow cover, ice thickness, and sediment loading; all of which are negatively related to productivity. In addition to the diatoms that dominate the algal assemblage, sea-ice communities contain a diverse mixture of bacteria, protozoans, and a rich meiofaunal and macroinvertebrate community dominated by amphipods, copepods, and nematodes. These organisms are, in turn, fed upon by higher trophic-level consumers, such as Arctic cod, seals, and birds. In addition, sea ice provides shelter and resting habitat for marine mammals and birds. Sea ice also supports the early life stages of fish (especially Arctic cod) and benthic invertebrates by providing temporary habitat (particularly nearshore sea ice) or by exporting seasonal pulses of organic matter to the seafloor (Gradinger and Bluhm 2005; Bluhm and Gradinger 2008). In addition, by trapping and transporting nutrients, sea ice can increase the spatial extent of nutrient availability to phytoplankton. Sea ice is responsible for strong ice-edge phytoplankton blooms, which occur as melting sea ice releases organic matter and fresh water, creating a stratified upper water column high in nutrients (Hopcroft et al. 2008; Mundy et al. 2009).

3.7.3.3.2 Climate Change. See Section 3.4.3 for a discussion of climate change and water resources in the Beaufort and Chukchi Seas. The effects of climate change on pelagic habitat in the Beaufort/Chukchi shelf are difficult to predict with certainty because of the complexity of the system. However, current trends suggest climate change will significantly alter the chemical, physical, and hydrologic properties of pelagic habitat, which will, in turn, affect biological communities. For example, increased river discharge is expected to alter the salinity, temperature, and turbidity regimes in nearshore areas (Hopcroft et al. 2008), which could change the distribution, abundance, and composition of existing phytoplankton and zooplankton communities (Section 3.8.5.3). Several rivers flow into the Beaufort shelf and this region may be more heavily affected than the western Chukchi shelf. The effects of increased river discharge on phytoplankton are difficult to predict because, although rivers deliver nutrients to coastal regions, the increase in sediment load could also reduce the availability of light.

Climate change in the Arctic is affecting the Arctic sea ice cover, which has retreated unusually far from the coastline during the last few decades (Arctic Council 2005). Climate change is expected to decrease the spatial extent and temporal duration of sea ice as well as make the ice thinner. Recent studies suggest the amount of ice formed in the winter is not sufficient to replace the amount of ice lost in the summer; consequently there has been a decrease in the ratio of thicker, multi-year ice to thinner, first-year sea ice (Kwok et al. 2009). Although thinner ice and less snow cover may promote the primary productivity beneath sea ice, increased river discharge (i.e., Mackenzie River) may trap more sediment within ice and reduce the availability of light (Gradinger and Bluhm 2005). In addition, a reduction in landfast ice will increase the sloughing of sediments from shoreline during storms, adding to the sediment loads and changing water chemistry in nearshore areas. In the winter, before the spring phytoplankton bloom, sea ice algae are the primary food source supporting pelagic biota (Lee et al. 2008). The loss of sea ice may therefore reduce seasonal food availability to sea ice dependent species. Spring ice melt occurs during a period when zooplankton are still inactive; therefore, much of the organic matter trapped in the sea ice is exported to the seafloor (Bluhm and Gradinger 2008). Recent data suggests that this strong benthic-pelagic coupling in the Chukchi Sea could be weakened if the existing temperature increases and reductions in sea ice continue (Grebmeier et al. 2006). The result could be a shift to a pelagic-based rather than a benthic-based food web as the flux of organic matter to the sediment is reduced and warmer temperatures promote increased phytoplankton grazing in the water column (Grebmeier et al. 2006; Hopcroft et al. 2008).

Overall phytoplankton productivity in the open water may increase as open water solar irradiance and wind-driven upwelling of nutrients increases with increasing temperature and ice retreat (Arctic Council 2005; Hopcroft et al. 2008; Arrigo et al. 2008). With the increase in phytoplankton productivity, the biomass of zooplankton may also increase if the phytoplankton blooms occur when zooplankton are active (Bluhm and Gradinger 2008). Alternatively, phytoplankton productivity may decrease or shift to picoplanktonic species if the upwelling of nutrients to the upper water column is reduced by stronger water column stratification from higher temperatures and ice melt (Li et al. 2009). In this case, there would be less energy available to larger zooplankton and ultimately pelagic fish, mammals, and birds.

Ocean acidification from increasing CO_2 inputs into the ocean is also predicted to continue in Arctic waters, which may reduce the availability of calcite and aragonite to calcifying marine organisms. Surface waters in the Arctic are currently supersaturated with aragonite (another form of carbonate), but it is predicted that they will be undersaturated by the century's end or earlier (reviewed in Fabry et al. 2009). Aside from affecting pelagic invertebrates, ocean acidification could also adversely affect calcifying phytoplankton species, such as the coccolithophores, which are often a dominant primary producer in low-nutrient waters over the outer continental shelf and slope. However, other research suggests that despite the potential adverse effects of reduced pH oncoccolithophore plate formation, their productivity could increase due to greater CO_2 concentrations which are used in photosynthesis. Clearly more research is needed as very few species have been tested, and many of these studies are laboratory based and may not be relevant to the far more complex oceanic environment (see Royal Society [2005] and Doney et al. [2009] for recent reviews).

3.7.4 Essential Fish Habitat

The National Marine Fisheries Service (NMFS) manages commercial and recreational fisheries within Federal waters under the Magnuson-Stevens Fishery Conservation and Management Act (FCMA) (16 USC 1801-1883). The 1996 amendments to this Act require regional fishery management councils (FMCs), with assistance from NMFS, to delineate essential fish habitat (EFH) in Fishery Management Plans (FMPs) or FMP amendments for all federally managed fisheries. EFH is defined as the water and substrate necessary for fish spawning, breeding, feeding, and growth to maturity (50 CFR Part 600). FMPs for fishery resources are submitted to the NMFS for approval and implementation. The FCMA mandates that any FMP shall: (1) describe and identify EFH for the fishery, (2) minimize to the extent practicable adverse effects on such habitat caused by fishing, and (3) identify other actions to encourage the conservation and enhancement of such habitat. The FCMA also requires Federal agencies to consult on activities that may adversely affect EFHs designated in the FMPs. Oil and gas development activities may have direct and indirect effects on an EFH that could be site-specific or habitat-wide.

In addition to designating EFH, the NMFS requires FMCs to identify habitat areas of particular concern (HAPCs) within FMPs (Figure 3.7.2.1.2-1). These HAPCs are discrete subsets of EFHs that the Councils may designate based on: (1) the importance of the ecological function provided by the habitat; (2) the extent to which the habitat is sensitive to human-induced environmental degradation; (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; or (4) the rarity of the habitat type (GMFMC 2004). While the HAPC designation does not confer additional protection for or restrictions on an area, it can help prioritize conservation efforts.

3.7.4.1 Gulf of Mexico

Various State and Federal agencies are involved in the management of fish resources in the GOM. The GOM Fishery Management Council (GMFMC), which typically prepares FMPs for the GOM, has identified marine and estuarine EFHs within its management area for a variety of fish and invertebrates. These species are listed in Tables 3.7.4-1 and 3.7.4-2 (NMFS 2010a). See Section 3.8.4.1 for a general discussion of fish in the GOM, as well as the potential changes to fish communities resulting from climate change.

Estuarine and coastal EFH includes the following habitats: submerged aquatic vegetation, emergent intertidal wetlands (marshes and mangroves), soft-bottom (mud, sand, or clay), live hard-bottom, oyster reefs, and estuarine water column. See Section 3.7.1.1 for a description of these coastal habitats. Coral reefs, marine water column, marine sediment, live-/hard-bottom, the continental slope, chemosynthetic cold seeps, *Sargassum*, and man-made

TABLE 3.7.4-1 Species for Which Essential Fish Habitat Has Been Designated in the GOM Region by the GOM Fishery Management Council

Reef Fish Fishery

Snappers – Family Lutjanidae
- Blackfin snapper (*Lutjanus buccanella*)
- Cubera snapper (*Lutjanus cyanopterus*)
- Gray snapper (*Lutjanus griseus*)
- Lane snapper (*Lutjanus synagris*)
- Mutton snapper (*Lutjanus analis*)
- Queen snapper (*Etelis oculatus*)
- Red snapper (*Lutjanus campechanus*)
- Silk snapper (*Lutjanus vivanus*)
- Vermillion snapper (*Rhomboplites aurorubens*)
- Yellowtail snapper (*Ocyurus chrysurus*)
- Wenchman (*Pristipomoides aquilonaris*)

Groupers – Family Serranidae
- Black grouper (*Mycteroperca bonaci*)
- Gag (*Mycteroperca microlepis*)
- Red grouper (*Epinephelus morio*)
- Scamp (*Mycteroperca phenax*)
- Speckled hind (*Epinephelus drummondhayi*)
- Snowy grouper (*Epinephelus niveatus*)
- Yellowedge grouper (*Epinephelus favolimbatus*)
- Yellowfin grouper (*Mycteroperca enenosa*)
- Yellowmouth grouper (*Mycteroperca interstitialis*)

Jacks – Family Carangidae
- Greater amberjack (*Seriola dumerili*)
- Lesser amberjack (*Seriola fasciata*)
- Almaco jack (*Seriola rivoliana*)
- Banded rudderfish (*Seriola zonata*)

Triggerfishes – Family Balistidae
- Gray triggerfish (*Balistes capriscus*)

Reef Fish Fishery (Cont.)

Tilefishes – Family Malacanthidae
- Goldface tilefish (*Caulolatilus crysops*)
- Blueline tilefish (*Caulolatilus microps*)
- Tilefish (*Lopholatilus chamaeleonticeps*)

Wrasses – Family Labridae
- Hogfish (*Lachnolaimus maximus*)

Red Drum Fishery
- Red drum (*Sciaenops ocellatus*)

Coastal Migratory Pelagic Fishes
- Cobia (*Rachycentron canadum*)
- King mackerel (*Scomberomorus cavalla*)
- Spanish mackerel (*Scomberomorus maculatus*)

Corals
- Class Hydrozoa (stinging and hydrocorals)
- Class Anthozoa (sea fans, whips, precious coral, sea pen, stony corals)

Shrimp Fishery
- Brown shrimp (*Penaeus aztecus*)
- Pink shrimp (*Penaeus duorarum*)
- Royal red shrimp (*Hymenopenaeus robustus*)
- White shrimp (*Penaeus setiferus*)

Lobster Fishery
- Spiny lobsters (*Panulirus* spp.)

Source: NMFS 2010a; 50 CFR Part 622.

TABLE 3.7.4-2 Highly Migratory Species Designated in the GOM Region under Federally Implemented Fishery Management Plans

Coastal Sharks	**Pelagic Sharks**
Atlantic angel shark (*Squatina dumerili*)	Bigeye sixgill shark (*Hexanchus vitulus*)
Atlantic sharpnose (*Rhizoprionodon terraenovae*)	Bigeye thresher shark (*Alopias superciliosus*)
Basking shark (*Cetorhinus maximus*)	Blue shark (*Prionace glauca*)
Bigeye sand tiger (*Odontaspis noronhai*)	Common thresher shark (*Alopias vulpinus*)
Blacknose shark (*Carcharhinus acronotus*)	Longfin mako shark (*Isurus paucus*)
Bignose shark (*Carcharhinus altimus*)	Porbeagle shark (*Lamna nasus*)
Blacktip shark (*Carcharhinus limbatus*)	Sevengill shark (*Heptranchias perlo*)
Bonnethead (*Sphyrna tiburo*)	Sixgill shark (*Heptranchias griseus*)
Bull shark (*Carcharhinus leucas*)	Shortfin mako shark (*Isurus oxyrinchus*)
Caribbean sharpnose shark (*Rhizoprionodon porosus*)	Oceanic whitetip shark (*Carcharhinus longimanu*)
Caribbean reef shark (*Carcharhinus perezi*)	
Dusky shark (*Carcharhinus obscurus*)	**Tuna**
Finetooth shark (*Carcharhinus isodon*)	Albacore (*Thunnus alalunga*)
Galapagos shark (*Carcharhinus galapagensis*)	Atlantic bigeye (*Thunnus obesus*)
Great hammerhead (*Sphyrna mokarran*)	Atlantic bluefin (*Thunnus thynnus*)
Lemon shark (*Negaprion brevirostris*)	Atlantic yellowfin (*Thunnus albacares*)
Narrowtooth shark (*Carcharhinus Brachyurus*)	Skipjack (*Katsuwonus pelamis*)
Night shark (*Carcharhinus signatus*)	
Nurse shark (*Ginglymostoma cirratum*)	**Swordfish**
Sandbar shark (*Carcharhinus plumbeus*)	Swordfish (*Xiphias gladius*)
Scalloped hammerhead (*Sphyrna lewini*)	
Silky shark (*Carcharhinus falciformis*)	**Billfish**
Smooth hammerhead (*Sphyrna zygaena*)	Blue marlin (*Makaira nigricans*)
Spinner shark (*Carcharhinus brevipinna*)	Sailfish (*Istiophorus platypterus*)
Tiger shark (*Galeocerdo cuvieri*)	White marlin (*Tetrapturus albidus*)
White shark (*Carcharodon carcharias*)	Longbill spearfish (*Tetrapturus pfluegeri*)
Sand tiger shark (*Carcharias taurus*)	
Whale shark (*Rhinocodon typus*)	

Source: NMFS 2010a.

structures are representative offshore and marine EFH. See Section 3.7.2.1 and Section 3.7.3.1 for descriptions of marine benthic and pelagic habitats in the GOM as well as the potential changes to these habitats resulting from climate change.

Within the Central and Western GOM Planning Areas, several individual reefs and banks located offshore of the Louisiana–Texas border have been designated HAPCs by the GMFMC (NMFS 2010a; Table 3.7.4-3; Figure 3.7.2-1). The HAPCs in the Eastern Planning Area that could be affected by oil spills from the Central or Western Planning Areas include the Florida Middle Grounds, the Madison-Swanson Marine Reserve, Pulley Ridge, and Tortugas North and South Ecological Reserve. Most of these HAPCs are important with respect to corals and coral reefs, and provide habitats for reef species such as snappers, groupers, and spiny lobster. In addition, NMFS has designated a HAPC for bluefin tuna located west of 86°W and seaward of

TABLE 3.7.4-3 The HAPCs Designated within the Central, Western, and Eastern GOM Planning Areas

Central and Western Planning Areas	
East Flower Garden Banks	Geyer Bank
West Flower Garden Banks	McGrail Bank
Stetson Bank	Jakkula Bank
29 Fathom Bank	Bouma Bank
MacNeil Bank	Sonnier Bank
Rezak Sidner Bank	Alderdice Bank
Rankin Bright Bank	
Eastern Planning Area	
Florida Middle Grounds	Madison-Swanson Marine Reserve
Tortugas North and South Ecological Reserves	Pulley Ridge

Source: NMFS 2010a.

the 100 m (328 ft) isobath, extending from the 100 m (328 ft) isobath to the Exclusive Economic Zone (EEZ), the limit of U.S. jurisdiction (Atlantic Bluefin Tuna Status Review Team 2011).

3.7.4.1.1 Effects of DWH Event on EFH and Managed Species. The DWH event has the potential to affect coastal and offshore EFH and managed species. Oil released as a result of the DWH event affected more than 1,046 km (650 mi) of the GOM coastal EFH, from the Mississippi River delta to the Florida panhandle (OSAT-2 2011; National Commission 2011b). More than 209 km (130 mi) of coastal habitat were moderately to heavily oiled, primarily in Louisiana (National Commission 2011b). EFH affected by oiling included beaches, coastal marshes, mudflats, mangroves, seagrass beds, and submerged aquatic vegetation (Section 3.7.1.1.5). Coastal EFH can also be affected by prevention and cleanup efforts such as excavation and removal of sand or mud (OSAT-2 2011). Studies of several oiled beaches in Florida, Alabama, Mississippi, and Louisiana indicated that 86–98% of the PAH fractions in the oil remaining in beach sands after cleanup were depleted, although the remaining PAH fractions had the potential to cause toxicological effects (OSAT-2 2011). Loss of marsh habitat along its edge as a result of oiling was observed. Of the over 5,000 water samples taken along the GOM, only 22 exceeded USEPA’s aquatic life benchmarks for PAHs and could be attributed to oil from the DWH event. After August, none of the water samples that exceeded USEPA benchmarks contained oil that could be traced to the DWH event (OSAT 2010). A full understanding of the effects of the spill is expected to take a considerable period of time, likely years.

The DWH event affected offshore marine EFH as well. OSAT reported toxic PAH concentrations were present in less than 2% of sediment and water column samples taken from offshore and deepwater areas (OSAT 2010). However, some researchers have reported seeing what appeared to be thick deposits of an unidentified substance on the seafloor as well as dead and dying deepwater corals (BOEMRE 2010b). Follow-up studies indicated that the flocculent contained oil from the DWH event located approximately 11 km (7 mi) to the northeast and almost half of the corals at the site had been impacted by exposure to oil (White et al. 2012). Surveys of 11 other deepwater coral sites in the GOM did not suggest they had been impacted by the DWH event (White et al. 2012).

The DWH event occurred several hundred kilometers from hard-bottom topographic features considered HAPC. There were no reports of oil from the spill reaching the FGBNMS (http://flowergarden.noaa.gov/education/oilspill.html). The FGBNMS is monitored as part of a regular program, and any changes related to the spill should be detected.

The DWH event released oil and methane gas into marine water column EFH, forming both a surface slick and a subsurface plume containing oil mixed with dispersants (Section 3.7.3.1.1; Camilli et al. 2010; Kessler et al. 2011; Kujawinski et al. 2011). The methane plume appeared to be relatively short-lived, with most of the methane being consumed by bacteria within 120 days from the onset of release (Kessler et al. 2011; Hazen and Atlas 2011). Dispersant was detectable at low, nontoxic levels up to 300 km (186 mi) away from the wellhead 64 days after the dispersant application ended (Kujawinski et al. 2011).

There are many ongoing studies, but little data available on impacts to fisheries from the DWH event. The spill has the potential to cause population-level impacts on commercially harvested fish and invertebrate species, particularly species that have already-depressed populations or early life stages that rely heavily on marine and coastal habitats affected by the spill. The Atlantic Bluefin Tuna Status Review Team estimated that the DWH event, under a worst-case scenario, would reduce the 2010 bluefin tuna year class by 20%, which would result in up to a 4% reduction in spawning biomass (Atlantic Bluefin Tuna Status Review Team 2011). The few initial studies suggest that, despite occurring during the spawning period for many GOM fishes, the DWH event did not have an immediate negative impact on fish populations (including juvenile age classes, although there remains the potential for long-term population impacts from sublethal and chronic exposure (Fodrie and Heck 2011). Several years may be required to fully assess the impacts of the DWH event on fish populations, given the time lag between the spill and the eventual recruitment of immature year classes that may have been affected by the spill.

3.7.4.2 Alaska – Cook Inlet

See Section 3.8.4.2 for a general description of fish communities, their life history, and their ecological role in the Cook Inlet Planning Area as well as the potential changes to fish communities resulting from climate change. This section discusses managed species and EFH within Cook Inlet. Cook Inlet falls within the Gulf of Alaska (GOA) Fisheries Management Area of the North Pacific Fishery Management Council (NPFMC). As required under the FCMA, EFH is described for federally managed species in each FMP. The FMPs and the EFHs that occur in waters of Cook Inlet are described below. Regulatory measures to mitigate the effects of fishing on EFH include permanent and temporary closures for certain times or areas; restrictions on vessel sizes and trip limits; restrictions or limitations on gear types; restrictions on the spacing of nets; restrictions on the catch size and number; fishing practices that minimize bottom contact; limitations on boat sizes and speeds; bycatch limits; and license limitations

(NPFMC 2002). Supporting EFH documents can be found in NMFS (2005) and at http://www.fakr.noaa.gov/npfmc/index.html. Additional information concerning the biology, ecology, and behavior of fish species of Cook Inlet can be found in Section 3.8.4.2. The NMFS Alaska Fisheries Science Center also regularly publishes Stock Assessment and Fishery Evaluation Reports that describe stocks and other germane population information for valued fish resources (see http://www.afsc.noaa.gov).

FMPs applicable to Cook Inlet include the GOA Groundfish FMP, the Scallop FMP, and the Salmon FMP. The GOA Groundfish FMP (NPFMC 2010) applies to the U.S. EEZ waters south and east of the Aleutian Islands at longitude 170° W and Dixon Entrance at longitude 132°40' W and includes the western, central, and eastern regulatory areas. The Groundfish FMP covers all stocks of finfish except salmon (*Oncorhynchus* spp.), steelhead (*Oncorhynchus mykiss*), Pacific halibut (*Hippoglossus stenolepis*), Pacific herring, and tuna (*Scombridae*). Tuna are not found in Alaskan waters except during El Nino years. Species groups managed under the GOA Groundfish FMP are listed in Table 3.7.4-4. EFH has not been designated for all life stages of managed species. For example, there is insufficient information to specify EFH for early juvenile stages of all managed species. In addition, no EFH has been designated for any life stage of the following species: sharks, octopus, and forage fish. For species and life stages for which EFH has been designated, EFHs includes, taken together, the entire sediment and water column from lower Cook Inlet to the Gulf of Alaska Shelf (NPFMC 2010). The most diverse species group, the rockfish, is represented by 30 species (NMFS 2005). These fish use one or more aquatic habitats during different stages of their life cycles; the habitats include estuarine; bays; kelp forests; reefs; and nearshore, coastal, continental shelf, oceanic, and bathypelagic waters and/or substrates. Information on species-specific EFHs can be found in NPFMC (2010). The Alaska Seamount Habitat Protection Areas and Gulf of Alaska Coral Protection Areas are designated as HAPCs. No HAPC is designated within Cook Inlet. See individual sections on water quality, coastal habitat, and marine benthic and pelagic habitats in the Cook Inlet Planning Area for a description of these habitat types as well as potential changes to these habitats resulting from climate change.

The scallop FMP covers all Federal waters off the GOA. The fishery occurs in the GOA from the panhandle out to the Aleutian Islands and the Bering Sea. Portions of upper and lower Cook Inlet are closed to scallop fishing to reduce crab bycatch and protect crab habitat from dredging damage (NPFMC 2006). Closed areas are specified in regulations. Under existing State regulations, most areas closed to scallop dredging are also closed to bottom trawling. Scallops are found from intertidal waters to a depth of 300 m (984 ft). Their abundance tends to be greatest between 45 and 130 m (148 and 426 ft) on beds of mud, clay, sand, and gravel (Hennick 1973 cited in NPFMC 2006). Traditional knowledge and sampling data indicate that scallop distributions may contract and expand as the result of a variety of factors, including, but not limited to, temperature changes, current patterns, changes in population size, and changes in predator and prey distribution (NMFS 1998). EFH has been defined only for the late juvenile and adult life stages of weathervane scallops (*Patinopecten caurinus*; NPFMC 2006). The EFH for weathervane scallops was identified on the basis of historical information on their range and includes the lower Cook Inlet (NPFMC 2006). Weathervane scallops occur in discrete beds in areas 60 to 140 m (197 to 459 ft) deep over predominantly clayey silt and sandy bottoms, but

TABLE 3.7.4-4 Managed Species Designated under the Gulf of Alaska Groundfish Fisheries Management Plan and Life Stages for which EFH Has Been Designated

Management Group	Life Stage[a]	Management Group	Life Stage
Walleye pollock (*Theragra chalcogramma*)	E, L, LJ, A	Sculpins (various species)	LJ, A
Pacific cod (*Gadus macrocephalus*)	E, L, LJ, A	Atka mackerel (*Pleurogrammus monopterygius*)	L, A
Sole (*Pleuronectidae* spp., including dover, yellowfin, Alaska paice, rex, and flathead)	E, L, LJ, A	Squid	LJ, A
Northern rock sole (*Lepidopsetta polyxystra*)	L, LJ, A	Skates	A
Arrowtooth flounder (*Atheresthes stomias*)	L, LJ, A	Sharks	I
Sablefish (*Anoplopoma fimbria*)	E, L, LJ, A	Octopus	I
Pacific Ocean perch (*Sebastes alutus*)	L, LJ, A	Forage fish (eulachon, capelin, sand lance, myctophids and bathylagids, sand fish, euphausiids, and pholids and stichaeids).	I
Rockfish (*Sebastes* spp., including shortraker, rougheye, northern, dusky, yelloweye, and thornyhead)	Varies by species		

[a] E = egg; L = larvae; LJ = late juvenile; A = adults; I = insufficient information.

they are also found in areas with gravelly sand and silty sand. No HAPC has been designated within Cook Inlet for scallops.

Salmon fisheries are managed by the State of Alaska rather than the NPFMC. Even though the Council and NMFS are removed from routine management of salmon fisheries in the EEZ, the FMP asserts general NMFS and Council participation in and oversight of salmon management in the EEZ, and it asserts their express and specific authority in the State in the southeast commercial troll fishery and the EEZ sport fishery. At present, Council staff is comprehensively reviewing the Salmon FMP and may repeal or modify the current plan.

The Salmon FMP applies to the EEZ off the coast of Alaska and the salmon fisheries that occur there (NMFS 2005). Most fishing occurs in coastal waters or inlets, bays, and rivers where salmon are migrating, but fishing also occurs in offshore waters. The EFH has also been defined for the six salmon life stages: eggs and larvae, juveniles in freshwater, juveniles in estuaries, juveniles before their first winter in the marine environment, immature and maturing adults in the marine environment, and adults in fresh water. EFH for Pacific salmon includes waters and substrate necessary for spawning, breeding, feeding, or growth to maturity. The locations of many bodies of fresh water that are used by salmon (including several within Cook Inlet and associated tributaries and lakes) are described in documents organized and maintained by the Alaska Department of Fish and Game (ADFG) in the *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes* (http://www.adfg.alaska.gov/sf/SARR/AWC). Additional information on the biology, ecology, and EFH of Pacific salmon can be found at http://www.fakr.noaa.gov/habitat/efh/review/appx5.pdf.

Some fisheries that occur in Cook Inlet and the GOA are managed by authorities other than the NPFMC. Pacific halibut is managed by the International Halibut Commission, and there are a variety of State-managed fisheries for groundfishes, shellfish, salmon, and Pacific herring. The ADFG regularly publishes stock assessment information on State-managed fishes.

3.7.4.3 Alaska – Arctic

See Section 3.8.4.3 for a general description of fish communities, their life histories, and their ecological role in the Beaufort and Chukchi Sea Planning Areas as well as potential changes in Arctic fish communities resulting from climate change. This section discusses managed species and EFH within the Beaufort and Chukchi Sea Planning Areas. There are two fishery management plans that apply to the Chukchi and Beaufort Planning Areas: the FMP for the Arctic Management Area (Arctic FMP; NPFMC 2009) and the FMP for the salmon fisheries in the EEZ off the coast of Alaska (NPFMC and NMFS 1990). The Arctic FMP applies to all marine waters in the U.S. EEZ of the Chukchi and Beaufort Seas from 5.6 km (3.5 mi) (3 NM) offshore the coast of Alaska or its baseline to 370 km (230 mi) (200 NM) offshore, north of the Bering Strait (from Cape Prince of Wales to Cape Dezhneva), westward to the 1990 U.S./Russia maritime boundary line, and eastward to the U.S./Canada maritime boundary (NPFMC 2009). Complete FMPs can be found at http://www.fakr.noaa.gov/npfmc/fmp/fmp.htm.

The Arctic FMP governs commercial fishing for all stocks of finfish and shellfish in Federal waters, except for Pacific salmon and Pacific halibut, which are managed under the salmon FMP and the International Pacific Halibut Commission, respectively (NPFMC and NMFS 1990). The Arctic Management Area is closed to commercial fishing until such time in the future that sufficient information is available with which to initiate a planning process for commercial fishery development (NPFMC 2009). Although species managed under separate FMPs, such as salmon, groundfish, halibut, crabs, and scallops, are present in Arctic waters, their commercial harvest is not permitted in the Beaufort and Chukchi Sea Planning Areas (NPFMC 2009).

Under the Arctic FMP, EFH has been designated for three species (NPFMC 2009):

- *Arctic cod (*Boreogadus saida*).* Insufficient information is available to determine EFH for eggs, larvae, and early juveniles. However, this species has been reported to spawn under ice from during winter (Parker-Stetter et al. 2011). For late juveniles and adults, EFH includes pelagic and epipelagic Arctic waters from 0 to 200 m (0 to 656 ft) and upper slope waters from 200 to 500 m (656 to 1,640 ft).

- *Saffron cod (*Eleginus gracilis*).* Insufficient information is available to determine EFH for eggs, larvae, and early juveniles. For late juveniles and adults, EFH includes coastal pelagic and epipelagic Arctic waters from 0 to 50 m (0 to 164 ft) and wherever there are sand and gravel substrates.

- *Snow crab (*Chionoecetes opilio*).* Insufficient information is available to determine EFH for larvae and early juvenile life stages. EFH for eggs, late juveniles, and adult snow crabs consists of bottom habitats along the inner shelf from 0 to 50 m (0 to 164 ft) and middle shelf from 50 to 100 m (164 to 328 ft) in Arctic waters south of Cape Lisburne, wherever there are substrates consisting mainly of mud.

See individual sections on water quality, coastal habitat, and marine benthic and pelagic habitats in the Beaufort and Chukchi Seas for a description these habitat types as well as potential changes to these habitats resulting from climate change.

The salmon FMP designates EFH for the juvenile or adult marine life stages of chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), pink (*O. gorbuscha*), sockeye (*O. nerka*), and chum (*O. keta*) salmon as being all marine waters of the Chukchi Sea and Arctic Ocean from the mean higher tide line to the 370-km (200-NM) limit of the U.S. EEZ (NMFS 2005). There are no salmon HAPCs designated within the Beaufort Sea or Chukchi Sea Planning Area. No commercial fishing for salmon is allowed in the U.S. EEZ off Alaska except in designated areas, none of which are in the Beaufort or Chukchi Sea Planning Areas. Thus no commercial salmon fishery is present. In addition, all five managed salmon species decrease in abundance north of the Bering Strait (Craig and Haldorson 1986) and from west to east along the coast of the Beaufort and Chukchi Seas. Pink salmon and chum salmon are most common in Arctic waters (Augerot 2005; Stephenson 2005; Moss et al. 2009; Kondzela et al. 2009). Salmon are most abundant west of Point Barrow and appear to be rare in the Beaufort Sea and extremely rare in the eastern Beaufort Sea, although chum salmon are natal to the Mackenzie River and consistently found there in low numbers (Irvine et al. 2009). Chum and pink salmon may be natal to other rivers on the North Slope; that possibility has not been confirmed (Irvine et al. 2009).

3.8 MARINE AND COASTAL FAUNA

3.8.1 Mammals

All marine mammals are protected in U.S. waters under the Marine Mammal Protection Act of 1972 (MMPA; 16 USC 1631 *et seq*.). The MMPA organizes marine mammals into separate stocks for management purposes. By definition, a stock is a group of animals in common spatial arrangement that interbreed (NMFS 2011a). Some species receive additional protection under the Endangered Species Act (ESA; 16 USC 1531 *et seq*.). In the northern GOM and the Alaska OCS regions, the NMFS is the Federal agency responsible for conservation and management of whales, seals, dolphins, and porpoises. The USFWS manages manatees in the

GOM, and in Alaska waters, the USFWS manages sea otters, walruses, and polar bears. The MMPA also created the U.S. Marine Mammal Commission to provide an oversight role for the Federal agencies implementing the MMPA. Marine mammals are among the most important subsistence resources for coastal Alaskan Natives, and a large body of traditional and local knowledge exists about marine mammals (see Section 3.14.3). In recognition of both these factors, many marine mammal stocks are co-managed by the Federal Government (USFWS or NMFS) and Alaskan Native subsistence users under the authority of the MMPA. The take of other mammals (upland or terrestrial) is primarily regulated by the respective State.

3.8.1.1 Gulf of Mexico

3.8.1.1.1 Marine Mammals. The U.S. GOM marine mammal community is diverse and distributed throughout the northern GOM waters (Table 3.8.1-1). Twenty-one species of cetaceans regularly occur in the GOM (Jefferson et al. 2006; Davis et al. 2000) and are identified in the NMFS GOM Stock Assessment Reports (Waring et al. 2010) in addition to one species of Sirenian. The GOM's marine mammals are represented by members of the taxonomic order Cetacea, which is divided into the suborders Mysticeti (i.e., baleen whales) and Odontoceti (i.e., toothed whales), as well as the order Sirenia, which includes the manatee and dugong. Most GOM cetacean species have worldwide distributions; however, exceptions include the Gervais' beaked whale (*Mesoplodon europaeus*), Atlantic spotted dolphin (*Stenella frontalis*), and clymene dolphin (*Stenella clymene*). These species are found only in the Atlantic Ocean and its associated waters.

There are species that have been reported from GOM waters, either by sighting or stranding, that are not considered further in this document. These species include the blue whale (*Balaenoptera musculus*), the North Atlantic right whale (*Eubalaena glacialis*), and the Sowerby's beaked whale (*Mesolplodon bidens*), all considered extralimital in the GOM; along with the humpback whale (*Megaptera novaeangiliae*), the fin whale (*Balaenoptera physalus*), the sei whale (*Balaenoptera borealis*), and the minke whale (*Balaenoptera acutorostrata*), all considered rare occasional migrants in the GOM (Würsig et al. 2000; Mullin and Fulling 2004). Because these species are uncommon in the GOM (and by extension the WPA), they are not included in the most recent NMFS Stock Assessment Reports for the GOM (Waring et al. 2010).

Marine Mammals Listed under the Endangered Species Act. Five baleen whales including the North Atlantic right whale (*Eubalaena glacialis*), blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), and humpback whale (*Megaptera novaeangliae*); one toothed whale, the sperm whale (*Physeter macrocephalus*); and one sirenian, the West Indian manatee (*Trichechus manatus*) occur in the northern GOM; and are all listed as federally endangered under the ESA. The sperm whale is common in oceanic waters of the northern GOM and may be a resident species, while the baleen whales are rare or extralimital in the northern GOM (Würsig et al. 2000). The West Indian manatee typically inhabits only coastal marine, brackish, and freshwater areas.

TABLE 3.8.1-1 Marine Mammals in the GOM[a]

Family/Species	Status[c]	General Occurrence[b] Western GOM[d]	 Central GOM[e]	 Eastern GOM[f]	Typical Habitat Coastal	 Shelf	 Slope/ Deep
Order Cetacea							
Suborder Mysticeti (Baleen whales)							
Family Balaenidae							
North Atlantic right whale (*Eubalaena glacialis*)	E/D	EX	EX	EX	–	X	X
Family Balaenopteridae							
Bryde's whale (*Balaenoptera edeni*)		O	O	O	–	X	X
Fin whale (*Balaenoptera physalus*)	E/D	EX	EX	EX	–	X	X
Humpback whale (*Megaptera novaeangliae*)	E/D	EX	EX	EX	–	X	X
Minke whale (*Balaenoptera acutorostrata*)		EX	EX	EX	–	X	X
Sei whale (*Balaenoptera borealis*)	E/D	EX	EX	EX	–	X	X
Blue whale (*Balaenoptera musculus*)	E/D	EX	EX	EX	–	X	X
Suborder Odontoceti (Toothed whales and dolphins)							
Delphinidae							
Atlantic spotted dolphin (*Stenella frontalis*)		C	C	C	–	X	X
Bottlenose dolphin (*Tursiops truncatus*)		C	C	C	X	X	X
Clymene's dolphin (*Stenella clymene*)		C	C	C	–	–	X
False killer whale (*Pseudorca crassidens*)		O	O	O	–	–	X
Fraser's dolphin (*Lagenodelphis hosei*)		O	O	O	–	–	X
Killer whale (*Orcinus orca*)		O	O	O	–	–	X
Melon-headed whale (*Peponocephala electra*)		UC	UC	O	–	–	X
Pantropical spotted dolphin (*Stenella attenuata*)		C	C	C	–	–	X

TABLE 3.8.1-1 (Cont.)

		General Occurrence[b]			Typical Habitat		
Family/Species	Status[c]	Western GOM[d]	Central GOM[e]	Eastern GOM[f]	Coastal	Shelf	Slope/ Deep
Delphinidae (Cont.)							
Pygmy killer whale (*Feresa attenuata*)		O	O	O	–	–	X
Risso's dolphin (*Grampus griseus*)		UC	UC	UC	–	–	X
Rough-toothed dolphin (*Steno bredanensis*)		UC	UC	UC	–	–	X
Short-finned pilot whale (*Globicephala macrorhynchus*)		UC	UC	O	–	–	X
Spinner dolphin (*Stenella longirostris*)		O	O	O	–	–	X
Striped dolphin (*Stenella coeruleoalba*)		UC	UC	UC	–	–	X
Kogiidae							
Dwarf sperm whale (*Kogia sima*)		O	O	O	–	–	X
Pygmy sperm whale (*Kogia breviceps*)		O	O	O	–	–	X
Physeteridae							
Sperm whale (*Physeter macrocephalus*)	E/D	C	C	C	–	–	X
Ziphidae							
Blainville's beaked whale (*Mesoplodon densirostris*)		O	O	O	–	–	X
Cuvier's beaked whale (*Ziphius cavirostris*)		O	O	O	–	–	X
Gervais' beaked whale (*Mesoplodon europaeus*)		O	O	O	–	–	X
Sowerby's beaked whale (*Mesoplodon bidens*)		EX	EX	EX	–	–	X
Order Sirenia							
Sirenidae							
West Indian manatee, Florida subspecies (*Trichechus manatus latrostris*)	E	O	O	UC	X	–	–

Footnotes on next page.

TABLE 3.8.1-1 (Cont.)

[a] C = Common — regularly observed throughout the year; EX = Extralimital — known only on the basis of a few records that probably resulted from unusual wanderings of animals into the region; O = Occasional — relatively few observations throughout the year, but some species may be more frequently observed in some locations or during certain times (e.g., during migration); and UC = Uncommon — infrequently observed throughout the year, but some species may be more common in some locations or during certain times of the year (e.g., during migration or when on summer calving grounds or wintering grounds). – = Absent — not recorded from the area; X = Present.

[b] The indicated occurrence does not reflect the distribution and occurrence of individual stocks of marine mammals within localized geographic areas, but rather the broad distribution of the species within the larger categories of OCS waters.

[c] E = Endangered under the Endangered Species Act; D = Depleted under the Marine Mammal Protection Act.

[d] Western GOM includes OCS waters from the Texas-Mexico border to the Texas-Louisiana border.

[e] Central GOM includes OCS waters from the Texas-Louisiana border to the Alabama-Florida border.

[f] Eastern GOM includes OCS waters of the west coast of Florida.

Source: Waring et al. 2010.

Cetaceans: Mysticetes. The occurrences of the North Atlantic right whale in the northern GOM represent distributional anomalies, normal wanderings of occasional animals, or a more extensive historic range beyond the sole known calving and wintering ground in the waters of the southeastern United States (Waring et al. 2010), and are therefore considered extralimital. The North Atlantic right whale inhabits primarily temperate and subpolar waters (Jefferson et al. 2006). It ranges from wintering and calving grounds in coastal waters of the southeastern United States to summer feeding, nursery, and mating grounds in New England waters and northward to the Bay of Fundy, the Scotian Shelf, and the Gulf of St. Lawrence (Waring et al. 2010). In the North Atlantic, it primarily inhabits the area between 20° and 60°N (NMFS 2011a). The North Atlantic right whale forages on or near the surface on copepods and other zooplankton (e.g., krill) (Jefferson et al. 2006). Six major congregation areas identified for the western North Atlantic right whale are the coastal waters of the southeastern United States, Great South Channel, Georges Bank/Gulf of Maine, Cape Cod and Massachusetts Bays, Bay of Fundy, and Scotian Shelf (Waring et al. 2010). The minimum stock size in western North Atlantic, estimated in 2005, is 361 individuals (Waring et al. 2010). The few confirmed records of the North Atlantic right whale in the northern GOM have been in the Northern GOM Slope and the GOM Basin Level II Ecoregions (see Figure 3.2.2-1).[9]

The blue whale is the largest marine mammal. Blue whales are extralimital in the northern GOM (Würsig et al. 2000) with the only records consisting of two strandings, one each on the Louisiana and Texas coasts, with the identifications for both strandings being questionable (Davis and Schmidly 1997). It occurs in all major oceans of the world (Jefferson et al. 2006; Waring et al. 2010). They migrate to feeding grounds in subarctic waters during spring and

9 Descriptions of the marine ecoregions in the northern GOM are provided in Section 3.2.3.

summer, after wintering in subtropical and tropical waters (Würsig et al. 2000). Most blue whale sightings in the North Atlantic are from the Gulf of St. Lawrence, where they may be present throughout most of the year (NMFS 2011a). Blue whales tend to occur in the open ocean; however, in some areas they come close to shore to feed and possibly breed (Jefferson et al. 2006). Blue whales tend to occur alone or in pairs, but aggregations of 12 or more may develop in prime feeding grounds (Jefferson et al. 2006). They feed almost exclusively on krill (euphausids) (Pauly et al. 1995; Jefferson et al. 2006; NMFS 2011a). The minimum blue whale population estimate for the western North Atlantic, based on counts made in the Gulf of St. Lawrence, is 440 (Waring et al. 2010).

The fin whale is an oceanic species that occurs worldwide. There are few reliable reports of fin whales in the northern GOM, indicating that fin whales are not abundant there (Jefferson and Schiro 1997) and they are therefore considered extralimital. Most fin whale sightings occur where deep water approaches the coast (Jefferson et al. 2006), and it mostly occurs in temperate to polar waters and less commonly in tropical waters (NMFS 2011a). Fin whales tend to be more common north of 30°N (NMFS 2010b). In the North Atlantic, fin whales occur in groups of two to seven (NMFS 2011a). The fin whale makes seasonal migrations between tropical and subtropical waters (where it mates and calves in winter) and the north-temperate polar feeding grounds that it occupies during the summer months (Jefferson et al. 2006). New England waters are a major feeding ground for fin whales (Waring et al. 2010), where they feed on concentrations of zooplankton (e.g., krill), fishes, and cephalopods (Pauly et al. 1995; Jefferson et al. 2006). The best estimate for the western North Atlantic fin whale stock is 3,985 with a minimum estimate of 3,269 (Waring et al. 2010).

The sei whale is rare in the northern GOM (Würsig et al. 2000), based on records of a single stranding in the Florida Panhandle and three strandings in eastern Louisiana (Jefferson and Schiro 1997) and they are therefore considered extalimital. It is an oceanic species that occurs in tropical to polar waters, being more common in the mid-latitude temperate zones. It seldom occurs close to shore (Jefferson et al. 2006). Groups of two to five individuals are commonly observed, but loose aggregations of 30 to 50 occasionally occur (Jefferson et al. 2006; NMFS 2011a). The sei whale feeds on concentrations of zooplankton (e.g., krill and copepods), fishes, and cephalopods (Pauly et al. 1995). The best estimate for the Nova Scotia sei whale stock is 386 with a minimum estimate of 208 (Waring et al. 2010).

Humpback whales are rare in the northern GOM (Würsig et al. 2000), based on a few confirmed sightings and one stranding event, and are therefore considered extralimital. The humpback whale occurs in all oceans, feeding in higher latitudes during spring, summer, and autumn, and migrating to a winter range over shallow tropical and subtropical banks, where they calve and presumably breed (Jefferson et al. 2006). They normally occur in coastal and shelf waters but frequently travel across deep water during migration (Clapham and Mead 1999). Humpback whales usually occur alone or in groups of two or three, although larger aggregations occur in breeding and feeding areas (Jefferson et al. 2006). Humpback whales feed on concentrations of zooplankton (e.g., krill) and fishes (Pauly et al. 1995; Jefferson et al. 2006). The best estimate of the Gulf of Maine humpback whale stock is 11,570 individuals (NMFS 2011a).

Cetaceans: Odontocetes. The sperm whale occurs worldwide in deep waters from the tropics to the pack-ice edges, although generally only large males venture to the extreme northern and southern portions of the species' range (Jefferson et al. 2006). It is the only great whale considered common in the northern GOM (Mullin et al. 1991; Davis and Fargion 1996; Jefferson and Schiro 1997). Consistent sightings and satellite tracking results indicate that sperm whales occupy the northern GOM throughout the year (Mullin et al. 1991; Davis and Fargion 1996; Jefferson and Schiro 1997; Davis et al. 2000; Jochens et al. 2008), where it is widely distributed in the Northern GOM Slope, Mississippi Fan, and GOM Basin Level II Ecoregions (see Figure 3.2.2-1) (Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009). Sperm whales tend to inhabit areas with water depths of 600 m (1,970 ft) or more and are uncommon at depths shallower than 300 m (984 ft) (NMFS 2011a). However, they do come close to shore where submarine canyons or other geophysical features bring deep water near the coast (Jefferson et al. 2006). Aggregations of sperm whales commonly occur in waters over the shelf edge in the vicinity of the Mississippi River Delta in waters that are 500 to 2,000 m (1,641 to 6,562 ft) in depth (Mullin et al. 1991; Davis and Fargion 1996; Davis et al. 2000). Sperm whales often concentrate along the continental slope in or near cyclones and zones of confluence between cyclones and anticyclones (Davis et al. 2000). They commonly occur in medium to large groups of up to fifty individuals (Jefferson et al. 2006). Dive depths observed in the GOM range from 544 to 644 m (1,784 to 2,113 ft) and average 45.5 minutes in length (Watwood et al. 2006). Sperm whales prey on cephalopods, fishes, and benthic invertebrates (Pauly et al. 1995; Jefferson et al. 2006). For management purposes, sperm whales in the GOM are considered a separate stock from those in the Atlantic Ocean (Jochens et al. 2008). The best estimate of the abundance of sperm whales in the northern GOM is 1,665 individuals with a minimum population estimate of 1,409 (Waring et al. 2010).

Sirenians. The West Indian manatee occurs in tropical and subtropical coastal marine, brackish, and fresh waters of the southeastern United States, GOM, Caribbean Sea, and Atlantic coast of northeastern South America (Jefferson et al. 2006). There are two subspecies of the West Indian manatee: the Florida manatee (*T. m. latirostris*), which ranges from the northern GOM to Virginia, and the Antillean manatee (*T. m. manatus*), which ranges from northern Mexico to eastern Brazil, including the islands of the Caribbean Sea (Jefferson et al. 2006). The Florida manatee inhabits marine, estuarine, and freshwater habitats (coastal tidal rivers and streams, mangrove swamps, salt marshes, freshwater springs, and vegetated bottoms). In the northern GOM, most Florida manatee sightings are from the Western Florida Estuarine Area and Eastern Gulf Neritic Level III Ecoregions (see Figure 3.2.2-1) (Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009). The Florida manatee makes use of specific areas for foraging (especially shallow grass beds with ready access to deep water), drinking (springs and freshwater runoff sites), resting (secluded canals, creeks, embayments, and lagoons), and for travel corridors (open waterways and channels) (USFWS 2007a). While Florida manatees can occur at depths greater than 4 m (12 ft), most occur in relatively shallow water (Haubold et al. 2006). The West Indian manatee mostly occurs alone or in groups of up to six individuals. However, larger groups may occur, especially in winter at sources of warm water (e.g., power plant outfalls) (Jefferson et al. 2006). The Florida manatee feeds on submerged, floating, and emergent vegetation, and requires freshwater for drinking (USFWS 2012h). In some cases (e.g., at docks), they actively consume invertebrates (Courbis and Worthy 2003).

The Florida manatee is intolerant of cold waters, seeking warm-water sites when temperatures drop below 20°C (68°F). It is unable to tolerate prolonged exposures to temperatures colder than 16°C (61°F) (Haubold et al. 2006). To avoid cold water, the Florida manatee seeks refuge in natural warmwater sites (e.g., springs, deep water areas, and areas thermally influenced by the Gulf Stream) and industrial plant thermal discharges (Laist and Reynolds 2005). Nearly two thirds of Florida manatees winter in industrial plant discharges, most of which are power plants (USFWS 2007a). In winter, the GOM subpopulations move southward to warmer waters. The winter range is restricted to waters at the southern tip of Florida and to waters near localized warm-water sources, such as power plant outfalls and natural springs in west-central Florida. Crystal River in Citrus County is typically the northern limit of the manatee's winter range on the GOM coast. In the spring, they leave warm-water sites and often travel large distances along the GOM and Atlantic coastlines. During warmer months, manatees are common along the GOM coast of Florida from Everglades National Park northward to the Suwannee River in northwestern Florida and less common farther westward, infrequently occurring as far west as Texas (Powell and Rathbun 1984; Rathbun et al. 1990; Davis and Schmidly 1997).

Florida manatees have been divided into four distinct regional management units: the Atlantic Coast Unit that occupies the east coast of Florida, including the Florida Keys and the lower St. Johns River north of Palatka, Florida; the Southwest Unit that occurs from Pasco County, Florida, south to Whitewater Bay in Monroe County, Florida; the Upper St. Johns River Unit that occurs in the river south of Palatka, Florida; and the Northwest Unit that occupies the Florida Panhandle south to Hernando County, Florida (USFWS 2012h). Manatees from the Northwest Unit are more likely to be seen in the northern GOM, and can be found as far west as Texas; however, most sightings are in the eastern GOM. Based on a survey of warm water refuges made in 2009, the best available count of the Florida manatee is 3,802 individuals (Waring et al. 2010). This includes manatees that occur within the GOM and along the Atlantic coast.

Marine Mammals Not Listed under the Endangered Species Act. Twenty-two species of cetaceans, not listed under the ESA, occur in the GOM. The mysticetes (baleen whales) account for two of these species while the other 20 species are odontocetes (toothed whales and dolphins).

Cetaceans: Mysticetes. The Bryde's whale (*Balaenoptera edeni*) occurs in tropical and subtropical waters throughout the world, both offshore and near the coast (Jefferson et al. 2006). Individuals tend to occur alone or in pairs, but may aggregate in groups of 10 to 20 on feeding grounds. The Bryde's whale feeds on fishes, shrimp, pelagic red crabs, and large zooplankton such as krill and copepods (Pauly et al. 1995; Jefferson et al. 2006; NMFS 2011a). Dives last 5 to 15 minutes and can reach a depth of 300 m (1,000 ft) (NMFS 2011a). In the northern GOM, most sightings of Bryde's whales have been made in the DeSoto Canyon region and off western Florida, although some sightings have been made in the west-central portion of the northeastern GOM (i.e., in the Northern GOM Slope Level II Ecoregion south of the Florida Panhandle; see Figure 3.2.2-1) (Waring et al. 2010; Read et al. 2011; Wilkinson et al. 2009). The best estimate of Bryde's whale abundance for the northern GOM is 15 individuals with the minimum population estimate of 5 individuals (Waring et al. 2010).

The minke whale *(Balaenoptera acutorostrata*) occurs worldwide. It prefers temperate to boreal waters, but also occurs in subtropical to tropical waters (NMFS 2011a). Most records from the GOM have come from the Florida Keys, although strandings in western and northern Florida, Louisiana, and Texas have been reported (Jefferson and Schiro 1997) and they are therefore considered extralimital. The minke whale occurs more often in coastal and inshore areas compared to offshore areas (Jefferson et al. 2006). Similar to other baleen whales, minke whales generally occupy the continental shelf rather than the continental shelf edges (Waring et al. 2010). It usually occurs alone or in groups of only two to three whales, although loose aggregations of up to 400 can occur in feeding areas in higher latitudes (NMFS 2011a). The minke whale preys on a variety of large zooplankton (e.g., krill and copepods) and small schooling fishes (Pauly et al. 1995; Jefferson et al. 2006). Minke whales are rare in the GOM with the only confirmed records coming from stranding information (Würsig et al. 2000), and are therefore considered extralimital. The best estimate for the Canadian East Coast population, which includes the minke whales that occur off the eastern coast of the United States to the GOM, is 8,987 individuals. The minimum population estimate is 6,909 (Waring et al. 2010).

Cetaceans: Odontocetes (Family Kogiidae). The pygmy sperm whale (*Kogia breviceps*) has a worldwide distribution in deep waters from temperate to tropical waters. It is especially common over and near the continental slope (Jefferson et al. 2006). The pygmy sperm whale usually occurs alone or in groups up to seven individuals (NMFS 2011a). In some areas, including the GOM, it is among the most frequently stranded small whale species (Jefferson et al. 2006; Waring et al. 2010). Pygmy sperm whales can dive at least 300 m (1,000 ft) (NMFS 2011a). They feed mainly on squid, but will also eat crab, shrimp, and fishes (Pauly et al. 1995; Jefferson et al. 2006). In the GOM, they occur primarily along the continental shelf edge and in deeper waters off the continental shelf (Mullin et al. 1991).

The dwarf sperm whale *(Kogia sima*) has a worldwide distribution in temperate to tropical waters, mostly over the continental shelf and slope (Jefferson et al. 2006; Culik 2010). In the northern GOM, most sightings occur in oceanic waters (Waring et al. 2010). The dwarf sperm whale mostly occurs in groups of less than five individuals, although groups of up to 10 do occur (Jefferson et al. 2006). It is capable of diving to a depth of at least 300 m (1,000 ft) (NMFS 2011a). The dwarf sperm whale feeds on squid, fishes, and crustaceans (Pauly et al. 1995; Jefferson et al. 2006).

At sea, it is difficult to differentiate the pygmy sperm whale from the dwarf sperm whale. Most sightings of these two species have been in the Northern GOM Slope and GOM Basin Level II Ecoregions (see Figure 3.2.2-1) (Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009). The best estimate of abundance for dwarf and pygmy sperm whales combined in the northern GOM is 453 individuals with a minimum population estimate of 340 (Waring et al. 2010).

Cetaceans: Odontocetes (Family Ziphiidae). Due to the difficulty of at-sea identification of beaked whales, most observations in the GOM are identified as Cuvier's beaked whales (*Ziphius cavirorostris*), *Mesoplodon* spp., or unidentified *Ziphiidae* (Waring et al. 2010). In the northern GOM, beaked whales are broadly distributed in waters greater than 1,000 m (3,280 ft) in depth over lower slope and abyssal landscapes (Davis et al. 1998, 2000) in the

Northern GOM Slope, Mississippi Fan, and GOM Level II Ecoregions (see Figure 3.2.2-1) (Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009).

The Blainville's beaked whale (*Mesoplodon densirostris*) occurs in warm-temperate to tropical waters worldwide, mostly in offshore deep waters (Jefferson et al. 2006). It is often associated with steep underwater geologic structures such as banks, submarine canyons, seamounts, and continental slopes (NMFS 2011a). The Blainville's beaked whale most commonly occurs singly or in pairs, but groups of up to 7 to 12 individuals are reported (Jefferson et al. 2006; NMFS 2011a). Commonly, dives occur to depths of 500 to 1,000 m (1,600 to 3,300 ft) and last 20 to 45 minutes (NMFS 2011a). Blainville's beaked whales feed on squid and some fishes (Pauly et al. 1995; Jefferson et al. 2006). There have been four documented strandings and two sightings of the Blainville's beaked whale in the northern GOM (Waring et al. 2010).

The Gervais' beaked whale (*Mesoplodon europaeus*) is widely, but sparsely, distributed in temperate to tropical oceanic waters of the central and north Atlantic Ocean (Waring et al. 2010; NMFS 2011a). It usually occurs alone or in small social groups (NMFS 2011a). The species feeds on squid, mysid shrimp, and fish (Pauly et al. 1995; Jefferson et al. 2006; NMFS 2011a). Stranding records suggest that the Gervais' beaked whale is probably one of the most common *Mesoplodon* species in the northern GOM (Jefferson and Schiro 1997).

The best abundance estimate for the Gervais' and Blainville's beaked whales combined in the northern GOM is 57 individuals with a minimum population estimate of 24 (Waring et al. 2010).

The Cuvier's beaked whale (*Ziphius cavirorostris*) occurs worldwide in offshore deep waters, except for polar waters (Jefferson et al. 2006; Waring et al. 2010). It prefers waters of the continental slope and edge and steep underwater geologic features such as banks, seamounts, and submarine canyons where depths are greater than 1,000 m (3,000 ft) (NMFS 2011a). The Cuvier's beaked whale mostly occurs alone or in small groups up to 12 individuals, although groups up to 25 whales have been reported (NMFS 2011a). It can dive to depths of at least 1,000 m (3,000 ft) that last 20 to 40 minutes (NMFS 2011a). Its diet consists of squid, fishes, and crustaceans (Pauly et al. 1995; Jefferson et al. 2006). The Cuvier's beaked whale is probably one of the most common beaked whale species in the northern GOM (Jefferson and Schiro 1997; Davis et al. 1998, 2000). The best estimate of abundance for Cuvier's beaked whale in the northern GOM is 65 individuals with a minimum population estimate of 39 (Waring et al. 2010).

The Sowerby's beaked whale (*Mesoplodon bidens*) generally occurs in cold temperate to subarctic waters of the North Atlantic. It usually occurs alone or in small groups of 3 to 10 individuals. Dives, lasting 10 to 15 minutes, can reach depths of 1,500 m (4,920 ft) (NMFS 2011a). It feeds on squid and small fishes (Pauly et al. 1995; Jefferson et al. 2006). There are no abundance estimates for the Sowerby's beaked whale in the GOM. The Sowerby's beaked whale does not regularly inhabit the GOM (MacLeod et al. 2006). The one stranding report from the GOM represents an extralimital occurrence (Jefferson and Schiro 1997; Waring et al. 2010).

Cetaceans: Odontocetes (Family Delphinidae). The Atlantic spotted dolphin (*Stenella frontalis*) is endemic to the Atlantic Ocean in tropical to temperate waters from about 50°N to 25°S (Culik 2010). It mostly occurs in coastal or continental shelf waters that are 20 to 250 m (65 to 820 ft) deep, but also inhabits continental slope waters up to 2,000 m (6,562 ft) deep (Culik 2010; Jefferson et al. 2006; NMFS 2011a). The Atlantic spotted dolphin may seasonally enter shallow water in pursuit of migratory prey (Perrin 2002). In the northern GOM, the Atlantic spotted dolphin is usually observed from the continental shelf waters 10 to 200 m (33 to 656 ft) deep to slope waters less than 500 m (<1,640 ft) deep throughout the Northern GOM Shelf and the more shoreward portions of the Northern GOM Slope Level II Ecoregions (see Figure 3.2.2-1) (Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009). The Atlantic spotted dolphin generally occurs in groups smaller than 50 individuals, with coastal groups usually consisting of 5 to 15 individuals (Jefferson et al. 2006); however, groups as large as 200 do occur (NMFS 2011a). They sometimes associate with other cetaceans such as bottlenose dolphins (*Tursiops truncatus*) (NMFS 2011a). Atlantic spotted dolphins usually dive about 10 m (30 ft) but can reach depths up to 60 m (200 ft) (NMFS 2011a). They feed on fishes and cephalopods (Pauly et al. 1995; Jefferson et al. 2006). Current population size for the Atlantic spotted dolphin in the northern GOM is unknown because survey data is more than 8 yr old. Estimated abundance, based on outer continental shelf observations made from fall 2000 and 2001 surveys, is 37,611 individuals (Waring et al. 2010).

The bottlenose dolphin inhabits tropical and temperate waters worldwide primarily between 45°N to 45°S (NMFS 2011a). For management purposes, in the northern GOM, bottlenose dolphins are divided into six stock groups: (1) western coastal stock (Mississippi River Delta to the Texas-Mexico border); (2) northern coastal stock (Mississippi River Delta to 84°W); (3) eastern coastal stock (84°W to Key West); (4) continental shelf stock; (5) oceanic stock; and (6) 32 bay, sound, and estuarine stocks (Waring et al. 2010). The seaward boundary for the three bottlenose dolphin coastal stocks is the 20-m (66-ft) isobath, which ranges 4 to 90 km (2.5 to 56 mi) from shore (Waring et al. 2010). The northern GOM continental shelf stock occurs in waters from 20 to 200 m (66 to 656 ft) deep, while the oceanic stock inhabits waters greater than 200 m (656 ft) deep (Waring et al. 2010). The continental shelf stock; coastal stocks; and bay, sound, and estuarine stocks occur throughout the Northern GOM Shelf Level II Ecoregion, while the oceanic stock occurs primarily within the Northern GOM Slope Level II Ecoregion (see Figure 3.2.2-1) (Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009).

Bottlenose dolphins usually occur in groups of less than 20 individuals, but offshore herds of several hundred individuals occur. It commonly associates with other cetaceans (Jefferson et al. 2006). Bottlenose dolphins are opportunistic feeders, taking a wide variety of fishes, cephalopods, and shrimp (Pauly et al. 1995; Jefferson et al. 2006). Coastal bottlenose dolphins consume benthic invertebrates and fish, while offshore individuals feed on pelagic fish and squid (NMFS 2011a).

The population sizes for the continental shelf stock; the western coastal stock; and most of the bay, sound, and estuarine stocks have been not been estimated in over 8 yr. Therefore, their current population estimates are unknown (Waring et al. 2010). The best current estimate of abundance for the eastern coastal stock is 7,702 with a minimum population estimate of

6,551 bottlenose dolphins, while the best current estimate of abundance for the northern coastal stock is 2,437 with a minimum population estimate of 2,004. The best current estimate of abundance for the oceanic stock is 3,708 individuals with a minimum population estimate of 2,641 dolphins (Waring et al. 2010).

The Clymene dolphin (*Stenella clymene*) is endemic to tropical and sub-tropical waters of the Atlantic Ocean including the Caribbean Sea and GOM. It is a deepwater oceanic species not often observed near shore (Jefferson et al. 2006), generally occurring in waters 250 to 5,000 m (820 to 16,400 ft) deep (NMFS 2011a). There is an atypical report of a Clymene dolphin off southern Texas waters with a bottom depth of 44 m (144 ft) (Fertl et al. 2003). In the northern GOM, most Clymene dolphin sightings are in the Northern GOM Slope, Mississippi Fan, and GOM Basin Level II Ecoregions (see Figure 3.2.2-1) (Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009). Herds, often segregated by age and sex, are normally less than 200 individuals and are often less than 50 individuals. Clymene dolphins occur with other dolphin species (Jefferson et al. 2006; Jefferson and Curry 2003). They occur in the GOM throughout the year (Jefferson et al. 1995; Jefferson and Curry 2003). The Clymene dolphin is an active bowrider and will approach ships from many miles away (Jefferson and Curry 2003). It feeds on fishes and cephalopods (Pauly et al. 1995; Jefferson et al. 2006). The best estimate for the abundance of the Clymene dolphin in the northern GOM is 6,575 individuals with a minimum population estimate of 4,901 (Waring et al. 2010).

The false killer whale (*Pseudorca crassidens*) occurs worldwide in tropical and temperate oceanic waters (generally between 50°N and 50°S) that are deeper than 1,000 m (3,300 ft) (Culik 2010; Jefferson et al. 2006; NMFS 2011a). However, inshore movements occasionally occur that are associated with either food resources or shoreward flooding of warm oceanic currents (Stacey et al. 1994). In the GOM, most sightings occur in the Northern GOM Slope, Mississippi Fan, and GOM Basin Level II Ecoregions (see Figure 3.2.2-1) (Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009). The false killer whale normally occurs in groups of 10 to 60, but groups of up to 300 or more do occur (Culik 2010). The false killer whale is one of the most common cetacean species involved in mass strandings; one observed mass stranding near Mar del Plata, Argentina, included 835 individuals (Baird 2009b). It associates with at least 10 other species of cetaceans, especially the bottlenose dolphin (Stacey et al. 1994). False killer whales primarily eat fish and cephalopods, but they will attack small cetaceans (Pauly et al. 1995; Jefferson et al. 2006). To increase their potential to find prey, a group may travel in a broad band several kilometers wide (NMFS 2011a). The best estimate for the abundance of the false killer whale in the northern GOM is 777 individuals with a minimum population estimate of 501 (Waring et al. 2010).

The Fraser's dolphin (*Lagenodelphis hosei*) has a worldwide distribution in tropical to warm temperate waters between 30°N and 30°S (NMFS 2011a). It normally occurs in oceanic waters deeper than 1,000 m (3,300 ft) but will occur near shore where deep water approaches the coast (Jefferson et al. 2006; NMFS 2011a). Fraser's dolphins are often associated with areas of upwelling (NMFS 2011a). In the GOM, they occur in deeper waters off the continental shelf (Waring et al. 2010), mostly in the Northern GOM Slope and at the boundary between the Northern GOM Slope and the GOM Basin Level II Ecoregions (see Figure 3.2.2-1) (Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009). Some Fraser's dolphins inhabit the northern GOM throughout the year (Waring et al. 2010). The Fraser's dolphin usually occurs in herds of 10 to 100 individuals, but occasionally occurs in herds consisting of hundreds to thousands of individuals (Jefferson et al. 2006; NMFS 2011a). It often occurs with other cetaceans, particularly the melon-headed whale (*Peponocephala electra*) (Jefferson et al. 2006). Fraser's dolphins can dive to nearly 600 m (2,000 ft) (NMFS 2011a), where they feed on fishes, cephalopods, and crustaceans (Pauly et al. 1995; Jefferson et al. 2006). Based on observations made from 1996 to 2001, 726 Fraser's dolphins occurred in the northern GOM.

The killer whale (*Orcinus orca*) has a worldwide distribution from tropical to polar waters. They are more common in nearshore cold temperate to subpolar waters (Jefferson et al. 2006). In the GOM, killer whales occur primarily in the deeper oceanic waters off the continental shelf at depths ranging from 256 to 2,652 m (840 to 8,700 ft) (Davis and Fargion 1996; Waring et al. 2010). Sightings in the northern GOM occur from the Northern GOM, Mississippi Fan, and GOM Basin Level II Ecoregions (see Figure 3.2.2-1) (Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009). Killer whale pods contain 1 to 55 individuals with resident pods tending to be larger than transient pods (Jefferson et al. 2006). Killer whales are top-level predators that feed on marine mammals, marine birds, sea turtles, fishes, and cephalopods (Pauly et al. 1995; Jefferson et al. 2006). The best estimate of the abundance of killer whales in the northern GOM is 49 individuals with a minimum population estimate of 28 (Waring et al. 2010).

The melon-headed whale has a worldwide distribution in subtropical to tropical oceanic waters (Jefferson et al. 2006). In the GOM, sightings of melon-headed whales are mostly in the Northern GOM Slope Level II Ecoregion, with some sightings in the GOM Basin Level II Ecoregion (see Figure 3.2.2-1) (Mullin et al. 1994; Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009). The melon-headed whale occurs in most areas of its range throughout the year (Jefferson and Barros 1997). Worldwide, it usually occurs in pods of 100 to 500 individuals with a known maximum of 2,000 individuals (Jefferson et al. 2006). Average herd size in the GOM is 130 to 310 individuals (Jefferson and Barros 1997). The melon-headed whale has strong social bonds, evidenced by mass strandings including up to several hundred individuals observed for mass strandings in Brazil and Australia (Jefferson and Barros 1997). Strandings of individual melon-headed whales have occurred in the GOM (Waring et al. 2010). In the GOM, melon-headed whales often occur with other species such as Fraser's dolphin or the rough-toothed dolphin (*Steno bredanensis*) (Jefferson and Barros 1997; Jefferson et al. 2006). Melon-headed whales will occasionally ride the bow waves of passing ships (Jefferson and Barros 1997). They feed on cephalopods, fishes, and some crustaceans (Pauly et al. 1995; Jefferson et al. 2006; NMFS 2011a). The best estimate of the abundance of the melon-headed whale in the northern GOM is 2,283 individuals with a minimum population estimate of 1,293 (Waring et al. 2010).

The pantropical spotted dolphin (*Stenella attenuata*) occurs in tropical to warm temperate oceanic waters worldwide roughly from 40°N to 40°S (Culik 2010). In the GOM, sightings of the pantropical spotted dolphin occur in the Northern GOM Slope, Mississippi Fan, and the GOM Basin Level II Ecoregions (see Figure 3.2.2-1) (Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009). During the day, they typically occur in waters between 90 and 300 m (300 and 1,000 ft) deep and will dive into deeper waters at night in search of prey

(NMFS 2011a). The pantropical spotted dolphin is the most common cetacean in the oceanic northern GOM (Mullin et al. 1991). School sizes may range from several to thousands of individuals (Perrin 2001). It often schools with other dolphins such as spinner dolphins (*Stenella longirostri*s) (NMFS 2011a). The pantropical spotted dolphin primarily feeds on epipelagic fishes and cephalopods (Pauly et al. 1995; Jefferson et al. 2006). The best estimate of the abundance of the pantropical spotted dolphin in the northern GOM is 34,067 individuals with a minimum population estimate of 29,311 (Waring et al. 2010).

The pygmy killer whale (*Feresa attenuata*) occurs worldwide in deeper tropical and subtropical waters, generally between 40°N and 35°S (Jefferson et al. 2006; Culik 2010). Generally, the pygmy killer whale occurs in groups of 50 individuals or less, although some herds of several hundred occur (Jefferson et al. 2006). Its diet includes cephalopods and fishes, though reports of feeding on other dolphins are reported (Pauly et al. 1995; Jefferson et al. 2006). In the northern GOM, the pygmy killer whale occurs primarily in deeper oceanic waters off the continental shelf (Waring et al. 2010). It inhabits the Northern GOM Slope, Mississippi Fan, and GOM Basin Level II Ecoregions (see Figure 3.2.2-1) (Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009). The best estimate of the abundance of the pygmy killer whale in the northern GOM is 323 individuals and the minimum population estimate is 203 (Waring et al. 2010).

The Risso's dolphin (*Grampus griseus*) occurs worldwide in tropical to temperate waters, generally between 60°N and 60°S, where it inhabits deep oceanic waters (e.g., depths greater than 1,000 m [3,300 ft]) seaward of the continental shelf and slopes) (Culik 2010; Jefferson et al. 2006; NMFS 2011a). In the northern GOM, they are widely distributed throughout the Northern GOM Slope, Mississippi Fan, and GOM Basin Level II Ecoregions (see Figure 3.2.2-1) (Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009). Their core area of occurrence is between the 350- and 975-m (1,150- and 3,200-ft) isobaths with seafloor slopes greater than 22 m/km (116 ft/mi) (Baumgartner 1997). Groups of 4,000 can occur, but herds tend to average 10 to 30 in number (Jefferson et al. 2006; NMFS 2011a). Risso's dolphins associate with other cetaceans and hybridization with bottlenose dolphins is recorded (Jefferson et al. 2006). It can dive to at least 300 m (1,000 ft) and remain underwater for up to 30 minutes (NMFS 2011a). The Risso's dolphin feeds primarily on squid and secondarily on fishes and crustaceans (Pauly et al. 1995; Jefferson et al. 2006). The best estimate of the abundance of the Risso's dolphin in the northern GOM is 1,589 individuals with a minimum population estimate of 1,271 (Waring et al. 2010).

The rough-toothed dolphin occurs in tropical to warm-temperate oceanic and continental shelf waters worldwide (Jefferson et al. 2006; Waring et al. 2010). In the northern GOM, sightings are scattered throughout most Level II ecoregions, with most sightings in the Northern GOM Slope (see Figure 3.2.2-1) (Mullin and Fulling 2004; Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009). It most commonly occurs in groups of 10 to 20, but herds of more than 100 do occur (Jefferson et al. 2006; NMFS 2011a). The rough-toothed dolphin often associates with other dolphins including the short-finned pilot whale (*Globicephala macrorhynchus*), bottlenose dolphin, pantropical spotted dolphin, and spinner dolphin (NMFS 2011a). It feeds on benthic invertebrates, cephalopods, and fishes (Pauly et al. 1995; Jefferson et al. 2006). The abundance of the rough-toothed dolphin in the northern GOM, based on a combined abundance estimate for the oceanic and OCS portions of the GOM based on surveys conducted between 2000 and 2004, was 2,653 (Waring et al. 2010).

The short-finned pilot whale occurs worldwide in tropical to temperate waters, generally in deep offshore areas (Jefferson et al. 2006). In the GOM, most sightings occur in the Northern GOM Slope with a few sightings in the Mississippi Fan and GOM Basin Level II Ecoregions (see Figure 3.2.2-1) (Waring et al. 2010; Wilkinson et al. 2009). Pods often consist of 25 to 50 animals; however, a pod can consist of up to several hundred individuals (Jefferson et al. 2006; NMFS 2011a). While swimming or looking for food, a pod may spread out over 1 km (0.6 mi) (NMFS 2011a). The short-finned pilot whale feeds at depths of 305 m (1,000 ft) or more (NMFS 2011a) predominately on squid, with fishes being consumed occasionally (Pauly et al. 1995; Jefferson et al. 2006). It is among the cetacean species that most frequently mass-strand (Jefferson et al. 2006). The best estimate of the abundance of the short-finned pilot whale in the northern GOM is 716 individuals with a minimum population estimate of 542 (Waring et al. 2010).

The spinner dolphin occurs worldwide in tropical, subtropical, and some warm-temperate waters normally in deep oceanic waters between 40°N and 40°S (Culik 2010; NMFS 2011a). In the northern GOM, most sightings are within the Northern GOM Slope Level II Ecoregion (see Figure 3.2.2-1) (Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009). Herd size ranges from under 50 to several thousand (Jefferson et al. 2006), and the spinner dolphin often schools with other dolphins, such as the pantropical spotted dolphin (Perrin 1998). It feeds on mesopelagic fishes, squid, and shrimp (Culik 2010; Pauly et al. 1995; Jefferson et al. 2006). The best estimate of the abundance of the spinner dolphin in the northern GOM is 1,989 individuals with a minimum population estimate of 1,356 (Waring et al. 2010).

The striped dolphin (*Stenella coeruleoalba*) occurs in tropical to temperate waters. In the northern GOM, sightings occur in oceanic waters (Waring et al. 2010). Its presence is often associated with areas of upwelling and convergence zones (NMFS 2011a). The striped dolphin only occurs close to shore in areas where deep water approaches the coast (Jefferson et al. 2006). In the northern GOM, sightings are mostly in the Northern GOM Slope, Mississippi Fan, and GOM Basin Level II Ecoregions (see Figure 3.2.2-1) (Read et al. 2011; Waring et al. 2010; Wilkinson et al. 2009). Mass strandings of the striped dolphin are rare because of its offshore distribution (Archer and Perrin 1999). Individual strandings in the GOM are reported (Waring et al. 2010). School size throughout its range generally ranges from about 25 to 100 individuals, although schools of hundreds to thousands of individuals do occur (NMFS 2011a). The striped dolphin can dive to depths of 700 m (2,300 ft) or more (NMFS 2011a). They feed primarily on small, mid-water squid and fishes, especially lanternfish (Pauly et al. 1995; Jefferson et al. 2006). The best estimate of the abundance of the striped dolphin in the northern GOM is 3,325 individuals with a minimum population estimate of 2,266 (Waring et al. 2010).

Factors Influencing Marine Mammal Distribution and Abundance. Various mesoscale oceanographic circulation patterns strongly influence the distribution and abundance of cetaceans within the northern GOM. These patterns are primarily driven by river discharge (primarily the Mississippi/Atchafalaya Rivers), wind stress, and the Loop Current and its derived circulation phenomena. Circulation on the continental shelf is largely wind-driven, with localized effects from freshwater (i.e., river) discharge, while mesoscale circulation beyond the shelf is largely driven by the Loop Current in the eastern GOM. Approximately once or twice a year, the Loop Current sheds anticyclonic eddies (also called warm-core rings). Anticyclones are long-lived, dynamic features that generally migrate westward and transport large quantities of high-salinity, nutrient-poor water across the near-surface waters of the northern GOM. These anticyclones, in turn, spawn cyclonic eddies (also called cold-core rings) during interaction with one another and upon contact with topographic features of the continental slope and shelf edge. These cyclones contain and maintain high concentrations of nutrients and stimulate localized production (Davis et al. 2000).

In the north-central GOM, the relatively narrow continental shelf south of the Mississippi River Delta may be an additional factor affecting cetacean distribution (Davis et al. 2000). Outflow from the Mississippi River mouth transports large volumes of low salinity, nutrient-rich water southward across the continental shelf and over the slope. River outflow also may be entrained within the confluence of a cyclone-anticyclone eddy pair and be transported beyond the continental slope. In either case, this nutrient-rich input of water leads to a localized deepwater environment with enhanced productivity, and may explain the persistent presence of aggregations of sperm whales within 50 km (31 mi) of the Mississippi River Delta in the vicinity of the Mississippi Canyon. Other marine predators, such as the bottlenose dolphin, also focus their foraging efforts on these abundant prey locations to improve overall efficiency and reduce energy costs (Bailey and Thompson 2010).

Climate Change. Marine mammal populations throughout the GOM may be affected by climate change and to a lesser extent by hurricane events. As previously discussed (Section 4.8.1.1), there is growing evidence that climate change is occurring, and potential effects in the GOM may include a change (i.e., rise) in sea level or a change in water temperatures. Such changes could affect the distribution, availability, and quality of marine mammal habitats and the abundance of marine mammal forage or prey resources. The construction of sea walls or other structures to protect coastal habitats against rising sea levels could potentially impact coastal marine species and possibly interfere with the movement of species such as the West Indian manatee (Learmonth et al. 2006). It is not possible at this time to identify the likelihood, direction, or magnitude of climate change on the marine mammals of the GOM. However, the current state of climate change and its impacts on marine mammals would need to be considered in any subsequent environmental reviews for lease sales or other OCS-related activities.

Unusual Mortality Event for Cetaceans in the Gulf of Mexico. On December 13, 2010, NMFS declared an unusual mortality event (UME) for cetaceans (whales and dolphins) in the GOM. A UME is defined under the MMPA as a "stranding that is unexpected, involves a significant die-off of any marine mammal population, and demands immediate response." Evidence of the UME was first noted by NMFS as early as February 2010. As of April 1, 2012, a total of 714 cetaceans (5% stranded alive and 95% stranded dead) have stranded since the start of the UME (NMFS 2012a). The vast majority of these strandings involve premature, stillborn, or neonatal bottlenose dolphins between Franklin County, Florida, and the Louisiana/Texas border (NMFS 2011f). Table 3.8.1-2 provides information on the cetacean strandings during

TABLE 3.8.1-2 Unusual Mortality Event Cetacean Data for the Northern Gulf of Mexico

Cetaceans Stranded	Phase of Deepwater Horizon Oil-Spill Response	Dates
114 cetaceans stranded	Prior to the response phase for the oil spill	February 1, 2010–April 29, 2010
122 cetaceans stranded or were reported dead offshore	During the initial response phase to the oil spill	April 30, 2010–November 2, 2010
478 cetaceans stranded[a]	After the initial response phase ended	November 3, 2010–April 1, 2012[b]

[a] This number includes 6 dolphins that were killed incidental to fish-related scientific data collection and 1 dolphin killed incidental to trawl relocation for a dredging project.

[b] The initial response phase ended for all four States on November 2, 2010. Response re-opened for eastern and central Louisiana on December 3, 2010 and closed again on May 25, 2011.

Source: NMFS 2012a.

pre-response, initial-response, and post-response phases for the DWH event. The 714 animals include 6 dolphins killed during a fish-related scientific study and 1 dolphin killed incidental to a dredging operation (NMFS 2012a).

It is unclear at this time whether the increase in strandings is related partially, wholly, or not at all to the DWH event (NMFS 2011f). The NMFS has also documented an additional 15 UMEs since 1991 that have been previously declared in the GOM; 11 of these involved cetaceans and the other 4 UMEs involved manatees (NMFS 2011g). However, the current data in Table 3.8.1-2 also shows a marked increase in strandings during the DWH event response and afterward. NMFS (2011f) considers the investigation into the cause of the UME and the potential role of the DWH event to be “ongoing and no definitive cause has yet been identified for the increase in cetacean strandings in the northern Gulf in 2010 and 2011.” It is therefore unclear whether increases in stranded cetaceans during and after the DWH event response period are or are not related to impacts from the DWH event; this will likely remain unclear until NMFS completes its UME and NRDA evaluation processes. However, investigations are ongoing to determine what role *Brucella* (a genus of bacteria) may be having on the UME. The adverse effects of *Brucella* include abortion, meningoencephalitis (brain infection), pneumonia, skin infection (e.g., blubber abscesses), and bone infection (NMFS 2012a). All marine mammals collected either alive or dead were found east of the Louisiana/Texas border through Franklin County, Florida. The highest concentration of strandings has occurred off eastern Louisiana, Mississippi, Alabama, and the panhandle of Florida, with a lesser number off western Louisiana (NMFS 2012a).

Deepwater Horizon Event. The DWH event in Mississippi Canyon Block 252 and the resulting oil spill and related spill-response activities (including use of dispersants) have affected marine mammals that have come into contact with oil and remediation efforts. Within the designated DWH spill area, 171 marine mammals (89% of which were deceased) were reported. This includes 155 bottlenose dolphins, 2 *Kogia* spp., 2 melon-headed whales, 6 spinner dolphins, 2 sperm whales, and 4 unknown species (NMFS 2011h). There have not been any manatees reported within the areas affected by the DWH event. All marine mammals collected either alive or dead were found east of the Louisiana/Texas border through Apalachicola, Florida. The highest concentration of strandings occurred off eastern Louisiana, Mississippi, and Alabama with a significantly lesser number off western Louisiana and western Florida (NMFS 2012a). Due to known low detection rates of carcasses (e.g., on average only 2% of cetacean deaths), it is possible that the number of deaths of marine mammals is underestimated (Williams et al. 2011). It is also important to note that evaluations have not yet confirmed the cause of death, and it is possible that many, some, or no carcasses were related to the DWH oil spill (NMFS 2011f).

3.8.1.1.2 Terrestrial Mammals Listed under the Endangered Species Act. This section focuses on federally endangered terrestrial mammals likely to be present in coastal habitats of the northern GOM, although numerous terrestrial mammal species not listed under the ESA may be present in coastal habitats at any given time. Four federally endangered GOM coast "beach mice" subspecies occupy restricted habitats within mature coastal dune habitats of northwestern Florida and Alabama: (1) the Alabama beach mouse (*Peromyscus polionotus ammobates*), (2) Choctawhatchee beach mouse (*Peromyscus polionotus allophrys*), (3) Perdido Key beach mouse (*Peromyscus polionotus trissyllepsis*), and (4) St. Andrew beach mouse (*Peromyscus polionotus peninsularis*). They are recognized subspecies of the old-field mouse (*Peromyscus polionotus*) (Bowen 1968; USFWS 1987). Additionally, the federally endangered Florida salt marsh vole (*Microtus pennsylvanicus dukecampbelli*), a subspecies of the meadow vole (*Microtus pennsylvanicus*), occurs in limited salt marsh areas in the Big Bend area of Florida (NatureServe 2010a). Figure 3.8.1-1 shows the GOM coast distributions of the four beach mouse subspecies and the Florida salt marsh vole.

Beach mouse habitat is restricted to mature coastal barrier sand dunes. The primary and secondary (frontal) dunes are generally characterized by thick growths of sea oats (*Uniola paniculata*) and other species such as blue stem (*Schizachyrium scoparium*), beach grass (*Panicum amarum*), and beach goldenrod (*Chrysoma pauciflosculosa*) (USFWS 2006a). The scrub dunes provide refugia for beach mice during and after tropical storm events (USFWS 2007b). The scrub dunes tend to be dominated by large patches of scrub live oak (*Quercus geminata*) with gopher apple (*Licania michauxii*) and green briar (*Smilax* spp.) ground cover (USFWS 2006a). The inland extent of the scrub dune habitat ends where the maritime forest begins (USFWS 2006a). Beach mice dig burrows mainly on the lee side of the primary dunes and in other secondary and interior dunes where the vegetation provides suitable cover. The beach mice may also use ghost crab (*Ocypoda quadratus*) burrows. The dynamic hurricane-dune regeneration cycle maintains the dune habitat structure preferred by beach mice (Bird et al. 2009).

Beach mice typically feed nocturnally in the dunes and remain in burrows during the day. Their diets vary seasonally but consist mainly of seeds, fruits, and insects (Bird et al. 2009).

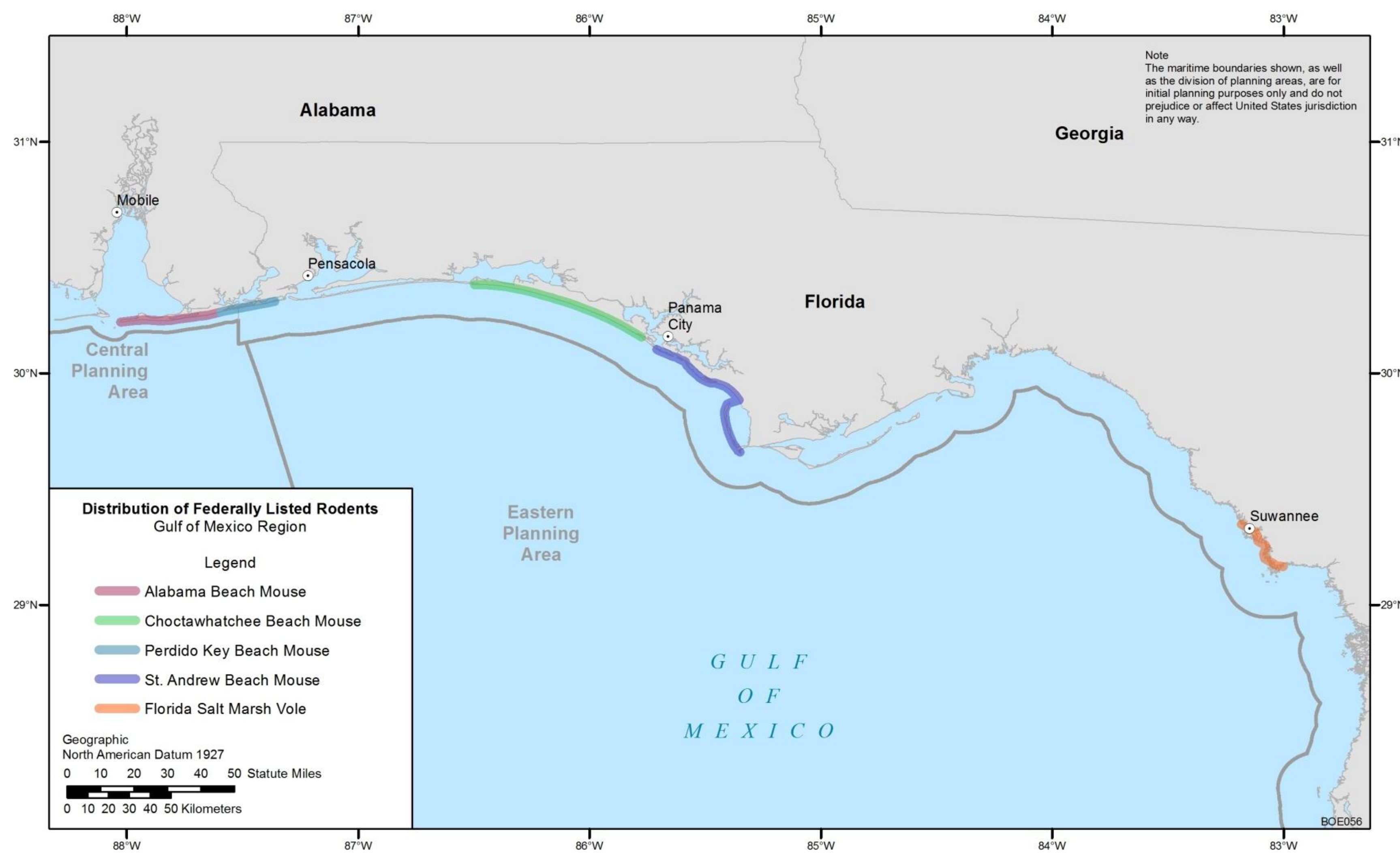

FIGURE 3.8.1-1 Coastal Distribution of the Endangered Beach Mouse Subspecies and the Florida Salt Marsh Vole in the GOM

Most foraging occurs in the sand dunes. Beach mice inhabit a single home range during their lifetime that averages about 5,000 m^2 (53,820 ft^2). Individual home ranges normally overlap. An individual may have 20 or more burrows within its home range (Bird et al. 2009). Beach mice use the highly vegetated areas of swales when moving between the primary and secondary dunes (Bird et al. 2009). The densities of beach mice are cyclic and can have large fluctuations on a seasonal and annual basis resulting from changes in reproductive rates, food availability, habitat quality and quantity, catastrophic events, disease, and predation (USFWS 2007b). Beach mice breed year-round with up to 13 generations per year. Peak breeding occurs in fall and winter, declines in spring, and occurs at low levels in summer. Average life span is about 9 months (USFWS 2007b).

The endangered status of beach mouse subspecies results from the loss and degradation of coastal dune habitats due to coastal development and natural processes. The combination of habitat loss and fragmentation resulting from beachfront development, the subsequent isolation of remaining habitat fragments and beach mouse populations, and destruction of these remaining habitats by hurricanes has increased the threat of extinction of the beach mouse subspecies (USFWS 1987; Oli et al. 2001).

The following provides additional information on the four beach mouse subspecies and the Florida salt marsh vole.

The Alabama beach mouse is known or believed to occur in Baldwin County, Alabama (USFWS 2012c). It occurs in Alabama within disjunctive private coastline holdings and a coastal strand habitat in the Bon Secour National Wildlife Refuge (Baldwin County). It appears to be the dominant small mammal in the dune and scrub habitats on the Fort Morgan Peninsula. Surveys and habitat analyses (Swilling et al. 1998; USFWS 2007b) provide overwhelming evidence that beach mice also forage and burrow in areas beyond the frontal dunes, including the escarpment and interior scrub. The Alabama beach mouse originally occurred along 53.9 km (33.5 mi) of coastline in Baldwin County, Alabama. As of May 2008, the Alabama beach mouse occurred within 991 ha (2,450 ac) of primary, secondary, and tertiary dunes and interior scrub habitat along an estimated 21 km (13 mi) of Alabama coastline (USFWS 2009a) (Figure 3.8.1-1). The revised critical habitat for the Alabama beach mouse encompasses about 490 ha (1,211 ac) of coastal dune and scrub habitat in Baldwin County, Alabama (USFWS 2007b). The critical habitat includes five units: (1) Fort Morgan — 180 ha (446 ac); (2) Little Point Clear — 108 ha (268 ac); (3) Gulf Highland — 111 ha (275 ac); (4) Pine Beach — 12 ha (30 ac); and (5) Gulf State Park — 78 ha (192 ac). The USFWS (2007b) describes and provides maps for these critical habitat units.

The Choctawhatchee beach mouse is known or believed to occur in Bay, Okaloosa, and Walton Counties, Florida (USFWS 2012d). It was once present along the coastal dunes between Choctawhatchee Bay and St. Andrew Bay, Florida. Since Hurricane Ivan, trapping sessions have indicated healthy populations at Topsail Hill Preserve State Park. The viability of populations elsewhere appear to be in decline and/or are at very low densities (USFWS 2007b). Habitat for the Choctawhatchee beach mouse is primary, secondary, and occasionally tertiary sand dunes with a moderate cover of grasses and forbs (FNAI 2001). About 1,010 ha (2,500 ac) of Choctawhatchee beach mouse habitat exists (USFWS 2007b). The revised critical habitat for the

Choctawhatchee beach mouse encompasses about 973 ha (2,404 ac) of coastal dune and scrub habitat in Okaloosa, Walton, and Bay Counties, Florida (USFWS 2006a). The critical habitat includes five units: (1) Henderson Beach — 39 ha (96 ac); (2) Topsail Hill — 125 ha (309 ac); (3) Grayton Beach — 73 ha (179 ac); (4) Deer Lake — 20 ha (49 ac); and (5) West Crooked Island/Shell Island — 716 ha (1,771 ac). The USFWS (2006a) provides maps for and describes these critical habitat units.

The Perdido Key beach mouse is known or believed to occur in Baldwin County, Alabama, and Escambia County, Florida (USFWS 2012e). Historically, the Perdido Key beach mouse occurred in coastal dune habitat between Perdido Bay, Alabama, and Pensacola Bay, Florida (Bowen 1968). The effects of Hurricane Frederic (in 1979) combined with increased habitat fragmentation due to human development led to the extirpation of all but one population of Perdido Key beach mouse. The remaining population at Gulf State Park (at the westernmost end of Perdido Key) contained 30 individuals. Some of the individuals from this site were used to reestablish the subspecies at Gulf Islands National Seashore (GINS) during 1986–1988 (Holler et al. 1989). In 2000, five pairs were relocated from the GINS-Perdido Key area to Perdido Key State Park. In February of 2001, this relocation was supplemented with an additional 16 pairs that were released on both north and south sides of Highway 292 in suitable habitat. After 2 yr of quarterly survey trapping, indications were that the relocations to Perdido Key State Park successfully established a population at that location. Individuals were also trapped on private lands between GINS and Perdido Key State Park in 2004, increasing documentation of current occurrences of the Perdido Key beach mouse. Currently, the Perdido Key beach mouse exists on lands in areas along 13.5 km (8.4 mi) of coastline from Perdido Key at GINS to Perdido Key State Park (Figure 3.8.1-1). The revised critical habitat for the Perdido Key beach mouse encompasses about 525 ha (1,300 ac) of coastal dune and scrub habitat in Baldwin and Escambia Counties, Florida (USFWS 2006a). The critical habitat includes five units: (1) Gulf State Park — 96 ha (238 ac); (2) West Perdido Key — 59 ha (147 ac); (3) Perdido Key State Park — 111 ha (275 ac); (4) Gulf Beach — 66 ha (162 ac); and (5) Gulf Islands National Seashore — 258 ha (638 ac). The USFWS (2006a) describes and provides maps for these critical habitat units.

The St. Andrew beach mouse is known or believed to occur in Bay and Gulf Counties, Florida (USFWS 2012f). It is the easternmost of the four GOM coastal subspecies (Figure 3.8.1-1) and currently consists of two disjunctive populations: East Crooked Island in Bay County, Florida, and St. Joseph Peninsula in Gulf County, Florida (USFWS 2010a). The current population at East Crooked Island is a result of translocations of beach mice from St. Joseph State Park to Crooked Island (1997–1998). The St. Andrew beach mouse also occurs on private lands to the west of Mexico Beach, Florida (USFWS 2009b). Population estimates reported in 2008 were 3,000 mice at East Crooked Island and 1,775 mice in the front dunes at St. Joseph State Park (USFWS 2009b). Optimal habitat is an undisturbed, intact, and functioning system of unconsolidated marine substrate, beach sand, primary natural sand dunes, and secondary and scrub dunes (USFWS 2009b). Of the estimated 83.3 km (51.8 mi) of current suitable habitat within the historic range of the St. Andrew beach mouse, the beach mouse occupies 44.5 km (27.7 mi) (USFWS 2010a). The critical habitat for the St. Andrew beach mouse encompasses about 1,008 ha (2,490 ac) of coastal dune and scrub habitat in Bay and Gulf Counties, Florida (USFWS 2006a). The critical habitat includes three units: (1) East Crooked

Island — 335 ha (826 ac); (2) Palm Point — 65 ha (162 ac); and (3) St. Joseph Peninsula — 608 ha (1,502 ac). The USFWS (2006a) describes and provides maps for these critical habitat units.

The Florida salt marsh vole is known or believed to occur in Levy County, Florida (USFWS 2012g). Originally the only known occurrence of the Florida salt marsh vole was Waccasassa Bay in Levy County, Florida, where it existed in low numbers. In 2004, several individuals were discovered on the Lower Suwannee National Wildlife Refuge located in southeastern Dixie/northwestern Levy Counties, Florida (Raabe and Gauron 2005). The two locations are only about 8 km (5 mi) apart (USFWS 2008a), resulting in the currently known approximate range shown in Figure 3.8.1-1. The Florida salt marsh vole appears to be most common in areas vegetated by saltgrass (*Distichlis spicata*). Its salt marsh habitat is vulnerable to flooding by hurricanes and extremely high tides (NatureServe 2010a). It probably survives high tides and storm flooding by swimming and climbing vegetation. Due to the very restricted range of the Florida salt marsh vole, catastrophic events could result in its extinction (NatureServe 2010a). Due to its rarity, life history and reproductive behavior of the subspecies are not well studied. However, some aspects are assumed to be similar to the meadow vole — feeding on a variety of plant matter, high reproductive rates with breeding throughout the year, and a lifespan of about 6 months (USFWS 1997). Critical habitat is not designated for the Florida salt marsh vole, primarily because publishing critical habitat maps could increase the chance of illegal collecting or attracting trespass on the lands where it occurs (USFWS 1991a).

Climate Change. GOM coastal habitats will be affected by climate change. Factors associated with climate change that can effect beach mice and the Florida salt marsh vole include alteration in stream flow and river discharges, wetland loss, sea level rise, changes in storm frequency and strength, sediment yield, mass movement frequencies and coastal erosion, and subsidence. The small tidal range of the GOM coast increases the vulnerability of coastal habitats to the effects of climate change. Rising sea levels and changes in the frequency, intensity, timing, and distribution of tropical storms and hurricanes are expected to have substantial impacts on coastal wetland and shoreline patterns and processes (Michener et al. 1997; Scavia et al. 2002). Increases in sea level rise and storm frequency and severity may increase inundation and erosion of beach mice and Florida salt marsh vole habitats. The construction of sea walls or other protective measures to protect coastal habitats from increasing sea levels could potentially impact alternative sites suitable for these species.

Deepwater Horizon Event. The DWH event in Mississippi Canyon Block 252 and the resulting oil spill and related spill-response activities (including use of dispersants) had the potential to affect the federally endangered terrestrial mammals and their habitats present in the coastal habitats of the northern GOM. OSAT-2 (2011) prepared a summary report on the fate and effects of residual oil from the DWH event in the beach environment. PAHs associated with the residual oil have the potential to impact terrestrial mammals (OSAT-2 2011). The report focused on four case study beach areas, one of which (Bonn Secour, Alabama) coincided with habitat for the Alabama beach mouse. Bon Secour generally received more oiling than the average of surrounding beaches (or the beaches where other endangered beach mice occur) and served as an example of a worst-case scenario (OSAT-2 2011). At Bon Secour, submerged oil mats consisted of 10.7% oil and 89.3% sand, small surface residue balls consisted of 7.4% oil and 92.6% sand, and supratidal buried oil consisted of 6.5% oil and 93.5% sand. Only 3% of trenches dug as part of the shoreline cleanup assessment were considered to have moderate-to-heavy oiling in the supratidal buried oil (OSAT-2 2011).

Only manual removal of oil was permitted in the Bon Secour National Wildlife Refuge (OSAT-2 2011). However, complete avoidance of beach mouse habitat is not always feasible when an oil response emergency occurs, and some beach mouse habitat has been damaged as a result of response activities to the DWH event (e.g., from sand removal, alteration, or compaction and by vegetation disturbance or destruction) (Frater 2011). Key findings by OSAT-2 (2011) of relative importance to beach mice are (1) in most locations, PAH concentrations in supratidal buried oil will decrease to 20% of current levels within 5 years, but there are isolated conditions where PAH concentrations are predicted to persist substantially longer; and (2) wildlife resources would likely experience a greater threat from further cleanup activities than from the oil that still remains on the beaches. OSAT-2 (2011) concluded that the inherent oil toxicity to beach mice was considered medium but the likelihood that beach mice would be exposed to supratidal buried oil, submerged oil mat, or small surface residue balls was low. Overall, impacts on beach mice would be possible (lowest impact-level determination in the report). Estimated daily doses of PAHs calculated for the Alabama beach mouse (the subspecies mostly likely to be exposed to oil at the highest concentrations) were below toxicity reference values, suggesting a low risk from incidental exposure to oil. It was also concluded that beach mice would likely avoid burrowing in areas with high levels of residual oil (OSAT-2 2011). Further cleanup would result in a low impact for submerged oil mats, a medium impact for small surface residue ball cleanup, and a high impact (most severe impact-level determination) for supratidal buried oil. Impacts could occur from additional alteration or damage to habitat from cleanup activities and from increased human traffic (OSAT-2 2011).

The long-term consequences of the DWH event are still being determined. It is uncertain how much oil impacted GOM beaches, how much continues to impact the beaches, how the physical and chemical characteristics of the oil are changing with time, and the magnitude and duration of future redepositional events. Long-term studies will be needed to determine if future changes in the beach ecosystem will be benign or serious (Hayworth et al. 2011). Ecological impact studies and restoration efforts related to the DWH event are ongoing. On April 18, 2012, the Deepwater Horizon Natural Resource Damage Assessment (NRDA) Trustees Council announced that they finalized the "Deepwater Horizon Phase I Early Restoration Plan & Environmental Assessment" that addresses eight restoration projects that will be implemented to restore ecological resources (Deepwater Horizon Natural Resource Trustees 2012). These include coastal dune habitat improvements that could benefit one or more of the endangered beach mouse species.

3.8.1.2 Alaska – Cook Inlet

3.8.1.2.1 Marine Mammals. The following information describes the life history attributes, distributions, and seasonal movements of 17 marine mammal species that occur in Cook Inlet (Cook Inlet Level III Coastal Ecoregion) or nearby waters of the Gulf of Alaska (Gulf of Alaska Level III Coastal Ecoregion) that could be affected by activities related to lease sales in Cook Inlet (Table 3.8.1-3).[10] (The Level III Ecoregions are described in Section 3.2.4 and are shown in Figure 3.2.2-2.) Nine of these species are threatened or endangered under the ESA.

Marine Mammals Listed under the Endangered Species Act.

Cetaceans: Mysticetes. In Alaska, the endangered blue whale (*Balaenoptera musculus*) primarily occurs south of the Aleutian Islands and the Bering Sea (Berzin and Rovnin 1966; NMFS 2011a). It also occurs north of 50°N extending from southeastern Kodiak Island across the Gulf of Alaska and from southeast Alaska to Vancouver Island (Berzin and Rovnin 1966). Individuals from the eastern North Pacific and western North Pacific blue whale stocks can occur in the Gulf of Alaska during spring and summer after wintering in subtropical and tropical waters (Carretta et al. 2011). The eastern North Pacific blue whale stock occurs in the eastern North Pacific, ranging from the northern Gulf of Alaska to the eastern tropical Pacific. Most winter in the highly productive waters of Baja California, Gulf of California, and on the Costa Rica Dome (Carretta et al. 2011). Blue whales from the central North Pacific stock feed in summer southwest of Kamchatka, south of the Aleutian Islands, and in the Gulf of Alaska. This stock winters in lower latitudes in the western Pacific and less frequently in central Pacific including offshore waters north of Hawaii (Carretta et al. 2011). While the blue whale occurs in south central Alaska, it is not expected to occur within Cook Inlet. Blue whales tend to occur alone or in pairs, but aggregations of 12 or more may develop in prime feeding grounds (Jefferson et al. 2006). Blue whales feed year-round (Carretta et al. 2011). They feed almost exclusively on krill (euphausids) (Pauly et al. 1995; Jefferson et al. 2006; NMFS 2011a). Mating and calving occur in the late fall and winter (Zimmerman and Rehberg 2008). The best estimate of the abundance of the eastern North Pacific blue whale stock is 2,497 with a minimum abundance of 2,046; no abundance estimates are available for the central North Pacific blue whale stock (Carretta et al. 2011).

The endangered fin whale (*Balaenoptera physalus*) ranges worldwide from subtropical to Arctic waters, and most sightings occur where deep water approaches the coast (Jefferson et al. 2006). Most fin whales migrate seasonally from relatively low-latitude wintering habitats where breeding and calving occur to high-latitude summer feeding areas (Perry et al. 1999). Northward migration begins in spring with migrating whales entering the Gulf of Alaska from early April through June (MMS 1996b). Their summer distribution extends from central California into the Bering and Chukchi Seas, while their winter range is restricted to the waters off the coast of California. Some fin whales feed in the Gulf of Alaska, including near the entrance to Cook Inlet (NMFS 2003). During the months of July and August, fin whales concentrate in the Bering Sea-eastern Aleutian Island area. In September to October, most fin whales are in the Bering Sea, Gulf of Alaska, and along the U.S. coast as far south as Baja, California (Mizroch et al. 1984; Brueggman et al. 1984). The fin whale feeds on concentrations of zooplankton (e.g., krill), fishes, and cephalopods (Pauly et al. 1995; Jefferson et al. 2006). A provisional estimate for the fin whale population west of the Kenai Peninsula is 5,700 animals (Allen and Angliss 2011).

[10] A solitary Pacific walrus inhabited the Cook Inlet from the 1980s until its death in 2001 (Little 2001); however, as the occurrence of the Pacific walrus in the Cook Inlet is atypical, the species is not addressed in this section.

TABLE 3.8.1-3 Cook Inlet Marine Mammals

Species	Status[a]
ORDER CETACEA	
Suborder Mysticeti (baleen whales)	
Eubalaena japonica (North Pacific right whale)	E/D
Balaenoptera acutorostrata (minke whale)	–
Balaenoptera borealis (sei whale)	E/D
Balaenoptera musculus (blue whale)	E/D
Balaenoptera physalus (fin whale)	E/D
Eschrichtius robustus (gray whale)	DL/D
Megaptera novaeangliae (humpback whale)	E/D
Suborder Odontoceti (toothed whales and dolphins)	
Physeter macrocephalus (sperm whale)	E/D
Delphinapterus leucas (beluga whale)	E/D
Orcinus orca (killer whale)	D
Lagenorhychus obliquidens (Pacific white-sided dolphin)	–
Ziphius cavirostris (Cuvier's beaked whale)	–
Phocoenoides dalli (Dall's porpoise)	–
Phocoena phocoena (harbor porpoise)	–
ORDER CARNIVORA	
Suborder Pinnipedia (seals, sea lions, and walrus)	
Eumetopias jubatus (Steller sea lion)	E/D, T/D[b]
Phoca vitulina richardsi (harbor seal)	–
Suborder Fissipedia (sea otters)	
Enhydra lutris (sea otter)	T

[a] Status: E = endangered under the ESA; T = threatened under the ESA; C = candidate for listing under the ESA; DL = delisted under the ESA; D = depleted under the MMPA (for the killer whale, it only applies to the AT1 group of eastern North Pacific transient killer whales); – = not listed.

[b] The western U.S. stock of Steller sea lion encompasses the range of the Western District Population Segment of the Steller sea lion, which is listed as endangered under the ESA, and the eastern U.S. stock encompasses the range of the Eastern District Population Segment, which is listed as threatened under the ESA.

The endangered humpback whale (*Megaptera novaeanglia*) occurs worldwide in all ocean basins, feeding in higher latitudes during spring, summer, and autumn, and migrating to a winter range over shallow tropical and subtropical banks, where they calve and presumably breed (Jefferson et al. 2006). Members of the Western North Pacific and Central North Pacific stocks occur in Alaskan waters. They migrate from winter breeding grounds near Japan, Hawaii, or Mexico to summer feeding grounds from Washington to as far north as the Chukchi Sea (Zimmerman and Karpovich 2008). In the Gulf of Alaska, areas with concentrations of humpback whales include the Portlock and Albatross Banks and west to the eastern Aleutian Islands, Prince William Sound, and the inland waters of southeastern Alaska (Berzin and

Rovnin 1966). Humpback whales have also been routinely observed in lower Cook Inlet (Rugh et al. 2005, 2007). The Kodiak Island area supports a feeding aggregation of humpback whales (Waite et al. 1999). Current data demonstrate that the Bering Sea remains an important feeding area. Humpback whales usually occur alone or in groups of two or three, although larger aggregations occur in breeding and feeding areas (Jefferson et al. 2006). Humpback whales feed on concentrations of zooplankton (e.g., krill) and fishes using a variety of techniques that concentrate prey for easier feeding (Pauly et al. 1995; Jefferson et al. 2006). Feeding rarely occurs while migrating or during winter while in tropical waters (Zimmerman and Karpovich 2008). The best population estimate for the Western North Pacific stock is 938 whales with a minimum population estimate of 732 individuals; the best population estimate for the Central North Pacific stock is 7,469 whales with a minimum population estimate of 5,833 individuals (Allen and Angliss 2011).

The endangered North Pacific right whale (*Eubalaena japonica*) historically ranged across the entire North Pacific north of 35°N and occasionally as far south as 20°N before commercial whaling reduced their numbers. Today, distribution and migratory patterns of the North Pacific stock are largely unknown. The whales in the North Pacific population summer in their high-latitude calanoid copepod and euphausid crustacean feeding grounds, and migrate to more temperate, possibly offshore, waters during the winter (Braham and Rice 1984; Scarff 1986; Allen and Angliss 2011). North Atlantic and Southern Hemisphere right whales calve in coastal waters during the winter, but locations of calving grounds in the eastern North Pacific are not known (Scarff 1986). Right whales remain in the southeastern Bering Sea from May through December (Allen and Angliss 2011).

There is evidence of North Pacific right whale occurrence in the Gulf of Alaska and Bering Sea (Wade et al. 2011). Recent sightings have been concentrated in the western outer Bristol Bay area, midway on a line between Unimak Island and Kuskokwim Bay, and this area may be an important feeding area for the few remaining North Pacific right whales (Shelden et al. 2005). More recent sightings of North Pacific right whales in the eastern Bering Sea during the summer are the first reliable observations in decades (Moore et al. 2000b; Tynan et al. 2001; Wade et al. 2011). These sightings include the first few calves documented in the eastern North Pacific in over a century (LeDuc et al. 2001; Brownell et al. 2001; Wade et al. 2011). These sightings suggest that the abundance in the eastern North Pacific is possibly in the tens of animals. North Pacific right whales remain the most highly endangered marine mammal in the world. Little is known regarding the migratory behavior, life history characteristics, and habitat requirements of this species. The basic life history parameters and census data (including population abundance, growth rate, age structure, breeding ages, gender ratios, and distribution) remain undetermined. Given that the population is extremely small and little current information is available, recovery is not anticipated in the foreseeable future (e.g., several decades or longer).

Based on available evidence, the NMFS revised the species' critical habitat on July 6, 2006 (71 FR 38277) to include one area in the Gulf of Alaska and one in the Bering Sea. For more information on North Pacific right whales, see NMFS (2006), which reported the largest number of eastern North Pacific right whales identified in the Bering Sea to be 23 individuals. The minimum estimate of abundance is 17 individuals (Allen and Angliss 2011).

The endangered sei whale (*Balaenoptera borealis*) is an oceanic species that occurs in tropical to polar waters, being more common in the mid-latitude temperate zones. It seldom occurs close to shore (Jefferson et al. 2006). They inhabit deepwater areas of the open ocean, most commonly over the continental slope (Carretta et al. 2011; Reeves et al. 1998). Sei whales migrate to lower latitudes for breeding and calving in the winter and to higher latitudes in summer for feeding, including the Gulf of Alaska and along the Aleutian Islands and the southern Bering Sea (Reeves et al. 1998). Sei whales begin their southward migration in August or September. Groups of 2 to 5 individuals are commonly observed, but loose aggregations of 30 to 50 occasionally do occur (Jefferson et al. 2006; NMFS 2011a). Sei whales feed on concentrations of zooplankton (e.g., krill and copepods), fishes, and cephalopods (Pauly et al. 1995). Sei whales observed in Alaska are members of either the Eastern North Pacific stock and/or the Hawaiian stock. The abundance of the Eastern North Pacific stock is estimated at 126 individuals with a minimum estimate of 83 whales; while abundance estimates for the Hawaiian stock are 77 with a minimum abundance of 37 (Caretta et al. 2011).

Cetaceans: Odontocetes. The NMFS recognizes five stocks of beluga whales (*Delphinapterus leucas*) in U.S. waters: (1) Cook Inlet, (2) Bristol Bay, (3) eastern Bering Sea, (4) eastern Chukchi Sea, and (5) Beaufort Sea (Allen and Angliss 2011). There are no physical barriers among these stocks, but genetic data indicates that the stocks do not interbreed (Citta and Lowry 2008). Most of the Cook Inlet stock was listed as an endangered distinct population segment (DPS) under the ESA in 2008 (NMFS 2008a). The beluga whales that inhabit Yakutat Bay (fewer than 20 individuals) are included as part of the Cook Inlet stock but are not considered part of the Cook Inlet DPS (Allen and Angliss 2011).

The beluga whale occurs throughout seasonally ice-covered Arctic and subarctic waters of the Northern Hemisphere (Stewart and Stewart 1989) and is closely associated with open leads and polynyas in ice-covered regions (Allen and Angliss 2011). Depending on season and region, beluga whales may occur in both offshore and coastal waters. Ice cover, tidal conditions, access to prey, temperature, and human interaction affect seasonal distribution (Allen and Angliss 2011). During the winter, beluga whales generally occur in offshore waters associated with ice packs, and in the spring, many migrate to warmer coastal estuaries, bays, and rivers for molting and calving (Sergeant and Brodie 1969). Breeding occurs in March or April, with calves born the following May through July, usually when herds are at or near summer concentration areas (Citta and Lowry 2008). Beluga whales shed their skin (molt) yearly in July in shallow water, often where there is coarse gravel to rub against (Citta and Lowry 2008).

The Cook Inlet DPS occurs near river mouths in the northern Cook Inlet during the spring and summer months and in mid-Inlet waters in the winter; evidence indicates that the stock remains in Cook Inlet throughout the year (Allen and Angliss 2011; NMFS 2008a). Based on surveys conducted in the Gulf of Alaska between 1936 and 2000, a few belugas occur in the Gulf of Alaska outside of Cook Inlet. Those belugas are considered part of the Cook Inlet stock (Laidre et al. 2000).

The NMFS (2011b) designated 7,800 km^2 (3,013 mi^2) of critical habitat for the Cook Inlet DPS of beluga whales on April 11, 2011 (Figure 3.8.1-2). Critical Habitat Area 1 and Critical Habitat Area 2 are respectively equivalent to the Type 1 and 2 habitats identified in the

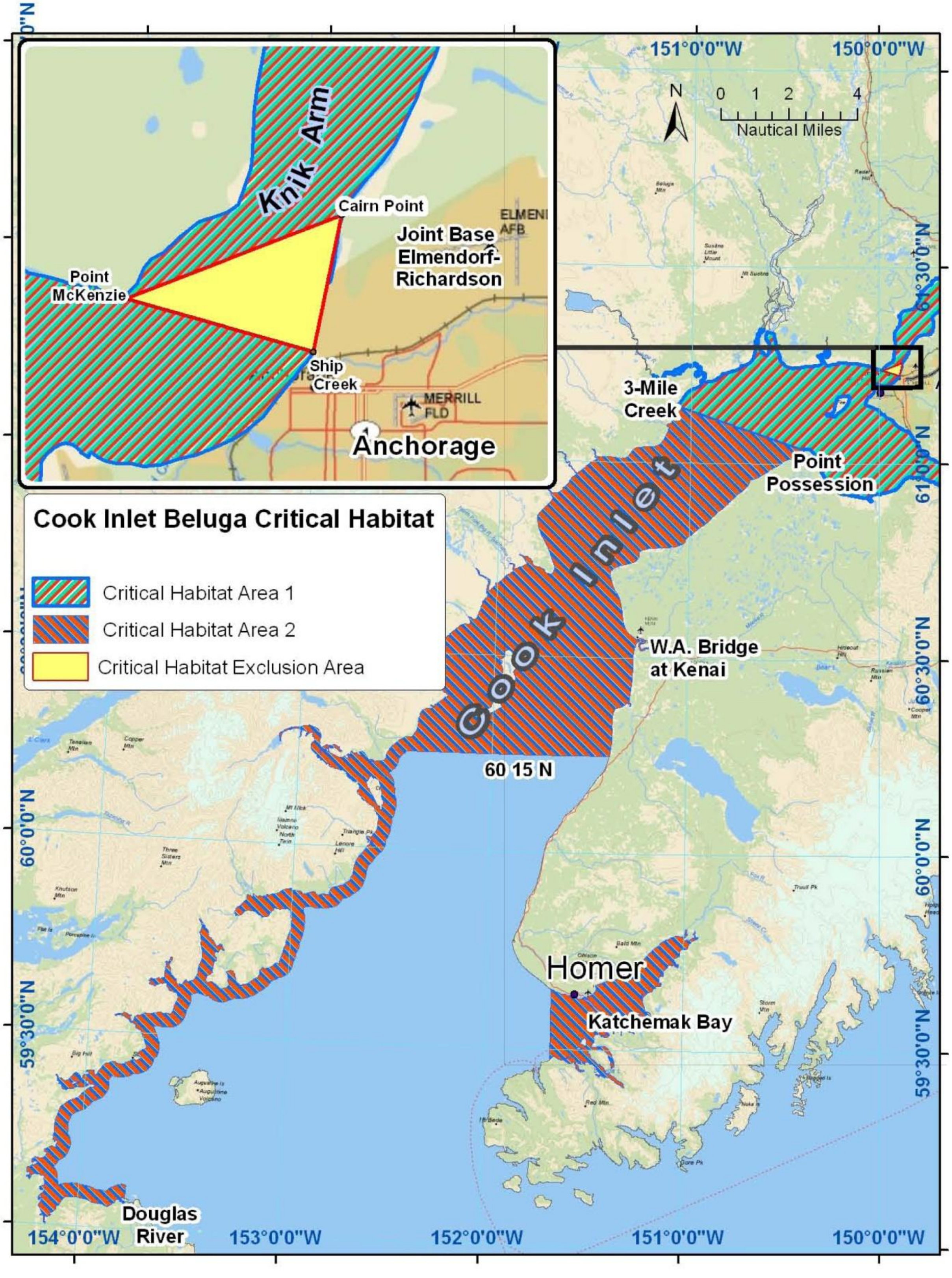

FIGURE 3.8.1-2 Critical Habitat for the Cook Inlet Beluga Whale DPS

conservation plan for the Cook Inlet beluga whale (NMFS 2008b). Critical Habitat Area 1, encompassing1,909 km^2 (738 mi^2), occurs in the upper portion of Cook Inlet that contains a number of shallow tidal flats, river mouths, and estuarine areas that are important for foraging, calving, molting, and escaping predators. This area, considered the most valuable habitat type for Cook Inlet belugas, contains the highest concentrations of belugas from spring through fall (NMFS 2008b, 2011b). Critical Habitat Area 2, encompassing 5,891 km^2 (2,275 mi^2), is used less during spring and fall, but is known to be used in fall and winter. Dispersed fall and winter feeding and transit areas occur in this critical habitat area, which includes near and offshore areas of the mid- and upper Inlet and nearshore areas of the lower Inlet (Figure 3.8.1-2). The deeper dives made by Cook Inlet beluga whales in this area of critical habitat suggest that the area is an important fall and winter feeding area that may be important to the winter survival and recovery of Cook Inlet beluga whales (NMFS 2008b, 2011b).

Two fish species especially fed upon by Cook Inlet beluga whales are king (Chinook) salmon and Pacific eulachon. Other items prominent in their diet are Pacific salmon, cod, walleye pollock, yellowfin sole, and other fishes and invertebrates (NMFS 2011b). In spring, the belugas feed on eulachon, gadids (cod and pollock), anadromous steelhead trout, and freshwater fishes. During summer, belugas prey on the Pacific salmon species that spawn in the rivers throughout Cook Inlet. In the fall, they feed on the various fish species that occur in nearshore bays and estuaries. Stomach samples for Cook Inlet belugas during winter are not available, but the belugas probably prey on deeper water prey such as flatfish, sculpin, and pollock (NMFS 2008b).

During 1978 to 1979, 95% of the Cook Inlet beluga whale range occupied 7,226 km^2 (2,790 mi^2) of Cook Inlet (Rugh et al. 2010). The Cook Inlet beluga whale stock (which includes the Cook Inlet DPS) was estimated at 1,300 animals in 1979 (NMFS 2008a). By 1994, the stock numbered 653 whales and declined to 347 whales by 1998. Subsistence hunting and interactions with fishing gear appear to be the major factors leading to abundance declines (Laidre et al. 2000). The Cook Inlet stock has continued to decline by 1.45% per year from 1999 to 2008 (Allen and Angliss 2011). Between 1998 and 2008, 95% of the beluga whale range in Cook Inlet was 2,806 km^2 (1,083 mi^2). Most areas occupied are in the upper portions of Cook Inlet (Rugh et al. 2010). The current best population estimate for the Cook Inlet DPS is 284 as of June 2011 (Hobbs et al. 2011). A healthy population level for the Cook Inlet beluga whale stock should be at least 780 individuals (NMFS 2008b).

The endangered sperm whale (*Physeter macrocephalus*) occurs worldwide in deep waters from the tropics to the pack-ice edges, although generally only large males venture to the extreme northern and southern portions of the species' range (Jefferson et al. 2006). Sperm whales tend to inhabit areas with water depths of 600 m (1,970 ft) or more and are uncommon at depths shallower than 300 m (984 ft) (NMFS 2011a). However, they do come close to shore where submarine canyons or other geophysical features bring deep water near the coast (Jefferson et al. 2006). In Alaska, their northernmost boundary extends from Cape Navarin (62°N) to the Pribilof Islands, with whales more commonly found in the Gulf of Alaska and along the Aleutian Islands. The shallow continental shelf may prevent their movement into the northeastern Bering Sea and Arctic Ocean (Allen and Angliss 2011). Females and young sperm whales usually remain in tropical and temperate waters year-round, while males move north to feed in the Gulf of Alaska, Bering Sea, and waters around the Aleutian Islands (Gosho et al. 1984; Allen and Angliss 2011). Seasonal movement of sperm whales in the North Pacific is not well-defined, but they typically occur south of 40°N during the winter (Gosho et al. 1984). Males move north in the spring and summer to feed in the Gulf of Alaska, Bering Sea, and waters around the Aleutian Islands (Berzin and Rovnin 1966). Fall migrations begin in September and most whales have left Alaskan waters by December (MMS 1996b), returning to temperate and tropical portions of their range, typically south of 40°N, in the fall (Gosho et al. 1984; Allen and Angliss 2011). Breeding occurs during the spring and early summer (April through August). Sperm whales are present year-round in the Gulf of Alaska, but are apparently more abundant in summer than in winter (Allen and Angliss 2011). Sperm whales commonly occur in medium to large groups of up to 50 individuals (Jefferson et al. 2006). Sperm whales prey on cephalopods, fishes, and benthic invertebrates (Pauly et al. 1995; Jefferson et al. 2006). The number of sperm whales occurring in Alaska waters is unknown. More than 100,000 sperm whales were estimated to occur in the western North Pacific in the late 1990s (Allen and Angliss 2011).

Pinnipeds. The Steller sea lion (*Eumetopias jubatus*) in Alaska is comprised of an eastern U.S. stock, which includes animals east of Cape Suckling, Alaska (144°W), and a western U.S. stock, including animals at and west of Cape Suckling (Allen and Angliss 2011). The eastern stock encompasses the range of the Eastern Distinct Population Segment of the Steller sea lion that is listed as threatened under the ESA, while the western stock encompasses the range of the Western Distinct Population Segment that is listed as endangered under the ESA (NOAA 2011a). The centers of abundance and distribution of the Steller sea lion are located in the Gulf of Alaska and the Aleutian Islands. Individuals from only the western stock inhabit areas of south central Alaska could be affected by oil and gas activities in the Cook Inlet Planning Area. The Steller sea lion is not known to migrate, but individuals disperse widely outside of the breeding season (late May to early July). At sea, Steller sea lions commonly occur near the 200-m (660-ft) depth contour, but individuals occur from nearshore to well beyond the continental shelf. Some individuals may enter rivers in pursuit of prey (NMFS 2008c). Steller sea lions eat a variety of fishes and cephalopods and occasionally birds and seals (Zimmerman and Rehberg 2008). Older juveniles can dive to depths of 500 m (1,500 ft) and can stay underwater for more than 16 minutes (Zimmerman and Rehberg 2008). However, dive depths of juveniles generally do not exceed 20 m (66 ft), while adults will dive to depths greater than 250 m (820 ft) (NMFS 1993).

Thirty-eight Steller sea lion rookeries and hundreds of haulouts occur within the range of the western stock of the Steller sea lion (Allen and Angliss 2011; NMFS 2008c). The locations of the rookeries and haulouts change little from year to year (NMFS 1993). Major rookeries in and near Cook Inlet include Outer Island, Sugarloaf Island, Marmot Island, Chirikof Island, and Chowiet Island. There are several major haulouts in and near Cook Inlet, 20-NM aquatic zones, and an aquatic foraging area in Shelikof Strait. All of these are part of Steller sea lion critical habitat. Breeding and pupping occur on rookeries; rookeries normally occur on relatively remote islands, rocks, reefs, and beaches, where access by terrestrial predators is limited. Rookeries are normally occupied from late May through early July (NMFS 1993). Haulouts are areas used for rest and refuge by all sea lions during the non-breeding season and by non-breeding adults and subadults during the breeding season. Some rookeries are used as haulouts after the breeding season is over. In addition to rocks, reefs, and beaches normally used as haulouts, sea lions may also use sea ice and man-made structures such as breakwaters, navigational aids, and floating docks (NMFS 1993). Sea lion critical habitat includes a 32 nautical km (20 nautical mi) buffer around all major haulouts and rookeries, as well as associated terrestrial, air, and aquatic zones. Special foraging areas in Alaska have also been designated critical habitat for Steller sea lions including the Shelikof Strait area of the Gulf of Alaska, the Bogoslof area in the Bering Sea shelf, and the Seguam Pass area in the central Aleutian Islands (NMFS 1993). Figure 3.8.1-3 shows the Steller sea lion critical habitat in the area of Cook Inlet Planning Area. The minimum population estimate for the Steller sea lion western stock is 42,366 (Allen and Angliss 2011). The abundance of the western stock is stable or slightly decreasing (NMFS 2008c).

Fissipeds. The sea otter (*Enhydra lutris*) inhabits shallow water areas along the shores of the North Pacific. Three stocks of the sea otter occur in Alaskan waters: (1) Southwest Alaska, extending from the Kodiak Archipelago southwest through the Alaska Peninsula to the Aleutian Islands; (2) south central Alaska, between Cape Yukataga and the east coast of Cook Inlet and including the eastern side of Cook Inlet; and (3) Southeast Alaska, extending from the U.S./Canadian border to Cape Yukataga (Gorbics and Bodkin 2001). Individuals from both the south central and southwest Alaska stocks occur in south central Alaska where they could be affected by oil and gas activities in the Cook Inlet Planning Area. The Southwest Alaska stock has declined dramatically over the past several decades, probably due to predation by killer whales (Schneider and Ballachey 2008), causing the USFWS to list that stock as a threatened DPS under the ESA (USFWS 2006b).

Five units totaling 15,164 km^2 (5,855 mi^2) are designated as critical habitat for the Southwest Alaska DPS (USFWS 2009c). Unit 5 (Kodiak, Kamishak, Alaska Peninsula), containing 6,755 km^2 (2,607 mi^2) of critical habitat (USFWS 2009c), is the most likely of the sea otter critical habitat units to be affected by activities related to lease sales in Cook Inlet. This unit ranges from Castle Cape in the west to Tuxedni Bay in the east, and includes the Kodiak Archipelago (USFWS 2009c). The unit includes the nearshore marine environment ranging from the mean high tide to the 20-m (66-ft) depth contour as well as waters occurring within 100 m (330 ft) of the mean high tide line (USFWS 2009c). The lower western half of Cook Inlet to Redoubt Point is included in Unit 5 of the critical habitat (USFWS 2009c).

The sea otter inhabits coastal waters less than 90 m (295 ft) deep, with the highest densities usually found within the 40-m (130-ft) isobath where young animals and females with pups forage. Preferred habitat includes rocky reefs, offshore rocks, and kelp beds. Sea otters in Alaska are not migratory and, while capable of movements over 100 km (60 mi), generally do not disperse over long distances (Allen and Angliss 2011). They will sometimes rest in groups of fewer than 10 to more than 1,000 individuals. Sea otters seldom come onshore, and when they do, they are seldom more than a few meters from water (Schneider and Ballachey 2008).

Sea otters prey on a great variety of mostly benthic food sources including sea urchins, clams, mussels, snails, abalone, crabs, scallops, chitons, limpets, octopus, and fin fish (Estes et al. 1978; Garshelis et al. 1986; Riedman and Estes 1990; Green and Brueggeman 1991; Kvitek et al. 1993). They dive to depths of 1.5 to 76 m (5 to 250 ft). A dive usually lasts 1 to 1.5 minutes, but can last 5 minutes or more (Schneider and Ballachey 2008). The recovery and

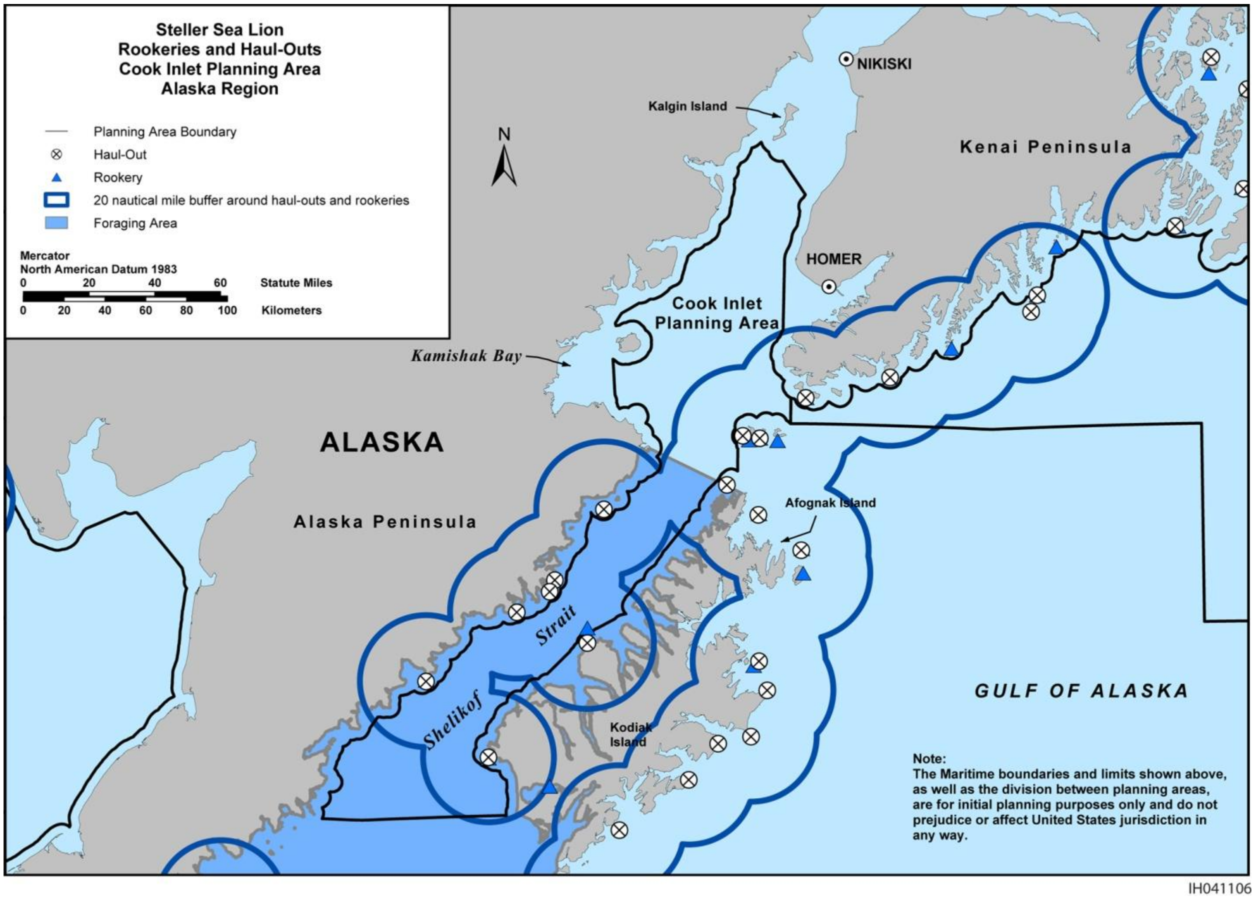

FIGURE 3.8.1-3 Steller Sea Lion Critical Habitat in the Area of the Cook Inlet Planning Area (note: the figure is in the process of being prepared/modified)

expansion of the sea otter populations in Prince William Sound and in Southeast Alaska, coupled with the otter's preference for crab and clam species that are of commercial interest (such as Dungeness crab and butter clam) (Garshelis et al. 1986; Kvitek et al. 1993), has resulted in competition and conflict with commercial-fishing interests (Garshelis and Garshelis 1984; USFWS 1994a).

Among marine mammals, sea otters probably have one of the higher reproductive rates and a potential for fairly rapid population recovery (such as 17–20% per year [Riedman et al. 1994]) after substantial losses due to natural or man-made causes (such as overharvest or an oil spill). Female sea otters can reach sexual maturity at 2 yr of age (30%), with all females mature at 5 yr of age (Bodkin et al. 1993). With a gestation period of about 6 months and a pup dependency of 6 months, most sexually mature female sea otters (85–90%) are able to pup in a given year (Jameson and Johnson 1993). Post-weaning survival can range from 18 to 86%, and survival of sea otters more than 2 yr of age can approach or exceed 90%. Females can live up to 22 yr and males up to 15 yr (USFWS 2010c).

The current estimate for the Southwest Alaska stock is 47,676 sea otters, with a minimum population estimate of 38,703, while the current estimate for the south central Alaska stock is 15,090 sea otters, with a minimum population estimate of 13,955. Of these, 2,673 sea otters occur in Cook Inlet/Kenai Fiords (Allen and Angliss 2011). The south central Alaska stock population trend is stable, while the Southwest Alaska stock is declining (Allen and Angliss 2011). The cause of the population decline is not known for sure, but weight of evidence indicates that increased predation by killer whales as the most likely cause. The most important threats to recovery of the population are predation and oil spills; other threats to recovery include subsistence harvest, illegal take, and infectious disease (USFWS 2010c).

Marine Mammals Not Listed under the Endangered Species Act.

Cetaceans: Mysticetes. The Eastern North Pacific population of the gray whale (*Eschrichtius robustus*) was delisted from the ESA in 1994 (USFWS and NMFS 1994). The Eastern North Pacific stock (which encompasses this population) winters primarily along the west coast of Baja California where calving occurs from January to mid-February (Allen and Angliss 2011). The northward migration, which occurs in nearshore waters, begins in mid-February and continues through May (Allen and Angliss 2011). Gray whales arrive for their feeding season in the Gulf of Alaska in late March and April (at which time some individuals may occur close to Cook Inlet), the northern Bering Sea (Cherikov Basin located west and north of the Norton Basin) in May or June, and the Chukchi and Beaufort Seas in July or August (Rice and Wolman 1971). Some gray whales have been observed feeding year-round in the waters southeast of Kodiak Island (Moore et al. 2007). They begin their southward migration in mid-October, passing through Unimak Pass from late October to early January (Frost and Karpovich 2008). Breeding occurs during their southward migration to the Gulf of California and Baja. In recent years, gray whales have begun to delay their southbound migration, are expanding their feeding range along the migration route and northward to Arctic waters, and some even remain in polar waters over winter (Moore 2008).

Gray whales usually live in small groups of about three whales, although groups up to 18 whales occur (Frost and Karpovich 2008). Gray whales feed primarily on benthic amphipods in the northern Bering, Chukchi, and western Beaufort Seas. Shallow coastal areas and offshore shoals in the Chukchi and western Beaufort Seas also provide rich feeding habitat (Rugh et al. 1999). Gray whales seldom feed while migrating or during winters in tropical waters (Frost and Karpovich 2008). In summer, gray whales select coastal/shoal waters and open waters, while in autumn they select coastal and shoal/trough habitats in light ice and open water (Moore et al. 2000a). They generally occur closer to shore than other large whale species (Berzin and Rovnin 1966). The abundance estimate for the Eastern North Pacific gray whale stock is 19,126 with a minimum estimate of 18,017 individuals. The population of this stock has been increasing over the past several decades (Allen and Angliss 2011).

The minke whale (*Balaenoptera acutorostrata*) occurs from the Bering and Chukchi Seas south to near the equator with apparent concentrations of whales near Kodiak Island (Allen and Angliss 2011). Zerbini et al. (2006) observed concentrations of minke whales in the area of the eastern Aleutian Islands with scattered observations along the Alaska Peninsula and Kodiak Island. In spring, most minke whales are found over the continental shelf and prefer shallow coastal waters. In Alaska, minke whales are most abundant in the Gulf of Alaska during summer for feeding but become scarce in the fall, with most whales leaving by October (Consiglieri et al. 1982). Only a few whales have been reported in the northeastern Gulf of Alaska (offshore the Icy Bay area) and in southeastern Alaska (Sitka area) during winter. Breeding occurs year-round in the Pacific. The minke whale usually occurs alone or in groups of only two to three whales, although loose aggregations of up to 400 can occur in feeding areas at higher latitudes (NMFS 2011a). The minke whale preys on a variety of large zooplankton (e.g., krill and copepods) and small schooling fishes (Pauly et al. 1995; Jefferson et al. 2006). No estimates are available for the number of minke whales in the entire North Pacific. The provisional estimate for the number of minke whales in central-eastern and southeastern Bering Sea is 810 and 1,003, respectively (Allen and Angliss 2011). There are no data on the trends of minke whale abundance in Alaska (Allen and Angliss 2011).

Cetaceans: Odontocetes. The Cuvier's beaked whale (*Ziphius cavirostris*) is the most widespread of the beaked whales, occurring in all oceans and most seas except in the high polar waters (Moore 1963). Its distribution in the northeastern Pacific ranges from Baja California to the northern Gulf of Alaska, Aleutian Islands, and Commander Islands (Allen and Angliss 2011). Although the Cuvier's beaked whale occurs in south central Alaska, individuals do not apparently enter Cook Inlet (Allen and Angliss 2011). The Cuvier's beaked whale prefers waters of the continental slope and edge and steep underwater geologic features such as banks, seamounts, and submarine canyons where depths are greater than 1,000 m (3,000 ft) (NMFS 2011a). Within its range, the Cuvier's beaked whale mostly occurs alone or in small groups up to 12 individuals, although groups up to 25 have been reported (NMFS 2011a). It dives to depths of at least 1,000 m (3,000 ft) that last 20 to 40 minutes (NMFS 2011a). Its diet consists of squid, fishes, and crustaceans (Pauly et al. 1995; Jefferson et al. 2006). Cuvier's beaked whale strandings indicate that it is the most widespread beaked whale and not as rare as originally thought (Moore 1963; Moore 1963; Culik 2010; Allen and Angliss 2011). Information on population abundance or trends for the Alaska stock of the Cuvier's beaked whale is not available (Allen and Angliss 2011).

The Dall's porpoise (*Phocoenoides dalli*) is present year-round throughout its entire range in the northeast Pacific, from Baja California, Mexico, to the Bering Sea in Alaska. However, within this range, the Dall's porpoise does not occur in the upper Cook Inlet or in the shallow eastern flats of the Bering Sea (Allen and Angliss 2011). Dall's porpoise generally occurs over the continental shelf adjacent to the slope and over oceanic waters greater than 2,500 m (8,200 ft) deep (Allen and Angliss 2011). It also occurs closer to shore in narrow channels and fjords that have clear, relatively deep water (Culik 2010). The Dall's porpoise usually travels in groups of 2 to 20 animals, but occasionally occurs in loosely associated groups of hundreds to thousands of animals (NMFS 2011a). They also occasionally occur with other marine mammals, especially the Pacific white-sided dolphin (*Lagenorhychus olbiquidens*) (Jefferson 1988). Dall's porpoises routinely feed at depths of 500 m (1,640 ft) or more, primarily on squid and small schooling fishes (Culik 2010; Jefferson 1988). Based on survey data over 8 yr old,[11] the best estimate of the abundance of the Alaska stock is 83,400 individuals with a minimum population estimate of 76,874 (Allen and Angliss 2011).

The harbor porpoise (*Phocoena phocoena*), in the Eastern North Pacific Ocean, ranges from Point Barrow, along the Alaska coast, and down the west coast of North America to Point Conception, California (Allen and Angliss 2011). They generally occur in harbors, bays, and river mouths but may also be concentrated in and along turbid river water plumes such as the Copper River and Icy Bay areas. In the Gulf of Alaska and southeast Alaska, the harbor porpoise frequents waters less than 100 m (330 ft) in depth, with high densities of animals occurring in Glacier Bay, Yakutat Bay, Copper River Delta, and Sitkalidak Strait (Dahlheim et al. 2000). Activities associated with lease sales in Cook Inlet could potentially affect harbor porpoise individuals in the Gulf of Alaska stock. This stock includes individuals occurring from Cape Suckling to Unimak Pass (Allen and Angliss 2011). Harbor porpoises usually occur in groups smaller than 8 individuals, although they will aggregate into groups of 50 to several hundred during feeding or migration (Culik 2010). Harbor porpoises consume a wide variety of fishes and cephalopods, apparently preferring non-spiny schooling fish such as herring, mackerel, and pollock (Leatherwood and Reeves 1987). Based on survey data over 11 yr old, the population estimate for the Gulf of Alaska harbor porpoise stock is 31,046 with a minimum estimate of 25,987 (Allen and Angliss 2011).

The killer whale (*Orcinus orca*) occurs along the entire Alaskan coast within the Beaufort Sea, Chukchi Sea, Bering Sea, Aleutian Islands, Gulf of Alaska, Prince William Sound, Kenai Fjords, and southeastern Alaska. Killer whales are relatively common in lower Cook Inlet, but are somewhat infrequent in the upper Cook Inlet (Shelden et al. 2003). NMFS recognizes several stocks of killer whales in Alaskan waters: (1) the Eastern North Pacific Northern Resident stock, occurring from British Columbia through part of southeastern Alaska; (2) the Eastern North Pacific Alaska Resident stock, occurring from southeastern Alaska to the Aleutian Islands and the Bering Sea; (3) the Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock, occurring mainly from Prince William Sound through the Aleutian Islands and the Bering Sea; (4) the AT1 Transient stock, occurring in Alaska from Prince William Sound through the Kenai Fjords; (5) the West Coast Transient stock, occurring from California through southeastern Alaska; and (6) the Eastern North Pacific Offshore stock, occurring from California through Alaska (Allen and Angliss 2011). Oil and gas activities in the Cook Inlet Planning Area could potentially affect killer whales from the Eastern North Pacific Alaska Resident stock and the Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock.

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[11] The NMFS has a policy to use data less than 8 years old for the purposes of calculating the potential biological removal, which is defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. The potential biological removal level is the product of the following factors:

- The minimum population estimate of the stock;
- One-half the maximum theoretical or estimated net productivity rate of the stock at a small population size; and
- A recovery factor of between 0.1 and 1.0.

Killer whales are top-level predators that feed on marine mammals, marine birds, sea turtles, fishes, and cephalopods (Pauly et al. 1995; Jefferson et al. 2006). The resident stocks mainly feed on salmonids, whereas the transient stocks tend to feed on marine mammals (NMFS 2011a). Killer whales occur along the entire coast of Alaska (Allen and Angliss). In summer, they concentrate in Prince William Sound, the Kodiak Island area, and the nearshore waters of southeastern Alaska. The movement of killer whales to nearshore waters may be in response to migration of their prey (Heimlich-Boran 1988; Culik 2010). In fall and winter, killer whales are numerous around Kodiak Island and adjacent shelf waters but not elsewhere in the Gulf of Alaska (Consiglieri et al. 1982). The peak breeding period of killer whales is May through July (Consiglieri et al. 1982).

Killer whale group or pod size varies from 1 to 100 (Braham and Dahlheim 1982). Most pods in Alaska have fewer than 40 individuals (Zimmerman and Small 2008). Transient killer whale pods move over broader ranges of territory than do resident pods and prefer to feed on other marine mammals, such as seals, porpoises, and baleen whales (Heimlich-Boran 1988; Ford et al. 2005; Jefferson et al. 1991). The minimum size of the Eastern North Pacific Alaska Resident stock is 2,084 individuals, while the minimum size of the Gulf of Alaska, Aleutian Island, and Bering Sea Transient stock is 552 individuals (Allen and Angliss 2011). As mentioned previously, individuals from these stocks could potentially be affected by oil and gas activity in the Cook Inlet Planning Area.

The Pacific white-sided dolphin occurs in the Eastern North Pacific from the southern Gulf of California, north to the Gulf of Alaska and west to Amchitka in the Aleutian Islands. They rarely occur in the southern Bering Sea (Allen and Angliss 2011). This dolphin species generally occurs offshore over the continental slope in waters from 200 to 2,000 m (660 to 6,600 ft) deep (Stacey and Baird 1991; Consiglieri et al. 1982). Individuals do enter the inshore passes of Alaska (Stacey and Baird 1991; Consiglieri et al. 1982; Ferrero and Walker 1996). In the Gulf of Alaska, occurrences of the Pacific white-sided dolphins vary seasonally, in that they are rarely present in winter, become increasingly abundant in spring, and are most abundant in the summer when fish abundance is highest (Consiglieri et al. 1982). They commonly occur in groups of several hundred individuals, and groups of more than 1,000 individuals have been sighted (Leatherwood and Reeves 1987). Pacific white-sided dolphins feed on squid and fish (Pauly et al. 1995). There are no reliable population estimates for the North Pacific stock of the Pacific white-sided dolphin because abundance estimates are over 8 yr old. The estimated minimum population abundance in the early 1990s was 26,880 individuals (Allen and Angliss 2011).

Carnivores: Pinnipeds. The harbor seal (*Phoca vitulinea richardsi*) is distributed along the southeast Alaska coastline west through the Gulf of Alaska and Aleutian Islands, and into the Bering Sea north to Cape Newenham and the Pribilof Islands (Allen and Angliss 2011). Among the three stocks of harbor seals that occur in Alaska, the Gulf of Alaska stock could be affected by oil and gas activities in the Cook Inlet Planning Area. The Gulf of Alaska stock occurs from Cape Suckling to Unimak Pass, including animals that occur throughout the Aleutian Islands (Allen and Angliss 2011). Harbor seals are nonmigratory with local movements associated with tides, weather, season, food availability, and reproduction (Allen and Angliss 2011). Harbor seals occupy a wide variety of habitats in fresh and saltwater and along protected and exposed coastlines. They prefer to haul out on gently sloping or tidally exposed habitats including reefs, offshore rocks and islets, mud and sandbars, sand and gravel beaches, and floating and shorefast ice (Calambokidis et al. 1987; Bigg 1981; Allen and Angliss 2011). In Cook Inlet, harbor seals haul out near available prey and in areas that avoid high anthropogenic disturbance. They also select sites of rock substrate and those near deep water (Montgomery et al. 2007). Typically, an individual in a given area uses one or two haulout sites. Breeding occurs generally in late spring through fall. Females aggregate on glacial fjords to give birth between May and mid-July (Kinkhart et al. 2008). Important pupping areas occur within Icy and Yakutat Bays and Kodiak Island (Allen and Angliss 2011). Most dives are less than 20 m (65 ft) deep and last less than 4 minutes, although dives can occur to depths of 500 m (1,640 ft) and last up to 20 minutes (Kinkhart et al. 2008). In Cook Inlet, harbor seal abundance increases with proximity to bathymetric depths of 20 m (66 ft) (Montgomery et al. 2007). Harbor seals are opportunistic feeders. Their diet varies with season and location; they primarily feed on fish, cephalopods, molluscs, and crustaceans (Kinkhart et al. 2008; Pauly et al. 1995). Feeding occurs in marine, estuarine, and occasionally fresh waters (Allen and Angliss 2011). The current estimate of the Gulf of Alaska stock is 45,975 with a minimum population estimate of 44,453 (Allen and Angliss 2011).

Climate Change. A major concern regarding marine mammals in Arctic and subarctic regions is the potential for climate change and associated changes in the extent of sea ice. Climate change will primarily affect marine mammals from loss of habitat, changes in prey availability, and potentially increased expansion of other species that are likely to cause competitive pressure on some species, as well as putting them at greater risk of predation, disease, and parasitic infections (Alter et al. 2010; Kovacs et al. 2011). Alteration of sea ice and increasing human presence and activities will cause extensive redistribution of mobile species, disappearance of non-mobile species throughout portions of their range, and possible species extinctions (Ragen et al. 2008). However, it is not possible at this time to identify the likelihood, direction, or magnitude of climate change on the marine mammals of Cook Inlet. The current state of climate change and its impacts on marine mammals would need to be considered in any subsequent environmental reviews for lease sales or other OCS-related activities.

3.8.1.2.2 Terrestrial Mammals. No terrestrial mammals listed under the ESA occur in the area of Cook Inlet. Approximately 40 species of terrestrial mammals not listed under the ESA occur in south central Alaska, including the American black bear (*Ursus americanus*), brown bear (*Ursus arctos;* also commonly known as the grizzly bear), caribou (*Rangifer tarandus*), Dall sheep (*Ovis dalli*), moose (*Alces americanus*), mountain goat (*Oreamnos americanus*), and Sitka black-tailed deer (*Odocoileus hemionus sitkensis*), American beaver (*Castor canadensis*), American marten (*Martes americana*), American mink (*Neovision vision*), Canadian lynx (*Lynx canadensis*), coyote (*Canis latrans*), ermine (*Mustela erminea*), gray wolf (*Canis lupus*), least weasel (*Mustela nivalis*), North American river otter (*Lontra canadensis*), red fox (*Vulpes vulpes*), and wolverine (*Gulo gulo*) (ADFG 2011a; McDonough 2007; Peltier 2007; Van Daele and Crye 2007). The following information describes the life history attributes, distribution, and seasonal movement of select terrestrial big game and furbearer species expected to use coastal habitats in the Cook Inlet Planning Area or nearby coastal habitats in the Gulf of Alaska.

American Black Bear (*Ursus americanus*). In Alaska, American black bears occur throughout most forests and coastal areas. However, they do not occur on the Seward Peninsula, Yukon-Kuskokwim Delta, north of the Brooks Range, several islands in the Gulf of Alaska and from the Alaska Peninsula beyond the area of Lake Iliamma. However, they do inhabit most islands in Southeast Alaska except for Admiralty, Baranof, Chichagof, and Kruzof (ADFG 2011a). About 100,000 American black bears occur in Alaska; several thousand occur in south central Alaska, which encompasses Cook Inlet (ADFG 2011a; Peltier 2008). American black bears hibernate during winter. Following den entrance, pregnant females give birth to one to three cubs. On the Kenai Peninsula, average dates of den entrance and emergence are October 18 and April 26, respectively, although severe spring weather can delay den emergence (Schwartz et al. 1987). Breeding occurs during the summer. Apart from that time, American black bears are usually solitary, except for sows with cubs. Cubs remain with their mother through the first winter. American black bears make heavy use of coastal habitats in the spring following den emergence (McIlroy 1972; Johnson 2008). During the summer, salmon are common food sources (if available), but bears will also eat vegetation, insects, berries, winter-killed animals, and newborn moose calves (Johnson 2008). Large amounts of berries are particularly important to American black bears during the summer; often bears will switch from salmon to berries during this time.

Brown Bear (*Ursus arctos*). Brown bears (also commonly referred to as grizzly bears) occur throughout most of Alaska except on the islands south of Frederick Sound in southeast Alaska, west of Unimak in the Aleutian Islands, and on the Bering Sea islands (Eide et al. 2008). Recent genetic studies do not support the differentiation of brown bear subspecies (NatureServe 2011b). The brown bear mating season occurs from May to July. Pregnant females tend to enter their dens in the fall. Females give birth to one to four cubs in their dens between January and February and emerge from dens in June. Males enter their dens later than females and tend to emerge from them before females do. In the northern part of Alaska, brown bears may stay in their dens up to 8 months; in areas with relatively mild winters, they may stay active all winter (Eide et al. 2008). Cubs stay with their mothers for up to 3 yr, but fewer than half the cubs survive (Eide et al. 2008). Brown bear densities vary with the quality of the environment. For example, in areas of low productivity such as the North Slope, bear densities are as low as one bear per 777 km^2 (300 mi^2), while in areas of high productivity such as the Alaska Peninsula, Kodiak Island, and Admiralty Island, densities are as high as one bear per 39 to 65 km^2 (15 to 25 mi^2). Areas occupied by an individual bear overlap those used by other bears (Eide et al. 2008). In the early 1990s, the population for brown bears in Game Management Unit 16 (west side of Cook Inlet) was estimated to range between 586 and 1,156. Similar numbers were estimated in the early 2000s (Kavalok 2007).

Large males may weigh up to 680 kg (1,500 lb) in coastal areas but only 227 kg (500 lb) in interior areas (Eide et al. 2008). Brown bears are generally solitary, but may aggregate at feeding areas such as salmon spawning streams, sedge flats, open garbage dumps, or whale carcasses (Eide et al. 2008). Brown bears are omnivorous — their foods include grasses, sedges, berries, fish, ground squirrels, caribou, moose, domestic animals, garbage, and carrion (Eide et al. 2008). During spring, coastal bears rely heavily on beaches, meadows, and shorelines while foraging on newly emergent plants, carrion, and intertidal infauna such as clams. In summer and early fall, brown bears aggregate along coastal streams to feed on salmon and other spawning fish. The salmon runs are especially important to the Kodiak Island, Alaska Peninsula, and McNeil River brown bears; the salmon runs are available from late June to mid-December on Kodiak Island (Barnes 1990). Large amounts of berries are particularly important to brown bears during the summer; often bears will switch from salmon to berries during this time.

Moose (*Alces americanus*). Moose are associated with northern forests. They are most abundant in recently burned areas where dense stands of willow, aspen, and birch shrubs have propagated; timberline plateaus; and along major rivers of south central and interior Alaska (Crouse et al. 2008). Up to 200,000 moose occur in Alaska. Based on estimates made between 2000 and 2005, about 6,000 moose occur in the western Kenai Peninsula (which includes the eastern side of Cook Inlet), while about 2,000 moose occur in game management units that include the western portion of Cook Inlet (ADFG 2011a). Moose make seasonal movements to calving, rutting, and wintering areas. Females generally breed at 28 months, with breeding occurring in the fall. Calves are born from mid-May to early June after a gestation period of about 120 days. Calves remain with their mothers until about 1 yr old (Crouse et al. 2008). Moose consume willow, birch, and aspen twigs in the fall and winter; twigs, sedges, horsetail, pond weeds, and grasses in spring; and pond plants, forbs, and leaves of birch, willow, and aspen in summer (Crouse et al. 2008). Predation by wolves and bears limits population growth of moose in many locations in Alaska. Hunting and severe winter weather are also controlling factors on moose populations (Crouse et al. 2008).

North American River Otter (*Lutra canadensis*). River otters frequently occur in nearshore coastal waters, beaches, and intertidal areas throughout south central Alaska, where they forage on small fish, clams, crustaceans, and other invertebrates (Solf and Golden 2008). River otters in Alaska breed in May, with mating occurring in and out of the water (Solf and Golden 2008). One to six pups are born the following year any time from late January to June. River otters reach sexual maturity at 2 yr of age and live up to 20 yr (Solf and Golden 2008). Family units consisting of a female with her pups, with or without an adult male, travel only a few kilometers. Larger groups of neighboring family units (more than 10 individuals) form temporary associations. These groups travel over a wide area and apparently do not have exclusive territories (Solf and Golden 2008).

Sitka Black-Tailed Deer (*Odocoileus hemionus sitkensis*). Sitka black-tailed deer are native to wet coastal rainforests of southeast Alaska and north-coastal British Columbia. Transplants have led to the establishment of populations near Yakutat in Prince William Sound and on Kodiak and Afognak Islands (ADFG 2011b). Sitka black-tailed deer populations fluctuate depending on the severity of winters. They have a high reproductive potential, so they can generally rebound quickly from reduced populations (ADFG 2011b). From winter through early spring, they are mostly restricted to uneven-aged old-growth forest below 366 m (1,500 ft) in elevation. During extreme snow events, the deer may congregate in heavily timbered stands at lower elevation or even on beaches (ADFG 2011b). After the winter snow pack recedes, migratory deer move to high-elevation alpine and subalpine habitats, while resident deer remain at lower elevation forested areas. With the first heavy frost, deer occupying alpine and subalpine habitats descend to the upper forest (Merriam et al. 2008). Summer and winter home ranges average 454 ha (1,122 ac) and 107 ha (264 ac), respectively (Van Daele and Crye 2009). The distance between winter and summer home ranges is about 22 km (13 mi) for migratory deer and 0.8 km (0.5 mi) for resident deer (Merriam et al. 2008; Van Daele and Crye 2009). During summer, Sitka black-tailed deer feed on herbaceous vegetation and shrub leaves, while in winter they feed on evergreen forbs and woody browse (ADFG 2011b). The breeding season begins in late October and continues through November. Fawning occurs from late May to early June (ADFG 2011b). In 2008, about 60,000 Sitka black-tailed deer populated the Kodiak Archipelago with the population appearing to be decreasing (Van Daele and Crye 2009).

Climate Change. Cook Inlet coastal habitats are vulnerable to the effects of climate change. Sea level rise is expected to inundate low-lying coastal habitats (Nicholls et al. 2007). Changes in sea level and increases in storms and erosion could result in loss of low-lying habitats critical to productivity and welfare of some wildlife species (Clark et al. 2010). Moose have timing and synchrony or parturition area adaptations to long-term patterns in climate and may be more susceptible to climate change than other ungulates that are more adapted to climatic variability (Bowyer et al. 1998). Shorter winters caused by climate change may increase the threat from ticks and deer-borne parasites (Howard 2011). Because brown bears are opportunistic, omnivorous, and highly adaptable, climate change is not expected to threaten their populations due to ecological threats or constraints; however, it may lead to an increase in brown bear/human interactions, in part from later den entry and earlier den exit (Servheen and Cross 2010).

3.8.1.3 Alaska – Arctic

3.8.1.3.1 Marine Mammals. There are 15 species of marine mammals in the Arctic region (Beaufort and Chukchi Seas). Four of these species are listed as threatened or endangered under the ESA, one is a candidate species, and two are proposed for listing as threatened species (Table 3.8.1-4). The following information describes the life history attributes, distribution, and seasonal movement of these 14 marine mammal species within the Alaska OCS lease sale areas in the Arctic region (Beaufort and Chukchi Seas). These areas encompass and/or could impact marine mammals that occur in the Beaufort/Chukchian Shelf Level II Ecoregion and include the Chukchian Neritic and Beaufortian Neritic Level III Ecoregions. (The ecoregions are described in Section 3.2.5 and shown in Figure 3.2.2-3.)

Marine Mammals Listed under the Endangered Species Act.

Cetaceans: Mysticetes. The endangered bowhead whale (*Balaena mysticetus*) occurs in seasonally ice-covered waters of the Arctic and near Arctic, typically between 60°N and 75°N in the Western Arctic Basin (Allen and Angliss 2011). Critical habitat for the bowhead whale has not been identified because habitat issues were not a factor in the decline of the species (ADNR 2009). The Western Arctic stock is the only bowhead stock found in U.S. waters (Allen and Angliss 2011). As shown in Figure 3.8.1-4, bowhead whales generally migrate from winter breeding areas (November to March) in the northern Bering Sea, through the Chukchi Sea in the spring (March through June) where most calving occurs, and into the Canadian Beaufort Sea where they spend much of the summer (mid-May through September) (Allen and Angliss 2011).

TABLE 3.8.1-4 Arctic Marine Mammals

Species	Status[a]
ORDER CETACEA	
Suborder Mysticeti (baleen whales)	
Balaenoptera acutorostrata (minke whale)	–
Balaenoptera mysticetus (bowhead whale)	E/D
Balaenoptera physalus (fin whale)	E/D
Eschrichtius robustus (gray whale)	DL/D
Megaptera novaeangliae (humpback whale)	E/D
Suborder Odontoceti (toothed whales and dolphins)	
Delphinapterus leucas (beluga whale)	–
Monodon monoceros (narwhal)	
Orcinus orca (killer whale)	D
Phocoena phocoena (harbor porpoise)	–
ORDER CARNIVORA	
Suborder Pinnipedia (seals, sea lions, and walrus)	
Erignathus barbatus (bearded seal)	PT
Odobenus rosmarus divergens (Pacific walrus)	C
Phoca fasciata (ribbon seal)	–
Phoca hispida (ringed seal)	PT
Phoca largha (spotted seal)	–
Suborder Fissipedia (polar bears)	
Ursus maritimus (polar bear)	T/D

[a] Status: E = endangered under the ESA; T = threatened under the ESA; C = candidate for listing under the ESA; DL = delisted under the ESA; D = depleted under the MMPA (for the killer whale, it only applies to the AT1 group of eastern North Pacific transient killer whales); PT = proposed threatened under the ESA; – = not listed.

In the fall (September through November), bowheads were presumed to return along this general route, closer to shore across the Beaufort Sea, to the Bering Sea to overwinter in polynyas and along edges of the pack ice (Braham et al. 1980; Moore and Reeves 1993). Important winter areas in the Bering Sea include polynyas along the northern Gulf of Anadyr, south of St. Matthew Island, and near St. Lawrence Island. Some bowhead whales, thought to be part of the expanding Western Arctic stock, remain in the Bering and Chukchi Seas during summer (Rugh et al. 2003).

Incorporation of recent scientific and traditional knowledge has provided updated information on the movements and behavior of the Western Arctic bowhead whale stock. Based on satellite tracking of bowheads from August 1, 2005 through July 12, 2010, most whales do summer in the eastern Beaufort Sea (Quakenbush et al. 2010a). However, some whales also occur in the western portion of the Chukchi Sea in summer (Quakenbush et al. 2010a; Citta et al. 2012). In addition, some bowheads undergo long-distance movements during

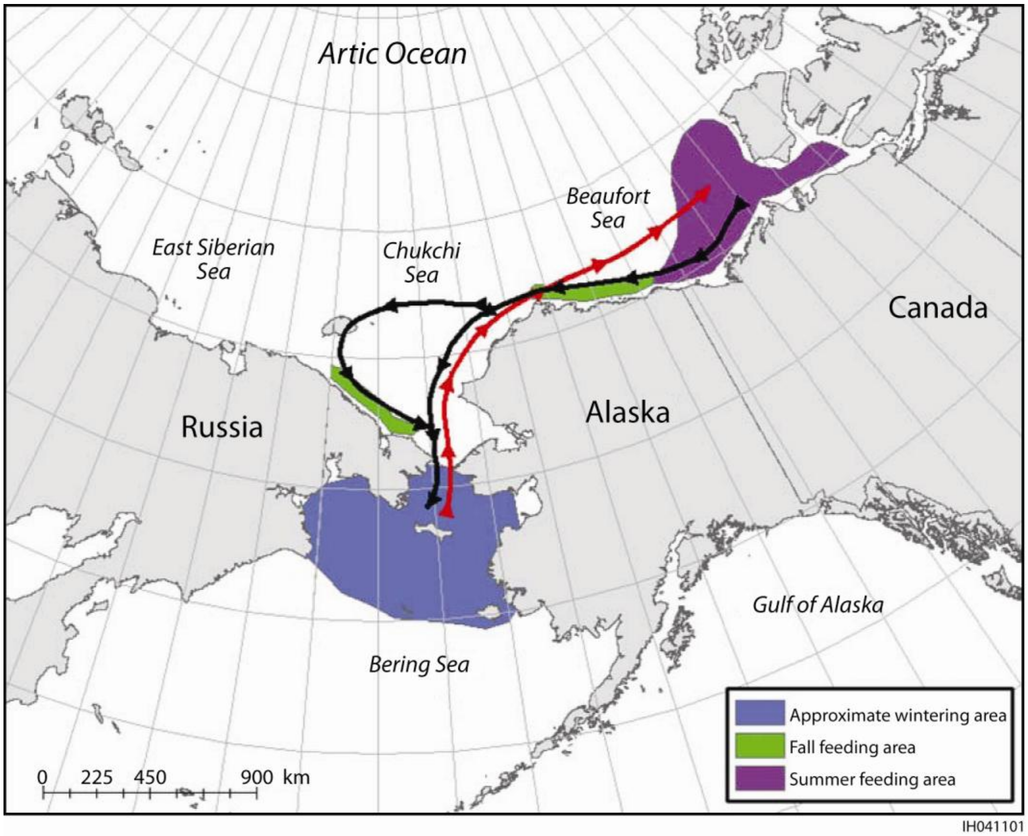

FIGURE 3.8.1-4 Generalized Migration Route, Feeding Areas, and Wintering Area for the Western Arctic Bowhead Whale Stock (Source: Moore and Laidre 2006)

summer. For example, one whale made a 1,400-km (870-mi) round trip from Amundsen Gulf to the north end of Banks Island in July, while three whales made trips from the Canadian Beaufort to Barrow and back (Quakenbush et al. 2010a).

The main fall migration begins in late August. The first whales are typically the larger ones, which establish the migration route in the Beaufort Sea. Migration through the eastern Alaskan portion of the Beaufort Sea continues through September and into October (Huntington and Quakenbush 2009). Figure 3.8.1-5 shows the fall movements of 19 satellite-tagged bowhead whales (Quakenbush et al. 2010b). The fall migration from Amundsen Gulf to Barrow included some whales that traveled inshore and others that traveled offshore (Quakenbush et al. 2010a). From Barrow to the Bering Sea, bowheads occur throughout much of the Chukchi Sea. All of the tagged whales traveled through Lease Sale Area 193 during the fall migration, but only one whale did so during the spring migration (Quakenbush et al. 2010a). Most whales traversed the lease sale area in less than one week; however, one whale remained in the area for 30 days (Quakenbush et al. 2010b). In addition, during the fall migration, several whales passed Barrow, then returned to Barrow for a period of time before completing their migration to the Bering Sea. Quakenbush et al. (2010a) noted that during fall, the area near Barrow and the northern half of Lease Sale Area 193 in the Chukchi Sea received a lot of use by bowheads; whereas the eastern

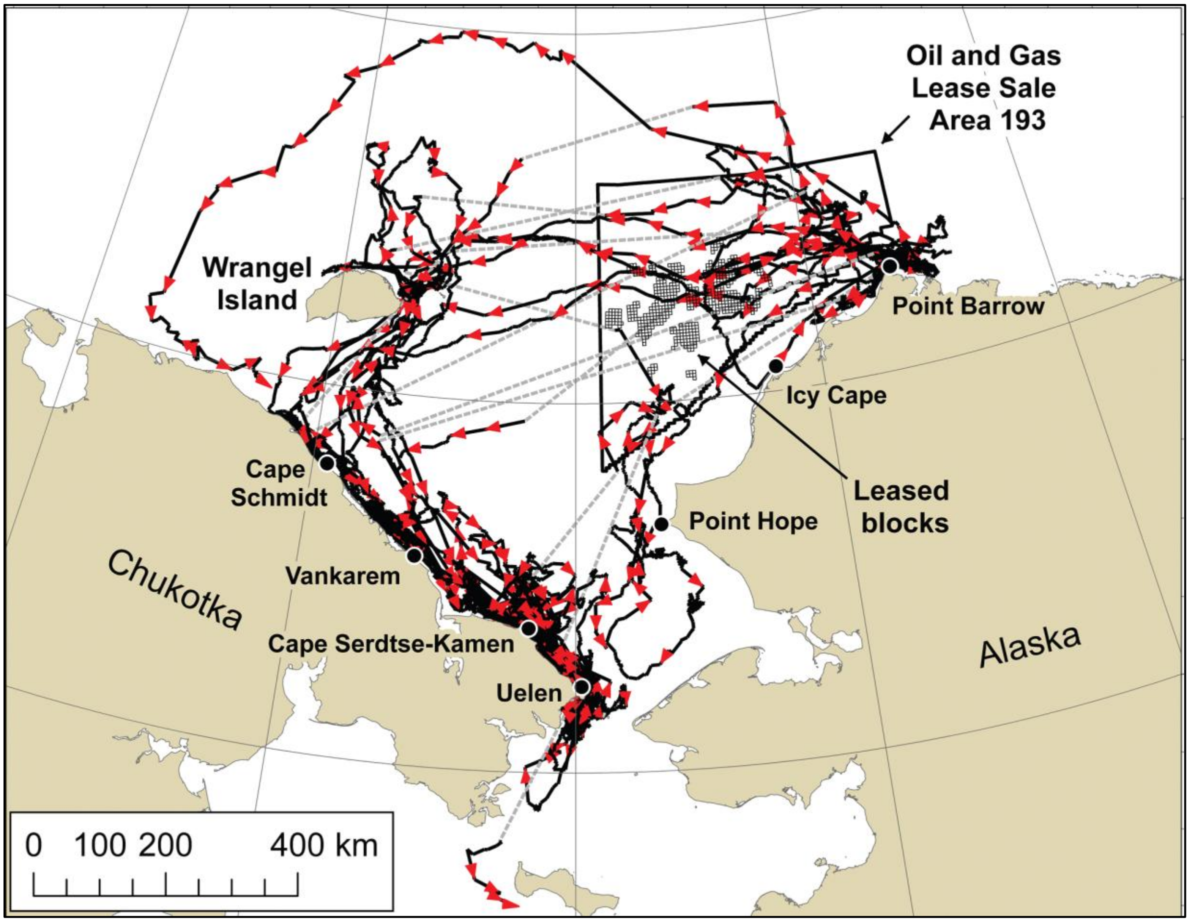

FIGURE 3.8.1-5 Tracks of Satellite-Tagged Bowhead Whales in the Chukchi Sea from 2006 through 2008 (August through December each year) (Quackenbush et al. 2010b)

Chukchi Sea, especially nearshore from Wainwright to the Bering Sea, was not used as often. The western Chukchi Sea, including nearshore areas, received extensive use during the fall (Quakenbush et al. 2010a).

Quakenbush et al. (2010a) noted that, rather than spending most of the winter in nearshore polynyas and near the ice edge, most bowheads spent most of their time in offshore areas of the Bering Sea in relatively heavy ice. In addition to sea ice, factors such as age, reproductive status, or prey availability likely account for the winter distribution of bowheads. Citta et al. (2012) discussed the winter movements of bowhead whales in the Bering Sea. The average date tagged whales entered the Bering Sea was December 14, and ranged from November 7 to January 11. All whales entered the Bering Sea between Cape Pe'ek and Big Diomede Island. The approximate winter range of tagged bowhead whales in the Bering Sea encompasses the area north of the 200-m (656-ft) isobath; west of a line connecting St. Matthew Island, St. Lawrence Island, and Nome; just north of the Bering Strait; and east of a line connecting Sireniki and Cape Navarin (Citta et al. 2012).

During spring, bowheads primarily migrate east of Little Diomede Island, up the coast of Alaska to Barrow, and then head straight to Amundsen Gulf (regardless of where ice leads are located). However, some bowheads migrate along the Chukotka Peninsula to the area west of Wrangel Island (Quakenbush et al. 2010a). In the past, bowheads first arrived near Wainwright in late April, but recently they arrive in early April and sometimes in March (Quakenbush and Huntington 2010). Three different waves of bowheads pass Wainwright in spring in the following order: (1) primarily small, young whales; (2) mid-sized whales; and (3) the largest whales and most of the mother-and-calf pairs. The third wave passes Wainwright in the second half of May and early June (Quakenbush and Huntington 2010). In the spring, bowheads have been observed calving, mating, and feeding in the nearshore lead near Wainwright and Barrow (Huntington and Quakenbush 2009; Quakenbush and Huntington 2010).

Except for land-fast ice, the presence of sea ice does not appear to limit the movements of whales in the spring in the Beaufort Sea or in the winter in the Bering Sea (Quakenbush et al. 2010a). However, sea ice does limit light penetration and wind-driven upwelling, which influences prey availability and thus whale movements (Quakenbush et al. 2010b). Bowhead feeding areas may have the physical and oceanographic factors necessary to concentrate zooplankton prey. Areas where bowhead whales spend time, and are likely feeding, include Amundsen Gulf, Barrow, Wrangel Island, the Chukotka coast between Wrangel Island and the Bering Strait, and western Bering Sea. Bowheads spend a good proportion of their time, even when traveling, feeding on or near the bottom. As whales may visit different feeding areas during different times, their movements become asynchronous; therefore, the complex pattern of fall movements is a combination of both migratory movements and movements to foraging areas. In spring, ice obstructs feeding opportunities; therefore, bowhead migratory movements are more predictable and consistent between the Bering Strait and Amundsen Gulf (Quakenbush et al. 2010a).

Most mating occurs in late winter and spring in the Bering Sea, although some mating occurs as late as September and early October (Quakenbush 2008; Allen and Angliss 2011). Most calving occurs during the spring migration in and adjacent to the eastern Chukchi Sea and the Beaufort Sea spring lead ice systems (MMS 2008a). Females give birth to a single calf every 3 to 4 yr (MMS 2008a).

Bowhead whales usually travel alone, in small groups of up to six whales, or in mother-calf pairs (ADNR 2009). Also, bowhead whales usually feed as individuals, but groups occasionally feed together in an echelon formation (Quakenbush 2008). Bowheads feed throughout the water column, including bottom or near-bottom feeding as well as surface feeding. Food items of bowheads include euphausiids, copepods, and amphipods (Quakenbush 2008; NMFS 2011a).

The best estimate of the abundance of the Western Arctic bowhead whale stock is 10,545 with a minimum population estimate of 9,472 (Allen and Angliss 2011). Overall, the stock appears to be healthy and increasing in population (Allen and Angliss 2011).

The endangered fin whale ranges from subtropical to Arctic waters and usually occurs in high-relief areas where productivity is probably high (Brueggeman et al. 1988). Their summer distribution extends from central California into the Chukchi Sea, while their winter range is restricted to the waters off the coast of California. In Alaskan waters, some fin whales feed in the Gulf of Alaska, while others migrate farther north to feed throughout the Bering and Chukchi Seas from June through October. There are few observations of fin whales in the eastern half of the Chukchi Sea and no documented occurrences of fin whales in the Beaufort Sea (MMS 2008b). From September through November, most fin whales migrate southward to California; however, a few animals may remain in the Navarin Basin (Brueggman et al. 1984). Northward migration begins in spring with migrating whales entering the Gulf of Alaska from early April–June (MMS 1996b).

Fin whales usually breed and calve in the warmer waters of their winter range (Mizrock et al. 1984). The fin whale feeds on concentrations of zooplankton (e.g., krill), fishes, and cephalopods (Pauly et al. 1995; Jefferson et al. 2006). Reliable abundance estimates for the Northeast Pacific fin whale stock are not available. A provisional estimate for the fin whale population west of the Kenai Peninsula is 5,700 (Allen and Angliss 2011).

The endangered humpback whale occurs worldwide in all ocean basins, although it is less common in Arctic waters. In winter, most humpback whales occur in the temperate and tropical waters. Humpback whales in the North Pacific are seasonal migrants to Arctic waters where they feed on zooplankton and small schooling fishes in the cool coastal waters of the western United States, western Canada, and the Russian Far East (NMFS 1991). The historic feeding range of humpback whales in the North Pacific encompassed coastal and inland waters around the Pacific Rim from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotck (Johnson and Wolman 1984; Allen and Angliss 2011). The observation of some individuals in the Beaufort Sea east of Barrow suggests a northward expansion of their feeding grounds (Zimmerman and Karpovich 2008; Allen and Angliss 2011). Current data demonstrate that the Bering Sea remains an important feeding area. During summer months, humpback whales will also enter the Chukchi Sea with rare observations in the western Beaufort Sea (Johnson and Wolman 1984; Hashagen et al. 2009; Allen and Angliss 2011). It is currently unknown whether the humpbacks observed in the southeastern Chukchi Sea and in the Beaufort Sea are part of the Western or Central stock.

NMFS recognizes three stocks of humpback whales occurring in U.S. waters, including the (1) California/Oregon/Washington and Mexico stock; (2) central North Pacific stock that migrates from Hawaii to northern British Columbia/Southeast Alaska and Prince William Sound west to Kodiak; and (3) western North Pacific stock that most likely migrates from Japan to waters west of the Kodiak Archipelago (the Bering Sea and Aleutian Islands) during the summer/fall (Berzin and Rovnin 1966; Allen and Angliss 2011). Winter/spring populations of humpback whales also occur near Mexico's offshore islands. The western North Pacific stock spends winter and spring in waters off Japan and migrates to the Bering Sea, Chukchi Sea, and Aleutian Islands in the summer and fall (Berzin and Rovnin 1966; Allen and Angliss 2011). During migrations, humpbacks are pelagic. The central North Pacific stock winters in Hawaiian Island waters and migrates to northern British Columbia/southeast Alaska and Prince William Sound west to Kodiak Island in the summer and fall (Baker et al. 1990; Allen and Angliss 2011). In the Gulf of Alaska, concentration areas of humpbacks include the Portlock and Albatross

Banks and west to the eastern Aleutian Islands, Prince William Sound, and the inland waters of southeast Alaska (Berzin and Rovnin 1966).

Breeding and calving occur on the wintering grounds, and most births occur between January and March (Johnson and Wolman 1984). During the summer feeding period, the humpback whales generally occur nearshore. The central North Pacific stock of humpback whale feeding aggregations occur along the northern Pacific Rim. Humpback whale distribution in summer is continuous from British Columbia to the Russian Far East, with humpbacks present offshore in the Gulf of Alaska (Allen and Angliss 2011). Their diet consists of euphausiids, amphipods, mysids, and small schooling forage fishes (Jefferson et al. 2006; Pauly et al. 1995).

The minimum population estimate for the Western North Pacific humpback whale stock is approximately 732 individuals and that for the central North Pacific stock is approximately 5,833 individuals (Allen and Angliss 2011).

Pinnipeds. The bearded seal (*Erignathus barbatus*, proposed threatened [NMFS 2010c]) occurs throughout the Arctic and usually inhabits waters less than 200 m (660 ft) in depth in areas of broken, moving sea ice (Cleator and Stirling 1990; Allen and Angliss 2011). Most of the bearded seals in Alaska occur over the continental shelf of the Bering, Chukchi, and Beaufort Seas between 85°N and 57°N (Cameron and Boveng 2009). Bearded seal densities are greatest during the summer and lowest during the winter. Many of the seals that winter in the Bering Sea migrate north in April and May to the summer ice edge of the Chukchi Sea (Seal Conservation Society 2011). Others remain in the open waters of the Bering and Chukchi Seas (Seal Conservation Society 2011). During spring, bearded seals prefer areas that contain 70 to 90% sea ice coverage and are most abundant 32 to 161 km (20 to 100 mi) from shore, except for the nearshore concentration to the south of Kivalina (Allen and Angliss 2011). Bearded seals generally prefer ice habitat that is in constant motion and produces natural openings and areas of open water, such as leads, fractures, and polynyas for breathing, hauling out on the ice, and access to water for foraging. They usually avoid areas of continuous, thick, shorefast ice and rarely occur in the vicinity of unbroken, heavy, drifting ice or large areas of multi-year ice (Cameron et al. 2010).

Pupping takes place on top of the ice less than 1 m (3 ft) from open water (Kovacs et al. 1996) from late March through May mainly in the Bering and Chukchi Seas, although some pupping occurs in the Beaufort Sea. Breeding occurs around one month later following the weaning of pups. Bearded seals tend to be solitary (Nelson 2008a), but sometimes form loose aggregations in areas such as polynya systems. Bearded seals primarily feed on benthic prey such as crustaceans, mollusks, fishes, and octopuses (NMFS 2011a). In the 1970s, the estimated number of bearded seals in the Bering and Chukchi Seas was 250,000 to 300,000 (Nelson 2008a). Allen and Angliss (2010) stated that there are no current population estimates or trends for the Alaska stock of the bearded seal; however, NMFS (2010c) has given a population estimate for the Beringian DPS (which encompasses the Arctic region) of 155,000 individuals. Estimates provided in NMFS (2010c) are 3,150 bearded seals for the entire Beaufort Sea in June, and 27,000 bearded seals in the Chukchi Sea in the May–June timeframe. During the open water season, many seals from the Bering Sea follow the sea ice as it retreats north and the populations in the Beaufort and Chukchi Seas are believed to increase manyfold.

The ringed seal (*Phoca hispida*, proposed threatened [NMFS 2010d]) is circumpolar in distribution and is associated with ice for much or all of the year. It occurs throughout the Beaufort, Chukchi, and Bering Seas as far south as Bristol Bay (Allen and Angliss 2011). The ringed seal is the most abundant seal in the Arctic (Citta 2008). Ringed seals live on and under extensive, largely unbroken, shorefast ice, and generally occur over water depths of 10 to 20 m (33 to 66 ft) (ADNR 2009). They are generally solitary when hauled out on ice (ADNR 2009). Ice cover strongly influences ringed seal movements, foraging, reproductive behavior, and vulnerability to predation (Kelly et al. 2010b). In the winter/spring period, when ringed seals occupy shorefast ice, their home ranges extend from <1 to 27.9 km^2 (<0.4 to 10.8 mi^2). Ringed seals inhabiting shorefast ice in the Beaufort Sea occupy ranges averaging <2 km^2 (<0.8 mi^2) during April through early June (Kelly et al. 2010a). In summer/fall, ringed seals may range up to 1,800 km (1,120 mi) from their winter/spring home ranges and return to the same home range sites during the ice-bound months in the following year. They continue to use sea ice as resting platforms during the summer/fall period (Kelly et al. 2010a). Some ringed seals occur during ice-free periods in the Bering and Chukchi Seas (Citta 2008). Primary pupping habitat is located on fast ice along the coasts of St. Lawrence Island, Norton Sound, and the Yukon River Delta. Ringed seals are monogamous to weakly polygamous (Kelly et al. 2010b). When sexually mature, males establish territories during the fall and maintain them during the pupping season. Pups are born in late March and April in subnivian lairs that seals excavate above breathing holes in the ice (Kelly et al. 2010b). During the breeding and pupping season, adults on shorefast ice (floating fast-ice zone) usually move less than individuals in other habitats; they depend on a relatively small number of holes and cracks in the ice for breathing and foraging. Ringed seals molt between mid-May to mid-July, at which time they spend long periods on the ice (NMFS 2010d). They are capable of diving to depths over 500 m (1,640 ft) and dives can last up to 39 minutes (Born et al. 2004). In the winter/spring, ringed seals feed under the ice while in summer/fall they feed either in open water or under the ice (Kelly et al. 2010a). Ringed seals preferred prey includes Arctic cod, herring, shrimps, and mysids (NMFS 2011a). A reliable population estimate for the Alaska stock is not available, but is assumed to be over 249,000 based on information published in 2002 and 2005 (see Allen and Angliss 2011). Kelly et al. (2010b) estimated a reasonable population of ringed seals to be about 1 million.

The Pacific walrus (*Odobenus rosmarus divergens*), a candidate for listing under the ESA (USFWS 2011a), ranges throughout the shallow continental shelf waters of the Bering and Chukchi Seas, where its distribution is closely linked with the seasonal distribution of the pack ice. It occasionally moves into the eastern Siberian Sea and western Beaufort Sea during summer (Fay 1982). The Pacific walrus is an extremely social and gregarious animal that spends approximately one third of its time hauled out onto land or ice, usually in close physical contact with others. Group size can range from several individuals to several thousand individuals (USFWS 2011a). The Pacific walrus relies on sea ice as a substrate for resting, giving birth and nursing, isolation from predators, and passive transport to new feeding areas (USFWS 2009d). Spring migration usually begins in April, and most Pacific walruses move north through the Bering Strait by late June. During the summer months, most of the population moves into the Chukchi Sea; however, several thousand individuals, primarily adult males, use coastal haulouts in the Bering Sea (USFWS 2009d). Two large Arctic areas are occupied by Pacific walruses during summer — from the Bering Strait west to Wrangell Island, and along the northwest coast of Alaska from about Point Hope to north of Point Barrow. Within this area, summer/fall haulouts include Cape Lisburne, Corwin Bluff, Point Lay Barrier Islands, Icy Cape, Wainwright, Naokok, Asiniak Point, and Peard Bay (USFWS 2011b). Although a few Pacific walruses may move east throughout the Alaskan portion of the Beaufort Sea to Canadian waters during the open-water season, the majority of the population occurs west of 155°W, north and west of Barrow, with the highest seasonal abundance along the pack-ice front. With the southern advance of the pack ice in the Chukchi Sea during the fall (October to December), most of the Pacific walrus population migrates south of the Bering Strait, although solitary animals may occasionally overwinter in the Chukchi and Beaufort Seas. Breeding occurs in areas of broken ice from January through March, with calves born in late April or May of the following year (USFWS 2009d).

Most Pacific walrus feeding dives last 5 to 10 minutes, with a 1- to 2-minute surface interval between dives (USFWS 2009d). The diet primarily includes molluscs, snails, decapod crustaceans, amphipods, sea cucumbers, and segmented worms. Some walruses will occasionally eat seals (Fay 1985; USFWS 2009d).

Allen and Angliss (2011) provided estimates of the Pacific walrus population over the past several centuries. A minimum population of 200,000 animals occurred in the 18th and 19th centuries. Commercial harvests reduced the population to an estimated 50,000 to 100,000 by the 1950s. Between 1975 and 1990, the population estimate ranged from 201,039 to 234,020 animals, and the 2006 estimated minimum population was 129,000 animals. Major stressors to the Pacific walrus are subsistence harvest and loss of sea ice (USFWS 2011a).

Fissipeds. The federally threatened polar bear (*Ursus maritimus*) lives only on the Arctic ice cap in the Northern Hemisphere, mainly near coastal areas. The polar bear is considered a marine mammal because it principally inhabits the sea-ice surface rather than adjacent land masses (Amstrup 2003). In Alaska, polar bears primarily occur on the northern and northwestern coasts as far south as St. Matthew Island and the Pribilof Islands and extending north and eastward into the Chukchi and Beaufort Seas, from the Bering Strait to the Canadian border (Ray 1971). There are two polar bear stocks recognized in Alaska: the Southern Beaufort Sea stock and the Chukchi/Bering Seas stock (Figure 3.8.1-6). The Southern Beaufort Sea population ranges from the Baillie Islands, Canada, and west to Point Hope, Alaska. Individuals of the Bering/Chukchi Seas stock range widely on pack ice from Point Barrow, Alaska, west to the Eastern Siberian Sea. The stock's southern boundary in the Bering Sea is determined by the annual extent of the pack ice (Allen and Angliss 2011). These two stocks overlap between Point Hope and Point Barrow, Alaska, centered near Point Lay (Allen and Angliss 2011).

The USFWS designated critical habitat for the polar bear on December 7, 2010 (USFWS 2010b). Three habitat areas designated as critical habitat include barrier islands, sea ice, and terrestrial denning habitat. USFWS (2010b) contains figures showing the location of the critical habitat areas. These critical habitat areas total about 484,734 km^2 (187,157 mi^2) of lands and water within the United States. The barrier island habitat includes coastal barrier islands and spits along the Alaska coast. These areas are used for denning, refuge from human disturbance, access to maternal dens and feeding habitat, and travel along the coast. A total of 10,576 km^2 (4,083 mi^2) of barrier island habitat is identified as critical habitat (USFWS 2010b). The sea ice critical habitat occurs over the continental shelf and includes water 300 m (984 ft) or less in

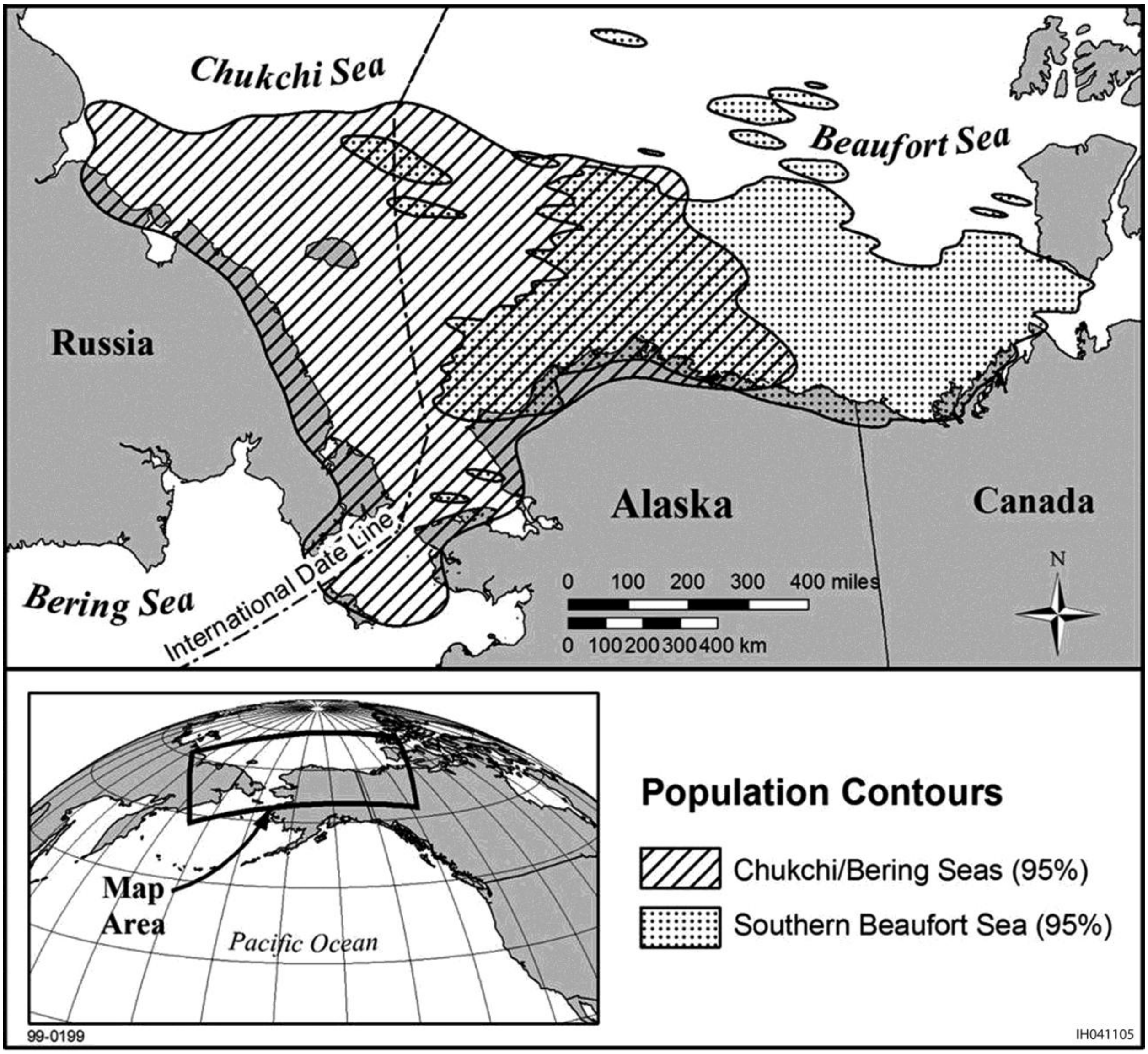

FIGURE 3.8.1-6 Distribution of Polar Bear Stocks in the Arctic Region (USFWS 2010c)

depth. Sea ice habitat is essential for most polar bear activities as a platform for hunting and feeding, searching for mates and for breeding, moving to terrestrial maternity denning areas, resting, and making long-distance movements. A total of 464,924 km^2 (179,508 mi^2) of sea ice habitat has been designated as critical habitat (USFWS 2010b). Terrestrial denning critical habitat includes lands within 32 km (20 mi) of the northern coast of Alaska between the U.S./Canadian border and Kavik River and within 8 km (5 mi) between the Kavik River and Barrow. A total of 14,652 km^2 (5,657 mi^2) of terrestrial denning habitat has been designated as critical habitat (USFWS 2010b).

Seasonal movements of polar bears reflect changing ice conditions and breeding behavior. In spring, polar bears in the Beaufort Sea overwhelmingly prefer regions with ice concentrations greater than 90% and composed of ice floes 2 to 10 km (1.2 to 6.2 mi) in diameter (Durner et al. 2004). Mature males range offshore in early spring, but move closer to shore during the spring breeding season. With the breakup of the ice during spring and early summer, polar bears move northward where they select habitats with a high proportion of old ice. To reach this ice, polar bears may migrate as much as 1,000 km (620 mi) (Amstrup 2003). As ice reforms in the fall, the bears move southward, and by late fall are distributed seaward of the Chukchi and Beaufort Sea coasts. During winter, polar bears prefer the lead ice system at the shear zone between the shorefast ice and the active offshore ice. Annual activity areas for female polar bears in the Beaufort Sea range from 13,000 to 597,000 km^2 (5,020 to 230,500 mi^2) with an average of 149,000 km^2 (57,530 mi^2) (Amstrup et al. 2000).

Pregnant and lactating females with newborn cubs are the only polar bears that occupy winter dens for extended periods (Lentfer and Hensel 1980; Amstrup and Gardner 1994). The key denning habitat characteristics are topographic features that catch snow for den construction and maintenance (USFWS 2008b). The main terrestrial denning areas for the Southern Sea stock in Alaska occur on the barrier islands from Barrow to Kaktovik and along coastal areas up to 40 km (25 mi) inland (Allen and Angliss 2011). Most onshore dens are close to the seacoast, usually not more than 8–10 km (5–6 mi) inland. Information on polar bear use of terrestrial habitat for maternity denning in and near the Prudhoe Bay oil field indicates that dens were located or associated with pronounced landscape features, such as coastal and river banks, as well as lake shores and abandoned oil field gravel pads (Durner et al. 2003). In the Beaufort Sea and to a limited extent the Chukchi Sea, females may den on the drifting pack ice (Schliebe et al. 2005). Females enter dens by late November, with young being born in late December or January (Lentfer and Hensel 1980). Polar bears do not have denning site fidelity, but do return to the general substrate (i.e., land or ice) and geographic area (e.g., eastern or western Beaufort Sea) (ADNR 2009). Females and cubs emerge from dens in late March or early April. Coastal areas provide important denning habitat for polar bears. More polar bears are now denning near shore, rather than in far offshore regions. Data indicated that approximately 64% of all polar bear dens in Alaska from 1997 to 2004 occurred on land, compared to approximately 36% of dens from 1985 to 1994 (Fischbach et al. 2007). Recent information indicates that survival rates of cubs-of-the-year are now significantly lower than they were in previous studies, and there has also been a declining trend in cub-of-the-year size for the Southern Beaufort Sea stock. Although many cubs are currently being born into the Southern Beaufort Sea Stock region, more females are apparently losing their cubs shortly after den emergence, lowering recruitment of new bears into the population (Regehr et al. 2006).

Polar bears normally occur at low densities throughout their range. Most of the year, polar bears are solitary or occur in family groups of a mother and her cubs (Lentfer and Small 2008). Polar bears do aggregate along the Beaufort Sea coastline in the fall in areas where harvesting and butchering of marine mammals occurs. Specific aggregation areas include Point Barrow, Cross Island, and Kaktovik (USFWS 2011j). Polar bear concentrations also occur during the winter in areas of open water, such as leads and polynyas, and areas where beach-cast marine mammal carcasses occur (USFWS 2011j).

The predominant prey item of polar bears in Alaska is ringed seals, and to a lesser degree bearded seals (Stirling and McEwan 1975; Stirling and Archibald 1977; Stirling and

Latour 1978) and spotted seals. To hunt seals in the Beaufort Sea, polar bears concentrate in shallow waters less than 300 m (1,000 ft) deep over the continental shelf and in areas with greater than 50% ice cover (Allen and Angliss 2011). In addition, bears may take walruses (Calvert and Stirling 1990), beluga whales (Freeman 1973; Heyland and Hay 1976; Lowry et al. 1987), caribou (Derocher et al. 2000; Brook and Richardson 2002), and other polar bears (Amstrup et al. 2006; Taylor et al. 1985). Cannibalism of cubs and juvenile bears by adult bears is not uncommon (Dyck and Daley 2002; Derocher and Wiig 1999). Polar bears also scavenge whale, seal, and walrus carcasses (USFWS 2008b). When regular prey items are not available, polar bears may consume small mammals, birds, eggs, and vegetation, although these foods are not important dietary components (USFWS 1994b). They also will consume human refuse (Amstrup 2003).

About 20,000 to 25,000 polar bears occur worldwide in 19 relatively discrete populations (USFWS 2008b). A reliable estimate for the Chukchi/Bering Seas stock does not exist, but the best information available provides a minimum population estimate of 2,000 individuals for the stock. There is also no reliable population trend for this stock (Allen and Angliss 2011). The best population estimate for the Southern Beaufort Sea stock is 1,526 individuals with a minimum population abundance of 1,397. This stock is experiencing a population decline due to loss of sea ice (partly due to climate change), potential overharvest, and human activities (including industrial activities) in nearshore and offshore environments (Allen and Angliss 2011).

Marine Mammals Not Listed under the Endangered Species Act.

Cetaceans: Mysticetes. The eastern North pacific population of the gray whale (*Eschrichtius robustus*) was removed from ESA listing in 1994 (USFWS and NMFS 1994). The gray whale (*Eschrichtius robustus*) occurs in the Gulf of Alaska in late March and April, moves into the Northern Bering Sea in May or June, and then enters the Chukchi and Beaufort Sea area in July or August (Rice and Wolman 1971; Consiglieri et al. 1982; Frost and Karpovich 2008). Gray whales migrate out of the Chukchi and Beaufort Seas at freezeup and migrate out of the Bering Sea during November to December (Rugh and Braham 1979). Section 3.5.4.2.1 provides additional information on the gray whale, including population estimates.

The minke whale (*Balaenoptera acutorostrata*) occurs from the Bering and Chukchi Seas south to near the equator with apparent concentrations of whales near Kodiak Island (Leatherwood et al. 1982; Rice and Wolman 1982). Very little is known about minke whale use of the Chukchi Sea, and they would not be expected to occur in the Beaufort Sea. Sightings are infrequent during the summer months in the Chukchi Sea. There are no estimates for minke whales in the Chukchi Sea, but numbers are clearly very low because it is the northern extreme of the species range (Brueggeman 2009). Section 3.5.4.2.1 provides additional information on the minke whale.

Cetaceans: Odontocetes. The beluga whale (*Delphinapterus leucas*) is a subarctic and Arctic species. Both the Beaufort Sea and Eastern Chukchi Sea stocks occur in the Arctic region. Beluga whales are associated with open leads and polynyas in ice-covered regions (Allen and Angliss 2011). Ice cover, tidal conditions, access to prey, temperature, and human interactions affect the seasonal distribution of beluga whales. They occur in ice-covered areas of the Bering Sea in winter and spring and in coastal waters of the Chukchi and Beaufort Seas in summer and fall. Some beluga whales migrate more than 2,700 km (1,500 mi) between the Bering Sea and the Mackenzie River estuary in Canada, sometimes moving more than 180 km (100 mi) per day. They will ascend large rivers and are apparently unaffected by salinity changes (Citta and Lowry 2008).

Small groups of 2 to 5 beluga whales are common, but they can occur in groups of up to 1,000 animals (Citta and Lowry 2008). Adult males will occur together in pods of 8 to10, while females occur in pods with juveniles and calves (Citta and Lowry 2008). Breeding occurs in March or April with calves being born between May and July after a gestation period of about 14.5 months. Calving occurs when herds are generally near or in their summer concentration areas (Citta and Lowry 2008). Fall migration occurs in September and October. While some belugas migrate along the coast (Johnson 1979), most migrate offshore along the pack-ice front (Moore et al. 2000b; Richard et al. 2001; Suydam et al. 2001).

Belugas shed their skin around July. To do this, they tend to concentrate in shallow water where there is coarse gravel to rub against (Citta and Lowry 2008). Feeding occurs over the continental shelf and in nearshore estuaries and river mouths. During summer, belugas feed primarily on various schooling and anadromous fishes and occasionally on cephalopods, shrimp, crabs, and clams. Winter foods are not known (Citta and Lowry 2008). Most feeding dives are to depths of 6 to 30 m (20 to 100 ft) and last up to 5 minutes; however, they can dive to over 860 m (2,800 ft) (Citta and Lowry 2008).

The best population estimate for the Beaufort Sea stock is 39,258 with a minimum estimate of 32,453 individuals; while the best population estimate for the Chukchi Sea stock is 3,710 individuals (which is also considered the minimum population size) (Allen and Angliss 2011). The population trend for the Beaufort Sea stock is unknown, and there is no evidence that the eastern Chukchi Sea stock is declining (Allen and Angliss 2011).

The narwhal (*Monodon monoceros*) typically occurs above the Arctic Circle. Narwhals are most common in Nunavut, Canada, west Greenland, and the European Arctic; but incidental sightings occur in the East Siberian, Bering, Chukchi, and Beaufort Seas (COSEWIC 2004; Jefferson et al. 2006). During summer, narwhals inhabit coastal areas with deep water and shelter from the wind. During the fall migration and, especially, while wintering in the pack ice, they prefer deep fjords and the continental slope at depths of 1,000 to 1,500 m (3,281 to 4,921 ft) (COSEWIC 2004). Narwhals often travel in small groups of under ten individuals, but do congregate in the hundreds during spring and fall migration. Peak mating occurs in mid-April with calving generally occurring in July and August following a gestation of up to 15.3 months (COSEWIC 2004). Prey items include fish and invertebrates including squid, shrimp, cod, and other demersal fish and crustaceans (COSEWIC 2004; Jefferson et al. 1993; Pauley et al. 1995). Population estimates for the Nunavut waters are up to 86,000 individuals (DFO 2008). There are no reliable population estimates or trends in population abundance for the narwhal in Alaska (Allen and Angliss 2011).

The harbor porpoise (*Phocoena phocoena*) ranges from Point Conception, California, to Point Barrow, Alaska (Allen and Angliss 2011 belong to the Bering Sea stock. The Bering Sea stock includes harbor porpoises that occur throughout the Aleutian Islands and all waters north of Unimak Pass (Allen and Angliss 2011). Harbor porpoises frequent waters less than 100 m (325 ft) in depth (Dahlheim et al. 2000). Mating likely occurs from June or July to October, with peak calving occurring the following May and June (Consiglieri et al. 1982). Harbor porpoises consume a wide variety of fish and cephalopods, apparently preferring non-spiny schooling fish such as herring, mackerel, and pollock (Houck and Jefferson 1999; American Cetacean Society 2006). The best population estimate for the Bering Sea stock is 48,215 with a minimum population estimate of 40,039 based on survey data that is over 10 yr old (Allen and Angliss 2011).

The killer whale (*Orcinus orca*) occurs along the entire Alaska coast within the Chukchi Sea, Bering Sea, Aleutian Islands, Gulf of Alaska, Prince William Sound, Kenai Fjords, and southeast Alaska. Some killer whales may also stray into the western portion of the Beaufort Sea. Killer whales that occur in the northern Bering Sea, Chukchi Sea, and Beaufort Sea move south with the advancing pack ice (Culik 2010). Within these areas, three genetically distinct ecotypes, or forms, of killer whales exist: resident, transient, and offshore (Allen and Angliss 2011). The whales found in the Arctic region likely belong to the eastern North Pacific Transient Stock. Members of this stock occur from California to Alaska, with some also occurring within Canadian waters (Allen and Angliss 2011). Section 3.5.4.2.1 provides additional information on the killer whales in Alaska.

Pinnipeds. The ribbon seal (*Phoca fasciata*) inhabits the North Pacific Ocean and adjacent fringes of the Arctic Ocean. In Alaskan waters, ribbon seals occur in the open sea, on the pack ice, and only rarely on shorefast ice (Allen and Angliss 2011), generally occurring in the open sea in summer and on the pack ice in winter (Nelson 2008b). The ribbon seal rarely occurs on land (Boveng et al. 2008). The ribbon seal ranges northward from Bristol Bay in the Bering Sea into the Chukchi and western Beaufort Seas (Allen and Angliss 2011). It inhabits the Bering Sea ice front from late March to early May. As the ice recedes in May to mid-July, ribbon seals move farther north in the Bering Sea, where they haul out on the receding ice edge (Allen and Angliss 2011). Many ribbon seals migrate into the Chukchi Sea for the summer (Allen and Angliss 2011. The ribbon seal is strongly associated with sea ice during its whelping, mating, and molting periods which occur from mid-March through June. During the remainder of the year, ribbon seals remain at sea feeding on fishes, cephalopods, and crustaceans (Nelson 2008a). Reliable population estimates and trends for the Alaska stock of the ribbon seal are not available, although there is a provisional estimate of 49,000 ribbon seals in the eastern and central Bering Sea based on aerial surveys done in 2003, 2007, and 2008 (see Allen and Angliss 2011). This estimate is consistent with historical estimates, which suggests no major changes in the ribbon seal stock over the past several decades (Allen and Angliss 2011).

Only the Bering Sea Distinct Population Segment of the spotted seal (*Phoca largha*) occurs in U.S. waters (NMFS 2011a). It occurs along the continental shelf of the Beaufort, Chukchi, and Bering Seas (Allen and Angliss 2011). It occurs year-round in the Bering Sea, while occurring in the Chukchi and Beaufort Seas in summer (Nelson 2008c). Terrestrial haul-out sites are generally located on isolated mud, sand, or gravel beaches or on rocks close to shore. Haul-out sites are apparently selected based on proximity to food (e.g., in Alaska, haul-out sites are located near herring and capelin spawning areas), lack of disturbance, and favorable tidal conditions (Boveng et al. 2009). Beaufort Sea coastal haul-out and concentration areas include the Colville River Delta, Peard Bay, Smith Bay, and Oarlock Island in Dease Inlet/Admiralty Bay, while along the Chukchi Sea coast they mostly haul out at Kasegaluk Lagoon but also at other locations to a lesser degree. Along the west coast of Alaska, spotted seals occur around the Pribilof Islands, Bristol Bay, and the eastern Aleutian Islands (Allen and Angliss 2011). Spotted seals frequently enter estuaries and sometimes ascend rivers, presumably to feed on anadromous fishes. Spotted seals migrate out of the Arctic region in the fall (September to mid-October) as the shorefast ice reforms and the pack ice advances southward. They spend the winter and spring periods offshore north of the 200-m (660-ft) isobath along the ice front throughout the Bering Sea where pupping, breeding, and molting occur (Lowry et al. 2000). Adult spotted seals forage at depths up to 300 m (984 ft), while pups can dive to 80 m (262 ft) (Boveng et al. 2009). Their diet includes a variety of fishes, crustaceans, and cephalopods (Nelson 2008b). A reliable population estimate for the Alaska stock is not available, but preliminary results provide a population estimate of over 59,000 individuals (Allen and Angliss 2011).

Climate Change. A number of reviews discuss the potential responses of Arctic marine mammals to climate change (e.g., Tynan and DeMaster 1997; Learmonth et al. 2006; Laidre et al. 2008; Moore and Huntington 2008; Ragen et al. 2008; Simmonds and Eliott 2009; Kovacs et al. 2011). Climate change will primarily affect marine mammals from loss of habitat (particularly the extent and concentration of sea ice), changes in prey availability, and potentially increased expansion of other species that are likely to cause competitive pressure on some species, as well as putting them at greater risk of predation, disease, and parasitic infections (Alter et al. 2010; Kovacs et al. 2011). These changes may alter the seasonal distributions, geographic ranges, migration patterns, nutritional status, prey species, reproductive success, and ultimately the abundance and stock structure of some marine mammal species. The capacity of Arctic marine mammals to adapt to new or different food sources will have a key role in their ability to cope with climate change, with generalists probably having a better chance of coping than specialists (Kovacs et al. 2011).

Climate change impacts on marine mammals can be either direct (e.g., effects of reduced sea ice and rising sea levels on seal haul-out sites, or species tracking a specific range of water temperatures in which they can physically survive); or indirect (e.g., changes in prey availability and increased susceptibility to disease or contaminants) (Learmonth et al. 2006). Predicted indirect impacts on cetacean species are decreased reproductive capacity, asynchrony in space or time with prey species, increased prevalence and/or susceptibility to disease, and loss of habitat (Simmonds and Eliott 2009). Alteration of sea ice and the productive food web associated with it, as well as increasing human presence and activities, will cause extensive redistribution of mobile species, disappearance of non-mobile species throughout portions of their range, and possible species extinctions (Ragen et al. 2008). For instance, the loss of sea ice could have some potential beneficial effects on bowhead whales by increasing prey availability (Moore and Laidre 2006). However, loss of sea ice would include increase noise and disturbance related to increased shipping, increased interactions with commercial fisheries, including noise and disturbance, incidental intake, and gear entanglement; changes in prey species concentrations and distribution; and changes in subsistence-hunting practices.

Species that seasonally occupy Arctic and subarctic habitats may move further north, remain there longer, and compete with endemic Arctic species (Moore and Huntington 2008). For example, humpback whales now occur as far north as the Beaufort Sea and fin whales occur farther north than usual within the Chukchi Sea. Higher calf counts in the spring are associated with years of delayed onset of freezeup in the Chukchi Sea. Killer whales appear to be extending their season of Arctic habitation and are expanding their range northward. Other species that may be shifting their summer distribution northward in the Arctic include the sei whale, blue whale, minke whale, and harbor porpoise (Kovacs et al. 2011). However, information is not sufficient to determine or predict whether short-term apparent changes in their distribution will persist and become longer term trends in the Arctic (MMS 2008b).

Changes in sea ice will reduce habitat available for ice-associated marine mammals that give birth on sea ice, hide from predators, seek shelter from inclement weather on ice fields, or consume ice-associated fish and invertebrate prey or ice-associated marine mammals (Kovacs et al. 2011). Changes in the extent, concentration, and thickness of the sea ice in the Arctic may alter the distribution, geographic ranges, migration patterns, nutritional status, reproductive success, and ultimately the abundance of ice-associated pinnipeds that rely on the ice platform for pupping, rest, and molting (Tynan and DeMaster 1997). The early breakup of sea ice has resulted in increased mortality of seal pups within their birth lairs (Stirling and Derocher 1993). In the Alaskan Beaufort Sea, ringed seal-lair abandonment began earlier each year from 1999 (May 21) to 2003 (April 28) and was associated with early onset of spring melt over the sea-ice cover and the snow pack turning isothermal, at which time the thermal and structural integrity of the lairs was compromised (Kelly et al. 2010b). Climate change may adversely affect populations of ringed seals as warmer temperatures and rain may collapse roofs of birth lairs, exposing pups to predators and to wet weather before they have enough blubber to insulate them (Kelly 2001; Ferguson et al. 2005; Citta 2008). Although longer periods of open water may increase prey accessibility, earlier spring break-up may force ringed seal pups into open water at an earlier age and expose them to increased risk of predation and thermal challenges (Ferguson et al. 2005). A loss of suitable sea ice due to climate change could isolate bearded seals from suitable benthic prey communities (Cameron and Boveng 2009).

Reductions in sea-ice coverage would adversely affect the availability of pinnipeds prey for polar bears (Stirling et al. 1999; Stirling and Derocher 1993). This can force polar bears ashore earlier than normal and in poorer condition. Lack of access to seals for a long period of time can cause a decline in polar bear health, reproduction, survival, and population size. Generally, polar bears cannot meet their caloric needs from just terrestrial sources of food (USFWS 2008b). Changing ice conditions due to climate change is expected to increase polar bear use of the coast during open-water seasons (June through November). Polar bears spending extended periods of time on land without an adequate food source may be nutritionally stressed animals and potentially more dangerous when encountering humans (USFWS 2009f). Monnett and Gleason (2006) speculated that mortalities due to offshore swimming during late-ice (or mild ice) years may be an important and unaccounted source of natural mortality given energetic demands placed on individual polar bears engaged in long-distance swimming. Drowning-related deaths of polar bears may increase in the future if the observed trend of pack ice regression and/or longer open water period continues. Polar bear survival, breeding rates, and cub litter survival decline with an increasing number of days per year that waters across the continental shelf are ice free (Regehr et al. 2010).

Pacific walruses have been showing negative impacts of sea-ice reductions (e.g., reports of abandoned calves at sea, and mothers and calves spending more time on land, where stampede incidents have caused significant mortality). The Pacific walrus may also be shifting its diet toward eating more seals and fewer benthic invertebrates (Kovacs et al. 2011). Decreases in summer extent of sea ice may decrease the access of Pacific walrus to their food resources and increase their exposure to polar bear predation (Kelly 2001).

Unusual Mortality Event in the Arctic. On December 20, 2011, NMFS declared an UME in the Arctic and Bering Strait region of Alaska. From mid-July through December 20, 2011, over 60 dead and 75 diseased seals (mostly ringed seals) were reported in Alaska (NMFS 2011k). Some diseased spotted and bearded seals were also reported (NMFS 2011l). The USFWS also identified diseased and dead walruses at the annual mass haulout at Point Lay (NMFS 2011k). Symptoms of the disease included skin sores (usually on the hind flippers or face) and patchy hair loss. Similar symptoms have been observed in ringed seals and walruses in Russia and ringed seals in Canada (NMFS 2011k). Necropsies have revealed fluid in the lungs, white spots on the liver, and abnormal growths in the brain. Undersized lymph nodes, indicating compromised immune systems, were also seen in some of the pinnipeds. Animals still alive also exhibited labored breathing and appeared lethargic. A single cause of the disease is not known, but tests have ruled out radionuclide exposure and a number of bacteria and viruses known to affect marine mammals (NMFS 2011k, 2012c,d). Potential causes of the disease being investigated include immune system-related diseases, fungi, man-made toxins, bio-toxins, contaminants, and stressors related to sea ice change (NMFS 2011k). Few cases of the disease were found from November 2011 through March 2012 (NMFS 2012d). Additional information on this UME can be found at NOAA(2012c) and USFWS (2012i). On April 6, 2012, the USGS (2012) reported that nine polar bears in the southern Beaufort Sea region near Barrow have been observed with alopecia (loss of fur) and other skin lesions. The cause of these symptoms, and whether they are related to similar symptoms for sei seals and walruses, is unknown at this time.

3.8.1.3.2 Terrestrial Mammals. No terrestrial mammals listed under the ESA occur in the Arctic region. Approximately 30 species of terrestrial mammals not listed under the ESA occur in Alaska's Arctic region (Sage 1996); these species include big game species such as the brown bear (*Ursus arctos*), caribou (*Rangifer tarandus*), moose (*Alces alces*), Dall sheep (*Ovis dalli*), and muskox (*Ovibos moschatus*); furbearers such as the Arctic fox (*Alopex lagopus*), ermine (*Mustela ermine*), gray wolf (*Canis lupus*), least weasel (*Mustela rixosa*), North American river otter (*Lutra canadensis*), red fox (*Vulpes vulpes*), and wolverine (*Gulo gulo*); and small mammal prey species such as Alaska marmots, Arctic ground squirrels, Alaskan hare (*Lepus othus*), snowshoe hare (*Lepus americanus*), Alaska marmot (*Marmota broweri*), and the brown lemming (*Lemmus trimucronatus*) (ADFG 2011a; Carroll 2007; Szepanski 2007). Among these, the Arctic fox, brown bear, caribou, and muskox are the species most likely to be affected by proposed OCS oil and gas activities. The following information describes the life history attributes, distribution, and seasonal movement for these terrestrial mammal species in the Arctic region.

Arctic Fox (*Alopex lagopus*). In Alaska, the Arctic fox occurs in treeless coastal areas from the Aleutian Islands north to Point Barrow and east to the U.S./Canadian border (Stephenson 2008). Pups are born in dens that adults construct in sandy, well-drained soils of low mounds and river cutbanks (Stephenson 2008). In winter, dens provide shelter. In developed areas, Arctic foxes also use culverts and road embankments as denning sites (Audet et al. 2002). A den may cover more than 50 m^2 (540 ft^2) and contain up to 100 entrances. Den densities range from 1.0 den/2,500 km^2 (965 mi^2) to 1.0 den/12 km^2 (5 mi^2) (Audet et al. 2002). Arctic fox populations peak whenever lemmings and voles (their main prey) are abundant (Stephenson 2008). Other food sources include carrion, insects, berries, and newborn ringed seal pups (Frafjord 1993; Hammill and Smith 1991). Arctic foxes are the most common predator of Arctic nesting birds and their eggs. They will cache eggs to consume during the winter. A single Arctic fox is capable of caching hundreds of eggs per nesting season (Audet et al. 2002). Marine mammals are an important part of the diet of Arctic foxes that occur along the coast of western Alaska (Anthony et al. 2000). In winter, Arctic foxes primarily feed on remains of polar bear kills (USFWS 2008b), and many Arctic foxes venture onto sea ice to search for seal remains (Stephenson 2008). The availability of winter food sources directly affects the Arctic foxes' abundance and productivity (Angerbjorn et al. 1991). During midwinter, Arctic foxes tend to be solitary except when congregating at carcasses of marine mammals or caribou (Stephenson 2008). Arctic foxes on the Prudhoe Bay oil field readily use developed sites for feeding, resting, and denning; their densities are equal to or greater in the oil fields than in surrounding undeveloped areas (Eberhardt et al. 1982; Ballard et al. 2000). Development on the Prudhoe Bay oil fields probably has led to increases in Arctic fox abundance and productivity (Burgess 2000).

Brown Bears (*Ursus arctos*). Population estimates for brown (grizzly) bears across the North Slope of Alaska are: 900 to 1,120 in Game Management Unit 26A (western North Slope) and 659 in Game Management Units 26B and 26C (eastern North Slope) (Carroll 2009; Lenart 2009c). Brown bears are solitary animals except when breeding or concentrating near high-value food sources. On the North Slope, brown bear densities vary from about 0.1 to 2.3 bears/100 km^2 (0.3 to 5.9 bears/100 mi^2), with a mean density of 0.4 bear/100 km^2 (1 bear/100 mi^2). The number of brown bears using the Prudhoe Bay and Kuparuk oil fields adjacent to the Liberty Project in the Beaufort Sea has increased in recent years. An estimated 60 to 70 brown bears, or approximately 4 bears/1,000 km^2 (10 bears/1,000 m^2), inhabit the oil field area (Shideler and Hechtel 2000). Brown bears in the oil field area can have large home ranges, between 2,600 to 5,200 km^2 (1,000 to 2,000 mi^2), and travel up to 50 km (31 mi) per day (Shideler and Hechtel 1995). Home range size is influenced by the distribution of food and by the individual's age, sex, social status, condition, and foraging habits (Pasitschniak-Arts 1993). Home ranges overlap and there is no territorial defense (Pasitschniak-Arts 1993). Most brown bears den and hibernate during winter when food is scarce. On the North Slope, den sites are located in pingos, banks of rivers and lakes, sand dunes, and steep gullies in the uplands (Harding 1976; Shideler and Hechtel 1995). The grass meadows on the bluffs along the Colville River provide forage for brown bears during the spring. Common foods include berries, nuts, vegetation, roots, insects, fish, ground squirrels, birds and their eggs, carrion, and human garbage. In the Arctic region, brown bears will also prey on newborn muskoxen and particularly caribou and will occasionally prey on healthy adults of these species. Large males prey on newborn brown bear cubs and occasionally females (Pasitschniak-Arts 1993).

Caribou (*Rangifer tarandus*). Within the coastal habitats adjacent to the Arctic region occur two large caribou herds — the Western Arctic Herd (WAH) and the Porcupine Caribou Herd (PCH) — and two smaller herds — the Teshekpuk Lake Herd (TLH) and the Central Arctic Herd (CAH) (Figure 3.8.1-7). While the calving areas are separate for each herd, some intermingling occurs on winter and summer ranges (ADNR 2009; Lenart 2009a). Caribou herd size naturally fluctuates (e.g., cycles of years of growth followed by years of decline) due to a number of factors such as weather patterns, overpopulation, predation, disease, and hunting (Valkenburg and Arthur 2008).

The WAH herd, covering about 363,000 km^2 (140,000 mi^2) (Dau 2009), ranges over northwestern Alaska from the Chukchi Coast east to the Colville River and from the Beaufort Coast south to the Kobuk River. Herd size estimates included 490,000 animals in 2003, 377,000 in 2007, and 348,000 in 2009 (ADFG 2011d).

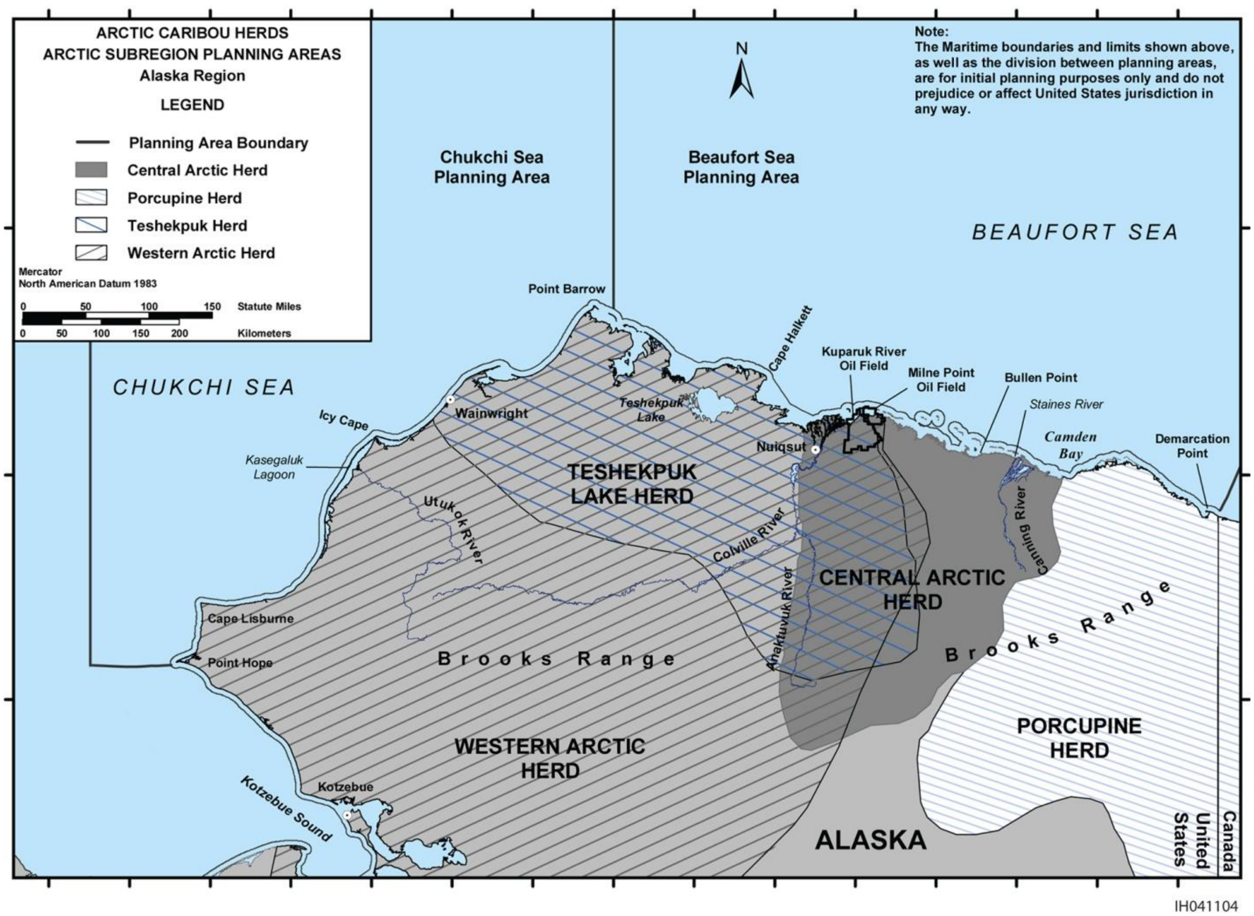

FIGURE 3.8.1-7 Distribution of Caribou Herds in the Arctic Region (Source: MMS 2007a)

The PCH, covering about 336,700 km^2 (130,000 mi^2) (Caikoski 2009), ranges south from the Beaufort Sea Coast, from the Canning River of Alaska in the west, eastward through the northern Yukon and portions of the Northwest Territories in Canada, and south to the Brooks Range. The herd peaked at 178,000 caribou in 1989, but had declined to 123,000 by 2001 (Caikoski 2009). A 2010 photocensus indicates the herd has grown to an estimated 169,000 caribou (ADFG 2011c).

The TLH primarily inhabits the central coastal plain north of the Brooks Range in spring and summer; its wintering areas encompass much of northwestern Alaska (Parrett 2009). The TLH occurs primarily within the National Petroleum Reserve-Alaska (NPR-A), with its summer range extending between Barrow and the Colville River. It uses the area around Teshekpuk Lake for calving, grazing, and insect relief (ADNR 2009). In some years, most of the TLH remains in the Teshekpuk Lake area all winter. In other years, part or all of the herd winters in the Brooks Range or within the range of the WAH and CAH. The TLH contained a record 64,106 caribou in 2008 (Parrett 2009).

The CAH ranges from the Itkillik River east to the Canning River and from the Beaufort Coast south into the Brooks Range. It occurs east and west of the Sagavanirktok River, and individuals show considerable movement between the eastern and western segments of the herd (Cronin et al. 2000; Lenart et al. 2009a). In 2008, the CAH totaled about 67,772 caribou (Lenart 2009a).

Most caribou herds migrate seasonally between their calving area, summer range, and winter range to take advantage of seasonally available forage resources; however, as previously mentioned, in some years the TLH may remain in the Teshekpuk Lake area the entire year. If movements are greatly restricted, caribou are likely to overgraze their habitat, perhaps leading to a drastic, long-term population decline. The winter diet of caribou consists predominantly of lichens and mosses, shifting to vascular plants during the spring (Thompson and McCourt 1981). However, when TLH caribou winter near Teshekpuk Lake, where relatively few lichens are present, the herd may consume more sedges and vascular plants.

Spring migration of parturient female caribou from the overwintering areas to the calving grounds starts in April (Dau 2009). Often the most direct routes are used; however, certain drainages and routes are used during calving migrations because they tend to be corridors free of snow or with shallow snow (Lent 1980). Bulls and non-parturient females generally migrate at a very leisurely pace, with some remaining on winter ranges until June. Severe weather and deep snow can delay spring migration, with some calving occurring en route. Cows calving en route usually proceed to their traditional calving grounds (USFWS 2008d).

The spring migration to traditional calving grounds consistently provides high nutritional forage to lactating females during calving and nursing periods, which is critical for the growth and survival of newborn calves. Calciphiles such as the sheathed cottonsedge (*Eriophorum vaginatum*) appear to be very important in the diet of lactating caribou cows during the calving season (Lent 1966; Thompson and McCourt 1981; Eastland et al. 1989), while shrubs (especially willows) are the predominant forage during the post-calving period (Thompson and

McCourt 1981). The winter availability of sedges, which are dependent on temperature and snow cover, probably affects specific calving locations and calving success.

Cows reach calving grounds from mid-May to the first few days in June, with calving occurring late May through early June (Dau 2009; ADNR 2009). The sequential spring migration, first by cows and later by bulls and the rest of the herd, is a strategy for optimizing the quality of forage as it becomes available with snowmelt on the Arctic tundra (Whitten and Cameron 1980). The earlier migration of parturient cow caribou to the calving grounds also could reduce forage competition with the rest of the herd during the calving season.

Insect-relief areas become important during late summer when oestrid fly and mosquito harassment peaks (Valkenburg and Arthur 2008). Harassment by insects reduces foraging efficiency and increases physiological stress (Hagemoen and Reimers 2002). Caribou use various coastal and upland habitats for relief from insect pests, including areas such as sandbars, spits, river deltas, some barrier islands, mountain foothills, snow patches, and sand dunes. Stiff breezes in these settings prevent insects from concentrating and alighting on the caribou. Members of the TLH generally aggregate close to the coast for insect relief, but some small groups gather in other cool windy areas such as the Pik Dunes located about 30 km (19 mi) south of Teshekpuk Lake (Hemming 1971; Person et al. 2007). Caribou aggregations move frequently from insect-relief areas along the Arctic coast (CAH, WAH, and especially the TLH) and in the mountain foothills (some aggregations of the WAH) to and from green foraging areas. After calving along the coast, much of the PCH will move back into the Brooks Range foothills for insect relief.

During the post-calving period in July through August, caribou generally attain their highest degree of aggregation. They join into increasingly larger groups, foraging primarily on the emerging buds and leaves of willow shrubs and dwarf birch (Thompson and McCourt 1981). In the PCH and WAH, continuous masses of animals can number in the tens of thousands. Cow/calf groups are most sensitive to human disturbance during this period.

Fall migration begins from mid-August through late September and can last through late November. Migration is triggered by weather conditions such as the onset of cold weather or a snowstorm (ADNR 2009). Once on wintering grounds, caribou are relatively sedentary until spring migration initiates (Dau 2009). The primary winter range of the WAH is located south of the Brooks Range along the northern fringe of the boreal forest. During winters of heavy snowfall or severe ice crusting, caribou may overwinter within the mountains or on the Arctic Slope (Hemming 1971). Even during normal winters, some caribou of the WAH overwinter on the Arctic Coastal Plain (Davis et al. 1982). The TLH generally calves south of Teshekpuk Lake. The herd is distributed all around the lake by late June and by late July is spread widely from the Colville River to Barrow. The herd is again south of the lake by late August. Major wintering concentrations occur southeast of the lake and in the foothills of Brooks Range (Parrett 2009). The CAH overwinters primarily in the northern foothills of the Brooks Range (Lenart 2009a).

The movement and distribution of caribou over the winter ranges reflect their need to avoid predators and their response to wind (storm) and snow conditions (depth and snow density), which greatly influence the availability of winter forage (Henshaw 1968; Bergerud and Elliot 1986). The numbers of caribou using a particular portion of the winter range are highly variable from year to year (Davis et al. 1982; Whitten 1990). Range condition, distribution of preferred winter forage (particularly lichens), and predation pressure all affect winter distribution and movements (Johnson et al. 2001; Joly 2011).

Muskox (*Ovibos moschatus*). Indigenous populations of muskox were extirpated in the 1800s in northern Alaska (Smith et al. 2008). As a result of restoration efforts, numbers of muskoxen in Alaska had grown to about 3,800 individuals by the year 2000. This included 650 on Nunivak Island, 250 on Nelson Island, 550 in north-central and northeastern Alaska, 450 in northwestern Alaska, 1,800 on the Seward Peninsula, and 100 on the Yukon-Kuskokwim Delta (Smith et al. 2008). Between the years 2000 and 2006, the numbers in north-central and northwestern Alaska declined by about 200 individuals. The most likely factors causing this decline are severe winters, predation by bears and wolves, and the limited availability of winter forage (Smith et al. 2008). Smith et al. (2008) concluded that muskoxen populations elsewhere in Alaska will continue to increase and expand their range. Lenart (2009b) stated that the likely combined population of muskoxen in Game Management Units 26A (eastern portion), 26B, and 26C, which comprise the Arctic Slope area, is less than 300 individuals. There is little or no overlap of habitat and feeding sites between muskoxen and caribou (Lent 1988).

Unlike caribou, muskoxen are sedentary, but will engage in limited movement in response to seasonal changes and variations in snow cover and vegetation. Being poor diggers, their winter habitat is generally restricted to areas with minimal snow accumulations or areas blown free of snow (Smith et al. 2008). They also use willow-shrub riparian habitats along the major river drainages on the Arctic Slope year-round. Calving takes place from mid-April through June (Lent 1988). Distributions of muskoxen during the calving season, summer, and winter are similar, with little movement during winter (Reynolds 1992). The breeding season occurs from August to October with calves born the following April to June (Smith et al. 2008). During the mating season, harems consist of 5 to 15 females and subadults with one dominant bull; mixed male and female winter herds may contain up to 75 animals. Some non-breeding bulls may form bull-only herds during spring (Smith et al. 2008). Muskoxen are herbivores and consume grasses, sedges, forbs, and woody plants (Smith et al. 2008).

Climate Change. An increase in temperature associated with climate change is not expected to directly affect most terrestrial mammals. Physiological tolerance to heat load would allow most species to survive, but changes in habitat through climate-vegetation linkages are expected to influence terrestrial mammal distributions (Johnston and Schmitz 1997). Climate change is predicted to increase the number and geographic range of large rain-on-snow events. When rain falls on snowpack, the rain either pools at the surface or trickles down to the soil below the snowpack, then freezes into a sheet of ice. Such events have been known to cause death due to starvation to muskoxen and caribou because they are unable to break through the ice to browse on plants under the snow (Putkonen and Roe 2003; Joyce 2009).

Other effects of climate change on caribou herds potentially include alteration in habitat use, migration patterns, foraging behavior, quality of forage, and demography (Lenart et al. 2002; Vors and Boyce 2009; Sharma et al. 2009). If climate change brings about a longer growing season, the amount of plant biomass available for caribou may increase and likely decrease calf abortion, improve birth mass of calves, and increase parturition rates (Couturier et al. 2009; Tews et al. 2007); this would increase the survival and fecundity of migratory caribou and may also decrease the dependence of caribou on lichen (Sharma et al. 2009). However, adverse effects can occur if there is a mismatch between the timing of increased resource demands by caribou and resource availability. In West Greenland, this has caused an increase in offspring mortality and a decrease in offspring production (Post and Forchhammer 2008). It is also possible that climate change may lead to an overlap of herds in spring that could increase competition on the calving grounds or change their distribution (Post and Forchhammer 2008).

The absence or incomplete formation of ice on large streams and rivers can result in delays in crossing and possibly drowning of some migratory caribou (Sharma et al. 2009). Increased insect harassment appears to be a key climate change related factor that may adversely impact caribou (Weladji et al. 2002; Sharma et al. 2009). In addition, warming temperatures will benefit free-living bacteria and parasites whose survival and development is limited by lower temperatures. Climate warming may also favor the release of persistent environmental pollutants, some of which can affect wildlife immune systems and may favor the increased rates of some diseases (Bradley et al. 2005). Overall, climate change is predicted to negatively impact caribou body condition and demography (Couturier et al. 2009; Miller and Gunn 2003).

Potential changes in habitat across the North Slope due to development and climate change may influence the distribution and abundance of muskoxen in the future (Smith et al. 2008). Population declines in muskoxen are proposed to occur due to changes in forage availability, insect harassment, parasite load, infectious diseases, and habitat availability (Ytrehus et al. 2008). The absence or incomplete formation of ice on large streams and rivers can possibly result in drowning of muskoxen (Sharma et al. 2009).

Red foxes prey on and are superior hunters to Arctic foxes. Their expansion into the range of the Arctic fox, which has already begun, will continue as the tundra warms. In addition, Arctic fox prey (lemming and voles) are expected to have their population cycles disrupted and their numbers decrease as the climate changes (Hersteinsson and Macdonald 1992; Sillero-Zubiri and Angerbjorn 2009).

Because brown bears are opportunistic, omnivorous, and highly adaptable, climate change it is not expected to threaten their populations due to ecological threats or constraints; however, it may lead to an increase in brown bear/human interactions, in part from later den entry and earlier den exit (Servheen and Cross 2010).

3.8.2 Marine and Coastal Birds

3.8.2.1 Marine and Coastal Birds of the Northern Gulf of Mexico

The northern GOM and its ecoregions possess a diverse bird fauna composed of resident marine and coastal species (Clapp et al. 1982; Sibley 2000). The bird fauna of the region also includes many species that inhabit northern latitudes and pass through the region in large numbers during spring and fall migrations (Russell 2005), or move into coastal habitats of the GOM to overwinter. For example, in the fall, many migratory species arrive at the northern GOM coast and then fly several hundred miles directly across the open waters or westward along the coast to wintering areas in Central and South America (Lincoln et al. 1998).

3.8.2.1.1 Nonendangered Species. Nearly all birds, regardless of Federal ESA listing, are protected by the Migratory Bird Treaty Act of 1918 as well as by State laws. The northern GOM, with its diverse array of terrestrial and aquatic habitats, supports a diverse avifauna of well over 600 species (Table 3.8.2-1). Many of these species may be found in more than one of the five GOM States, while a much smaller subset are largely restricted to a particular State or locale. For example, the brown pelican (*Pelecanus occidentalis*) is ubiquitous throughout the GOM States, while the endangered Mississippi sandhill crane (*Grus canadensis pulla*) is only found in Mississippi.

Although more than 400 species have been reported in the northern GOM, many of these species would not be likely to occur in marine and coastal habitats where they could encounter OCS oil and gas activities. Instead, these species occur in more interior, terrestrial habitats. Species that would be most likely to encounter, and thus be potentially affected by, OCS oil and gas activities are the aquatic/semi-aquatic species that rely on coastal and marine habitats. Within any individual GOM State, these species account for between 34 and 40% of all species reported from the State. Among these aquatic/semi-aquatic species, several species are very uncommon or incidental in occurrence, being occasional visitors or transients that in some cases may only be observed once every few years (Table 3.8.2-1). These species account for no more than 10% of all species reported from any of the GOM States. The occurrence of some other species is based on observations of individuals following large storm events such as hurricanes. For example, the brown noddy (a type of tern) has been reported only six times from Alabama, and three of those were following the passage of Hurricanes Frederick (1979), Isidore (2002), and Ivan (2004) (Alabama Ornithological Society 2011).

There are six general categories of marine and coastal birds that occur in the GOM region for at least some portion of their life cycle: seabirds, shorebirds, wetland birds, waterfowl, passerines, and raptors (Table 3.8.2-2). The first four categories represent birds that greatly utilize marine and coastal habitats (such as beaches, mud flats, salt marshes, coastal wetlands, and embayments), and thus these birds have the greatest potential for interacting with at least some phases of OCS-related oil and gas development activities, and for being affected by accidental oil spills that reach those habitats. For any of these categories, the occurrence and

TABLE 3.8.2-1 Number of Bird Species Reported from the Gulf Coast States

State	Total Number of Reported Species	Number of Aquatic/Semi-aquatic Species that Could Occur in Coastal and Marine Habitats[a]	Number of Aquatic/Semi-aquatic Species that are Very Uncommon or Incidental in Occurrence[b]
Florida[c]	510	189 (37%)	29 (6%)
Mississippi[d]	408	155 (38%)	37 (9%)
Alabama[e]	413	165 (40%)	35 (8%)
Louisiana[f]	471	172 (37%)	45 (10%)
Texas[g]	636	215 (34%)	65 (10%)

[a] Species that use coastal and marine aquatic habitats for nesting and/or foraging. Values in parentheses indicate the percent contribution of the aquatic/semi-aquatic species to the total number of species reported for the State.

[b] Species that are infrequently observed; many are currently in review regarding occurrence. Values in parentheses indicate the percent contribution of aquatic/semiaquatic species to the total number of species reported for the State.

[c] Source: Florida Ornithological Society 2011.

[d] Sources: Mississippi Ornithological Society 2007; Mississippi Coast Audubon Society 2010.

[e] Source: Alabama Ornithological Society 2006.

[f] Source: Louisiana Bird Records Committee 2011.

[g] Source: Texas Ornithological Society 2011.

abundance of individual species and types of birds varies considerably, both spatially and temporally.

Seabirds spend a large portion of their lives on or over seawater and may be found in both offshore and coastal waters of the northern GOM, where they feed on fish and invertebrates. This category is represented by four orders of birds, and includes gulls, terns, and phalaropes; loons; frigatebirds, pelicans, tropicbirds, cormorants, gannets, and boobies; and storm-petrels and shearwaters (Table 3.8.2-2). Some birds (such as the boobies, petrels, and shearwaters) inhabit only pelagic habitats in the GOM, including deeper waters of the continental slope and GOM basin. Most GOM seabird species, however, inhabit waters of the continental shelf and adjacent coastal and inshore habitats of the estuarine and neritic ecoregions. The temporal occurrence of seabirds in the GOM varies greatly among species and groups. Some species (e.g., northern gannet [*Morus bassanus*], black tern [*Chlidonias niger*]) may be fairly common in some areas in winter although they breed outside the GOM, while others (e.g., least tern [*Sternula antillarum*]) are most common in summer months when they breed in the GOM. Still other species, such as many of the gulls and other terns and the brown pelican, may be present year round and nest in appropriate habitats in the GOM.

TABLE 3.8.2-2 Marine and Coastal Birds of the Gulf of Mexico

Category	Order	Common Name	Representative Types
Seabirds	Charadriiformes	Gulls and terns Phalaropes	Ring-billed gull, laughing gull, common tern, Caspian tern
	Pelicaniformes	Frigatebirds Pelicans Tropicbirds Gannets and boobies	Magnificent frigatebird, brown pelican, northern gannet
	Procellariiformes	Storm-petrels Shearwaters	Band-rumped storm-petrel, Audubon's shearwater
Shorebirds	Charadriiformes	Plovers Oystercatchers Stilts and avocets Sandpipers, snipes, and allies	Semipalmated plover, American oystercatcher, willet, black-necked stilt
Wetland birds	Ciconiiformes	Bitterns, egrets, and herons Storks Ibises and spoonbills	Great blue heron, snowy egret, wood stork, white ibis
	Gruiformes	Cranes Limkins Rails and coots, and gallinules	Sandhill crane, sora, American coot
	Pelicaniformes	Cormorants	Double-crested cormorant
	Podicipediformes	Grebes	Pied-billed grebe, horned grebe
Waterfowl	Anseriformes	Ducks, geese, and swans	Blue-winged teal, mallard, red-breasted merganser, ring-necked duck, bufflehead, surf scoter
	Gaviiformes	Loons	Common loon
Passerines	Passeriformes	Perching birds	Warblers, swamp sparrow, thrushes, marsh wren, boat-tailed grackle
Raptors	Falconiformes	Birds of prey	Osprey, bald eagle

Shorebirds are represented by a single order and include the plovers, oystercatchers, stilts, avocets, sandpipers, and other similar forms (Table 3.8.2-2). These are typically small wading birds that feed on invertebrates in shallow waters and along beaches, mudflats, sand bars, and other similar areas. Shorebirds may be solitary or occur in small- to moderate-sized single-species flocks, although large aggregations of several species may be encountered, especially during migration. Shorebirds are generally restricted to coastline margins except when migrating, and would not be expected to occur over open waters of the continental shelf, slope, and basin areas of the GOM. Many North American shorebirds seasonally migrate between the high Arctic and South America, passing through the GOM during migration (Lincoln et al. 1998). Certain coastal and adjacent inland GOM wetlands serve as important habitats for overwintering shorebirds, and as temporary feeding and resting habitats for migrating shorebirds (see the later discussion on important bird areas of the GOM).

Overwintering shorebird species remain within specific areas throughout the season and typically utilize the same areas year after year; many of these areas in the northern GOM have been identified important bird areas (for example, ABC 2011; Audubon Society 2011a; see later discussion in this section). Overwintering shorebirds, as well as those that nest in spring and summer in specific areas, may be especially susceptible to habitat loss or degradation unless they move to other suitable habitats (if available) when their habitats are disturbed.

The wetland birds include a diverse array of birds from four orders (Table 3.8.2-2) that typically inhabit most coastal aquatic habitats of the northern GOM, including freshwater swamps and waterways, brackish and saltwater wetlands, and embayments. This group includes the large and small wading birds such as herons, egrets, cranes, rails, and storks, as well as diving birds such as cormorants and grebes. Most wetland birds are year-round residents of GOM coastal areas, with colonial or solitary nesting behaviors. Colonial nesting sites may be used year after year, typically being abandoned only following some sort of major disturbance (such as severe storm damage). Wetland birds feed on primarily fish and invertebrates (Sibley 2000). Similar to the shorebirds, this category may be especially susceptible to habitat loss or degradation unless they move to other suitable habitats when their current habitats are disturbed; colonial nesting habitats would be most difficult to replace.

Waterfowl are a diverse and important group that includes ducks, geese, loons, and swans. More than 30 species have been reported from coastal waters, beaches, flats, sandbars, and wetland habitats throughout the northern GOM (Sibley 2000). These birds forage on surface and submerged aquatic vegetation and aquatic invertebrates. There are three general groups of ducks. The surface-feeding ducks, such as the mallard (*Anas platyrhynchos*) and American widgeon (*A. americana*), use shallow freshwater and saltwater marshes throughout the northern GOM, and many are present throughout the year. In contrast, bay ducks (such as the ring-necked duck [*Aythya collaris*]) are diving ducks that frequent coastal bays and river mouths, typically overwintering in the northern GOM and nesting elsewhere. The sea ducks are diving ducks that occur in marine habitats except during the breeding season. Some species have developed salt glands to aid them in using saltwater habitats. Example species include the bufflehead (*Bucephala albeola*) and Barrow's goldeneye (*B. islandica*). The mergansers are fish-eating diving birds that overwinter in coastal habitats in the GOM. Geese and swans forage on vegetation in coastal lakes, rivers, and marshes and, with the exception of the Canada goose (*Branta canadensis*), they overwinter in the GOM and spend the rest of the year in other areas.

The passerines are perching birds, and include the sparrows, warblers, thrushes, blackbirds, wrens, and many other types of birds (Table 3.8.2-2). While the northern GOM provides suitable habitat and supports a wide diversity of year-round resident passerine species, many species are winter residents that move into the GOM in the fall from farther north to overwinter before returning to breeding areas in more northern latitudes.

Raptors are the birds of prey. While most prey on birds and small mammals in terrestrial habitats, two species are fish eaters and if present may forage in coastal freshwater and saltwater habitats. These species are the bald eagle and the osprey, and they may be found year round in the GOM and nesting in suitable habitats.

3.8.2.1.2 Birds Listed under the Endangered Species Act. The ESA was passed in 1973 to address the decline of fish, wildlife, and plant species in the United States and throughout the world. The purpose of the ESA is to conserve "the ecosystems upon which endangered and threatened species depend" and to conserve and recover listed species (ESA; Section 2). The law is administered by the Department of the Interior's USFWS and the Department of Commerce's NMFS. The USFWS has primary responsibility for terrestrial and freshwater organisms, while the NMFS is responsible primarily for marine species such as salmon and whales.

Under the law, species may be listed as either "endangered" or "threatened." The ESA defines an endangered species as any species that is in danger of extinction throughout all or a significant portion of its range (ESA; Section 3(6)). A threatened species is one that is likely to become an endangered species within the foreseeable future throughout all or a significant part of its range (ESA; Section 3(20)). All species of plants and animals, except pest insects, are eligible for listing as endangered or threatened. The ESA also affords protection to "critical habitat" for threatened and endangered species. Critical habitat is defined as the specific areas within the geographical area occupied by the species at the time it is listed on which are found physical or biological features essential to the conservation of the species and that may require special management considerations or protection (ESA; Section 3(5)(A and B)). Except when designated by the Secretary of the Interior, critical habitat does not include the entire geographical area that can be occupied by the threatened or endangered species (ESA; Section 3(5)(C)).

Some species may also be listed as "candidate" species (ESA; Section 6(d)(1) and Section 4(b)(3)). The USFWS defines candidate species as plants and animals for which the USFWS has sufficient information on their biological status and threats to propose them for listing as endangered or threatened under the ESA, but for which development of a listing regulation is precluded by other higher priority listing activities (USFWS 2001a). The NMFS defines candidate species as those whose status is of concern but about which more information is needed before they can be proposed for listing. Candidate species receive no statutory protection under the ESA, but by definition these species may warrant future protection under the ESA.

Several species of federally endangered, threatened, or candidate species of birds occur in the northern GOM during at least part of the year (Table 3.8.2-3). These include species that use primarily coastal beach and wetland habitats. The threatened or endangered species are the Audubon's crested caracara (*Polyborus plancus audobonii*), the Mississippi sandhill crane, the piping plover (*Charadrius melodus*), the roseate tern (*Sterna dougallii dougallii*), the whooping crane (*Grus americana*), and the wood stork (*Mycteria americana*). A single candidate species, the red knot (*Calidris canutus rufa*), is also reported from coastal habitats along the northern GOM. Among the threatened and endangered species, five are found in habitats within the OCS GOM Planning Areas where they could be affected by OCS oil and gas activities, and four are

TABLE 3.8.2-3 Species Listed as Endangered, Threatened, or Candidate under the Endangered Species Act That May Occur in Coastal or Marine Habitats of the Northern Gulf of Mexico

Species	Status	FL	AL	MS	LA	TX
Audubon's Crested Caracara	T	+	–	–	–	–
Mississippi Sandhill Crane	E	–	–	+	–	–
Piping Plover	T/E	+	+	+	+	+
Red Knot	C	+	+	+	+	+
Roseate Tern	T	+	–	–	–	–
Whooping Crane	E	–[a]	–	–	–[a]	+
Wood Stork	E	+	+	–	–	–

[a] Reintroduced as non-essential experimental population (USFWS 2011c).

Source: USFWS 2011d.

reported from Florida (two species are exclusive to Florida) in areas where they could be affected by a catastrophic oil spill but not by normal OCS oil and gas operations.

The Audubon's crested caracara is a large, diurnal raptor that is primarily associated with open country (pastureland, cultivated fields, and semidesert) but has been reported from coastal lowlands and beaches in some areas (USFWS 1999b). Nesting occurs in trees or cacti where possible, but crested caracaras will also nest on rock ledges or in brush in treeless areas. Crested caracaras commonly feed on roadkill and are often associated with vultures (USFWS 1999b). This species is currently listed as threatened for populations found in six coastal counties in Florida and has also been reported from coastal counties in Texas and Louisiana (USFWS 2011d; Figure 3.8.2-1). Because of its habitat preferences, this species is not expected to occur in areas where it could be affected by shore-based OCS-related oil and gas activities. In the event of an oil spill contacting coastlines in these counties, this species could be affected, if present.

The endangered Mississippi sandhill crane is a long-necked, long-legged wading bird that stands about 1.2 m (4 ft) tall. Habitats for this species include open savannas, swamp edges, young pine plantations, and wetlands along pine forests (NatureServe 2011a). Nesting territories are occupied year after year (NatureServe 2011a). It feeds on aquatic invertebrates, reptiles, amphibians, insects, and aquatic plants, picking food items from the ground surface or probing into the substrate. The only known wild population (about 120 individuals) occurs on or near the Mississippi Sandhill Crane Wildlife Refuge in Jackson County, Mississippi (Figure 3.8.2-1). Major reasons for the decline of this species include habitat loss, human predation, and human disturbance (USFWS 1991b).

The roseate tern is a seabird that commonly ventures into oceanic waters; however, its western Atlantic population is known to occur in the far southeastern GOM to breed in scattered colonies along the Florida Keys (NatureServe 2011a; Saliva 1993; USFWS 2011d). This species

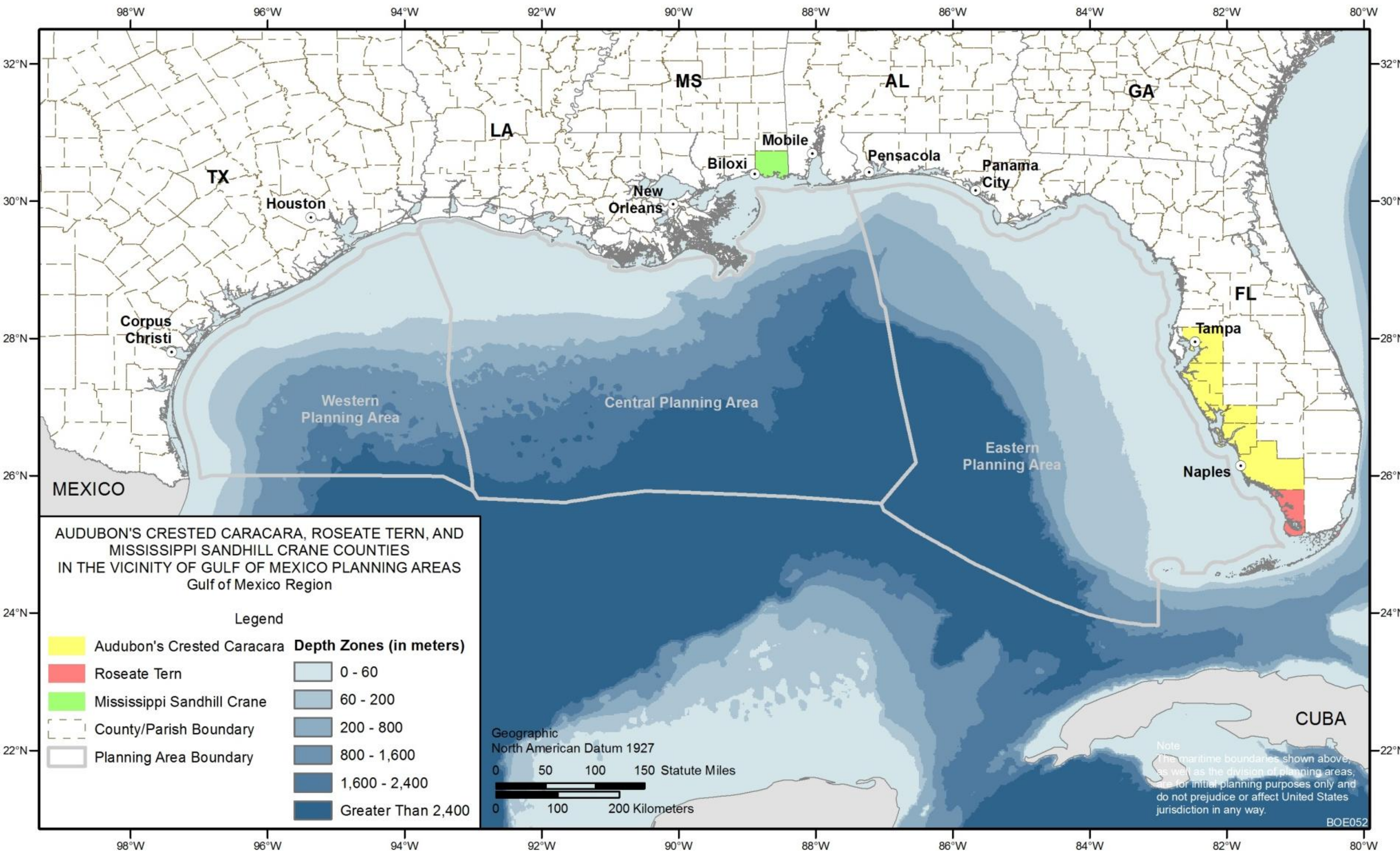

FIGURE 3.8.2-1 Coastal Counties from Which the Federally Endangered Mississippi Sandhill Crane and Roseate Tern, and the Federally Threatened Audubon's Crested Caracara, Have Been Reported (USFWS 2011d)

nests in colonies on isolated islands, rubble islets, dredge-spoil, and rooftops in southern Florida. Feeding roseates hover over schools of fish and plunge-dive to seize the fish (USFWS 2012b). It is currently listed as endangered for populations along the U.S. Atlantic Coast from Maine to North Carolina, Canada, and Bermuda; it is listed as threatened in Florida, Puerto Rico, the Virgin Islands, and the remaining western hemisphere and adjacent oceans. Historically, this species ranged along the Atlantic temperate coast south to North Carolina; in Newfoundland, Nova Scotia, and Quebec, Canada; and in Bermuda (USFWS 2011d). In the northern GOM, this species has only been reported from Monroe County at the extreme southwest tip of Florida (Figure 3.8.2-1).

The piping plover is a shorebird that inhabits coastal sandy beaches and mudflats. This species nests in sand depressions lined with pebbles, shells, or driftwood. Piping plovers forage for various small invertebrates along ocean beaches, on intertidal flats, and along tidal pool edges (NatureServe 2011a). This species is currently in decline and listed as endangered in the Great Lakes watershed (breeding range of the Great Lakes population of this species) and as threatened in the remainder of its range. It is listed as a result of historic hunting pressure, and loss and degradation of habitat. The threatened piping plover is reported from coastal counties in each of the GOM States except Mississippi, and the endangered piping plover is reported from coastal counties of Mississippi (USFWS 2011d). Critical wintering habitat has been designated in each of the GOM Coast States for all three populations (Atlantic, Great Lakes, and Great Plains) of the piping plover (66 FR 36038–36143) (Figure 3.8.2-2).

The whooping crane is a wetland species that nests within western Canada and the north-central United States, and overwinters on salt flats and wetland habitats along the Aransas National Wildlife Refuge on the Texas Coast. During the winter, whooping cranes forage for blue crabs, clams, and wolfberry (USFWS 2011d). It is currently listed as endangered over its entire range, except where listed as an experimental population (Figure 3.8.2-3). Three populations occurring in four of the GOM States (AL, FL, LA, MS) are designated as nonessential experimental. It is endangered because of historic hunting pressure and habitat loss and degradation. Critical habitat has been designated for this species in the GOM along the Texas coast (including Aransas National Wildlife Refuge) (43 FR 20938–20942).

The red knot is the only candidate bird species currently identified as occurring in the northern GOM. This highly migratory species travels between nesting habitats in mid- and high-Arctic latitudes and southern non-breeding habitats in South America and portions of North America (southern Atlantic and GOM coasts). Its population has exhibited a large decline in recent decades, and is now estimated in the low ten thousands (NatureServe 2011a). Red knots forage along sandy beaches, tidal mudflats, salt marshes, and peat banks for bivalves, gastropods, and crustaceans (USFWS 2011i). Horseshoe crab eggs are a critical food resource for this species, and it is believed that overharvest and population declines of horseshoe crabs may be a major reason for the decline of red knot numbers. Within the northern GOM, this species has been reported from coastal counties in each of the GOM States (USFWS 2012a) (Figure 3.8.2-3). In the event of an oil spill contacting coastlines in these counties, this species could be affected, if present.

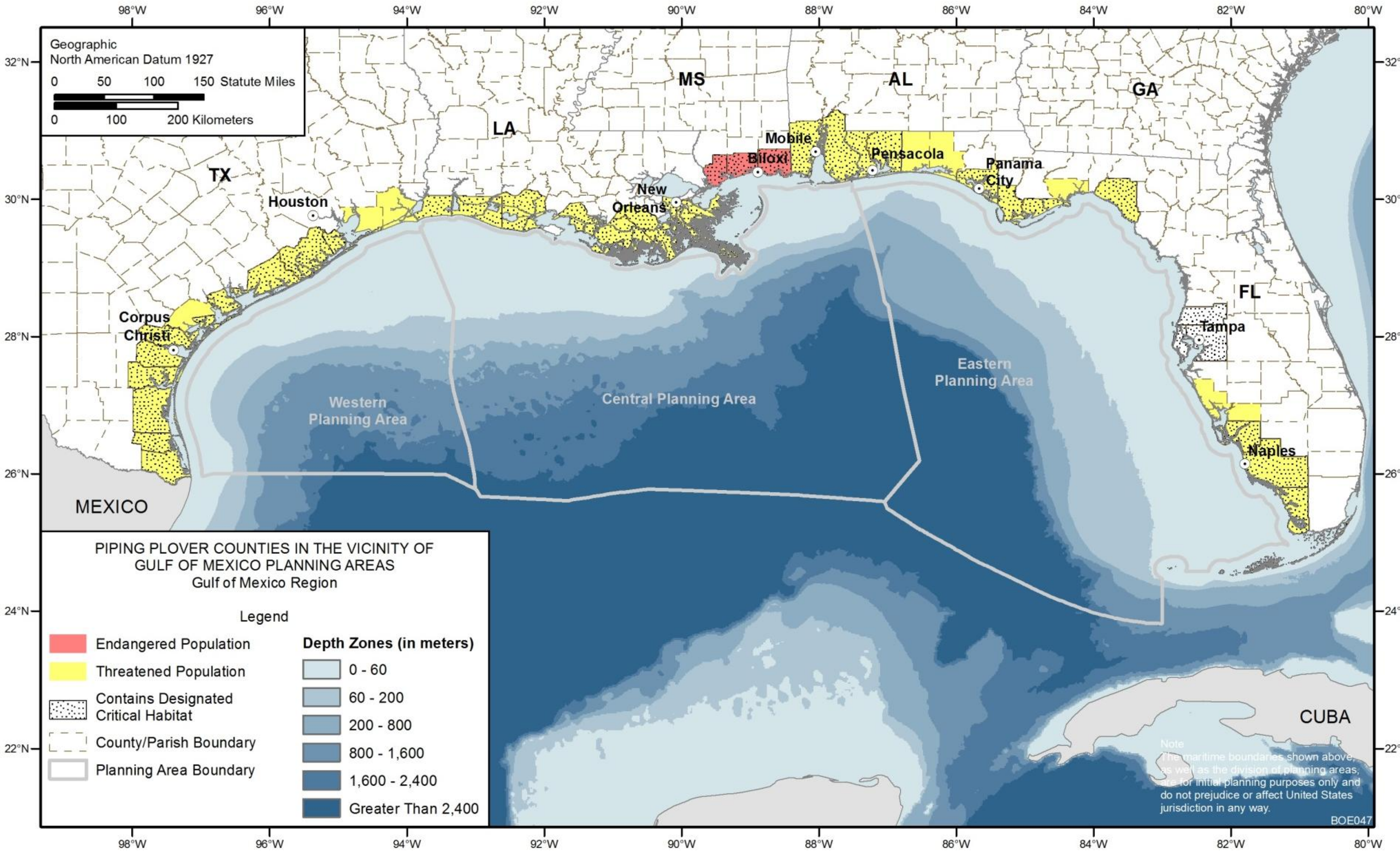

FIGURE 3.8.2-2 Coastal Counties from Which the Federally Threatened and Endangered Populations of Piping Plover Have Been Reported (USFWS 2011d)

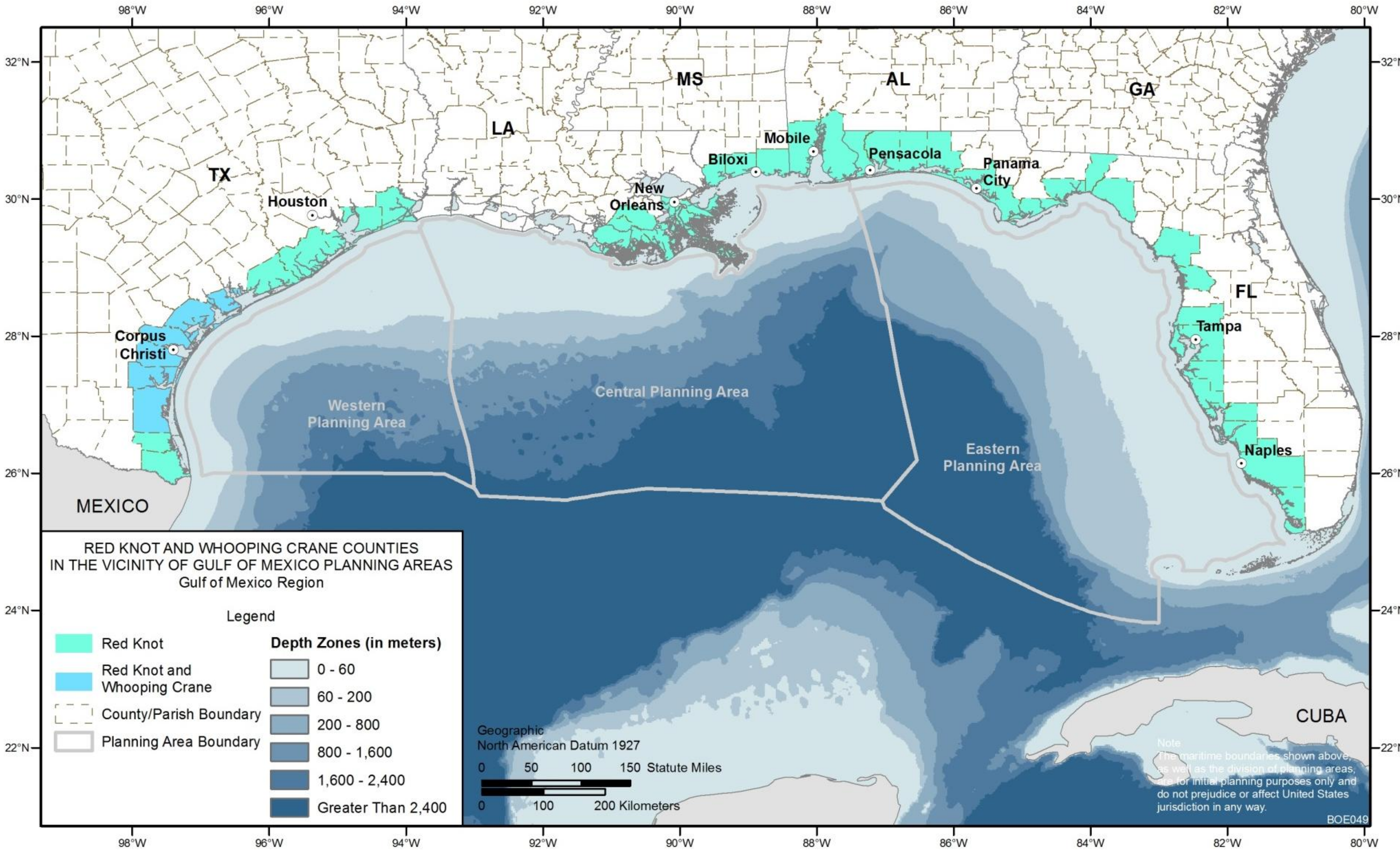

FIGURE 3.8.2-3 Coastal Counties from Which the Federally Endangered Whooping Crane and the Federal Candidate Red Knot Have Been Reported (USFWS 2011d)

The wood stork is the only stork that regularly occurs in North America. The published range of this wading bird is Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina, where this species is classified as endangered (USFWS 2011d). While a year-round resident of Florida and Georgia, the wood stork does occur in other GOM coast States (Figure 3.8.2-4). A non-endangered population of wood stork migrates north from Mexico after breeding and can be found in Texas and Louisiana (USFWS 2011d). Wood storks frequent freshwater and brackish coastal wetland habitats. This species nests mostly in upper parts of cypress trees, mangroves, or dead hardwoods over water or along streams or shallow lakes. No critical habitat has been designated for this species. Wood storks forage in shallow water and flooded fields for mainly small fish (NatureServe 2011a).

3.8.2.1.3 Migratory Birds. The GOM is an important pathway for migratory birds, including many coastal and marine species and large numbers of terrestrial species (Lincoln et al. 1998; USGS 2005). Most of the migrant birds (especially passerines or perching birds) that overwinter in the neotropics (tropical south Florida, Mexico, the Caribbean, Central America, and South America) and breed in eastern North America either directly cross the GOM (trans-GOM migration) or move north or south by traversing the GOM or the Florida peninsula (Figure 3.8.2-5) (Lincoln et al. 1998; Russell 2005).

Birds migrate in large, broad fronts that at times may number 2 million birds or more (USGS 2005). During the migration seasons, nearly all of the migratory birds of the eastern United States, as well as many western species, use the coastal plains of the northern GOM. Florida migrants then remain in place, cross to the Bahamas Archipelago, or travel directly across the Florida Straits and into the Antilles (Lincoln et al. 1998). Recent studies indicate that the flight pathways of the majority of the trans-GOM migrant birds during spring are directed toward the coastlines of Louisiana and eastern Texas (Morrison 2006). As many as 300 million birds may cross the GOM each spring (Russell 2005). During overwater flights, migrant birds (other than seabirds) sometimes use offshore structures, such as oil and gas production platforms, for rest stops or as temporary shelter from inclement weather. Spring migrants fly northward across the GOM, arrive on coastal habitats (especially those in Louisiana) with depleted energy reserves, and use those habitats for resting and rebuilding energy reserves. In the fall, migrants use food resources in the coastal habitats to build up energy reserves for migration southward either directly across the open waters of the GOM or along the GOM coast to Mexico and beyond.

3.8.2.1.4 Important Bird Areas. The northern GOM coast provides a diverse range of habitats that support the many migratory and resident bird species of the area. These habitats include coastal wetlands and marshes, mud flats, and beaches, which may be used for nesting, foraging, and for some species staging areas during spring and fall migration. While these habitats occur along the entire northern GOM coastline, some coastal areas may be especially important to birds living along or using the northern GOM, and it is areas such as these that, if impacted by oil and gas activities or accidental oil spills, could impact local or regional populations of the species relying on the affected habitats provided. Some of these areas are

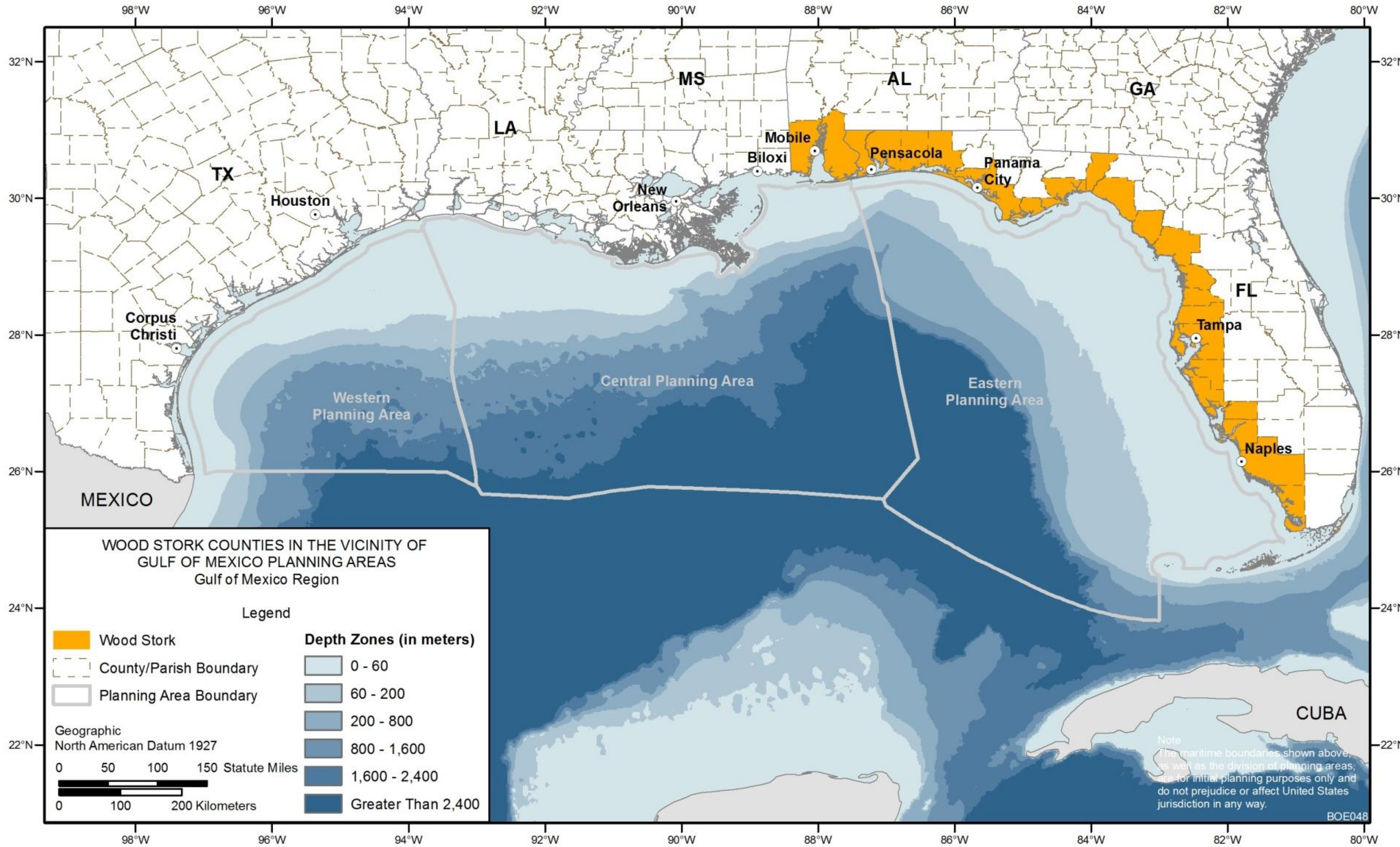

FIGURE 3.8.2-4 Coastal Counties from Which the Federally Endangered Wood Stork Has Been Reported (USFWS 2011d)

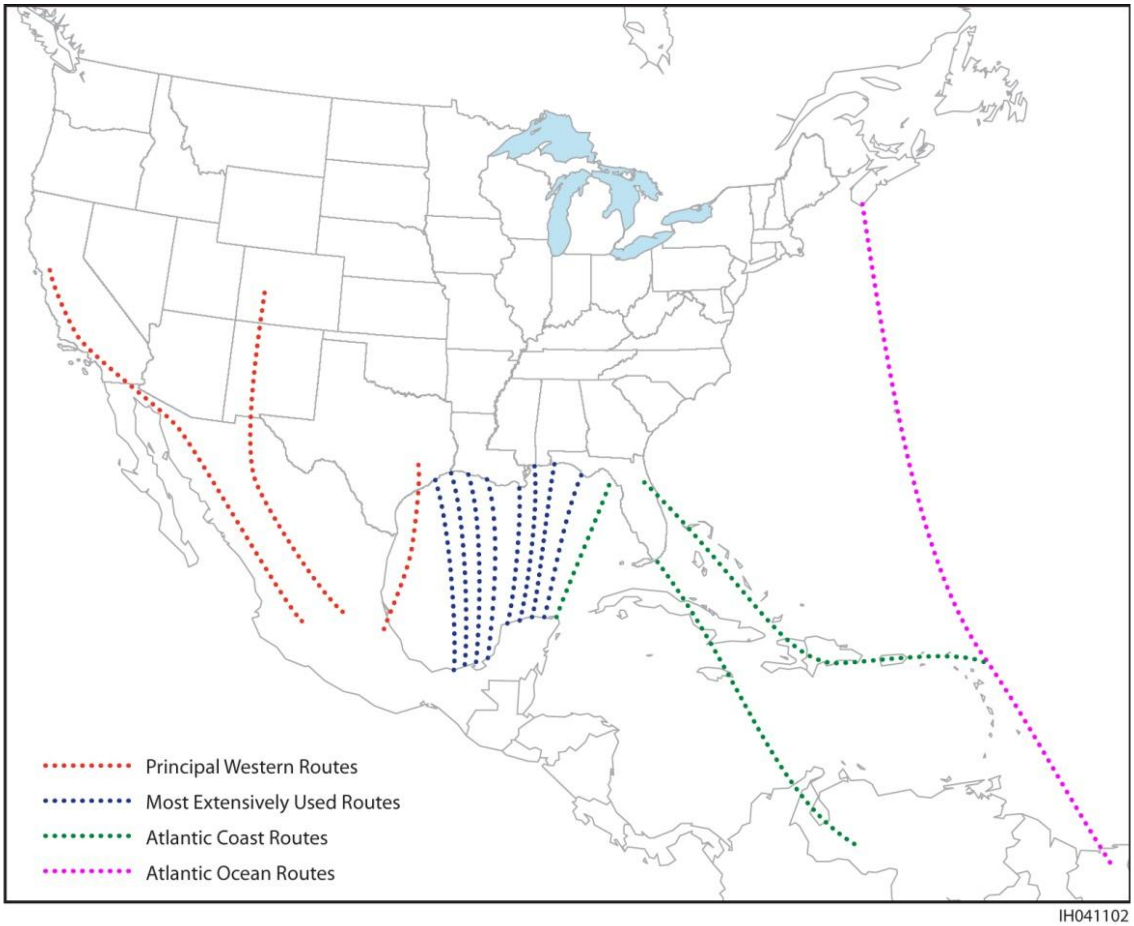

FIGURE 3.8.2-5 Primary Migration Routes Used by Birds in Passing from North America to Winter Quarters in the West Indies, Central America, and South America (The routes crossing the Gulf of Mexico are those most extensively used by birds and are also used by many species returning to North America in spring; specific routes taken by migrating birds may vary within and between years, depending on local and regional weather conditions, including storms and prevailing winds.) (Lincoln et al. 1998)

protected by Federal or State regulations (e.g., National Wildlife Refuges and National Parks), while others may have no legal protection.

Since its start in Europe in the 1980s, the Important Bird Area (IBA) concept has led to the identification and protection of some 3,500 sites worldwide that are considered as exceptionally important, even essential, for bird conservation (ABC 2011). Both the American Bird Conservancy (ABC) and the Audubon Society have identified a number of IBAs along the northern GOM coast (ABC 2011; Audubon Society 2011a). These IBAs are not afforded regulatory protection unless they occur on protected Federal (such as USFWS National Wildlife Refuges) or State lands or include ESA-designated critical habitat.

The ABC has identified 37 important bird areas in coastal counties along the northern GOM coast (Figure 3.8.2-6). Many of these sites include national wildlife refuges, national parks, national forests, State lands, conservation organization lands, and even some private lands. To be included, a site must, during at least some portion of the year, contain habitat that supports:

1. A significant population of a threatened or endangered species;

2. A significant population of a U.S. Watch List species;

3. A significant population of a species with a limited range; or

4. A significantly large concentration of breeding, migrating, or wintering birds, including waterfowl, seabirds, wading birds, raptors, or land birds (ABC 2011).

The IBAs along the northern GOM include 17 areas in Texas, 9 in Florida, 5 in Louisiana, and 3 each in Alabama and Mississippi (Table 3.8.2-4). This list is not all-inclusive and focuses only on those IBAs in coastal counties. Because these areas are located in coastal areas and, in some cases, are islands and seashores, they have a greater likelihood of interacting with OCS oil and gas activities in the GOM.

The Audubon Society has identified 52 IBAs for the northern GOM coast (Audubon Society 2011a). These include 8 sites in Texas, 6 in Louisiana, 7 in Mississippi, 4 in Alabama, and 27 in Florida; and only 7 of the Audubon IBA sites overlap with the ABC sites (Figure 3.8.2-7; Table 3.8.2-5).

Some of these IBAs are associated with specific, individual species. For example, the Aransas National Wildlife Refuge in Texas was established in 1937 as a refuge and breeding ground for migratory birds, and hosts the largest wild flock of endangered whooping cranes each winter. Similarly, the Gulf Coast Least Tern Colony Globally Important Bird Area in Mississippi supports the largest colony of the least tern.

Other sites provide important overwintering habitat for federally threatened piping plover, or provides foraging and resting habitat for large variety of waterfowl, shorebirds, wading birds, and migrating passerines. For example, Dauphin Island in Alabama is one of the few known breeding localities for snowy plover (*Charadrius alexandrines*), mottled duck (*Anas fulvigula*), and seaside sparrow (*Ammodramus maritimus*) (Audubon Society 2011b).

3.8.2.1.5 Climate Change and Gulf of Mexico Birds. Climate change effects are occurring on all continents and oceans, with atmospheric and ocean warming being observed in many locations (see climate change discussions presented in Section 3.3). Environmental responses in the GOM Planning Areas include climate change-related sea level rise, changes in precipitation and temperature patterns, changes in storm intensity, and potential for high erosion of GOM coasts (Woodrey et al. 2012).

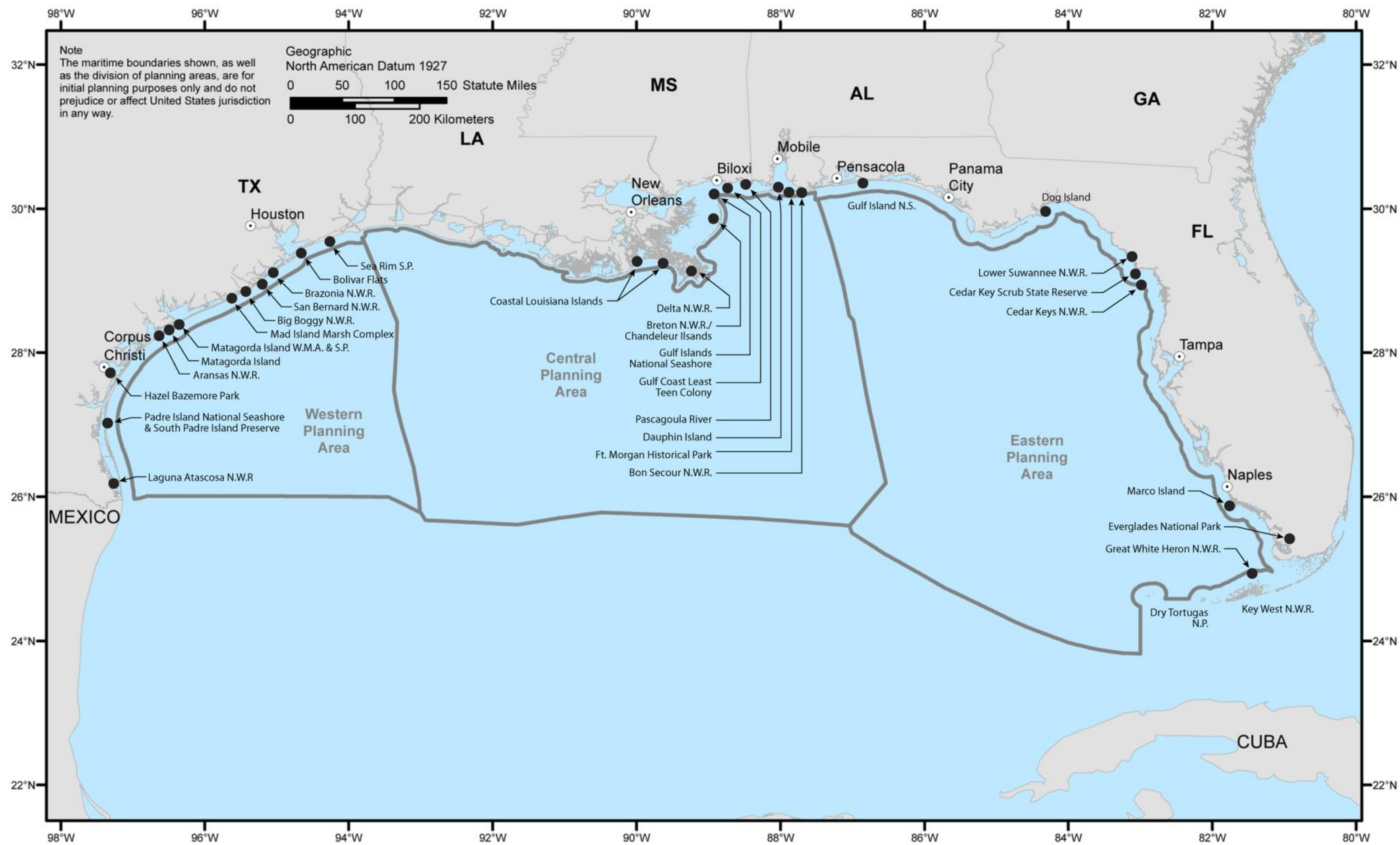

FIGURE 3.8.2-6 Important Bird Areas along the Northern Coast of the Gulf of Mexico (ABC 2011)

TABLE 3.8.2-4 Important Bird Areas Identified by the American Bird Conservancy for the Coastal Counties of the Northern Gulf of Mexico

State	Important Bird Area	County
Texas	Aransas National Wildlife Refuge	Aransas
	Columbia Bottomlands	Brazoria
	San Bernard National Wildlife Refuge	Brazoria
	Matagorda Island	Calhoun
	Laguna Atascosa National Wildlife Refuge	Cameron
	South Padre Island Preserve	Cameron
	Anahuac National Wildlife Refuge	Chambers
	Smith Point	Chambers
	High Island	Galveston
	McFadden National Wildlife Refuge	Jefferson
	Texas Point National Wildlife Refuge	Jefferson
	Sea Rim State Park	Jefferson
	Kings Ranch	Kenedy, Kleberg, Neuces, Willacy
	Padre Island National Seashore	Kenedy, Kleberg, Willacy
	Big Boggy National Wildlife Refuge	Matagorda
	Mad Island Marsh Wildlife Complex	Matagorda
	Hazel Bazemore County Park	Neuces
Louisiana	Breton National Wildlife Refuge	St. Bernard
	Catahoula National Wildlife Refuge	LaSalle
	Delta National Wildlife Refuge	Plaquemines
	Coastal Louisiana Islands	Cameron, Vermillion, Iberia, St. Mary, Terrebonne, LaFourche, Jefferson, Plaquemines, St. Bernard
Mississippi	Gulf Coast Least Tern Colony	Harrison
	Gulf Islands National Seashore[a]	Harrison, Jackson
	Mississippi Sandhill Crane National Wildlife Refuge	Jackson
Alabama	Bon Secour National Wildlife Refuge[a]	Baldwin
	Dauphin Island[a]	Mobile
	Fort Morgan Historical Park	Baldwin
Florida	Apalachicola National Forest	Wakulla, Franklin
	Cedar Key Scrub State Reserve	Levy
	Cedar Keys National Wildlife Refuge	Levy
	Dog Island[a]	Franklin
	Elgin Air Force Base[a]	Okaloosa
	Gulf Islands National Seashore[a]	Escambia, Santa Rosa
	Honeymoon Island State Recreation Area	Pinellas
	Ochlockonee River State Park	Franklin
	St. Marks National Wildlife Refuge[a]	Wakulla

[a] Also identified as an IBA by the Audubon Society; see Table 3.8.2-5.

Source: ABC 2011.

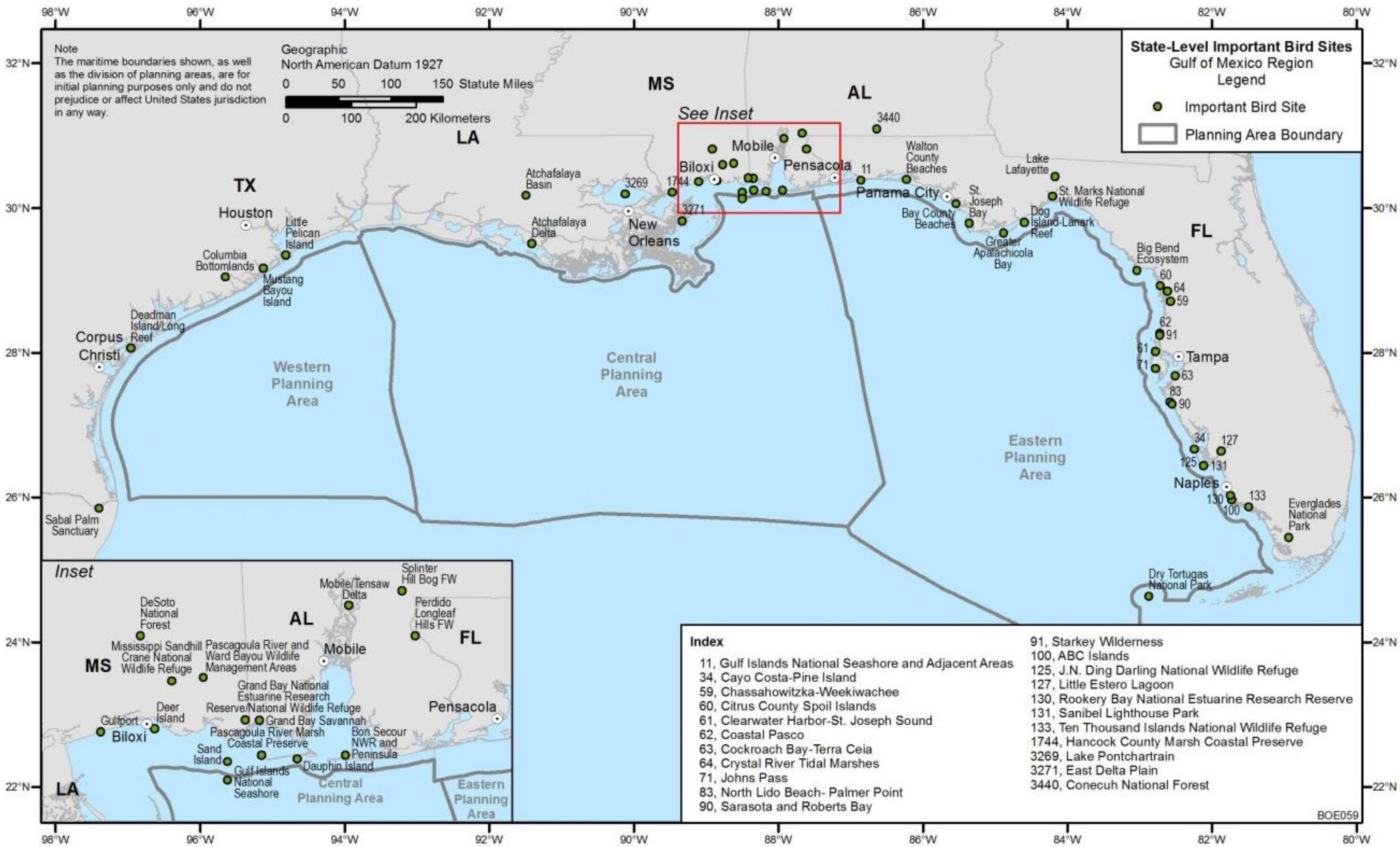

FIGURE 3.8.2-7 Important Bird Areas Identified by the Audubon Society for the Northern Coast of the Gulf of Mexico (Audubon Society 2011a)

TABLE 3.8.2-5 Important Birds Areas Identified by the Audubon Society for the Coastal Counties of the Northern Gulf of Mexico

State	Important Bird Area	County
Texas	Deadman Island/Long Reef	Aransas
	Islands South of South Bird Island	
	Little Pelican Island	Galveston
	Mustang Bayou Island	Brazonia
	Pelican Island	
	Port Bolivar Bird Sanctuaries-Horseshoe Marsh	
	Second Chain of Islands	
	Shamrock Island	
Louisiana	Active Delta (Mississippi River Birdsfoot Delta)	Plaquemines
	Atchafalaya Delta	Assumption, St. Mary, Terrebonne
	Barataria Terrebonne	Assumption, Jefferson, LaFrouche, Plaquemines, St. Charles, St. James, St. John the Baptist, St. Mary, Terrebonne
	Chenier Plain	Calcasieu, Cameron, Iberia, Jefferson Davis, St. Mary, Vermillion
	East Delta Plain	Orleans, Plaquemines, St. Bernard, St. Tammany
	Isles Dernieres-Timbalier Islands	Terrebonne
Mississippi	Deer Island	Harrison
	Grand Bay National Estuarine Research Reserve/National Wildlife Refuge	Jackson
	Gulf Islands National Seashore[a]	Harrison, Jackson
	Gulfport	Harrison
	Hancock County Marsh Coastal Preserve	Hancock
	Pascagoula River Marsh Coastal Preserve	Jackson
	Sand Island	Jackson
Alabama	Bon Secour National Wildlife Refuge[a] and Peninsula	Baldwin
	Dauphin Island[a]	Mobile
	Grand Bay Savannah	Mobile
	Mobile/Tensaw Delta	Baldwin, Mobile
Florida	ABC Islands	Collier
	Bay County Beaches	Bay
	Big Bend Ecosystem	Dixie, Levy, Taylor
	Cayo Costa-Pine Island	Lee
	Chassahowitzka-Weekiwachee	Citrus, Hernando, Pasco
	Citrus County Spoil Islands	Citrus
	Clearwater Harbor-St. Joseph Sound	Pinellas
	Coastal Pasco	Pasco
	Cockroach Bay-Terra Ceia	Manatee, Hillsborough
	Crystal River Tidal Marshes	Citrus
	Dog Island[a] -Lanark Reef	Franklin

TABLE 3.8.2-5 (Cont.)

State	Important Bird Area	County
Florida (Cont.)	Dry Tortugas National Park	Monroe
	Elgin Air Force Base[a]	Okaloosa
	Great White Heron National Wildlife Refuge	Monroe
	Gulf Islands National Seashore[a] and Adjacent Areas	Escambia, Santa Rosa
	J.N. Ding Darling National Wildlife Refuge	Lee
	Johns Pass	Pinellas
	Little Estero Lagoon	Lee
	North Lido Beach-Palmer Point	Sarasota
	Oscar Scherer State Park	Sarasota
	Pelican Shoal	Monroe
	Rookery Bay National Estuarine Research Reserve	Collier
	Sanibel Lighthouse Park	Lee
	Sarasota and Roberts Bay	Manatee, Sarasota
	St. Joseph Bay	Gulf
	St. Marks National Wildlife Refuge[a]	Jefferson, Wakulla, Taylor
	Starkey Wilderness	Pasco
	Ten Thousand Islands National Wildlife Refuge	Collier
	Walton County Beaches	Walton

[a] Also identified as an IBA by the ABC; see Table 3.8.2-4.

Source: Audubon Society 2011a.

Climate change in the GOM may be expected to result in short-term and long-term effects on marine and coastal birds of the region. These effects may be beneficial or detrimental in nature and could result in population-level effects on marine and coastal birds (NABCI 2010). Which species may be most affected and how they may respond to climate change over several decades are unknown.

Climate change may have a variety of adverse effects on marine and coastal birds of the GOM planning areas, with potential impacts mostly associated with loss of food and habitat. Increased water temperature and ocean acidification may affect invertebrate community distribution in terms of both species composition and total productivity. Invertebrates in nearshore areas are expected to experience the greatest hydrologic changes (see discussion of climate change impacts on aquatic invertebrates in Section 3.8.5.1). Changes in this prey base could affect shorebirds and waterfowl that forage on these invertebrates during nesting, staging, and migrating (Galbraith et al. 2002; Moller et al. 2008; NABCI 2010). Hatchling success of coastal nesting shorebirds may decline if hatch dates do not match patterns in the availability of food resources. Migrating shorebirds that stop over in the GOM to feed in coastal areas may not be able to gain the body weight necessary to reach their breeding grounds if the abundance of invertebrates is reduced (NABCI 2010).

Increased precipitation in the Mississippi River Basin due to climate change has been predicted to increase river discharge by 20%. This increased discharge is expected to increase the average extent of hypoxia on the northern GOM shelf (Howard 2012). These hypoxic conditions may affect prey availability for migratory and resident birds in the GOM planning areas.

Recent climate change projections suggest the global sea level will rise by 0.8–2.0 m (2.6–6.6 ft) by 2100 due to climate change (IPCC 2007a). The GOM has experienced some of the highest rates of sea level rise in the United States. Rising sea levels are expected to fragment or flood low-lying habitats such as salt marshes, sandy beaches, barrier islands, and mudflats (NABCI 2010). Sea level rise may reduce coastal wetland area, alter near-shore depth distributions, change estuarine/river interactions, and alter plant community composition. These habitat changes may contribute to enhanced competition among coastal bird species as foraging and habitat resources are reduced (Woodrey et al. 2012).

Climate change is expected to increase the intensity and frequency of tropical storms. The expected increase in sea level combined with tropical storm changes may lead to storm surges extending farther inland (Woodrey et al. 2012). This could potentially affect inland bird populations and habitats. Erosion and flooding are expected to increase as a result of more frequent severe storms, especially in the GOM, where coastal landforms are dominated by barrier islands, marshes, and deltas, which are easily eroded (Woodrey et al. 2012). High-intensity storms may degrade habitat and affect food resources for bird species, as well as cause direct mortality (O'Connell and Nyman 2011).

3.8.2.1.6 Effect of the Deepwater Horizon Event on Marine and Coastal Birds. With the exception of the passerines, most of the bird groups that occur in the northern GOM are associated with aquatic habitats, whether coastal and estuarine shorelines, wetlands, mudflats, and beaches, or open water areas such as bays and marine waters on the OCS. The DWH event resulted in the release of oil in the open waters of the OCS, with some of this oil moving to the coast and contacting coastal and shoreline habitats, and marine and coastal birds were exposed to the oil in affected coastal and open water habitats. The USFWS, as part of a multi-agency response to the DWH event, began reporting of oiled and dead birds, and established a program to provide accurate data regarding not only oiled and dead birds but also marine mammals and sea turtles (USFWS 2011e). Observations of direct exposure of birds included signs of visible oiling of feathers and other body surfaces. Indirect exposure through ingestion of oil or of food items contaminated with oil is expected to have occurred as well. In addition, the shoreline cleanup efforts of the DWH event may have disturbed nesting populations and degraded or destroyed habitat in some localized areas.

Table 3.8.2-6 presents a summary of the most recent DWH event bird impact data collected by the USFWS (USFWS 2011e). Over 6,600 individuals representing at least 129 bird taxa had been collected in the DWH event potential impact area as of May 12, 2011. Birds were reported as dead or alive in one of three categories: visibly oiled from the DWH event, visibly oiled from an undetermined source; and not visibly oiled. Of the birds most closely associated with aquatic habitats, seabirds represented the majority (79–90%) of birds reported for any of these categories, followed by wetland birds (5–10%) and shorebirds (3–7%), with laughing gulls

TABLE 3.8.2-6 Deepwater Horizon Event Bird Impact Data through May 12, 2011

Avian Category	No. of Taxa	Visibly Oiled; Attributed to DWH Event			Not Visibly Oiled			Visibly Oiled; Unknown Source			Grand Total
		Dead[a]	Live	Total	Dead	Live	Total	Dead	Live	Total	
Seabirds	32	1,822	480	2,302	2,324	0	2,324	654	271	925	5,551
Shorebirds	16	70	8	78	205	2	207	52	10	62	347
Wetland Birds	28	118	19	137	249	0	249	88	29	117	503
Waterfowl	14	9	3	12	34	0	34	10	8	18	64
Passerines	30	17	3	20	54	0	54	17	20	37	111
Raptors	9	2	1	3	15	0	15	4	3	7	25
Total	129	2,038	514	2,552	2,881	2	2,883	827	341	1,168	6,603

[a] Includes birds that were recovered live but subsequently died.

Source: USFWS 2011e.

representing 41% of all birds reported. In contrast, relatively few waterfowl (≤1%), passerines (≤3%), and raptors (<1%) were collected.

Birds that are heavily oiled usually do not survive. Oiled birds that do not perish shortly after oiling may experience more chronic physiological effects of oil exposure. Birds exposed through the ingestion of oil during feeding or grooming, or through inhalation, may also incur chronic, sublethal physiological effects. For example, ducklings fed crude oil for 8 weeks failed to develop normal flight feathers and exhibited symptoms of stress, such as a decrease in spleen weight and an increase in liver weight (Szaro et al. 1978). Adult ducks exhibited reduced body weight initially, but returned to a normal growth rate later in the study period (Patton and Dieter 1980). Hens fed crude oil exhibited a reduction in oviduct weight and a reduction in the number of eggs laid, but eggs of treated hens hatched as well as controls (Coon and Dieter 1981). Both weathered crude oil and oil dispersants applied to fertilized mallard duck eggs resulted in decreased hatching success, but the weathered oil was considerably less toxic than fresh crude oil (Finch et al. 2011; Wooten et al. 2011). Post-DWH event exposure may occur in habitats and media where oil in an unweathered toxic form may remain indefinitely. Chronic effects may not yet be evident, but may become realized at a later date. It is not known how sublethal exposure to oil from the DWH event may have affected marine and coastal birds of the GOM; any such effects may not be realized for several years. The impacts of DWH on marine and coastal birds of the GOM are still being studied, but this information is not needed at the programmatic stage to make a reasoned choice among alternatives (see Section 1.4.2, Incomplete and Unavailable Information).

3.8.2.2 Marine and Coastal Birds of Alaska – Cook Inlet

More than 492 naturally occurring species in 64 families and 20 orders have been identified in Alaska (University of Alaska 2011), and 237 species have been recorded in the Kodiak Island Archipelago (MacIntosh 1998). Birds traveling to and from breeding areas in interior Alaska, the North Slope, and west coast areas of Alaska use Cook Inlet during these movements. Annual use patterns of the Cook Inlet are characterized by the sudden and rapid occurrence of very large numbers of birds in early May followed by an abrupt departure in mid-to-late May; surveys conducted at this time have had counts of 150,000 birds or more per day (Gill and Tibbitts 1999).

3.8.2.2.1 Nonendangered Species. Representatives of six major groups of birds occur in the Cook Inlet Planning Area (Table 3.8.2-7). Among these groups, three may have the greatest potential for being affected by oil and gas leasing and development: (1) seabirds, which occur in open ocean waters; (2) waterfowl, which utilize a variety of freshwater and nearshore marine habitats; and (3) shorebirds, which utilize shoreline habitats throughout the planning area. Many of these species are migratory and may seasonally occur in locally large concentrations such as nesting colonies or as mobile flocks.

TABLE 3.8.2-7 Major Groups of Marine and Coastal Birds of the Cook Inlet Planning Area

Category	Order	Common Name	Representative Types
Seabirds	Charadriiformes	Gulls Terns Phalaropes Alcids	Mew gull, glaucius-winged gull, Arctic tern, red-necked phalarope, common murre, pidgeon guillomot, ancient murrelet
	Procellariiformes	Storm-petrels Shearwaters Albatrosses	Fork-tailed storm-petrel, northern fulmer, short-tailed albatross
Shorebirds	Charadriiformes	Jaegers Plovers Oystercatchers Sandpipers, snipes, and allies	Parasitic jaeger, black-bellied plover, black oystercatcher, dunlin, western sandpiper
Wetland birds	Gruiformes	Cranes	Sandhill crane
	Pelicaniformes	Cormorants	Double-crested cormorant
	Podicipediformes	Grebes	Horned grebe
Waterfowl	Anseriformes	Ducks, geese, and swans	Trumpeter swan, mallard, greater scaup, common goldeneye, harlequin duck
	Gaviiformes	Loons	Pacific loon, common loon
Passerines	Passeriformes	Perching birds	Warblers, boreal chickadee, American pipet, common redpoll
Raptors	Falconiformes	Birds-of-prey	Osprey, bald eagle

In the summer, seabirds and sea ducks are found along the coastlines of Cook Inlet. Colonial seabirds, except for gulls and terns, are mostly confined to the lower portions of the inlet where foraging areas are more abundant (Nature Conservancy 2003). The intertidal habitats of Cook Inlet are used by millions of shorebirds (such as western sandpipers [*Calidris mauri*] and dunlin [*C. alpine*]) during spring migration, and several species breed in the planning area. In the summer, Cook Inlet provides breeding habitat for migratory waterfowl, and during fall migration the inlet may be used by as many as 1 million migrating waterfowl. Waterfowl are valued as subsistence resources, and they also provide a sport-hunting resource. In contrast to conditions that lead to large numbers of birds being present in spring, summer, and fall, ice conditions limit overwinter use of the upper portions of the inlet by birds.

A number of large seabird colonies (i.e., ranging from 20,000 to multiple hundreds of thousands of individuals) occur in the subregion, including on the Chisik and Gull Islands in Cook Inlet, the Barren Islands south of Cook Inlet, and the Kodiak Island group (Stephensen and Irons 2003). Many smaller colonies, whose aggregate population represents a substantial concentration of seabirds, also occur in these areas.

The factors most responsible for the status of bird populations in the Cook Inlet Planning Area are associated with the availability and quality of wintering, migratory, and nesting habitats and the availability of food in those habitats. Changes in breeding habitat availability or quality and food resources during breeding could affect egg production and nesting success.

Bird density and diversity is lowest in winter. Typically, only a single species of shorebird, the rock sandpiper (*Calidris ptilocnemis*), remains through the winter in upper Cook Inlet, although some black turnstones (*Arenaria melanocephala*) and dunlins also may stay. The approximately 20,000 individuals may represent the entire Bering Sea breeding population of the rock sandpiper (Gill and Tibbitts 1999; Gill et al. 2002). The Kodiak area is also an important wintering ground for several species of waterfowl and seabirds (Forsell and Gould 1981; Larned and Zwiefelhofer 2001), including cormorants, scoters, long-tailed ducks (*Clangula hyemalis*), eiders, common murres (*Uria aalge*), murrelets, and crested auklets (*Aethia cristatella*). Winter bird counts in the area are among the highest in Alaska, with more than 1.5 million seabirds overwintering in nearshore waters surrounding Kodiak Island (USFWS 2011h). Emperor geese winter from the Aleutians to Kodiak. Lower Cook Inlet also is relatively important for overwintering waterfowl, murres, fulmars, and storm-petrels (Agler et al. 1995).

3.8.2.2.2 Birds Listed under the Endangered Species Act. Several species of federally endangered, threatened, or candidate species (see Section 3.8.2.1.2 for a discussion of the ESA and definitions of these categories) occur in the Cook Inlet Planning Area. These species are the federally endangered short-tailed albatross (*Phobastria albatrus*) and the federally threatened Steller's eider (*Polysticta stelleri*). Two candidate species, and Kittlitz's murrelet (*Brachyramphus brevirostris*) and the yellow-billed loon (*Gavia adamsii*), also occur in the planning area.

The short-tailed albatross is a long-winged seabird that was listed in 2000 as endangered in the United States (65 FR 46643), making it so designated throughout its range. This species was originally listed in 1970 under the then-Endangered Species Conservation Act of 1969, before passage of today's ESA. As a result of an administrative error and not because of any biological evaluation, this species was listed as endangered throughout its range except within the United States. This error was corrected in 2000 when this species was listed as endangered throughout its range. No critical habitat has been designated in marine waters within U.S. jurisdiction. The greatest current threat to this species is the potential volcanic eruption of Torishima, where most breeding occurs. Other existing threats include incidental catch in commercial fisheries, ingestion of plastics, contamination by oil and other pollutants, the potential for habitat usurpation or degradation by non-native species, and the adverse effects of climate change (USFWS 2008c).

Short-tailed albatross occurs in waters throughout the North Pacific, primarily along the east coasts of Japan and Russia; in the continental shelf edge of the Gulf of Alaska, along the Aleutian Islands; and in the Gulf of Alaska south of 64°N latitude (USFWS 2008c), and is a relatively frequent visitor to the South Alaska subregion. While once thought to number 5 million individuals, about 2,400 birds were known to exist in June 2008, with about 450–500 breeding pairs. This albatross is known to breed on only two small islands near Japan, with 80–85% of all breeding occurring on the active volcanic island of Torishima in the western Pacific.

During the non-breeding season, short-tailed albatrosses range along the Pacific Rim from southern Japan to northern California, primarily along continental shelf margins

(USFWS 2008c). On the basis of ship-based observations and telemetry data, this species may be relatively common nearshore where upwellings occur near the coast; this species should be considered a "continental shelf-edge specialist" rather than a coastal or nearshore species (Piatt et al. 2006). The shelf edge in the vicinity of the Cook Inlet Planning Area occurs about 121 km (75 mi) from the southern boundary of the planning area.

The Steller's eider is the smallest of the four eider duck species. This species breeds in the Arctic, and the Alaska breeding population was listed as threatened in 1997 (62 FR 31748). There are three breeding populations, two in Russia and one in Alaska (USFWS 2002). The Alaska breeding population nests primarily on the Arctic coastal plain, and is the only one of the three populations listed under the ESA as threatened. While the causes for the population decline observed for this species are unknown, possible factors affecting the Alaska population may include predation, hunting, ingestion of spent lead shot, habitat loss or degradation, and exposure to contaminants (USFWS 2002; NatureServe 2010b).

On the coastal plain, Steller's eiders breed on grassy edges of tundra lakes and ponds, or within drained lake basins. Although they nest in terrestrial environments, they spend the majority of their time in shallow marine waters. Steller's eider does not breed in the Southern Alaska Subregion. After nesting in the Arctic coastal plains, they move to protected marine areas to molt. Molting occurs at a number of locations in southwest Alaska, with the largest numbers of birds concentrating in four areas along the north side of the Alaska Peninsula (USFWS 2002). Three lagoons on the north side of the Alaska Peninsula have been designated as critical habitat for the Steller's eider (66 FR 8850).

After molting, many of the birds disperse to the Aleutian Islands, the south side of the Alaska Peninsula, Kodiak Island, and lower Cook Inlet (USFWS 2002; Larned 2006). Wintering birds usually occur in shallow waters (<10 m [30 ft] in depth) within 400 m (1,300 ft) of shore, unless the shallows extend farther offshore into bays and lagoons. Substantial numbers of Steller's eiders remain in lagoons on the north side of the Alaska Peninsula in winter until freezing conditions force them out. In Cook Inlet, the largest concentrations of sightings in 2004 were from the Homer Spit north to about Ninilchik and along the south central shore of Kamishak Bay on the inlet's west side (Larned 2006).

The Kittlitz's murrelet is a small diving seabird related to the puffins and murres. All of the North American and most of the world population of this species breed, molt, and winter in Alaska (USFWS 2006d). The North American population of this small diving seabird occupies coastal waters discontinuously from northern Southeast Alaska in the Gulf of Alaska, north to Point Lay in the Chukchi Sea during the nesting season. Wintering areas are not well known, and are assumed to include offshore waters in at least the Gulf of Alaska and Bering Sea portions of the range (USFWS 2006d). Spring migration extends from the third week of March to mid-June, fall migration from mid-July to late October, and breeding from mid-May to late August.

Based on apparent evidence of a population decline in the Prince William Sound area, the Kittlitz's murrelet was petitioned for listing in 2001 and became a candidate for listing in a May 2004 Candidate Notice of Review (69 FR 24877). This species is an uncommon and secretive breeder, choosing unvegetated scree slopes, coastal cliffs, talus above timberline, and barren ground, especially in the vicinity of advancing or stable glaciers or in recently glaciated areas, primarily in coastal areas but also up to 80 km (50 mi) inland (USFWS 2006d). Nests have been found in most coastal regions from southeast to western Alaska (Day et al. 1999). During breeding, Kittlitz's murrelets are found in several core population centers in Alaska, including Lower Cook Inlet (Agler et al. 1998; USFWS 2006d). Possible threats to this species include marine oil pollution, decreases in food stock, gillnet fisheries, and melting of glaciers (USFWS 2006d; NatureServe 2010c).

The yellow-billed loon is a migratory, fish-eating seabird that in Alaska nests in solitary pairs on the Arctic Coastal Plain and winters in more southern coastal waters of the Pacific Ocean (USFWS 2011d). This species became a candidate for listing as endangered or threatened in March 2009 with a listing priority of 8, primarily due to subsistence use of this species during migration (74 FR 12932). Yellow-billed loons typically nest near large, deep tundra lakes on low islands or near the edges of lakes to avoid terrestrial predators. In Alaska, nesting occurs from the Canning River westward to Point Lay, and migration occurs along coastlines of the Beaufort and Chukchi Seas (North 1994; NatureServe 2010d). During nesting, this species uses nearshore and offshore marine waters adjacent to their breeding areas for foraging in summer (74 FR 12932).

During non-breeding, this species spends most of its time in marine waters and uses open water leads for resting and feeding during migration. In Alaska, the yellow-billed loon winters in sparse numbers in nearshore marine waters from Kodiak Island to Prince William and throughout southeast Alaska (North 1994). Wintering habitats include sheltered marine waters less than 30 m (98 ft) deep, from 1.6 to 32 km (1 to 20 mi) offshore (74 FR 12932). Lower Cook Inlet is used in winter by overwintering birds and by immature and possibly non-breeding adults throughout the year.

3.8.2.2.3 Use of the Cook Inlet Planning Area by Migratory Birds. The coastal wetlands and bays along Cook Inlet provide important staging habitats for migratory birds, with large seasonal aggregations of waterfowl and shorebirds. The highest diversity and density of birds in coastal waters, particularly over the continental shelf, occur in spring when large numbers of loons, waterfowl, shorebirds, and seabirds return to nesting areas or stage there before migrating to areas farther north.

During spring migration (April–May), large numbers of birds arrive from southern wintering areas either to occupy breeding habitats along the northern Gulf of Alaska coast or to use habitats in the area as they stage for further migration northward to breeding areas in interior Alaska and along the Arctic Coastal Plain. During spring migration, species diversity and density along the northern Gulf of Alaska are greatest in exposed inshore waters and in bays and lagoons and associated tidal mudflats (e.g., Kachemak Bay), river deltas (e.g., Copper River Delta), and salt marshes, as well as along exposed outer coasts where large numbers of seabirds gather prior to nesting. This latter topography is common in many areas of this subregion, including the exposed outer coast between Prince William Sound and the lower Kenai Peninsula, much of the Kodiak Island archipelago, numerous islands and headlands along the south side of the Alaska Peninsula, and virtually all of the Aleutian Islands. Seabirds most frequently occupy bays and exposed inshore waters. Geese and dabbling ducks primarily use river floodplains and marshes, while diving ducks are most prevalent in bays. Shorebirds are found mainly on mudflats and gravel beaches, and gulls use a variety of habitats. During spring migration, millions of shorebirds make a critical stop on coastal intertidal mudflats to feed before continuing their northward migration. The largest number of migrating shorebirds occurs on the Copper River Delta where 10–12 million birds may stop each spring. About 36 species of shorebirds migrate through the northern Gulf of Alaska each spring (Cline 2005); their numbers are dominated by the western sandpiper, representing most of the world's population of 3-4 million.

Pelagic bird densities begin to decline in September, as shearwaters depart for the southern hemisphere breeding areas. Postbreeding alcids disperse from coastal nesting colonies for offshore areas, where they will spend the winter. Migration of waterfowl and shorebirds is more protracted in the fall than in the spring, and there is some evidence that some shorebird species bypass the Gulf of Alaska during fall. Only goose and dabbling duck densities increase in fall, as migrating birds move in from areas to the north and west.

Winter bird densities along the northern Gulf of Alaska are perhaps 20–50% of those in the summer. Most of the decrease reflects seasonal changes in species composition as many seabirds leave areas they occupied in summer. While seabird numbers are lowest during the winter, the Gulf of Alaska still is important for species that winter offshore such as the northern fulmar (*Fulmarus glacoalis*), fork-tailed storm-petrel (*Oceanodroma furcata*), black-legged kittiwake (*Rissa tridactyla*), and both murre and puffin species. Coastal wintering species along the northern Gulf of Alaska coast include Pacific (*Gavia pacifica*), red-throated (*G. stellate*), and yellow-billed loons; red-necked grebe (*Podiceps grisegena*); herring (*Larus argentatus*), mew (*L. canus*), and glaucous-winged (*L. glaucescens*) gulls; ancient (*Synthliboramphus antiquus*) and marbled (*Brachyramphus marmortus*) murrelets; and Cassin's (*Ptychoramphus aleuticus*) and parakeet (*Aethia psittacula*) auklets. In the winter, waterfowl densities increase substantially as a number of species migrate south from breeding areas on the Arctic coastal plain to overwinter along the coast; sea ducks are the most abundant waterfowl present in winter. These include king (*Somateria spectablis*) and common (*S. mollissima*) eiders; long-tailed and harlequin (*Histrionicus histrionicus*) ducks; black (*Melanitta Americana*) and surf scoters (*M. perspicillata*) and Barrow's goldeneye.

3.8.2.2.4 Important Bird Areas of the Cook Inlet Planning Area. As discussed above, Cook Inlet and the Cook Inlet Planning Area provide a diversity of habitats for resident and migratory marine and coastal birds. While habitats such as mudflats, sand and gravel beaches, lagoons, and islands may be found throughout Cook Inlet and some areas are considered as being particularly important to birds living along or using the northern Gulf of Alaska. Areas in Cook Inlet that may be considered as important to overwintering and migratory birds have been identified by a number of organizations.

Because of its importance to shorebirds of the Pacific Flyway, Kachemak Bay in Lower Cook Inlet has been designated as Western Hemisphere Shorebird Reserve. Western Hemisphere Shorebird Reserves (WHSR) are designated by the WHSR Network (WHSRN), a multinational shorebird conservation organization whose mission is to conserve shorebirds and their habitats through a network of key sites across the Americas[12] (WHSRN 2009a). The first WHSR designated site was Delaware Bay in the United States; there are currently 85 sites in 13 countries. Kachemak Bay in Cook Inlet is a WHSR of international importance, being designated in 1994. WHSR sites are considered of international importance if they support at least 100,000 shorebirds annually, or at least 10% of the biogeographic population for a species. Kachemak Bay received international importance status on the basis of it supporting more than 100,000 shorebirds annually. The bay has about 515 km (320 mi) of shoreline, which together with tides of as much as 9 m (30 ft), provides an abundance of intertidal habitat for migrating shorebirds. In addition, 36 species of shorebird have been reported from the area (WHSRN 2009b). Within Kachemak Bay, the Fox River Flats Critical Habitat Area (managed by the Alaska Department of Fish and Game) serves as a major staging area for thousands of waterfowl and a million or more shorebirds during spring migration.

Kachemak Bay and Fox River Flats are two of 21 sites that have been identified by the Audubon Society as Important Bird Areas (IBAs) in the Cook Inlet area (Audubon Alaska 2011; see discussion of IBAs in Section 3.8.2.1.4). This identification has no regulatory consequences but does provide information on avian habitats of Cook Inlet. Among these 21 sites (Table 3.8.2-8), 14 occur adjacent to or within the Cook Inlet Planning Area, and because of their locations these areas and their avian fauna have a greater likelihood of interacting with OCS oil and gas activities in the Cook Inlet Planning Area. The remaining sites occur in the upper reaches of Cook Inlet, above Kalgin Island (Figure 3.8.2-8), and would not be expected to be affected by normal oil and gas exploration and development activities. While the Swanson Lakes IBA is located inland of the Cook Inlet coast, the waterfowl and shorebirds that use this area likely also use Cook Inlet waters and shorelines for foraging, and thus could also be affected by oil and gas activities. All of the sites provide migratory staging, resting, foraging, and/or breeding habitat for a wide variety of marine and coastal birds, and especially seabirds, waterfowl, and shorebirds. Except for the Swanson Lakes IBA, most of the Cook Inlet IBAs are coastal in nature, several are islands, and one (Cook Inlet, Marine IBA) is an open water area.

3.8.2.2.5 Climate Change and Cook Inlet Birds. Climate change effects are occurring on all continents and oceans, with atmospheric and ocean warming being observed in many locations (see climate change discussions presented in Section 3.3). Environmental responses to climate change in the Cook Inlet Planning Area may include loss of sea ice and permafrost thawing (Lemke et al. 2007), changes in precipitation, erosion/siltation, increased storm severity, and additional concerns that are associated with the climate change-related sea level rise (Carter and Nielsen 2011; NRDC 2011).

[12] U.S. members of the WHSRN council include, among others, the National Audubon Society, the U.S. Department of Agriculture Forest Service, the U.S. Geologic Survey, the U.S. Fish and Wildlife Service National Wildlife Refuge System, and the Nature Conservancy.

TABLE 3.8.2-8 Important Birds Areas in Cook Inlet (Audubon Alaska 2011)

Important Bird Area	County	Importance/important Species/Bird Groups
Kachemak Bay, South Shore[a]	Kenai Peninsula	Waterfowl, shorebirds, Steller's eider
Redoubt Bay	Kenai Peninsula	Hosts 70% of all migrating shorebirds in spring; largest known world concentration of Tule white-fronted goose; waterfowl
Swanson Lakes	Kenai Peninsula	Trumpeter swan; highest density of nesting common loons in North America; significant assemblage of migratory terrestrial species
Trading Bay	Kenai Peninsula	Entire population of Wrangell Island snow goose use site and mouth of Kenai River as spring migratory staging area; spring stopover site for shorebirds
Tuxedni Bay[a]	Kenai Peninsula	Supports up to 20% of the estimated 1.2 million shorebirds using western Cook Inlet intertidal areas; western sandpiper; waterfowl
Barren Islands[a]	Kenai Peninsula	One of largest populations of nesting seabirds in Gulf of Alaska; 18 breeding species, >400,000 seabirds
Clam Gulch[a]	Kenai Peninsula	Supports >1% of the biogeographic population of wintering Steller's eider
Homer Spit[a]	Kenai Peninsula	Steller's eider; large numbers of shorebirds in spring migration; 5% global population of rock sandpipers overwinter
Fox River Flats[a]	Kenai Peninsula	Major world site for migratory birds; thousands of waterfowl and millions of shorebirds; major spring staging area for geese and ducks, large wintering waterfowl population
Cook Inlet, Marine[a]	Kenai Peninsula Kodiak Island	Short-tailed albatross, shearwaters, seabirds, storm-petrels, fulmers, murres, tufted puffins
Uganik Bay and Viekoda Bay[a]	Kodiak Island	14 seabird colonies, >100 resident breeding pairs of black oystercatcher; foraging/nesting habitat for Kittlitz's murrelet and other alcids
Wide Bay[a]	Kodiak Island	Waterfowl use in spring and fall; Steller's eider; overwintering by Emperor goose; seabird colonies; Kittlitz's murrelet
Susitna Flats	Matanuska-Susitna	Waterfowl and shorebirds, especially during spring migration; among highest shorebird diversity of any site in Cook Inlet; entire world population of rock sandpiper winters here (October–April)
Kenai River Flats	Kenai Peninsula	Supports nearly entire population of Wrangell Island (Siberia) snow goose during spring migration; shorebirds, waterfowl, sandhill crane; large colonies of herring and mew gulls
Amakdedulia Cove[a]	Kenai Peninsula	Supports 1% of a subspecies of the double-crested cormorant; large numbers of sea ducks in summer

TABLE 3.8.2-8 (Cont.)

Important Bird Area	County	Importance/important Species/Bird Groups
Northwest Afognak Island[a]	Kodiak Island	Nesting and foraging habitat for variety of seabirds and shorebirds; 125–150 breeding pairs of black oystercatcher
Goose Bay	Matanuska-Susitna	Important spring and fall migratory resting/feeding habitat for waterfowl; snow goose, Canada goose, trumpeter swan, tundra swan
Anchor River[a]	Kenai Peninsula	Multi-species assemblages of migratory terrestrial birds
Chugach Islands[a]	Kenai Peninsula	Significant foraging area for seabirds; albatrosses, puffins, cormorants, gulls, all three murrelet species
Contact Point[a]	Kenai Peninsula	Over 1,000 seabirds of seven species nest here; high numbers of seaducks, gulls, diving ducks, and dabbling ducks in spring
Palmer Hay Flats	Matanuska-Susitna	Large numbers of waterfowl in spring

[a] Site occurs adjacent to or within the Cook Inlet Planning Area.

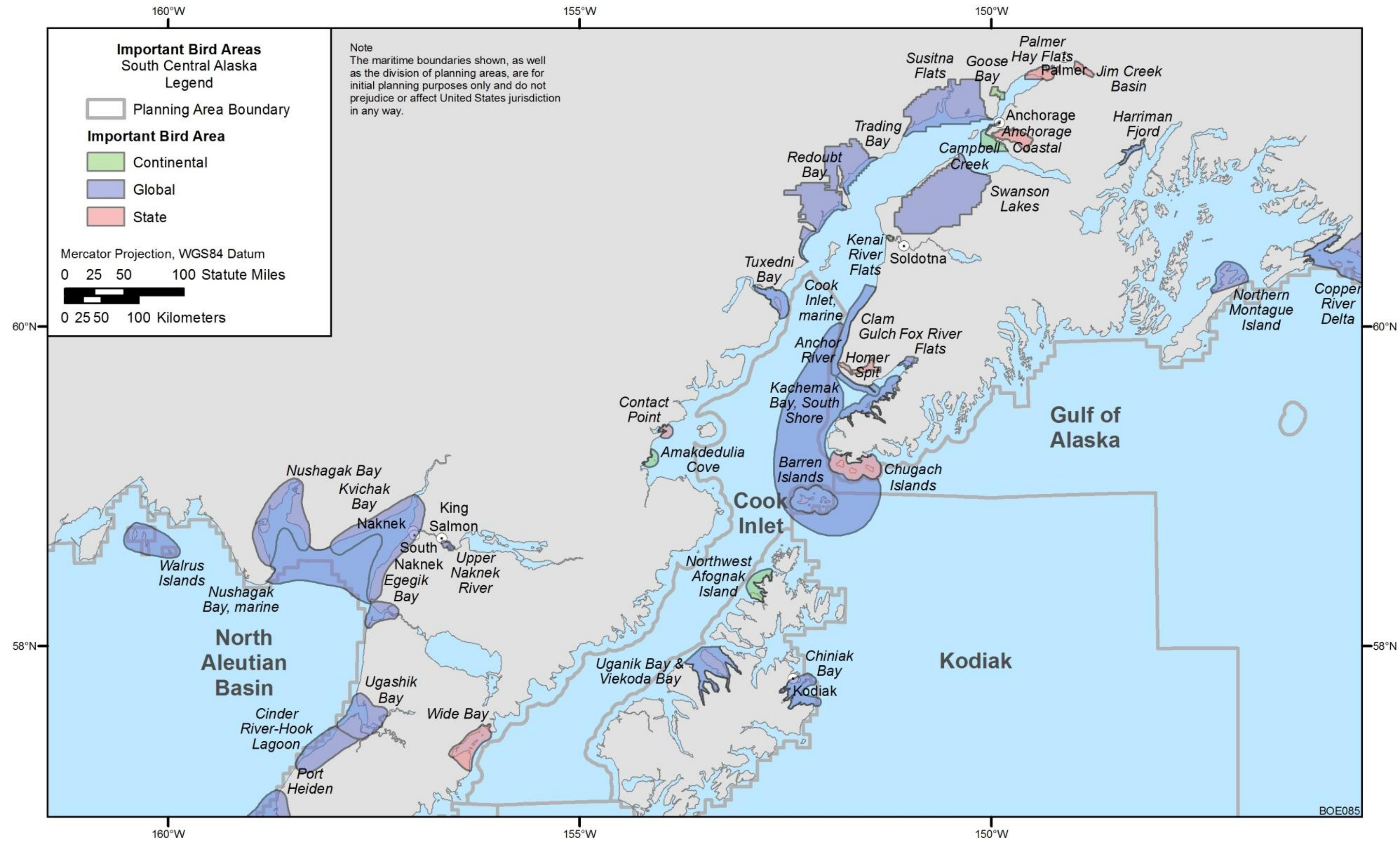

FIGURE 3.8.2-8 Important Bird Areas of the Cook Inlet Planning Area (Audubon Alaska 2011)

The potential effects of sea ice loss, permafrost thawing, and sea level rise may have a variety of adverse effects on marine and coastal birds of the planning area, with potential impacts associated mostly with loss of food and habitat. Sea level rise and altered precipitation, temperature, and river discharge regimes may affect invertebrate communities in terms of both species composition and total productivity (see discussion of climate change impacts on aquatic invertebrates in Section 3.8.5.2). Changes in this prey base could affect shorebirds and waterfowl that forage on these invertebrates during nesting, staging, and migrating (Galbraith et al. 2002; Moller et al. 2008; NABCI 2010). Although sea level rise may have some impact on coastal habitats of the Cook Inlet, at least parts of the region are not expected to be as greatly affected as other regions of Alaska. Coastal uplift of the local landmass is predicted to counterbalance much of the effect of rising seas and marshlands will likely keep up with sea level changes as they capture sediment and grow vertically (NRDC 2011).

The Cook Inlet coastline is susceptible to erosion during high-tide storms and may be affected by increased storm severity due to climate change (NRDC 2011). Degradation or loss of coastal wetlands in the Cook Inlet due to increased erosion may affect migratory bird species that rely on this area for stopover sites. For example, Fox River Flats is a major world site for migratory birds and loss of this habitat would affect thousands of waterfowl and millions of shorebirds.

The presence of landfast ice in Cook Inlet creates a productive marine ice biome that is essential for a variety of marine biota. Ice formation occurs primarily on the western side of Cook Inlet, but climate change may result in changes in ice formation. A reduction in ice scour could result in changes to marine productivity as well as the distribution, composition, and abundance of marine invertebrates (ACIA 2005; Moline et al. 2008) (see Section 3.8.5.2). Such changes could affect the prey base for seabirds, influencing their ability to provide food for chicks as well as preparing for the fall migration.

Climate change in Cook Inlet may be expected to result in short-term and long-term effects on marine and coastal birds of the region. These effects may be beneficial or detrimental in nature and could result in population-level effects on marine and coastal birds. Which species may be most affected and how they may respond to climate change over several decades are unknown.

3.8.2.3 Marine and Coastal Birds of the Beaufort and Chukchi Seas Planning Areas

As discussed earlier, more than 492 naturally occurring species in 64 families and 20 orders have been identified from Alaska (Johnson and Herter 1989; University of Alaska 2011). Because of the limited seasonal nature of open water and snow-free conditions, the Beaufort and Chukchi Seas support a much smaller number of avian species. For example, only about 180 species have been reported from the Arctic National Wildlife Refuge (ANWR 2010), while a 1999–2001 summer survey of birds in the western Beaufort Sea detected 30 species (primarily waterfowl) (Fischer and Larned 2004). Most birds occurring in the Beaufort and Chukchi Seas and their adjacent coastal habitats are migratory, being present for all or part of the period between May and early November. The avian fauna of these regions largely falls into two categories: (1) birds that arrive in spring at coastal breeding areas, breed and raise young, and then depart in fall to southern wintering areas; and (2) birds that migrate along the coast on their way to and from breeding areas elsewhere on the Arctic coast. Some groups, such as the passerines, are largely absent from coastal habitats along the Arctic coast, generally occurring as rare, casual, or accidental visitors.[13] A majority of species nesting in coastal areas are waterfowl and shorebirds, although in some locations seabirds occur in large nesting colonies.

3.8.2.3.1 Nonendangered Species. Although representatives of six major groups of birds have been reported from the planning areas (Table 3.8.2-9), three may be especially important because they have the greatest potential for being affected by oil and gas leasing and development: (1) seabirds, which occur in open ocean waters; (2) waterfowl, which use a variety of freshwater and nearshore marine habitats; and (3) shorebirds, which use shoreline habitats throughout the planning area. Members of these groups are migratory and occur seasonally, and some may occur in locally large concentrations in locations such as nesting colonies or as mobile flocks. The bays, inlets, and river mouths along the Beaufort and Chukchi Seas provide breeding, foraging, and staging areas for millions of shorebirds, seabirds, and waterfowl (Johnson 1993).

Seabirds. There are three general categories of seabirds: cliff-nesting species, Bering Sea breeders and summer residents of the Beaufort and Chukchi Seas, and high-Arctic species. The cliff dwelling species, such as the common and thick-billed (*Uria lomvia*) murres, the horned (*Fratercula corniculata*) and tufted (*F. cirrhata*) puffins, and the black-legged kittiwake, typically nest on cliffs, rock ledges, and sloping island surfaces on mainland cliffs, rocky headlands, and islands (Ainley et al. 2002; Audubon Alaska 2011; Hatch et al. 2009; Piatt and Kitaysky 2002a, b). These birds typically feed on fish and invertebrates, and many breed in colonies (some in mixed colonies) which in some locations may number 100,000 birds or more (Ainley et al. 2002; Audubon Alaska 2011). During breeding, these species may travel as much as 80 km (50 mi) from nest sites or colonies to forage on the continental slope and shelf (Gaston and Hipfner 2000; Hatch et al. 2000; Ainley et al. 2002; Hatch et al. 2009). Two major seabird colonies are present on the east coast of the Chukchi Sea (Cape Thompson and Cape Lisburne) consisting primarily of thick-billed murres, common murres, and black-legged kittiwakes, but also including horned puffins and tufted puffins (National Audubon Society 2012).

The Bering Sea breeders and summer residents of the Beaufort and Chukchi Seas include species such as the northern fulmar, the short-tailed shearwater (*Puffinus tenuirostris*), and the parakeet least (*Aethia pusilla*) and crested auklets. These species feed mostly on fish and invertebrates, and may forage as much as 100 km (62 mi) from breeding areas. They are colonial breeders (Jones 1993a, b; Jones et al. 2001; USFWS 2006e; Hatch and Nettleship 1998). Some of these species are among the most abundant birds in Alaskan waters. For example, the

[13] "Rare" — occurring regularly within its normal range, but in very small numbers; "casual" — beyond normal range, but irregular observations occur over several years; "accidental" — far from normal range and observations are unlikely and not expected.

TABLE 3.8.2-9 Marine and Coastal Birds of the Beaufort and Chukchi Seas Planning Areas

Category	Order	Common Name	Representative Types
Seabirds	Charadriiformes	Gulls Terns Alcids Jaegers	Glaucous gull, common murre, horned puffin, Arctic tern, parasitic jaeger
	Procellariiformes	Storm-petrels Shearwaters Albatrosses	Short-tailed shearwater
Shorebirds	Charadriiformes	Phalaropes Plovers Oystercatchers Sandpipers, snipes, and allies	Dunlin, red phalarope
Wetland birds	Gruiformes	Cranes	Sandhill crane
	Podicipediformes	Grebes	Horned grebe
Passerines	Passeriformes	Perching birds	Warblers, sparrows, raven
Waterfowl	Anseriformes Gaviiformes	Ducks, geese, and swans Loons	Long-tailed duck, common eider, king eider, greater white-fronted goose, lesser snow goose, tundra swan, Pacific loon, red-breasted merganser
Raptors	Falconiformes	Birds-of-prey	Snowy owl

least auklet is one of the most abundant seabirds in North America (Jones 1993a), while the short-tailed shearwater is one of the most abundant species in pelagic Alaskan waters. Hundreds of thousands of shearwaters may be found in pelagic areas of the Chukchi Sea in late summer (USFWS 2006e; Audubon Alaska 2011). The northern fulmar is another very abundant species. About half of all North American colonies of this species occur in Alaska. Although there are no known nesting colonies along the Beaufort or Chukchi Seas, tens of thousands of this species may be found in pelagic waters of the Chukchi Sea in late summer (Audubon Alaska 2011).

The high-Arctic seabirds are species that either breed in or migrate through Arctic habitats along the Arctic Ocean. Representative species include the black guillemot (*Cepphus gyrlle*), several species of gull (Ross's gull [*Rhodostethia rosa*], ivory gull [*Pagophila eburnean*], and glaucous gull [*Larus hyperboreus*]), several species of jaegers (pomerine jaeger [*Stercorarius pomarinus*], parasitic jaeger [*S. parasiticus*], and long-tailed jaeger [*S. longicaudus*]), and the Arctic tern (*Sterna paradisaea*). The black guillemot occurs in both planning areas, nesting in isolated pairs or in small colonies along rocky coasts with adjacent shallow waters (Butler and Buckley 2002). Cooper Island (east of Barrow) supports the largest breeding colony in Alaska, and the easternmost colony occurs on the Beaufort coast of the Yukon Territory (Butler and Buckley 2002; Audubon Alaska 2011). Some of the gulls (e.g., Ross's and ivory) do not breed in Arctic Alaska habitats, but are present in fall before moving to wintering areas in the Bering Sea (Divoky et al. 1988; Mallory et al. 2008). The glaucous gull occurs in both the Beaufort and Chukchi Seas and breeds along marine and freshwater coasts, tundra, offshore islands, cliffs, shorelines, and ice edges, and may breed in mixed avian colonies with geese, ducks, and cliff-breeders (Gilchrist 2001). The jaegers are common in summer in the Chukchi Sea, moving into the Bering Sea in the fall. The Arctic tern is a rare species that may be found in pelagic waters of the Chukchi Sea.

Waterfowl. A variety of waterfowl occur in the Beaufort and Chukchi Sea Planning Areas, including loons (Pacific, yellow-billed, and red-throated), ducks (including the long-tailed duck, common eider, king eider) and geese (Pacific brant [*Branta bernicla nigricans*], greater white-fronted goose [*Anser albifrons frontalis*], lesser snow goose [*Chen caerulescens caerulescens*], and tundra swan [*Cygnus columbianus*]). Many of the waterfowl migrate along the west coast of Alaska into the Chukchi Sea and/or Beaufort Sea in spring, where they breed in freshwater and coastal habitats (e.g., Divoky 1987; Ely and Dzubin 1994; Goudie et al. 2000; Robertson and Savard 2002). Some species, such as the common eider, breed colonially along marine coasts (Goudie et al. 2000), while others such as the king eider may breed in more interior locations. Following nesting, many of the species move to molting areas in coastal areas of the Beaufort Sea and Chukchi Sea, where they may stay for several weeks before continuing their fall migrations to wintering grounds farther south. Important molting and fall migration station areas include Peard Bay, Kasegaluk Lagoon, and Teshekpuk Lake along the Chukchi Sea coast (Johnson 1993; Lysne et al. 2004).

Shorebirds. Many of the shorebirds associated with the Beaufort and Chukchi Seas breed on the tundra, but also rely on coastal areas such as beaches, barrier islands, lagoons, and mudflats for some portion of their lifecycle. These coastal areas provide important feeding grounds that prepare the birds for their fall migration to southern winter grounds (Powell et al. 2010). As many as 29 shorebird species have been reported to breed on the Arctic Coastal Plain; the National Petroleum Reserve-Alaska has been estimated to have as many as 6 million breeding shorebirds in summer (Alaska Shorebird Group 2008). Common shorebird species that breed on or migrate through the Arctic Coastal Plain include the dunlin, pectoral sandpiper (*Caldris melanotos*), semipalmated sandpiper (*C. pusilla*), and red phalarope (*Phalaropus fulicarius*) (Alaska Shorebird Group 2008; Powell et al. 2010).

Breeding species typically use shallow freshwater tundra ponds (polygons), marshes, and freshwater rivers and deltas (Alaska Shorebird Group 2008). Following breeding, migrating birds use a number of staging areas along the Chukchi and Beaufort Sea coasts, including river deltas and coastal lagoons (Alaska Shorebird Group 2008). Important post-breeding shorebird areas include Elson Lagoon and the Colville River Delta along the Beaufort Sea, and Peard Bay and Kasegaluk Lagoon on the Chukchi Sea (Figure 3.8.2-9). Kasegaluk Lagoon is one of the longest lagoon-barrier island systems in the world, and is used by 19 different species of shorebirds during fall migration (Alaska Shorebird Group 2008).

3.8.2.3.2 Birds Listed under the Endangered Species Act. There are two species that are listed as threatened under the ESA (see Section 3.8.2.1.2 for a discussion of the ESA and for

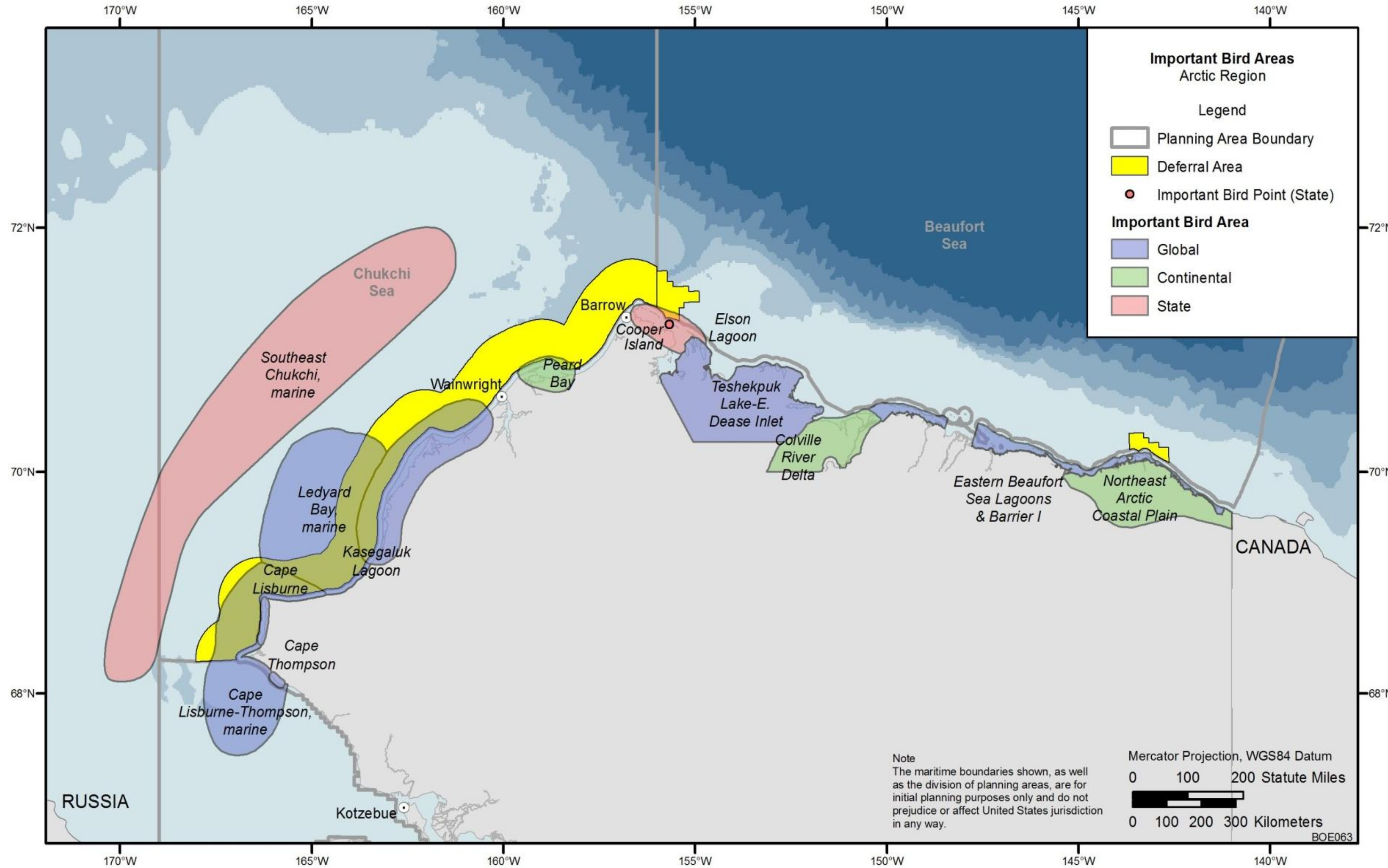

FIGURE 3.8.2-9 Important Bird Areas along the Beaufort Sea and Chukchi Sea Coasts (Audubon Alaska 2011)

definitions of listing categories) that occur in the Beaufort and Chukchi Sea Planning Areas and that could be affected by OCS oil and gas activities. These species are the spectacled eider (*Somatria fischeri*) and the Alaska breeding population of the Steller's eider. In addition, Kittlitz's murrelet and the yellow-billed loon, both Federal candidate species, occur in the coastal and inland waters of the Chukchi Sea Planning Area.

The spectacled eider was listed in 1993 as threatened throughout its range in Alaska and Russia (58 FR 27474). The USFWS also has designated critical habitat (wintering area) considered to be essential for the conservation of spectacled eider (66 FR 9146). On Alaska's North Slope or Arctic Coastal Plain (ACP), an average of 6,841 spectacled eiders (about 2% of the world population) are present each summer (Larned et al. 2005). Spectacled eiders generally nest at low density (about 0.22–0.25 birds/km^2) within about 80 km (50 mi) of the coast, primarily west of the Sagavanirktok River (Larned et al. 2005, 2006). Highest densities occur south of Oliktok Point, from Harrison Bay to south of Smith Bay, and Admiralty Bay/Barrow southwest to Wainwright (Larned et al. 2005, 2006).

Male and female spectacled eiders pursue quite different schedules and movement patterns between the nesting period and arrival at the wintering area. Males leave the breeding grounds as incubation begins, usually early June to early July, and begin a molt migration, stopping in bays and lagoons to molt and stage prior to fall migration. Important molting and staging areas include Harrison Bay, Smith Bay, Peard Bay (east of Point Belcher), Kasegaluk Lagoon (south of Icy Cape), and Ledyard Bay (a critical habitat unit) (east of Cape Lisburne) (Figure 3.8.2-9) (Johnson 1993; Larned et al. 1995a, b). The median departure of females and young-of-the-year from the breeding grounds is late August (Petersen et al. 2000). Ledyard Bay is one of the primary molting areas for females breeding on the ACP (Larned et al. 1995a).

The Steller's eider is the smallest of the four eider species. The Alaskan breeding population of Steller's eider has been listed since 1997 as threatened under the ESA (62 FR 31748). The USFWS also has designated (2001a) critical habitat for the Steller's eider (66 FR 8850). See Section 3.8.2.2.2 for a discussion of the status of this species. There are three breeding populations, two in Russia and one in Alaska (USFWS 2002). The Alaska breeding population nests primarily on the ACP, and is the only one of the three populations listed under the ESA. On the ACP, this species breeds on grassy edges of tundra lakes and ponds or within drained lake basins (Fredrickson 2001). Although they nest in terrestrial environments, they spend the majority of their time in shallow marine waters. After nesting in the ACP, they move to protected marine areas to molt. Molting occurs at a number of locations in southwest Alaska, with largest numbers of birds concentrating in four areas along the north side of the Alaska Peninsula (USFWS 2002).

The Kittlitz's murrelet is a small diving seabird related to the puffins and murres. All of the North American and most of the world population of this species breed, molt, and winter in Alaska (USFWS 2006d), where this species may be found in coastal waters discontinuously from northern southeast Alaska in the Gulf of Alaska, north to Point Lay in the Chukchi Sea during the nesting season (Day et al. 1999). Although wintering areas remain largely unknown, Kittlitz's murrelets have been observed around Prince William Sound, Kenai Fjords, Kachemak Bay, Kodiak Island, Sitka Sound, and in the northern Gulf of Alaska along the Alaska Coastal

Current and mid-shelf regions (USFWS 2011g). This species is an uncommon and secretive breeder, choosing unvegetated scree slopes, coastal cliffs, talus above timberline, and barren ground, primarily in coastal areas but also up to 80 km (50 mi) inland. Because of the absence of suitable habitat, this species is not believed to nest east from Cape Beaufort in the western Chukchi Sea (Day et al. 1999).

The yellow-billed loon is a migratory seabird that in Alaska nests in solitary pairs on the Arctic Coastal Plain and winters in more southern coastal waters of the Pacific Ocean (USFWS 2011d). Yellow-billed loons typically nest near large, deep tundra lakes on low islands or near the edges of lakes to avoid terrestrial predators. In the Alaskan Arctic, nesting occurs from the Canning River westward to Point Lay, and migration occurs along coastlines of the Beaufort and Chukchi Seas (North 1994; NatureServe 2010d). During nesting, this species uses nearshore and offshore marine waters adjacent to their breeding areas for foraging in summer (74 FR 12932).

3.8.2.3.3 Use of the Chukchi and Beaufort Sea Planning Areas by Migratory Birds. As previously discussed in Section 3.8.2.3.1, the Chukchi and Beaufort Sea Planning Areas undergo extreme weather variability that results in a very distinct seasonal availability of habitat. As a consequence of these conditions, virtually all species of birds that have been reported from the Beaufort and Chukchi Sea Planning Areas are seasonal visitors that for the most part are absent in winter. In general, birds migrate to or through the area in spring. Some species (i.e., greater white-fronted goose) migrate to breeding habitats where they nest and raise young. Other species (i.e., ivory gull) pass through the two planning areas on their way to Arctic habitats in Canada, while still others (i.e., short-tailed shearwater) move into the area to forage in summer in offshore waters. In late summer and early fall, many species move to molting and staging areas in preparation for their fall migrations out of the Arctic habitats to southern wintering areas.

Spring. Many of the species that move into the Beaufort and Chukchi Sea Planning Areas in spring migrate into the area along the Bering Sea coast (e.g., Dickson and Gilchrist 2002). Arrival times generally coincide with the formation of ice leads. Migration times vary by species, but for most species spring migration occurs between late March and late May. For example, waterfowl species such as the long-tailed duck and common eider migrate northward in spring along the Chukchi Sea coast following the recurrent lead system in the ice and then migrate eastward in the Beaufort Sea region along a broad front, which may include inland, coastal, and offshore routes, from early May to mid-June (Johnson and Herter 1989; Goudie et al. 2000; Robertson and Savard 2002). Arrival dates for various species range from late April to early June. The availability of open water off river deltas and in leads determines migratory routes and distribution of loons, waterfowl, and seabirds during this time (Johnson and Herter 1989).

Summer. As discussed earlier, birds migrate into the Chukchi and Beaufort Sea Planning Areas in spring to breed, moving into appropriate habitats where they nest and raise young. Depending on the species, nesting habitats include islands, rocky coastlines, river deltas, lagoons, and all types of tundra habitat on the ACP. Shorebirds nest in virtually all types of tundra habitats in the Arctic subregion, shifting to wetter marine littoral, saltmarsh, and barrier island shoreline types for brood rearing where insects are more abundant (Alaska Shorebird Group 2008).

Late Summer and Autumn. After breeding, many species of waterfowl, particularly sea ducks, undergo a migration to molting areas prior to fall migration to southern wintering areas (Goudie et al. 2000; Fredrickson 2001; Robertson and Savard 2002; Larned et al. 2006). Most brood rearing and molting of loons, swans, and geese occurs on large lakes or in coastal habitats. Major concentrations of molting waterfowl occur from late June through August in several areas along the Beaufort and Chukchi Sea coasts, including Teshekpuk Lake, Simpson Lagoon, Peard Bay, Kasegaluk Lagoon, and Ledyard Bay (Figure 3.8.2-9) (Audubon Alaska 2011).

Fall migration times also vary by species, and in some cases by gender and age group. For example, male and nonbreeding or failed-breeding female common eiders migrate to coastal molting areas in Chukchi Sea lagoons and bays beginning in late June and early July (Johnson and Herter 1989). Some females with young may molt in Beaufort coastal lagoons before moving south to wintering areas from August to as late as November (Johnson and Herter 1989; Goudie et al. 2000). Male king eiders undertake a molt migration to Chukchi and Bering Sea areas from early July through August (Suydam 2000). Females migrate from mid-August into September, staging an average of 14 km (9 mi) offshore for 9–32 days in the Beaufort. Young leave the breeding areas in September and October.

Along the Chukchi Sea and Beaufort Sea coastlines, non-incubating members of shorebird pairs concentrate in coastal habitats as early as mid-June (Alaska Shorebird Group 2008; Powell et al. 2010). In late June to early July, individuals and flocks of non-breeding and post-breeding adults of several species move to habitats surrounding small coastal lagoons and river deltas (Taylor et al. 2010). In late July and early August, adults relieved of parental duties flock in shoreline areas, followed by juveniles in August and September. Parents with fledged young follow in several weeks, and juveniles form large flocks in mid- to late August, and most have departed the area by mid-September. From late September to mid-October, a majority of the world's Ross's gull population (4,500–16,000) migrates from the Russian Chukchi to shoreline habitats from Wainwright to Point Barrow and eastward to the Plover Islands (Divoky et al. 1988), returning in mid-October. Most black guillemots probably overwinter in leads in the Beaufort and Chukchi Seas.

3.8.2.3.4 Important Bird Areas. The Beaufort Sea and Chukchi Sea Planning Areas and adjacent coastal areas include 11 sites that have been identified as IBAs (Table 3.8.2-10) (Audubon Alaska 2011; see discussion of IBAs presented in Section 3.8.2.1.4).

3.8.2.3.5 Climate Change and Arctic Birds. Climate change effects have been observed to be occurring on all continents and oceans, with atmospheric and ocean warming being observed in many locations, but especially in the Arctic (see climate change discussions

TABLE 3.8.2-10 Important Birds Areas in the Beaufort Sea and Chukchi Sea Planning Areas

Important Bird Area	Area Importance/Important Species or Bird Groups
Teshekpuk Lake-E. Dease Inlet	High densities of breeding shorebirds; large numbers (>50,000) of molting geese, including up to 30% of the Pacific Flyway Brant goose population; breeding populations of spectacled and Steller's eider; some of the highest breeding densities of the yellow-billed loon in the Western Hemisphere.
Ledyard Bay, marine	Site supports large numbers of sea birds and waterfowl. As many as 100,000 common murres and thick-billed murres and 10,000 black-legged kittiwake have been reported during the breeding season, and more than 30,000 spectacled eider have been reported outside of the breeding season.
Kasegaluk Lagoon	Nineteen shorebird species have been reported from the site, with more than 25,000 birds present. Most abundant shorebirds include the red phalarope and dunlin. Peak single-day bird counts in August of as many as 2,500 birds.
Eastern Beaufort Sea lagoons and barrier islands	Used by breeding and post-breeding migratory waterfowl; long-tailed ducks are the most abundant species in late summer and early fall; lagoons used during molting by Canadian-breeding and Alaska-breeding ducks; 10,000+ phalaropes regularly use the lagoons.
Cape Thompson	Supports only one of two known seabird colonies on the east coast of the Chukchi Sea. Total seabird population estimated to be on the order of 350,000 birds; species include thick-billed and common murres and black-legged kittiwakes.
Cape Lisburne	Supports only one of two known seabird colonies on the east coast of the Chukchi Sea. Total seabird population on the order of 500,000 birds, primarily thick-billed and common murres and black-legged kittiwakes.
Peard Bay	A large deep bay used for breeding by Brant goose, common eider, and spectacled eider, and as a resting/staging area by waterfowl and shorebirds during migration.
Northeast Arctic Coastal Plain	Used by post-breeding lesser snow goose for pre-migration foraging, with peak annual numbers in excess of 300,000.
Cooper Island	Supports largest black guillemot colony in Alaska, and is the most northerly known breeding site for horned puffins. Also supports very large Arctic tern colony.
Southeast Chukchi, marine	Tens of thousands of northern fulmers and hundreds of thousands of short-tailed shearwaters can be found in this area in late summer; thousands of auklets (primarily 1st and 2nd year birds) as far north as Cape Lisburne.
Elson Lagoon	Site estimated to support as many as 20,000 shorebirds; wide offshore zone important for waterfowl; and common eiders nest on the barrier islands. This site is pending global/continental status.

Source: Audubon Alaska 2011.

presented in Section 3.3). Environmental responses in the Beaufort and Chukchi Sea Planning Areas include loss of sea ice (Parkinson 2000) and permafrost thawing (Lemke et al. 2007), changes in precipitation, and additional concerns that are associated with the climate change-related sea level rise and potential for high erosion of Beaufort and Chukchi Sea coasts (Proshutinsky et al. 2001; Mars and Housenecht 2007).

The potential effects of sea ice loss, permafrost thawing, and sea level rise may have a variety of adverse effects on marine and coastal birds of the two planning areas, with potential impacts mostly associated with loss of food and habitat. Sea level rise and altered precipitation, temperature, and river discharge regimes may affect littoral zone invertebrate communities in terms of both species composition and total productivity (see discussion of climate change impacts on aquatic invertebrates in Section 3.8.5.3). Changes in this prey base could affect shorebirds and waterfowl that forage on these invertebrates during nesting, staging, and migrating (Rehfisch and Crick 2003; Galbraith et al. 2002; Moller et al. 2008; Lovvorn et al. 2009; NABCI 2010). Atmospheric warming, coupled with altered precipitation regimes, is predicted to cause boreal forests to expand northward, displacing tundra-breeding birds into narrower coastal areas (NABCI 2010) (see Section 3.7.1.3 for a discussion of potential climate effects on Arctic tundra and coastal habitats). The loss of tundra wetlands on the coastal plain would reduce nesting habitat for a variety of birds as well as affect prey abundance and distribution of tundra-nesting species. If climate change alters the timing of food abundance, this could affect both nesting and migrating birds. The arrival, nesting, and hatching of many shorebird species are closely tied to the emergence of insects upon which the hatchlings depend (Alaska Shorebird Group 2008).

The presence of sea ice and landfast ice in the Arctic creates a productive marine ice biome that is essential for a variety of marine biota. Sea ice in the Arctic has been estimated to be decreasing by 3% per decade since the 1970s (see Section 3.3 for a more detailed discussion of sea ice and climate change). Loss of sea ice may affect marine productivity as well as the distribution, composition, and abundance of marine invertebrates (ACIA 2005; Moline et al. 2008) (see Section 3.8.5.3). Such changes could affect the prey base for seabirds, affecting their ability to provide food for chicks as well as preparing for the fall migration.

Climate change in the Arctic may be expected to result in short-term and long-term effects on marine and coastal birds of the region. These effects may be beneficial or detrimental in nature and could result in population-level effects on marine and coastal birds. Which species may be most affected and how they may respond to climate change over the several decades are unknown.

3.8.3 Reptiles

3.8.3.1 Life Stages and Habitats in the Gulf of Mexico

Five species of sea turtles — the green, hawksbill, Kemp's ridley, leatherback, and loggerhead — are known to inhabit the GOM (Pritchard 1997), and all occur in coastal and offshore habitats in each of the GOM Planning Areas included in this PEIS. In addition to sea turtles, there are three additional federally protected reptile species that could occur in the GOM planning areas: Alabama red-belly turtle, gopher tortoise, and American crocodile. All eight reptile species are listed as either endangered or threatened species under the ESA. Habitat preferences and relative abundance of these species in the GOM are provided in Table 3.8.3-1. Other reptile species not discussed in this section that could occur in coastal or brackish environments may be listed as sensitive or species of concern by the USFWS or the States in the GOM Planning Region (e.g., diamondback terrapin [*Malaclemys terrapin*], gulf salt marsh snake [*Nerodia clarkia*]).

The life history of sea turtles includes four developmental stages: embryo, hatchling, juvenile, and adult. Habitats used and turtle mobility at each developmental stage are summarized in Table 3.8.3-2.

Habitat utilization and migrations of sea turtles vary depending upon these specific developmental stages and result in differential distributions (Marquez 1990; Ackerman 1997; Hirth 1997; Musick and Limpus 1997). Consequently, the degree of sea turtle vulnerability to specific human impacts may also vary between developmental stages. There are three types of life history patterns (see Table 3.8.3-1) followed by developing sea turtles, and sea turtles that occur in the GOM planning areas are generally considered to follow two of these life history types (Bolten 2003). The leatherback sea turtle exhibits the Type 3 life history pattern, in which both developmental and adult stages occur completely in the open oceanic zone. The other four sea turtles in the GOM planning areas (green, hawksbill, Kemp's ridley, and loggerhead) are believed to exhibit the Type 2 life history pattern, in which early development of hatchlings occurs in the open oceanic zone; later, juvenile and adult development takes place in neritic zones. Sea turtle eggs deposited in excavated nests on sandy beaches are especially vulnerable to coastal impacts. After hatching, hatchling turtles move immediately from these nests to the sea. Most species ultimately move into areas of current convergence or to mats of floating *Sargassum*, where they undergo primarily passive migration within oceanic gyre systems (Carr and Meylan 1980; Bolten 2003). The passive nature of hatchling turtles, along with their small size, makes them vulnerable in open-ocean environments. Pelagic *Sargassum* habitat is an important source of food and shelter for hatchling sea turtles. Developing sea turtles subsist on the shrimp, crabs, and other invertebrates that inhabit the *Sargassum* mats. A more detailed discussion of the distribution of *Sargassum* in the GOM is provided in Section 3.7.3.1.2. After a period of years, most juvenile turtles (defined as those which have commenced feeding but have not attained sexual maturity) actively recruit to nearshore developmental habitats within tropical and temperate zones. Juvenile turtles in some temperate zones also make seasonal migrations to foraging habitats at higher latitudes in summer months. The movements of turtles in tropical areas are typically more localized. When approaching sexual maturity, juvenile turtles move into adult foraging habitats. Thus, both juvenile and adult sea turtles may be vulnerable to impacts in both open-ocean and near-coastal environments but (unlike hatchlings) may actively avoid or escape certain impact-producing factors or conditions. Near the onset of nesting season, adult turtles move between offshore foraging habitats and nesting beaches. Mating may occur directly off the nesting beaches or remotely, depending on the species and population. During the nesting season, females become resident in the vicinity of the nesting beaches and may be more vulnerable to impacts within these near-coastal waters and on nesting beaches.

TABLE 3.8.3-1 Reptiles of the Gulf of Mexico That Are Listed under the Endangered Species Act

Species	Status	Juveniles or Hatchlings Potentially Present?	Habitat and Relative Abundance in the Gulf of Mexico
Family Cheloniidae			
Loggerhead turtle (*Caretta caretta*)	T[a]	Yes	Estuarine, coastal, and shelf waters. The most abundant sea turtle in the GOM (Dodd 1988). Total estimated nesting in the U.S. is approximately 68,000 to 90,000 nests per year (NOAA 2011c). Main U.S. nesting beaches are in southeast Florida and Florida Panhandle. Some reported nests in Texas through Alabama (NMFS and USFWS 1991). Exhibits the Type 2 life history pattern, in which early hatchling development occurs in the open oceanic zone, later followed by development in nearshore neritic zones (Bolten 2003).
Green turtle (*Chelonia mydas*)	T,E[b]	Yes	Shallow coastal waters, seagrass beds. Nesting in the U.S. primarily occurs along the central and southeast coasts of Florida where an estimated 200 to 1,100 females nest annually (NOAA 2011d). Exhibits the Type 2 life history pattern, in which early hatchling development occurs in the open oceanic zone, later followed by development in nearshore neritic zones (Bolten 2003).
Hawksbill turtle (*Eretmochelys imbricata*)	E	Yes	Coral reefs, hard-bottom areas in coastal waters; adults not often sighted in northern GOM. Least common of all sea turtles in the GOM; nesting limited to southeast Florida and the Florida Keys (NOAA 2011e). Exhibits the Type 2 life history pattern, in which early hatchling development occurs in the open oceanic zone, later followed by development in nearshore neritic zones (Bolten 2003).
Kemp's ridley turtle (*Lepidochelys kempi*)	E	Yes	Shallow coastal waters, seagrass beds. Nests mainly at Rancho Nuevo, Mexico. Nesting also occurs along the Texas coast and portions of western Florida and Alabama. As many as 127 nests have been recorded annually along coastal Texas since 2000, and as many as 8,000 nests have been recorded annually at Rancho Nuevo, Mexico, since 2000 (NOAA 2011f). Exhibits the Type 2 life history pattern, in which early hatchling development occurs in the open oceanic zone, later followed by development in nearshore neritic zones (Bolten 2003).

TABLE 3.8.3-1 (Cont.)

Species	Status	Juveniles or Hatchlings Potentially Present?	Habitat and Relative Abundance in the Gulf of Mexico
Family Dermochelyidae			
Leatherback turtle (*Dermochelys coriacea*)	E	Yes	Slope, shelf, and coastal waters; considered the most pelagic of the sea turtles. Some nesting in the northern GOM, especially Florida Panhandle; nearest major nesting concentrations are in Caribbean and southeast Florida. In Florida, about 35 nests are observed each year (USFWS 2011f). Exhibits the Type 3 life history pattern, in which both developmental and adult stages occur completely in the open oceanic zone (Bolten 2003).
Family Emydidae			
Alabama red-belly turtle (*Pseudemys alabamensis*)	E	Yes	Known only to occur in southern Alabama and Mississippi in the lower Mobile River system. Known to occur in bays and river inlets along the coast. Nests are made on sand spoil banks, berms, and levees (NatureServe 2012).
Family Testudinidae			
Gopher tortoise (*Gopherus polyphemus*)	C,T[c]	Yes	Occurs in the southeastern Coastal Plain from southern South Carolina to extreme southeastern Louisiana. Populations that are listed as threatened under the Endangered Species Act can occur on upland habitats close to coastal marshes and ridges in Alabama, Louisiana, and Mississippi (USFWS 2011j).
Family Crocodylidae			
American crocodile (*Crocodylus acutus*)	T,E[d]	Yes	In the continental U.S., this species is known from coastal mangrove swamps, brackish bays, and inshore freshwater habitats in southern Florida. Nests at edges of riparian thickets, sandy beaches, or on banks of coastal creeks or mangrove swamps. The crocodile population in Florida is estimated between 1,400 and 2,000 individuals, not including hatchlings (USFWS 2007c).

TABLE 3.8.3-1 (Cont.)

Status: C = candidate species; E = endangered species; and T = threatened species under the Endangered Species Act of 1973.

[a] The loggerhead turtle is currently listed under the ESA as nine distinct population segments (DPSs). The south Atlantic DPS, which occurs in the GOM, is listed as threatened under the ESA (NOAA 2011c).

[b] Green sea turtles are listed as threatened, except in Florida, where breeding populations are listed as endangered.

[c] Within the GOM planning areas, the gopher tortoise is listed as threatened west of the Mobile and Tombigbee Rivers in Alabama, Mississippi, and Louisiana. It is listed as a candidate species east of the Mobile and Tombigbee Rivers in Alabama and Florida.

[d] American crocodiles are listed as threatened in Florida; endangered elsewhere.

TABLE 3.8.3-2 General Sea Turtle Life Stages, Habitats, and Mobility in the Gulf of Mexico[a]

Developmental Stage	Habitat	Mobility
Embryo	Beaches	Stationary
Hatchling	Ocean/*Sargassum*	Passive migration
Juvenile	*Sargassum*/nearshore	Swimmers
Adult	Ocean	Swimmers

[a] These habitat-life-stage relationships are most similar to the Type 2 life history pattern reported in Bolten (2003) and most likely represent the life history of green, hawksbill, Kemp's ridley, and loggerhead sea turtles in the GOM planning areas.

Sea turtles are highly migratory and therefore have a wide geographic range. For this reason, each turtle species has the potential to occur throughout the entire GOM and may occur at suitable nesting beaches along the entire northern GOM coast. Areas of greater coastal and off-shore turtle observations have been provided to the Ocean Biogeographic Information System-Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) (Read et al. 2011) and are shown in Figure 3.8.3-1. Also illustrated in Figure 3.8.3-1 are approximate locations of turtle nesting locations cataloged by the Wider Caribbean Sea Turtle Nesting Beach Atlas (Dow et al. 2007). Most observations and nesting activity occurs along western and northwestern Florida and consists of primarily loggerheads, green, leatherback, and a few Kemp's ridley turtles. There are reports of recent nesting in Alabama (loggerhead, Kemp's ridley, and green turtles) along Dauphin Island and the Gulf Islands National Seashore; in Mississippi (loggerhead turtles) along the Gulf Islands National Seashore; and in Louisiana (loggerhead turtles) within the Breton National Wildlife Refuge (Figure 3.8.3-1). All five sea turtle species have been observed to nest along areas of the Texas coast (Padre Island National Seashore) (NPS 2011). Hatchling turtles found in the offshore waters of the northern GOM may have originated from these nesting beaches or nest beaches in the southern GOM and Caribbean Sea. Juvenile turtles may move into shallow water developmental habitats across the entire northern GOM. In some species or populations, adult foraging habitats may be geographically distinct from their developmental habitats (Musick and Limpus 1997).

There are no designated critical habitats or migratory routes for sea turtles in the northern GOM. However, many coastal areas of the GOM may be used as preferred habitats (i.e., important sensitive habitats that are essential for the species within a specific geographic area). For example, seagrass beds in Texas lagoons and other nearshore or inshore areas (including jetties) for green sea turtles (Renaud et al. 1995) and bays and lakes, especially in Louisiana and Texas, for Kemp's ridley sea turtles. *Sargassum* mats are also recognized as preferred habitat for hatchlings (Carr and Meylan 1980). In general, however, the entire GOM coastal and nearshore areas can serve as habitat for marine turtles, as shown in the plot of marine turtle potential habitat from the USGS's GAP database in Figure 3.8.3-1.

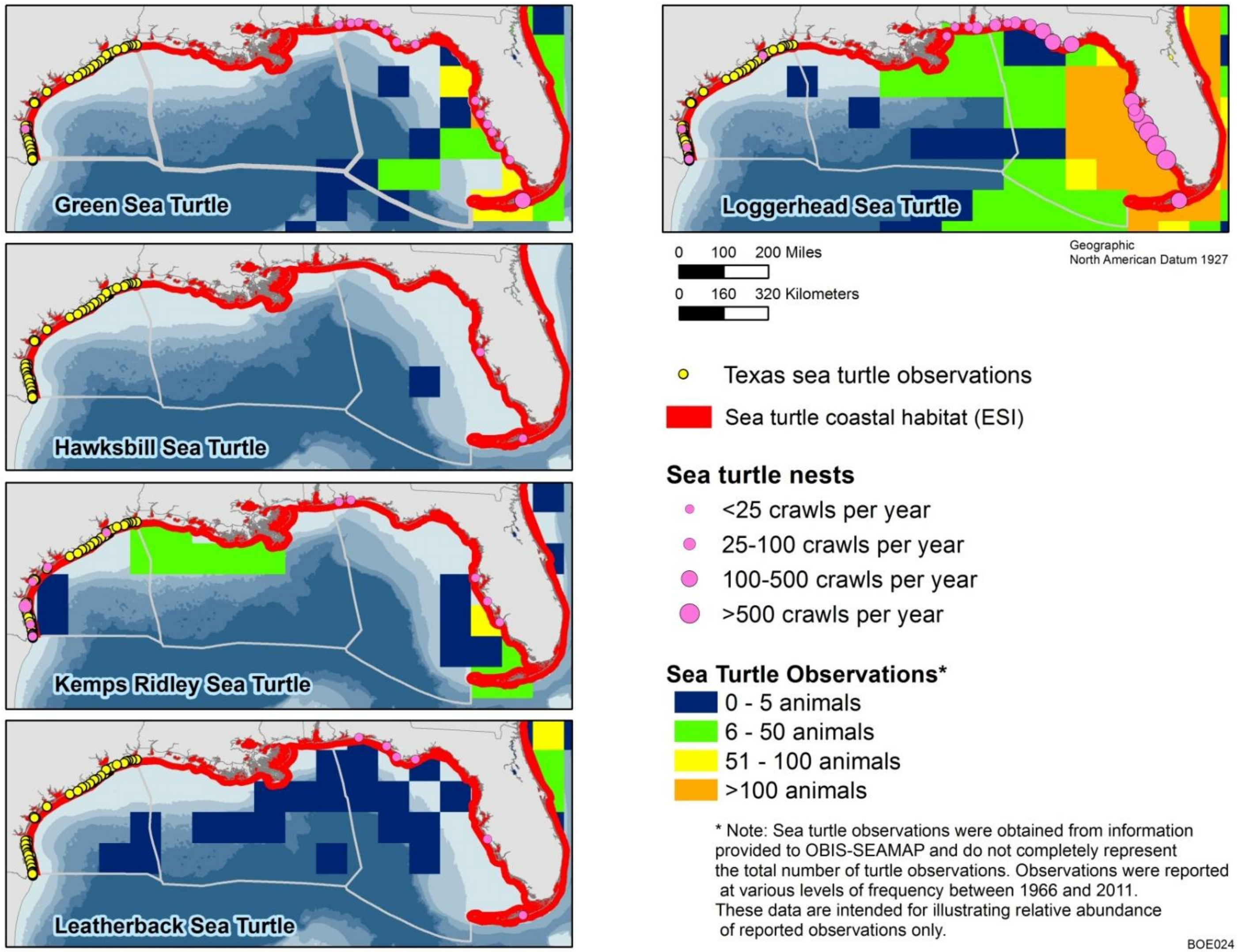

FIGURE 3.8.3-1 Reported Observations of Sea Turtles and Suitable Habitat in the GOM (data presented in these maps were obtained from various sources including the Environmental Sensitivity Index [NOAA 1996], OBIS-SEAMAP [Read et al. 2011], Texas General Land Office [TGLO 2012], and the Wider Caribbean Sea Turtle Nesting Beach Atlas [Dow et al. 2007])

The Alabama red-belly turtle occurs in southern Alabama and Mississippi in the lower Mobile River system. It is most common in backwater habitats of the upper Mobile Bay in areas with submerged vegetation. It also occurs in river channels and brackish water and salt marsh areas of the lower Mobile River system. This species does not occur in pelagic regions of the GOM. Nesting occurs on sand spoil banks, berms, and levees (NatureServe 2012). Critical habitat for this species has not been designated. County-level occurrences of the Alabama red-belly turtle are shown in Figure 3.8.3-2.

The gopher tortoise occurs in the southeastern Coastal Plain from southern South Carolina to extreme southeastern Louisiana. Populations of the gopher tortoise have been divided into eastern and western regions. Populations in the eastern region occur east of the Mobile and Tombigbee Rivers in Alabama, Florida, Georgia, and South Carolina. Populations in the western region occur west of the Mobile and Tombigbee Rivers in Alabama, Mississippi, and Louisiana. Populations in the eastern region are currently not listed as threatened or endangered under the ESA (these populations are candidates for listing); however, populations in the western region are listed as threatened under the ESA (USFWS 2011j). Populations in the western region that are listed as threatened under the ESA can occur on upland habitats close to coastal marshes and ridges in Alabama, Mississippi, and Louisiana. Critical habitat for this species has not been designated. County-level occurrences of threatened populations of the gopher tortoise are shown in Figure 3.8.3-2.

The American crocodile occurs in the continental U.S. in southern Florida. It primarily inhabits coastal mangrove swamps, brackish bays, and inshore freshwater habitats. This species does not occur in pelagic regions of the GOM. Nesting occurs in riparian thickets, swamps, beaches, or along creeks. Designated critical habitat for the American crocodile occurs in southern Florida, including Everglades National Park and the Florida Keys. Areas of suitable habitat for the American crocodile, determined by the Environmental Sensitivity Index (NOAA 1996), as well as county-level occurrences of the species, are illustrated in Figure 3.8.3-2.

3.8.3.1.1 Factors That Could Affect Baseline Conditions during the Program.

Extreme Weather Events. Hurricanes Katrina and Rita, which hit the GOM coast in August and September 2005, respectively, adversely affected sea turtle habitats. Some nesting sites (approximately 50 nests) for Kemp's ridley sea turtles were destroyed along the Alabama coast (Congressional Research Service 2005; USFWS 2006c), and the loss of beaches through the affected coastal areas has probably affected other existing nests and nesting habitats of this species as well as the loggerhead turtle. Similarly, impacts to seagrass beds may affect the local distribution and abundance of species that use these habitats, such as the green sea turtle and the Kemp's ridley sea turtle.

Catastrophic Oil Spills. The recent oil spill associated with the DWH event may have had detrimental consequences to sea turtles that had direct contact with spilled oil. Following the DWH event, a total of 1,146 sea turtles were recovered from the GOM that had come in contact with or were located in areas that were once in the vicinity of spilled oil. The recovered turtles

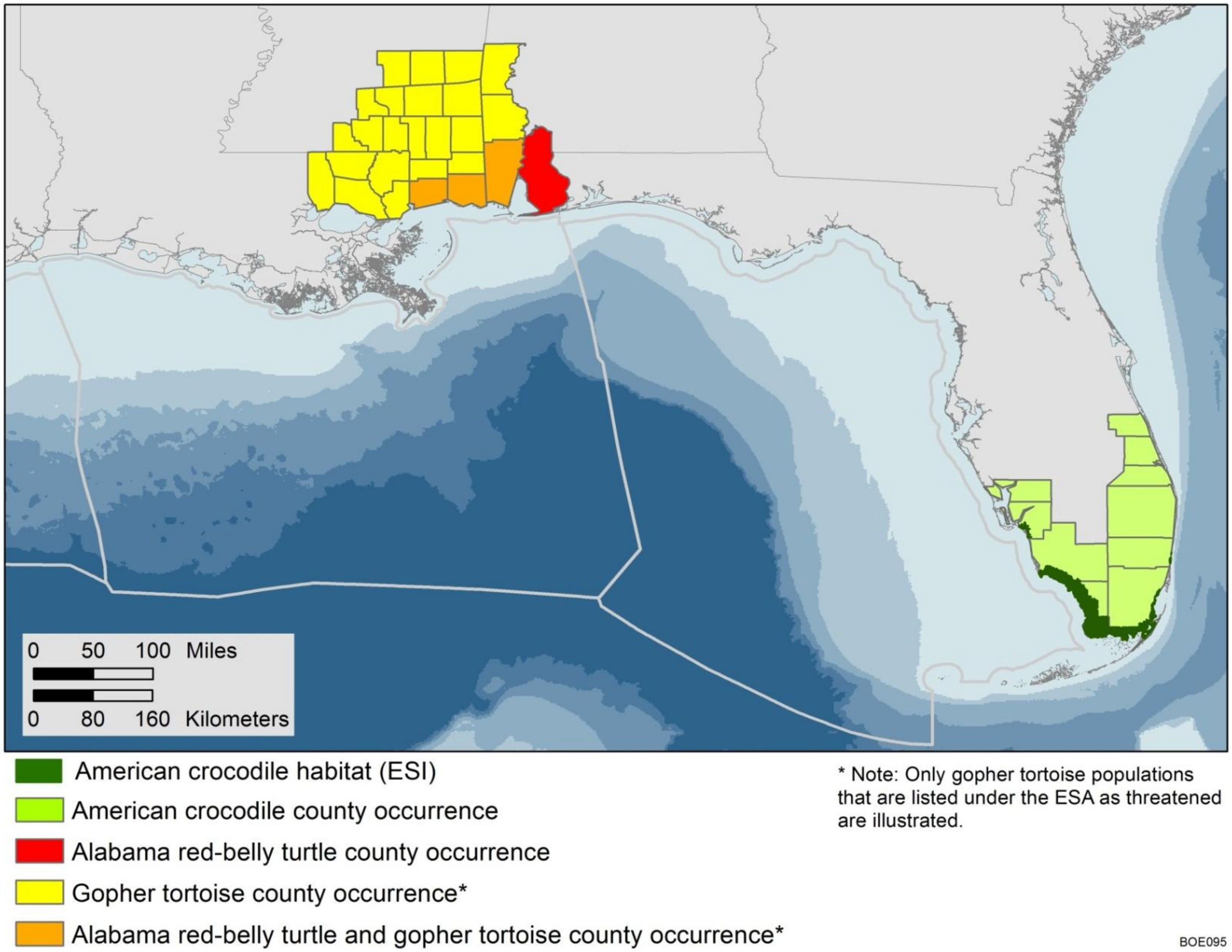

FIGURE 3.8.3-2 Reported County-Level Occurrences and Suitable Habitat for the American Crocodile, Alabama Red-belly Turtle, and Gopher Tortoise in the GOM Planning Areas (NOAA 1996; USFWS 2011d)

included adults or free-swimming juveniles of four species: green, hawksbill, Kemp's ridley, and loggerhead. However, the species of some recovered sea turtles could not be identified (Table 3.8.3-3). Of the total number of turtles recovered, approximately 53% were found dead and approximately 47% were found alive. Most of the recovered sea turtles (dead or alive) were Kemp's ridley sea turtles (Table 3.8.3-3). Approximately 85% of the live turtles recovered were visibly oiled; approximately 3% of the dead turtles recovered were visibly oiled (NOAA 2012a). The cause of death of the deceased turtles remains unclear, but it is possible for turtles to ingest or inhale oil that could be potentially fatal without any noticeable external indications.

The DWH event also had the potential to affect sea turtle populations by fouling habitats such as seagrass beds and nesting beaches. Preliminary reports from the NOAA Natural Resource Damage Assessment Team have indicated that about 1,600 km (1,000 mi) of shoreline along the GOM has tested positive for oil, including salt marshes, beaches, mudflats, and mangroves (NOAA 2010b). The presence of oil in these areas likely affected foraging and nesting habitats for sea turtles, although the true ecological consequences of these effects are not known. This information, however, is not needed at the programmatic stage to make a reasoned choice among alternatives (see Section 1.4, Analytical Issues).

As a measure to prevent oil fouling of turtle nests and hatchlings, sea turtle nests along the GOM were collected and hatchlings were translocated to eastern Florida along the Atlantic coast. In total, turtle nests of three species were translocated following the DWH event: green, Kemp's ridley, and loggerhead. Nests of the Kemp's ridley turtle were most commonly translocated (Table 3.8.3-3) (NOAA 2012b).

Catastrophic spills such as the DWH event have the potential to affect other reptile species that may inhabit coastal or estuarine environments. Such species in the GOM Planning Areas include the American crocodile (*Crocodylus acutus*). This species inhabits brackish and freshwater environments and is primarily known to occur in coastal mangrove swamps in southern Florida (Table 3.8.3-3). Depending upon location and magnitude, catastrophic oil spills in the GOM have the potential to affect coastal mangrove and beach habitats in southern Florida for the American crocodile. However, there is no evidence that the DWH event affected habitat for this particular species.

3.8.3.2 Climate Change Effects on Reptiles

Climate change also has the potential to affect marine and coastal reptile species in the GOM Planning Areas over the next 40–50 yr. Climate change effects, including warming air and water temperatures, rising sea levels, and more intense storms, have been reported in many U.S. coastal regions. These climate change effects have been scientifically correlated with atmospheric concentrations of greenhouse gases. Rising water temperatures, increased sea levels, and intense storms may affect the availability and suitability of foraging and nesting habitats for coastal and marine reptiles (Hawkes et al. 2009). For reptiles that rely on temperature to determine the gender of offspring in incubating eggs (referred to as temperature-dependent sex determination), including turtles and crocodilians, subtle increases in atmospheric temperatures could skew sex ratios of hatchlings, which could have future population

TABLE 3.8.3-3 Sea Turtle Species Recovered, Turtle Nests Translocated, and Turtle Hatchlings Released in the Atlantic Ocean Following the Deepwater Horizon Event

Species	Recovered Alive	Recovered Dead	Total Recovered	Translocated Nests	Hatchlings Released
Green turtle (*Chelonia mydas*)	172	29	201	4	455
Hawksbill turtle (*Eretmochelys imbricata*)	16	0	16	0	0
Kemp's ridley turtle (*Lepidochelys kempii*)	328	481	809	5	125
Loggerhead turtle (*Caretta caretta*)	21	67	88	265[a]	14,216
Unknown turtle species	0	32	32	0	0
Total	537	609	1,146	274	14,796

[a] Does not include one nest that included a single hatchling and no eggs.

Source: NOAA 2012b.

implications (Walther et al. 2002). It is also predicted that global warming and increased precipitation rates associated with climate change will cause sea levels to rise (Church et al. 2001). This phenomenon could alter or eliminate sea turtle coastal habitat in many areas (Hawkes et al. 2009). For example, a study in Hawaii predicted that as much as 40% of green sea turtle nesting habitat could be affected with a 0.9-m (2.7-ft) sea level rise (Baker et al. 2006).

3.8.4 Fish

3.8.4.1 Gulf of Mexico

In the northern GOM, fish assemblages can be categorized by habitat use. Demersal fishes live on the seafloor and near bottom waters and are distinct from pelagic fishes, which reside in the water column. Within these categories, fish can be further classified by their depth preference and their location along the gradient from the continental shelf to the abyssal plain. Habitat use also varies across life stages. For example, many species of both pelagic and demersal fish inhabit coastal estuaries during their early life stages to take advantage of the shelter and abundant food resources provided by coastal habitat. Similarly, demersal fishes may spend their egg and larval stages in the upper water column, where phytoplankton resources are concentrated, before ultimately moving to bottom waters. There are also unique categories of fish, for example, diadromous species (fish migrating between fresh and salt water) that spend most of their adulthood in saltwater but spawn in freshwater (anadromous) or that live primarily in freshwater and spawn in saltwater (catadromous).

3.8.4.1.1 Diadromous Fishes. There are three anadromous fish species in the GOM: Gulf sturgeon (*Acipenser oxyrinchus desotoi*), striped bass (*Morone saxatilis*), and Alabama shad (*Alosa alabamae*). Anadromous species spawn in rivers but spend part of their lives in oceans. Gulf sturgeon populations have declined in the last century and they are now a federally listed threatened species. Striped bass are native to rivers entering the GOM from Florida to Texas, although existing data suggests their numbers were historically small and not sufficient to support a large commercial fishery. Striped bass populations began declining earlier this century, and by the mid-1960s had disappeared from all GOM rivers except for the Apalachicola-Chattahoochee-Flint River System and the Mobile-Alabama-Tombigbee River System of Alabama, Florida, and Georgia (GSMFC 2006). The decline has been attributed to pollution and dams that reduced access to spawning habitat and created adverse hydrologic conditions for eggs. The USFWS and the GOM States initiated cooperative efforts to restore and maintain striped bass populations in the late 1960s, primarily through stocking of hatchery-raised fingerlings, and this effort continues today.

The historic range of Alabama shad was similar to that of the striped bass but extended well up the Mississippi River drainage. Populations of Alabama shad have declined significantly over the years, and they were designated a species of concern by the NMFS in 1997 (http://www.nmfs.noaa.gov/pr/pdfs/species/alabamashad_detailed.pdf). Spawning populations exist in the Apalachicola River, Florida; the Choctawhatchee and Conecuh Rivers, Alabama; and the Pascagoula River, Mississippi. Dams that have been built on many southeastern rivers are thought to be a major reason for the decline of anadromous fish species in the GOM. Little is known about their distribution or habitat use in marine environments.

The catadromous American eel (*Anquilla rostrata*) also occurs within waters of the GOM, with young and maturing individuals found in nearly all the rivers, bays, lakes, and estuaries associated with the GOM. Adult American eels spend most of their lives in freshwater but eventually swim to the Sargasso Sea where they spawn and die (Eales 1968). The young eventually migrate to inland waters. Commercial fishing has significantly reduced eel numbers, and in September of 2011, the USFWS announced the initiation of a status review of the American eel to determine if a listing under the Endangered Species Act is warranted (50 CFR Part 17: 60431–60444).

3.8.4.1.2 Pelagic Fishes. Coastal pelagic fishes include larger predatory species such as mackerels (*Scomberomorus* spp.), bluefish (*Pomatomus saltatrix*), cobia (*Rachycentron canadum*), dolphin fish (*Coryphaena hippurus*), jacks (family Carangidae), and little tunny (*Euthynnus alletteratus*), as well as smaller forage species such as Gulf menhaden (*Brevoortia patronus*), Atlantic thread herring (*Opisthonema oglinum*), Spanish sardine (*Sardinella aurita*), round scad (*Decapterus punctatus*), and anchovies (family Engraulidae). Coastal pelagic species typically form schools, undergo migrations, grow rapidly, mature early, and exhibit high fecundity. These species are either managed by GMFMC or are important prey fish for other species. The larger predatory species may be attracted to large concentrations of anchovies, herrings, and silversides (family Atherinidae) that sometimes congregate in nearshore areas.

Fish inhabiting oceanic waters can be divided into epipelagic, mesopelagic, and bathypelagic, on the basis of their depth preference. Epipelagic fishes inhabit the upper 200 m (700 ft) of the water column in oceanic waters, typically beyond the continental shelf edge (Bond 1996). In the GOM, this group includes several shark species, swordfish (family Xiphiidae), billfishes (family Istiophoridae), flyingfish (*Parexocoetus brachypterus*), halfbeaks (family Hemiramphidae), jacks, dolphinfish, and tunas (family Scombridae). A number of the epipelagic species, such as dolphin fish, sailfish (*Istiophorus albicans*), white marlin (*Tetrapturus albidus*), blue marlin (*Makaira nigricans*), and tunas, are in decline and have important spawning habitat in the GOM. All of these epipelagic species are migratory, but specific patterns are not well understood. Many oceanic species are associated with floating seaweed (*Sargassum* spp.), jellyfishes, siphonophores, and driftwood, because they provide forage and/or nursery habitat. Most fish associated with floating seaweed are temporary residents, for example, juveniles of species that reside in shelf or coastal waters as adults. However, several larger species, such as dolphinfish, tuna, and wahoo, feed on the small fishes and fish attracted to *Sargassum* (GMFMC 2004).

Below the epipelagic zone, the water column may be layered into mesopelagic (200–1,000-m [656–3,281-ft]) and bathypelagic (>1,000-m [>3,281-ft]) zones. Recent surveys over the continental slope found 126 species (30 families) of juvenile and adult mesopelagic fishes, which were numerically dominated by lanternfishes (family Myctophidae), bristlemouths (family Gonostomatidae), and hatchetfishes (family Sternoptychidae) (Ross et al. 2010). Mesopelagic fishes spend the daytime at depths of 200–1,000 m (656–3,281 ft), but migrate vertically at night into food-rich near-surface waters. Mesopelagic fishes, while less commonly known, are important ecologically because they transfer significant amounts of energy between mesopelagic and epipelagic zones over each daily cycle. The lanternfishes are also important prey for meso- and epipelagic predators (e.g., tunas) (Hopkins et al. 1996).

Deeper dwelling (bathypelagic) fishes inhabit the water column at depths greater than 1,000 m (3,000 ft). This group is composed of little-known species such as snipe eels (family Nemichthyidae), slickheads (family Alepocephalidae), bigscales (family Melamphaidae), and whalefishes (family Cetomimidae) (McEachran and Fechhelm 1998; Rowe and Kennicutt 2009). Most species are capable of producing and emitting light (bioluminescence) to aid communication. In general, deep-water species produce demersal eggs (Bond 1996) that are attached to the substrate.

3.8.4.1.3 Demersal Fishes. Demersal fish in the GOM can be generally characterized as soft-bottom fishes or hard-bottom fishes, according to their association with particular substrate types. Soft-bottom habitat is relatively featureless and has much lower species diversity than the more structurally complex hard bottom habitat. Thus species richness is lower in the Central and Western Planning Area compared to the Eastern Planning Area, where hard-bottom habitat is abundant.

In recent trawl surveys, Atlantic croaker (*Micropogonias undulatus*), longspine porgy (*Stenotomus caprinus*), and Atlantic bumper (*Chloroscombrus chrysurus*) were the most abundant demersal soft-bottom fishes on the continental shelf from south Texas to Alabama (Table 3.8.4-1; SEAMAP 2010). However, geographic divisions exist because soft-bottom fishes generally prefer certain types of sediments over others; this tendency led to the naming of three primary fish assemblages according to the dominant shrimp species found in similar sediment/depth regimes (Chittenden and McEachran 1976; reviewed in GMFMC 2004). In the GOM, pink shrimp are found in waters up to about 45 m (148 ft) over calcareous sediments. Common members of the pink shrimp assemblage include Atlantic bumper, sand perch (*Diplectrum formosum*), silver jenny (*Eucinostomus gula*), dusky flounder (*Syacium papillosum*), and pigfish (*Orthopristis chrysoptera*). This assemblage is typified by the west Florida shelf in the Eastern Planning Area. Fishes associated with brown shrimp and white shrimp are found on more silty sediments and are typical of the Western and Central Planning Areas. The brown shrimp assemblage extends to 91 m (299 ft). Porgies (family Sparidae), searobins (family Triglidae), batfish (family Ogcocephalidae), goatfish (family Carangidae), lefteye flounders (family Bothidae), lizardfishes (family Synodontidae), butterfishes (family Stromateidae), cusk-eels (family Ophidiidae), toadfishes (family Batrachoididae), and scorpionfishes (family Scorpaenidae) characterize the brown shrimp assemblage. The white shrimp assemblage exists in 3.5 to 22 m (11 to 72 ft) of water, and dominant fish include drums (family Scianenidae), Atlantic croaker, snake mackerels (family Trichiuridae), threadfins (family Polynemidae), sea catfishes (family Ariidae), herrings (family Clupeidae), jacks (family Carangidae), butterfishes (family Stromateidae), and flounders (family Bothidae). Many fish species in the white and brown shrimp assemblages spawn in shelf waters and spend their early life stages in estuaries (GMFMC 2004).

Another important habitat for demersal fishes on the continental shelf is the hard bottom. The term “hard bottom” generally refers to exposed rock, but can refer to other substrata such as coral and clay, or even artificial structures. Reef fishes such as sea basses (family Serranidae), snappers (family Lutjanidae), grunts (family Haemulidae), porgies (family Sparidae), squirrelfishes (family Holocentridae), angelfishes (family Pomacanthidae), damselfishes (family Pomacentridae), butterflyfishes (family Chaetodontidae), surgeonfishes (family Acanthuridae), parrotfishes (family Scaridae), and wrasses (family Labridae) inhabit hard-bottom habitats in the GOM (Dennis and Bright 1988). Recent surveys of reef fish from Texas to Florida indicate vermillion snapper (*Rhomboplites aurorubens*), red snapper (*Lutjanus campechanus*), and red porgy (*Pagrus pagrus*) are the most abundant large reef fish (Table 3.8.4-2; SEAMAP 2010).

Although reef fish are associated with hard-bottom habitat as adults, some species can be found over soft sediments as well. Like soft sediment species, many hard-bottom demersal fish are estuarine dependent and spend their juvenile states in coastal habitat. Oil and gas platforms serve as artificial hard-bottom sites and attract reef-associated species. Almaco jack, amberjack, red snapper, gray snapper (mangrove snapper), and gray triggerfish dominate the large fish assemblage near the platforms in the GOM (Stanley and Wilson 1997). Fish density is elevated near the platforms but declines to background densities within 10–50 m (33–164 ft) of the structure (Stanley and Wilson 1997).

TABLE 3.8.4-1 The Ten Most Abundant Demersal Fish Species in Trawl Surveys of the Continental Shelf from Texas to Alabama

Species	Total number	% Frequency[a]
Summer		
Atlantic croaker (*Micropogonias undulates*)	119,000	52.0
Longspine porgy (*Stenotomus caprinus*)	77,667	69.9
Atlantic bumper (*Chloroscombrus chrysurus*)	44,374	48.9
Blackwing sea robin (*Prionotus rubio*)	10,610	37.8
Gulf butterfish (*Peprilus burti*)	9,531	46.0
Largescale lizard fish (*Saurida brasiliensis*)	8,989	40.6
Silver seatrout (*Cynoscion nothus*)	8,230	33.8
Striped anchovy (*Anchoa hepsetus*)	6,381	25.6
Atlantic cutlassfish (*Trichiurus lepturus*)	5,869	34.4
Blackear bass (*Serranus atrobranchus*)	5,219	28.7
Fall		
Atlantic croaker (*Micropogonias undulates*)	74,515	70.2
Longspine porgy (*Stenotomus caprinus*)	38,520	61.0
Atlantic bumper (*Chloroscombrus chrysurus*)	13,713	37.9
Silver seatrout (*Cynoscion nothus*)	99,881	50.6
Shoal flounder (*Syacium gunteri*)	9,874	53.7
Spot (*Leiostomus xanthurus*)	8,666	45.5
Blackear bass (*Serranus atrobranchus*)	7,328	27.0
Inshore lizardfish (*Synodus foetens*)	5,580	60.4
Star drum (*Stellifer lanceolatus*)	5,440	18.8
Bigeye searobin (*Prionotus longispinosus*)	4,510	31.2

[a] Percentage of all trawls in which the species was collected.

Source: SEAMAP 2010.

The deep-sea demersal fish fauna occur from the shelf-slope transition down to the abyssal plain in the GOM. Recent trawl studies sponsored by BOEM have investigated deep-sea demersal fish assemblages from the edge of the continental shelf to the abyssal regions (Rowe and Kennicutt 2009). Overall, 119 species were collected and distinct depth-species relationships were observed. The most diverse group are the cod-like fishes such as hakes and grenadiers (family Macrouridae), followed by cusk-eels (family Ophidiidae) and slickheads (Alepocephalidae). In general, water depth and proximity to canyons were the primary determinants of community structure. Fish species richness and abundance were highest in the upper and mid slope. Across the station transects, the abundance and diversity of fishes was greatest near the Mississippi Trough and the DeSoto Canyon and lowest at the stations to the west of the Mississippi River (Rowe and Kennicutt 2009).

There are many ongoing studies, but little data available, regarding impacts on fish from the DWH event. The spill has the potential to cause population-level impacts on fish species, particularly species that have already depressed populations or early life stages that rely heavily on marine and coastal habitats affected by the spill. However, The Atlantic Bluefin Tuna Status

TABLE 3.8.4-2 The Ten Most Abundant Reef Fish Species Collected in SEAMAP Trap Collections from South Texas to South Florida

Species	Total Number	% Frequency[a]
Vermillion snapper (*Rhomboplites aurorubens*)	210	1.5
Red snapper (*Lutjanus campechanus*)	139	2.3
Red porgy (*Pagrus pagrus*)	45	2.0
Red grouper (*Epinephelus morio*)	24	1.7
Gray triggerfish (*Balistes capriscus*)	6	0.6
Lane snapper (*Lutjanus synagris*)	6	0.3
Bank sea bass (*Centropristis ocyura*)	5	0.3
Greater amberjack (*Seriola dumerili*)	4	0.3
Whitebone porgy (*Calamus leucosteus*)	3	0.3
Scamp (*Mycteroperca phenax*)	3	0.3

[a] Percentage of all traps in which the species was collected.

Source: SEAMAP 2010.

Review Team estimated that the DWH event, under a worst-case scenario, would reduce the 2010 bluefin tuna year class by 20%, which would result in up to a 4% reduction in spawning biomass (Atlantic Bluefin Tuna Status Review Team 2011).

OSAT reported that less than 1% of sediment and water column samples from offshore and deepwater areas contained PAH concentrations exceeding the USEPA's toxicity benchmarks for aquatic life (OSAT 2010), and extensive sampling of snappers, porgies, groupers, tuna, dolphin fish, wahoo, jack, and swordfish in Federal waters for PAHs and dispersants did not find evidence of contamination (Ylitalo et al. 2012). While these data suggest large-scale contamination is not an ongoing problem, localized impacts, particularly in heavily oiled marshes in Louisiana, may be significant. Whitehead et al. (2011) studied Gulf killifish (*Fundulus grandis*) from Louisiana marshes that were exposed to oil from the DWH event. He found killifish collected from oiled sites had higher expression of genes indicative of oil exposure, and hyperplasia of gill tissue (Whitehead et al. 2011). These effects were observed up to at least 2 months after exposure to oil. The long-term population-level effects are unclear. Several years may be required to fully assess the impacts of the DWH event on fish populations, given the lag between fish hatching and recruitment. This information, however, is not needed at the programmatic stage to make a reasoned choice among alternatives (see Section 1.4, Analytical Issues). The few initial studies suggest that, despite occurring during the spawning period for many GOM fishes, the DWH event did not have an immediate negative impact on fish populations (including juvenile age classes, although there remains the potential for long-term populations impacts from sublethal and chronic exposure (Fodrie and Heck 2011).

3.8.4.1.4 Species Listed under the Endangered Species Act.

Gulf Sturgeon. The Gulf sturgeon (*Acipenser oxyrinchus desotoi*) is a geographic subspecies of the Atlantic sturgeon. The Gulf sturgeon is an anadromous fish that migrates from the sea upstream into coastal rivers to spawn in freshwater. Historically, it ranged from the Mississippi River to Charlotte Harbor and Florida Bay; today, this range has contracted to encompass major rivers and inner shelf waters from the Mississippi River to the Suwannee River, Florida (USFWS and NMFS 2009). Populations have been depleted or driven to localized extirpation by fishing, boat collision, shoreline development, dredging, erosion, dam construction, declining water quality, and the species' low population growth rate (USFWS and NMFS 2009). These declines prompted the listing of the Gulf sturgeon as a threatened species in 1991 (56 FR 49653). Subsequently, a recovery plan was developed to ensure the preservation and protection of Gulf sturgeon spawning habitat (USFWS and Gulf States Marine Fisheries Commission 1995).

Females lay large numbers of eggs (>3 million) usually in deep areas or holes with hard bottoms and where some current is present (Sulak and Clugston 1998; Fox et al. 2000). The young fish remain in freshwater reaches of the rivers for about 2 yr, then begin to migrate back downstream to feed in estuarine and marine waters. The adults spend March through October in the rivers and November through February in estuarine or shelf waters. Near the river mouths and on the inner continental shelf, adults feed on clams, snails, crabs, shrimps, worms, brachiopods, amphipods, isopods, and small fishes (Gilbert 1992). Genetic studies show that the populations among different rivers are fairly distinct and that the Gulf sturgeon may even be river-specific (Stabile et al. 1996). In marine waters, however, Gulf sturgeon from different river systems were found to inhabit the same winter foraging grounds along the GOM barrier islands (Ross et al. 2009). In marine and estuarine habitats, Gulf sturgeon are found over coarse sand and shell substrates in clear and well oxygenated waters less than 7 m (23 ft) deep (Ross et al. 2009).

Currently, seven rivers are known to support reproducing populations of Gulf sturgeon (USFWS and NMFS 2009). After a review by NMFS in 2003, critical habitat for Gulf sturgeon was designated (68 FR 13370) and includes multiple areas of riverine, estuarine, and marine habitat from Louisiana to the Florida Panhandle (Figure 3.8.4-1). The 14 critical habitat units include the Pearl River Unit; the Pascagoula River Unit; the Escambia River Unit; the Yellow River Unit; the Choctawhatchee River Unit; the Apalachicola River Unit; the Suwannee River Unit; the Lake Pontchartrain, Lake St. Catherine, Rigolets, Little Lake, Lake Borgne, and Mississippi Sound Unit; the Pensacola Bay Unit; the Santa Rosa Sound Unit; the Florida Nearshore Unit; the Choctawhatchee Bay Unit; the Apalachicola Unit; and the Suwannee Sound Unit. Approximately 2,783 km (1,730 mi) of rivers and 6,042 km^2 (2,333 mi^2) are designated as critical habitat for the Gulf sturgeon. Detailed descriptions of these habitats can be found in 68 FR 13370–13495. Recent trends in abundance over the last decade indicate populations in Florida rivers are stable or increasing slightly. Populations in Mississippi and Louisiana Rivers are unknown due to the lack of recent comprehensive surveys (USFWS and NMFS 2009).

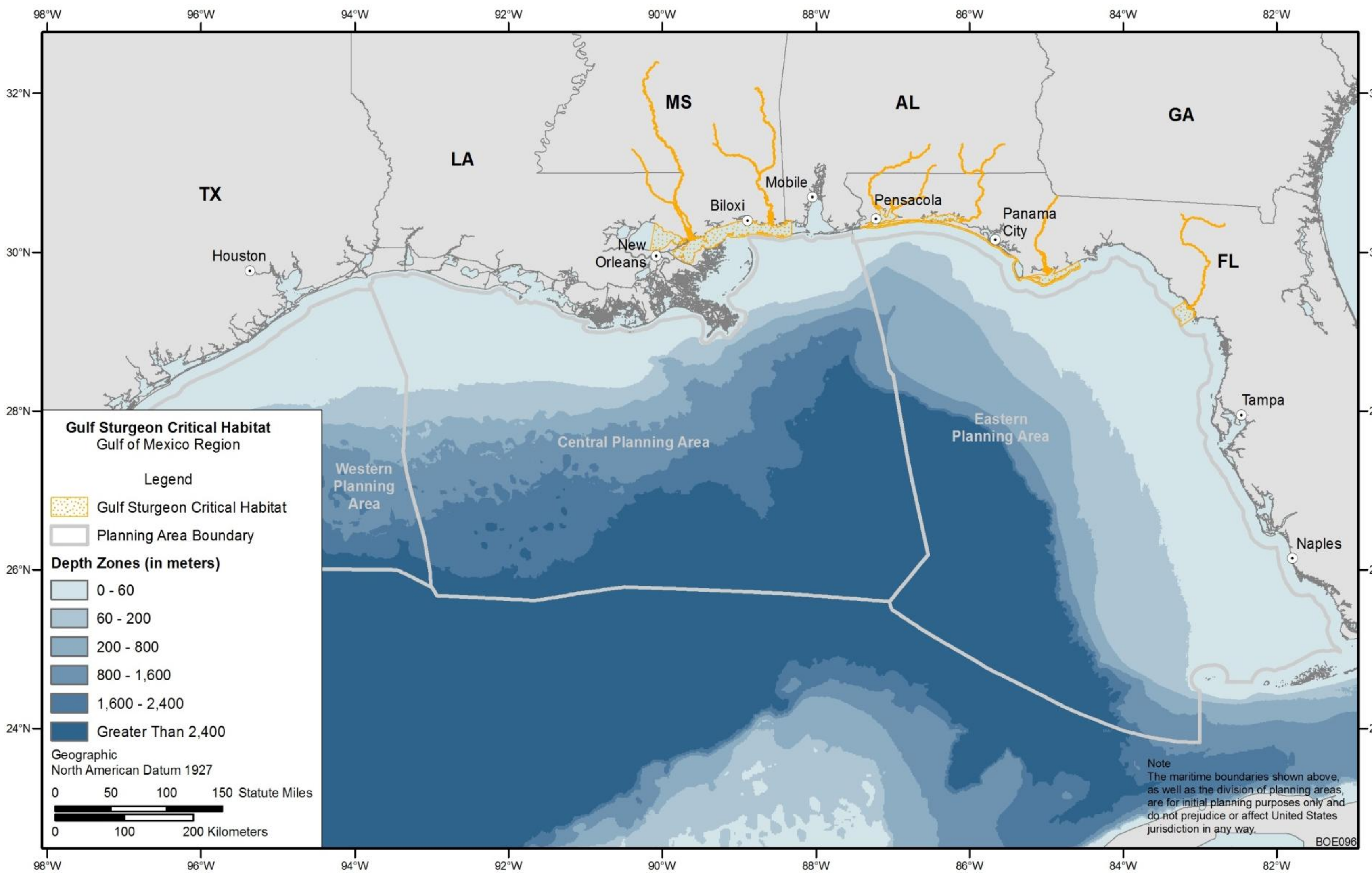

FIGURE 3.8.4-1 Gulf Sturgeon Critical Habitat

Smalltooth Sawfish. The smalltooth sawfish (*Pristis pectinata*) was listed as federally endangered in 2003 (68 FR 15674). Smalltooth sawfish are usually found over muddy and sandy bottoms in sheltered bays, on nearshore shallow banks, and in estuaries or river mouths at all ages (NMFS 2009). Juveniles appear to prefer shallow mud or sand bottom (often less than 1 meter [3 ft]) as well as mangrove root habitat. As they grow, sawfish move to deeper water, and large adults can be found in marine waters in depths up to at least 122 m (400 ft). Smalltooth sawfish take more than 10 yr to reach maturity. They are livebearers, producing litters of 15 to 20 pups. Small fish and benthic invertebrates compose most of their diets. The decline in smalltooth sawfish abundance has been largely attributed to their capture as bycatch in various fisheries, loss and limited availability of appropriate habitat, and the species' low reproductive rate. Historically, smalltooth sawfish were common throughout the GOM from Texas to Florida. However, the current range of this species has contracted to peninsular Florida, and, although no accurate estimates of abundance are available, smalltooth sawfish are now relatively common only in the Everglades region at the southern tip of the State. In the Western and Central Planning Areas, smalltooth sawfish were relatively abundant as recently as the 1960s, but are now rare. Most recent records from Texas or the Florida Panhandle occur from April to August only, suggesting that most smalltooth sawfish are not resident, but rather seasonal migrants to the northern GOM from south Florida or Mexico (NMFS 2009). Critical habitat for the smalltooth sawfish was designated in October 2, 2009 (74 FR 45353), and consists of two units: the Charlotte Harbor Estuary Unit and the Ten Thousand Islands/Everglades Unit (TTI/E). The two units are located along the southwestern coast of Florida between Charlotte Harbor and Florida Bay, in the Eastern Planning Area. There is no critical habitat for smalltooth sawfish located in the Central or Western Planning Areas.

3.8.4.1.5 Climate Change. Climate change could affect fish communities through direct physiological action, through habitat loss, and by altering large-scale oceanographic and ecosystem processes (Twilley et al. 2001; Rosenzweig et al. 2007; Portner and Peck 2010). At the level of individual behavior and physiology, increasing water temperature could alter reproductive rates by speeding growth and altering the timing of migrations (including reproductive movements). Fish could also be forced to move to other areas if temperatures rise above their physiological tolerance. Higher temperatures may also increase the spread and virulence of new and existing pathogens. Fish in river-influenced systems such as the GOM would be particularly susceptible to changes in salinity, turbidity, and temperature linked to changes in the hydrology of the Mississippi River and Atchafalaya River. In addition, aqueous concentrations of CO_2 projected to exist under certain climate change scenarios have been demonstrated to reduce the fitness of fish by reducing their ability to detect predators and adult habitat using olfactory and auditory cues (Munday et al. 2009, 2010).

In addition to direct physiological stress, climate change could reduce or eliminate critical fish habitats. Many fish in the GOM, including commercially important species, are estuarine-dependent, meaning they spend some portion of their life in estuarine waters. The predicted rise in sea level and increased storm frequency and severity could accelerate the loss of critical estuarine habitats such as salt marshes, lagoons, and barrier islands (Trenberth et al. 2007; CCSP 2009). In offshore areas, climate change may increase the size of the GOM "dead zone," reducing the amount of benthic habitat available to demersal fishes

(Rabalais et al. 2010). However, the extent and duration of hypoxia could also be decreased by the projected increase in tropical storms (Rabalais et al. 2010). Similarly, reef fish could suffer habitat loss if coral reefs decline as predicted by most climate change scenarios because of increased temperatures and/or ocean acidification (Hoegh-Guldberg et al. 2007).

Large-scale changes in oceanographic and ecosystem processes resulting from climate change could indirectly affect fish population in the GOM in several ways. For example, climate is a key determinant of fish abundance because climate influences critical recruitment processes such as the transport of larval fishes and the amount and seasonality of planktonic food resources. In addition, rising ocean temperatures could promote the expansion and establishment of tropical fish or allow the establishment of non-native fishes introduced by human activities. These species could in turn displace existing species and create changes in food web dynamics. Some have also speculated that climate change could increase the abundance of jellyfish, which prey heavily on fish larvae (Purcell et al. 2007). However, evidence for this hypothesis is limited (Purcell et al. 2007). Overall, predictions about the indirect effects of climate change on fish populations are subject to great uncertainty, given the complexity and compensatory mechanisms of the ecosystem (see Section 1.4.2, Incomplete and Unavailable Information).

3.8.4.2 Alaska – Cook Inlet

Waters of South Alaska support at least 314 fish species representing 72 families (Mecklenburg et al. 2002), and most of these species can be found in Cook Inlet. Fish species within Cook Inlet have a variety of habitat preferences and life history traits. Demersal fishes exist on the sea floor and near bottom waters and are distinct from pelagic fishes, which exist in the water column. In addition, there are anadromous fishes that that spend their adulthood in saltwater but spawn in freshwater.

3.8.4.2.1 Diadromous Fishes. Cook Inlet serves as a critical migratory corridor and early-life rearing area for several fish species, including all five species of Pacific salmon (Shields 2010a). Salmonids spawn in freshwater, where their eggs and juveniles develop and eventually migrate to the ocean as smolts. Salmon grow to maturity in the ocean and then return to their natal stream to spawn and die. Dolly Varden and steelhead trout also migrate through Cook Inlet; their life histories are similar to Pacific salmon, except that they are capable of spawning more than once and therefore make multiple migrations from freshwater to the ocean. The eulachon (*Thaleichthys pacificus*), known locally as hooligan, is a non-salmonid anadromous member of the smelt family that migrates through Cook Inlet. Both salmonids and eulachon provide critical food to marine mammals, predatory fish, and seabirds, and are important in recreational, commercial, and subsistence fisheries. Large schools of anadromous fish that seasonally enter freshwater habitat play an important role in the ecosystem; their carcasses provide food for terrestrial and stream consumers and release nutrients that are ultimately taken up by riparian forests and stream algae (Naiman et al. 2002).

The *Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes* and its associated Atlas (the Catalog and Atlas, respectively) specify which streams, rivers, and lakes within and adjacent to the Cook Inlet Planning Area are important to anadromous fish species and therefore are afforded protection under State law. Water bodies that are not "specified" within the Catalog and Atlas are not afforded that protection. The ADFG is solely responsible for maintaining anadromous waters data as well as revision to and publication of the Catalog and Atlas, which can be found at http://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=maps.maps.

3.8.4.2.2 Pelagic Fishes. Pelagic species found in Cook Inlet waters include smelt (*Osmerus* spp.), Pacific herring (*Clupea pallasi*), Pacific sand lance, (*Ammodytes hexapterus*), eulachon, and capelin (*Mallotus villosus*). Walleye pollock, capelin, and eulachon made up 93% of all fish collected by mid-water trawls near Shelikof Strait (Wilson 2009). The Shelikof Strait has important spawning and juvenile nursery areas for pollock and herring (Nagorski et al. 2007). Pelagic species provide critical food to marine mammals, predatory fish, and seabirds, and are important in recreational, commercial, and subsistence fisheries. Forage fish are historically subject to large fluctuation in population size due to variation in environmental conditions (Robards et al. 1999; Robards et al. 2002; NMFS 2005). Populations of capelin, herring, and eulachon have been reported at historically low levels, possibly due to natural oscillations in sea temperatures (NMFS 2005; Litzow 2006; Arimitsu et al. 2008). In addition, sand lance, herring, and capelin spawn in nearshore and intertidal areas and are therefore extremely vulnerable to oil spills that contact the shoreline. For example, herring underwent a significant decline following the *Exxon Valdez* spill; while numbers have fluctuated since the spill, they remain at very low levels. However, there is still debate about whether the population crash was due to the *Exxon Valdez* spill, disease, climactic shifts, or a combination of these factors (*Exxon Valdez* Oil Spill Trustee Council 2009).

3.8.4.2.3 Demersal Fishes. Cook Inlet has a variety of substrates and shorelines, including a significant proportion of hard substrates. The resulting habitat complexity allows multiple species of demersal fish to inhabit Cook Inlet. These fish are collectively referred to as groundfish, because they have a common preference for seafloor habitat. Examples found in Cook Inlet include rockfish (*Sebastes* spp.), Pacific cod (*Gadus macrocephalus*), pollock (*Theragra chalcogramma*), lingcod (*Ophiodon elongates*), Pacific halibut (*Hippoglossus stenolepis*), sculpin (family Cottidae), and skates (Nagorski et al. 2007; Trowbridge et al. 2008). Many groundfish are of great commercial and recreational importance. Halibut are an important subsistence resource, and other groundfish are taken incidentally. The rockfish are particularly diverse, and at least 32 rockfish species have been reported to occur in the Gulf of Alaska (Eschmeyer et al. 1984). Groundfish can have distinct habitat preferences and may specialize in a particular sediment type. For example, species such as rockfish and lingcod prefer hard substrate and submerged vegetation, while cod prefer soft sediments. Groundfish typically use Cook Inlet as a seasonal feeding area, while spawning occurs offshore, often on the continental shelf edge of the GOA. However, some species, such as walleye pollock, spawn primarily in Shelikof Strait and the Shumagin Islands. Most groundfish deposit their eggs on the sea floor, but egg and larval development occur in the upper water column. Juveniles and adults ultimately transition to bottom habitat (NMFS 2005).

3.8.4.2.4 Protected Species. While Alaskan stocks of Pacific salmon are considered healthy, there are federally endangered stocks of Chinook salmon, sockeye salmon, and steelhead trout present in the GOA, and most have natal streams in Washington, California, and Oregon (NMFS 2005). The ESA-listed salmon are mixed with Alaskan and Asian salmon stocks and are not visually distinguishable from Alaskan salmon stocks (NMFS 2005). Critical habitat designations for stocks of Pacific salmon do not include any Alaskan waters.

3.8.4.2.5 Climate Change. Climate change may have a number of effects on fish communities, including direct effects on physiology and behavior and indirect effects caused by habitat loss and large-scale changes in ecological processes (Portner and Peck 2010). Under most climate change models, coastal fish habitats will be subject to hydrologic and thermal regimes that will be very different from present conditions. Hydrologic changes in Cook Inlet could result from changes in precipitation and increased glacial and snow pack melt in the mountains around Cook Inlet. The behavior and physiology of fish in river-influenced systems such as Cook Inlet would be particularly affected by changes in salinity, turbidity, and temperature linked to changes in hydrology. In addition, rising surface water temperature has the potential to affect all aspects of fish growth, feeding, and movement (Portner and Peck 2010). Similarly, aqueous concentrations of CO_2 projected to exist under certain climate change scenarios have been demonstrated to reduce the fitness of fish by reducing their ability to detect predators and adult habitat using olfactory and auditory cues (Munday et al. 2009, 2010; Simpson et al. 2011).

Climate change also has the potential to affect the large number of anadromous fishes that migrate through Cook Inlet. For example, the migratory behaviors of Pacific salmon at all life stages are adapted to existing hydrology (Bryant 2009). Current behaviors may be maladaptive if expected changes in sea level and the timing and intensity of rainfall occur, resulting in mismatches between salmon emergence and the availability of their food resources. In addition to habitat alteration, critical coastal habitats could be reduced or eliminated by rising sea levels and increased storm damage to nearshore areas. For species spawning in low-lying areas or the intertidal zone, or species using coastal estuaries as nursery grounds, rising sea levels could also eliminate spawning or juvenile habitat. Anadromous fish and species using nearshore marshes are likely to be most affected. Temperature monitoring in the Kenai watershed also suggests that salmon stream temperatures are increasing and often exceed water quality guidelines in the summer (Mauger 2005).

Climate change could potentially effect large-scale changes in ecological processes. In response, the distribution and species composition of fish communities in Cook Inlet may change. For example, temperature is a critical ecosystem control in the Gulf of Alaska; fish communities appear to undergo major shifts following natural oscillations in water temperature related to the Pacific Decodal Oscillation and the El Niño–Southern Oscillation (Anderson and Piatt 1999; Litzow 2006; NPFMC 2010). During periods of cold water temperatures, benthic crustaceans and pelagic forage fish such as capelin and herring dominate the ecosystem biomass. After the climate cycles to warmer water temperatures, the biomass of forage species declines and the biomass of higher trophic level fish such as groundfish and salmon increases. These cycles occur naturally on multi-decadal scales. The current trend of steadily increasing sea surface temperature may favor higher trophic-level fish by increasing their local productivity or by promoting the expansion of large temperate predators into Alaskan waters (Litzow 2006). The establishment of temperate species and non-native fish introduced by human activities could come at the expense of native species, particularly forage fish like herring and capelin. However, given the complexity and compensatory mechanisms of the ecosystem, predictions about the indirect effects of climate change on fish populations are subject to great uncertainty (see Section 1.4.2, Incomplete and Unavailable Information).

3.8.4.3 Alaska – Arctic

Aquatic systems of the Arctic undergo extended seasonal periods of frigid and harsh environmental conditions. Important environmental factors that Arctic fishes must contend with include reduced light, seasonal darkness, prolonged low temperatures and ice cover and low seasonal productivity (McAllister 1975; Craig 1984, 1989). The lack of sunlight and the extensive ice cover in Arctic latitudes during winter months affect primary and secondary productivity, making food resources very scarce during this time, so most of a fish's yearly food supply must be acquired during the brief Arctic summer. In addition, most fish species inhabiting the frigid polar waters are thought to grow slowly relative to individuals or species inhabiting boreal, temperate, or tropical systems. Because of the harsh conditions, many species found in the Beaufort and Chukchi Seas are at the northern limits of their range.

Fishes of the Arctic may use one or more aquatic habitats to carry out their respective life cycles. Such habitats may include, but are not limited to bays; ice; reefs such as the Boulder Patch; and nearshore, coastal, continental shelf, oceanic, and bathypelagic waters and/or substrates. The Beaufort and Chukchi Seas support at least 98 fish species from 23 families (Mecklenburg et al. 2002). The greatest number of species is found in the Chukchi Sea (Hopcroft et al. 2008). Other species are likely to be found in the Arctic when deeper marine waters are more thoroughly surveyed. Additional information concerning the biology, ecology, and behavior of the fish species of Arctic Alaska is in Moulton and George (2000), Fechhelm and Griffiths (2001), Mecklenburg et al. (2002), and Childs (2004). More recent assessments of fish populations in the Chukchi Sea can be found in Norcross et al. (2009) and Mecklenburg et al. (2007, 2011). Recent fish surveys for the Beaufort Sea can be found in NMFS (2010e) and Logerwell et al. (2011).

Subsistence fishing has long been an integral part of Native life in the U.S. Arctic, and abundant local fisheries knowledge exists among these people (see Section 3.15.2.1 and Section 3.14.3.2). Commercial fishing, which occurred only infrequently and on a very small scale in the past, does not currently occur in the region, and therefore the typically published stock assessments and monitoring data do not exist. Because of the logistical difficulties of research and the lack of commercial fishing data, the published information on fish in the U.S. Arctic seas is relatively small compared to published information on fish in seas bordering other areas of the State of Alaska and the United States.

3.8.4.3.1 Diadromous Fishes. Common diadromous fishes found in the Beaufort and Chukchi Seas are salmonids and include Arctic cisco (*Coregonus autumnalis*), least cisco (*Coregonus sardinella*), humpback whitefish (*Coregonus pidschian*), broad whitefish (*Coregonus nasus*), and Dolly Varden (*Salvelinus malma*) (Craig 1989). The Colville River Delta and the Sagavanirktok River Delta have a particularly high abundance and diversity of diadromous fishes. Spawning occurs in the warmer months of the year. Life history traits of individual fish species in the Beaufort/Chukchi region are not well understood (DeGange and Thorsteinson 2011). Although present in Arctic waters, all five Pacific salmon species significantly decrease in abundance north of the Bering Strait (Craig and Haldorson 1986; Babaluk et al. 2000) and from west to east along the Beaufort and Chukchi Seas. Pink salmon and chum salmon are the most common Pacific salmon in Arctic waters (Augerot 2005; Stephenson 2005). Salmon appear to be rare in the Beaufort Sea and extremely rare in the eastern Beaufort Sea, although chum salmon are natal to the Mackenzie River and are consistently found there in low numbers (Irvine et al. 2009). Chum and pink salmon may be natal to other rivers on the North Slope, but this is unconfirmed (Irvine et al. 2009). Recent studies indicate that most of the juvenile chum salmon caught in the Chukchi Sea site were genetically related to populations in northwestern Alaska (Kondzela et al. 2009).

3.8.4.3.2 Pelagic Fishes. Common pelagic fish in the Beaufort Sea and Chukchi Sea include pacific sand lance (*Ammodytes hexapterus*), pacific herring (*Clupea pallasii*), Arctic cod (*Boreogadus saida*), capelin (*Mallotus villosus*), snailfish (Liparidae), and lanternfish (*Benthosema glaciale*). Anadromous species of salmonids are found in shallow nearshore waters. Mid-water trawl sampling in the Beaufort Sea indicated that young-of-the-year fish Arctic cod, sculpin (Cottidae), snailfish, poacher (Agonidae), and capelin dominated the pelagic biomass and the distribution of fish was related to depth, salinity, water temperature, and proximity to the Chukchi Sea (NMFS 2010e). Pelagic fishes can occupy benthic habitats as well at certain life stages. For example, Arctic cod are often demersal as adults, but young Arctic cod are closely associated with the underside of sea ice. Arctic cod are an ecologically important species because of their numerical dominance (Logerwell et al. 2011) and their role in linking zooplankton and sea ice invertebrates to higher trophic levels such as marine mammals and seabirds (Gradinger and Bluhm 2004).

3.8.4.3.3 Demersal Fishes. Most fish in the Beaufort Sea and Chukchi Sea are demersal species living on or near the bottom. Demersal fish in Arctic waters are often migratory species that originate from the Bering Sea or North Atlantic waters. In recent bottom trawl surveys in the Chukchi Sea, a total of 33 species were collected and 79% of all fishes caught were Arctic staghorn sculpin (*Gymnocanthus tricuspis*), shorthorn sculpin (*Myoxocephalus scorpius*), Bering flounder, or Arctic cod (Mecklenburg et al. 2007). Other recent surveys of the Chukchi Sea indicated cod (family Gadidae), poachers (family Agonidae), Bering flounder (*Hippoglossoides robustus*), and sculpins (family Cottidae) are the most abundant demersal fishes in the Chukchi Sea (Barber et al. 1997; Norcross et al. 2009). Greenlings (family Hexagrammidae), eelpouts (family Zoarcidae), smelts (family Osmeridae), wolfish (family Anarhichadidae) and snailfish (*Lycodes* spp.) are also present in Arctic waters (Barber et al. 1997; Norcross et al. 2009).

NOAA and BOEM have sponsored recent surveys of benthic fishes in the Beaufort Sea. In the Beaufort Sea, Arctic cod, eelpouts, and walleye pollock (*Theragra chalcogramma*) comprised the majority of the catch in benthic trawl surveys (NMFS 2010e) (Table 3.8.4-3). With the exception of Arctic cod, fish catch per unit effort (CPUE) is much lower in the Beaufort Sea compared to trawl CPUEs in the Chukchi and Bearing Seas (NMFS 2010e). Species distributions were primarily influenced by depth, temperature, and salinity (Logerwell et al. 2011). Sculpins were more strongly associated with relatively warm, low-salinity water, while polar cod and eelpouts were associated with cold, high-salinity bottom water. Depth was also significant (Logerwell et al. 2011). Sculpin were generally found in waters less than 100 m (328 ft) deep, in contrast to eelpouts, walleye pollock, and Arctic cod, which were most abundant in waters greater than 100 m (328 ft).

Rocky substrate is uncommon in subtidal areas of the Beaufort and Chukchi Seas and occurs primarily in the form of scattered boulders (Figure 3.7.2-4). Data on fish communities inhabiting these boulder patches are limited. Clingfish (*Liparis herschelinus*), four-horned sculpin (*Myoxocephalus quadricornis*), and the eelpout (*Gymnelis viridis*) have been observed in boulder patch habitat, and fish have been observed to lay eggs on boulders or associated vegetation (Dunton et al. 1982).

3.8.4.3.4 Climate Change. Climate change may have a number of effects on fish communities, including direct effects on physiology and behavior and indirect effects caused by habitat loss and large-scale changes in ecological processes. Changes in the magnitude or seasonality of water temperatures could affect growth rate, food demand, and reproductive behavior because water temperature is an important trigger for the seasonal fish migrations. Hydrologic changes in rivers flowing into the Beaufort and Chukchi Seas could result from changes in precipitation and ice melt. The behavior and physiology of fish in river-influenced systems such as the Beaufort and Chukchi Seas would be particularly affected by the alteration of salinity, turbidity, and temperature linked to changes in hydrology. In addition, rising surface water temperature has the potential to affect all aspects of fish growth, feeding, and movement

TABLE 3.8.4-3 The Five Most Abundant Fish Taxa Collected during 2008 Bottom Trawls in the Beaufort Sea

Common Name	Total Number	Total Weight (kg)
Arctic cod (*Boreogadus saida*)	66,278	1,242
Marbled eelpout (*Lycodes raridens*)	1,642	142
Walleye pollock (*Theragra chalcogramma*)	1,082	34
Canadian eelpout (*Lycodes polaris*)	772	38
Bering flounder (*Hippoglossoides robustus*)	231	35
Greenland turbot (*Reinhardtius hippoglossoides*)	221	16

Source: NMFS 2010e.

(Portner and Peck 2010). Similarly, aqueous concentrations of CO_2 projected to exist under certain climate change scenarios have been demonstrated to reduce the fitness of fish by reducing their ability to detect predators and adult habitat using olfactory and auditory cues (Munday et al. 2009; Simpson et al. 2011).

In addition to habitat alteration, critical coastal habitats could be reduced or eliminated by rising sea levels and increased storm damage to nearshore areas as the amount of open water increases. Anadromous fish and species that use coastal habitats are likely to be most affected. In addition, species such as the Arctic cod that depend on sea ice will lose habitat with the reduction in seasonal ice. However, Arctic cod may gain from the increase in open water plankton productivity. The impacts of climate change on Arctic habitat in the Beaufort and Chukchi Seas is discussed in Sections 3.7.2.3 and 3.7.3.3.

Climate change is also likely to change fish community composition. For example, the cold temperatures in Alaska are a critical ecosystem feature that limits species distribution. Historical records suggest that rising seawater temperatures could allow the establishment of sub-Arctic species in Arctic waters (reviewed in Loeng 2005). As a consequence of the range expansions of subArctic species, true Arctic species such as Arctic cod and capelin may be pushed northward (Loeng 2005). In offshore waters, NMFS (2010e) noted that comparison of their recent fish collections with earlier trawl data suggested that pollock and Pacific cod (*Gadus macrocephalus*) may have expanded northward into the Beaufort Sea as a result of rising surface water temperatures. There is also speculation that increasing water temperatures could allow Pacific salmon to expand their range and numbers into Arctic waters (Irvine et al. 2009). However, recent reviews (Stephenson 2005; Irvine et al. 2009) found there was no evidence of increased catches of most salmon species, and there is not enough information to state definitively that salmon are increasing in frequency in the Arctic due to climate change.

Large-scale changes in oceanographic and ecosystem processes resulting from climate change could indirectly affect fish populations in the Arctic in several ways. For example, climate change could alter ocean currents that govern the transport of larval fish. Temperature is another climate variable that is a critical feature in Arctic ecosystems that influences the amount and seasonal availability of planktonic food resources. Under the existing temperature regime, the Chukchi Sea has a food web dominated by benthic consumers and cryopelagic (sea ice-associated) fishes. The loss of sea ice and the increased surface water temperature may promote a shift to a pelagic-based food web with high phytoplankton and zooplankton productivity and greater numbers of predatory fish (Loeng 2005). Ultimately, however, predictions about the indirect and cascading ecological impacts of climate change on fish populations are subject to great uncertainty, given the complexity of the ecosystem (see Section 1.4.2, Incomplete and Unavailable Information).

3.8.5 Invertebrates and Lower Trophic Levels

Invertebrates (animals without a backbone) occupy multiple habitat types from the intertidal zone to the deep sea. Invertebrates can occupy benthic (bottom) or pelagic (water column) habitats, depending on their life histories. Invertebrates that occupy the benthos can be categorized by their size, location in the substrate, and feeding guild. Benthic invertebrates that burrow into the sediment are called infauna, and invertebrates that move on the sediment surface are called epifauna. Size classifications for benthic infauna are mieofauna (typically 43–500 µm), which are dominated by copepods and nematodes, and macroinfauna (>500 µm), which are usually dominated by polychaete worms, amphipods, and bivalves. Benthic invertebrates can be further classified into several trophic guilds, including (1) predators and scavengers, which feed on live animals or carrion; (2) scrapers, which remove biofilms from hard substrate; (3) suspension (filter) feeders, which filter food from the water; and (4) deposit feeders, which consume surface or subsurface sediment organic matter. Invertebrates in the various feeding guilds often occupy specific sediment types. For example, suspension feeders prefer clean sandy sediment or hard surfaces where they can avoid fine sediments that tend to clog their filtering organs. In contrast, deposit feeders prefer silty sediments that are rich in organic matter.

Pelagic invertebrates may drift with the current (zooplankton) or actively swim (nekton). Pelagic invertebrates can range in size from microscopic protozoans to large megafauna, such as squid and jellyfish. They play a critical role in the recycling of nutrients and organic matter in the water column and in the amount of and timing at which these food resources reach benthic consumers.

3.8.5.1 Gulf of Mexico

Following are brief descriptions of the classes of prokaryotes, viruses, and eukaryotic invertebrates common in marine environments, including the Northern GOM Shelf and Slope Marine Ecoregions:

- *Prokaryotes*. Prokaryotes are distinguished from invertebrates by not having a nucleus. Based on their genetics and cell membranes, prokaryotes are divided into Eubacteria and Archaea. Eubacteria are dominant in the benthos and the water column and are key drivers in a number of ecosystem processes. One primary function of bacteria is the break down and recycling of organic matter. In addition, bacteria are critical in nutrient (e.g., nitrogen, phosphorous, and sulfur) transformation in both the sediment and water column. Bacteria are heterotrophic and subsist on dissolved and particulate organic matter. They are consumed by protists and a variety of zooplankton and macroinvertebrates in the sediment. Although bacterial consumption of organic matter is an important ecological process, it facilitates the development of seasonal bottom-water hypoxia on the shallow continental shelf of the GOM. Archaea are prokaryotes found throughout the ocean but are strongly associated with extreme environments. Prokaryotes are the key biological components of cold seeps communities in the GOM, where methanogenesis (archaea) and coupled sulfate reduction (eubacteria) and methane oxidation (archaea) provide the substrates that support the cold seeps macroinvertebrate communities and their bacterial symbionts. Prokaryotic communities in the sediment and water column also play a critical role in the breakdown of hydrocarbons released by natural processes and human activities. These activities prevent the accumulation of hydrocarbons to toxic levels in the environment. Studies following the DWH event demonstrated that the amount of menthanotropic and oil-eating bacteria increased greatly after the DWH event (Camilli et al. 2010; Kessler et al. 2011).

- Viruses are simple life forms consisting of DNA and RNA in a protein covering. They reproduce by injecting their genetic material into the cells of other organisms and replicate their DNA using the cellular machinery of the host cell after which the host cell lyses and releases the replicated viruses. Viruses serve as a significant population control on bacteria in the ocean.

- *Protozoans*. Protozoans are a broad and diverse group of microorganisms that include foraminifierans, ciliates, radiolarians, and flagellates. They can occupy both benthic and pelagic habitats, where they act as parasites or free-living consumers of phytoplankton, bacteria, or other zooplankton. Protozoans with carbonate or silicate shells create oozes of relict shells on the seafloor of the deep ocean. Protozoans are abundant in the water column and sediments, and they are often dominant planktonic consumers in pelagic food webs in areas where biological productivity is low and nutrients and carbon are tightly cycled between small phytoplankton, microplankton, and bacteria.

- *Porifera*. Poriferans (sponges) are primitive sessile animals consisting of cellular aggregations held in a flexible protein/carbonate housing. Poriferans are suspension feeders that consume phytoplankton and particulates from the water column. They are found in all sediment types from the Northern GOM Shelf to the Slope Ecoregions. They may reproduce sexually or asexually.

- *Cnidarians and Ctenophores*. Cnidarians (jellyfish, hydrozoans, sea anemones, corals) are defined by their radial symmetry and the use of nematocysts (stinging cells) to capture prey. Comb jellies (Ctenophora) are similar to cnidarians but lack nematocysts. Cnidarians can reproduce sexually and asexually; they typically produce free-floating planktonic larvae that eventually settle to the seafloor. Ctenophores are pelagic throughout their life cycle. Cnidarians can be found across the shelf and slope of the GOM in both benthic habitats and water column habitats. Corals form ecologically significant benthic habitat (see Section 3.7.2.1.2). Jellyfish appear to be increasing in abundance in the GOM (Graham 2001), possibly because of higher water temperatures, lack of predators, and their hypoxia tolerance. The increase in jellyfish abundance could have negative consequences on the eggs and larvae of fish and invertebrates that they prey upon.

- *Worms*. Worms cover a wide range of taxa that have soft, elongated bodies and bilateral symmetry in common. As adults, most worms are sediment dwellers, but some species are pelagic (arrow worms [Chaetognatha]). Although benthic as adults, many worms produce free-living planktonic larvae. The GOM supports a diverse array of worms, such as peanut worms (Sipunculans), flatworms (Platyhelminthes), ribbonworms (Nemertea), nematodes (Nematoda), and segmented worms (Annelida; including polychaetes and oligochaetes). Nematodes and polychaetes are particularly abundant in sediments and are important food sources for higher trophic levels. In addition to their role as food sources, polychaetes continually displace and mix the sediments, thereby promoting biogeochemical cycling. Polychaetes can also significantly modify their environment by forming tubes from sediment particles; thus, they create microhabitats for other benthic organisms. Worms have a range of diets and feeding strategies; for example, they may be suspension feeders, predators, or deposit feeders. Worms show a range of tolerance to contaminants and therefore are important ecological indicators for assessments of human disturbance.

- *Mollusks*. Mollusks (bivalves, gastropods, and cephalopods) are characterized by having a muscular foot and mantle tissue that in most species produces a calcium carbonate shell. Bivalves, which have two shells joined by a hinge, can be found across coastal and marine sediments from estuaries to the deep sea. Bivalves reproduce by releasing sperm and eggs into the water column, where fertilization occurs. Their larvae undergo a temporary planktonic period before settling to the bottom and developing into adults. The common bivalves present in the GOM are clams, oysters (*Crassostrea virginica*), scallops, and mussels. Clams burrow into the sediments, where they deposit or suspension feed on small organisms or organic particles. Oysters are common in estuarine habitats, where they attach to hard substrates and feed by filtering plankton and particulate organic matter from the water column. Oysters are ecosystem engineers that provide critical reef habitat in estuaries. Mussels are relatively rare in marine waters but are common in estuaries and in deepwater methane seep communities. Bivalves can perform several ecological functions. Filter-feeding species have historically increased light penetration by removing particulates and phytoplankton from the water column. Also, because they produce feces that are consumed by other sediment biota, they can be an important link in the transfer of water column production to benthic consumers.

  Gastropods (snails and slugs) typically have a single whorled shell. Most species are sediment-dwelling, but species with reduced shells or no shell can also occupy the water column. Soft-sediment marine gastropods typical of the central and western portions of the Northern GOM Ecoregions are usually carnivores or scavengers. Most marine gastropods fertilize internally and lay eggs in the sediment. After larvae hatch, they may undergo a planktonic stage.

  Cephalopod mollusks are the octopi and squid, which are characterized by a pronounced head and complex eye development. Cephalopods like the octopus are benthic, while the squid may be found from relatively shallow to very deep portions of the water column. Cephalopods are carnivorous and, in turn, are important food sources for fish and marine mammals.

- *Crustaceans*. Crustaceans possess an exoskeleton and can be found as free-swimming water column forms, bottom-dwelling mobile forms, and attached forms. Copepod crustaceans are important phytoplankton grazers; in turn, they are often the primary food source for fish during their early life stages, and they represent a key link in transferring energy from primary producers to predatory consumers at higher trophic levels. Barnacles are examples of crustaceans that attach to hard substrate (including oil and gas platforms), where they filter food from the water column. Common epifaunal (on the sediment surface) crustaceans are the decapods, which include portunid crabs, stone crabs, and penaeid shrimp, many of which are commercially important. Decapods are found from the estuarine to the deep sea over soft and hard substrates and are key food resources for demersal fishes. Decapods usually have a pelagic larval life stage but are benthic as adults. Many decapods are estuarine-dependent (reside in an estuary during some period of their life cycle), and, given their abundance and high biomass, they are important in transferring nutrients and organic matter between estuarine and marine habitats.

- *Echinoderms*. Echinoderms are defined by their radial symmetry, tube feet, and an endoskeleton. Common examples in the Northern GOM Marine Ecoregions include sea stars (Asteroidea), brittle stars (Ophiuroidea), sea urchins (Echinoidea), and sea cucumbers (Holothuroidea). Sea stars, brittle stars, and sea cucumbers, in particular, are common throughout the marine environment — on soft and hard substrates from coastal waters to the deep sea. Echinoderms can be grazers (sea urchins), deposit feeders (sea cucumbers), or predators (sea stars). Echinoderms usually produce planktonic larvae that settle to the seafloor after some period of time in the water column.

- *Chordates*. Chordates have a primitive spinal cord at some point in their development, yet they are classified as invertebrates because they lack a backbone. In the GOM, the most common chordates are the filter-feeding tunicates (sea squirts, salps, and larvaceans). The most important chordate grazer in the northern GOM is the planktonic larvacean *Oikopleura dioica*, which filters bacteria and small phytoplankton out of the water column. Larvaceans have been reported to consume an average of 20% of the particles from the upper 5 m (16.4 ft) of the Mississippi River plume each day. Their abundance is so great that the deposition of their fecal pellets and discarded gelatinous houses may be great enough to contribute significantly to the bottom-water hypoxia that occurs seasonally in the GOM (Dagg et al. 2007).

There are few completed, peer-reviewed studies of the impacts of the DWH event on invertebrate communities in the GOM. However, multiple investigations of the long-term impacts of the DWH event on invertebrates are ongoing and, over time, these studies will add to our understanding on of the impact of oils spills on invertebrates. A description of these studies can be found at http://www.gulfspillrestoration.noaa.gov/oil-spill/gulf-spill-data. Samples of commercially harvested invertebrates in Federal waters from Louisiana to Florida found evidence of PAH contamination in only a few areas off the Louisiana coast (Ylitalo et al. 2012). Coastal sediment porewater samples collected from Florida to Louisiana were tested for toxicity to benthic invertebrates using sea urchin fertilization and embryological development as test endpoints (Biedenbach and Carr 2011). Porewater was found to be toxic at multiple locations along the Louisiana coast, but only one site in Mississippi, and no sites in Texas, Florida, or Alabama. Toxicity appeared to result primarily from the high concentrations of ammonia in the porewater.

In offshore areas, impacts from the DWH event appear to be localized. Some researchers have reported seeing dead and dying benthic animals, as well as what appear to be thick deposits of an unidentified brown substance on the seafloor (BOEMRE 2010b). Follow-up studies provide evidence that the flocculent contained oil from the DWH event (White et al. 2012). In addition, approximately half of the deepwater corals and brittle stars at the site showed signs of stress such as mucus secretion, bleaching, and abnormal color and/or attachment posture. However, evidence of DWH impacts was found at only 1 of the 11 deepwater coral reefs surveyed. In another study, remotely operated vehicle (ROV) surveys of benthic epifaunal invertebrates were conducted 500 m (1,640 ft) and 2000 m (6,562 ft) from the Macondo well from August to September 2010. Species richness and abundance were lower at the site located 500 m (1,640 ft) from the well compared to the more sites more distant from the well (Benfield 2011; Putt 2011). The surveys did not indicate an obvious change in species composition, although pre-spill data was qualitative and therefore statistical comparisons could not be made.

Several studies of areas affected by the DWH event indicated that oil dramatically altered the sediment (Hamdan and Fulmer 2011; Kostka et al. 2011) and water column (Hazen et al. 2010; Kessler et al. 2011; Lu et al. 2011) bacterial communities by increasing the relative abundance of oil-consuming microbes. These microbial communities were critical in the rapid disappearance of much of the oil. However, studies of microbial communities on oiled beaches in Louisiana also suggested the dispersant COREXIT® altered microbial communities by reducing the abundance of *Marinobacter* spp. and *Acinetobacter* spp., both hydrocarbon-degrading bacteria, and increasing the relative abundance of *Vibro* spp., a genera with comparatively less capacity to degrade hydrocarbons (Hamdan and Fulmer 2011). Patchy areas of hydrocarbon contamination were detected in zooplankton samples collected in the vicinity of the Macondo well and up to 20 km (12.5 mi) southwest of the well (Mitra et al. 2012). In coastal areas, the hydrocarbons appeared to be assimilated by bacteria and transferred up through the zooplankton food web (Graham et al. 2010). The carbon derived from the DWH event appeared to be processed and was no longer detectable in plankton samples after a few weeks (Graham et al. 2010).

Overall, several years may be required to fully assess the impacts of the DWH event on invertebrate populations. This information, however, is not needed at the programmatic stage to make a reasoned choice among alternatives (see Section 1.5, Analytical Issues).

3.8.5.1.1 Species Listed Under the Endangered Species Act.

Elkhorn Coral. Elkhorn coral (*Acropora palmata*) is a branching, reef-building, scleractinian coral. Like other species of coral, elkhorn coral derives energy from symbiotic algae (zooxanthellae) and filter feeding. Reproduction occurs sexually or by asexual fragmentation. This species is found in south Florida, the Caribbean, Central America, and South America, in waters typically less than 30 m (100 ft) in depth. The preferred temperature of Acropoird corals is 66°F to 88°F (see http://sero.nmfs.noaa.gov/pr/esa/acropora.htm). They were historically one of the most abundant and ecologically important coral species. However, since the 1970s Elkhorn coral abundance has declined by 95% within its historical range (Zimmer et al. 2010; see http://www.nmfs.noaa.gov/pr/species/invertebrates/staghorncoral.htm). White band and white pox disease were directly responsible for the decline, although other stressors on corals, such as climate change, sewage discharge, and coastal eutrophication, may have ultimately contributed to their decline and lack of subsequent recovery (Aronson and Precht 2001; Muller et al. 2008; Sutherland et al. 2011). In response to the steep population decline, elkhorn coral were listed as threatened under the Endangered Species Act (71 FR 26852) in 2006. In 2008, the NMFS designated marine areas of Palm Beach County, Florida, to the Tortugas and various areas in Puerto Rico and the Caribbean as critical habitat for elkhorn coral (73 FR 72210).

Two elkhorn colonies have been discovered in the northern GOM, one in the West Flower Gardens Bank in 2003 and one in the East Flower Gardens in 2005 (Zimmer et al. 2010). The East Flower Garden colony is 0.5 m (2 ft) in width and 1 m (3 ft) in height and is located on the southeast corner of the bank in approximately 24 m (77 ft) of water. Both colonies are still present, although Hurricane Ike appears to have broken off branches of the colony (Zimmer et al. 2010). The northward range expansion of elkhorn coral is likely due to increasing water temperatures in the northern GOM (Precht and Aronson 2004). In the West Flower Gardens Bank, the elkhorn colony was found at a depth of 22 m (71 ft) and as of May 2005, the colony measured less than 1 m (2 ft) wide by 0.5 m (2 ft) high, with a maximum branch length of 9 cm (4 in; Zimmer et al. 2010). The Flower Gardens Bank is not considered critical habitat for this species (73 FR 72210).

Candidate Species. There are currently 82 “candidate species” of coral that are under review for listing under the Endangered Species Act (75 FR 6616). Only eight of the species occur in the U.S. waters, and only a portion of these are found in the GOM; these include *Montastraea annularis*, *Montastraea faveolata*, and *Montastraea franksi*. Once NOAA Fisheries has reviewed the candidate species, a decision will be made as to whether each species will receive protection under the ESA.

3.8.5.1.2 Climate Change. Several major classes of invertebrates could be affected by the environmental changes predicted to result from climate change. A significant loss of corals could result from increased water temperature and ocean acidification. The impacts of climate change on habitat-forming invertebrates, such as corals, are discussed in detail in Section 3.7.2.1. As described in Sections 3.7.4.1 and 3.7.3.1, climate change might increase the range and temporal variability of a water column’s oxygen, salinity, and temperature, all of which are critical determinants of invertebrate community distribution, density, and species composition. Such large-scale changes in benthic and pelagic habitats could significantly alter the existing invertebrate community structure and ecosystem services. In particular, invertebrates in nearshore areas would be likely to experience more differences in the physical and chemical variables brought about by the change in the hydrologic regime. Invertebrates have specific physiological tolerances; thus, more fluctuations in environmental variables, especially salinity (Attrill 2002), would probably reduce their abundance and diversity as the more-tolerant species replaced the less-tolerant ones. Nonmobile or slow-moving benthic invertebrates, such as echinoderms, mollusks, and macroinfauna, would be most vulnerable to physiological stress. Invertebrate communities in the Mississippi Estuarine Area Ecoregion would be especially likely to undergo significant changes, because of the strong influence of Mississippi River discharge on biological communities. The rise in temperatures could also alter species compositions as more tropical species expanded north, potentially replacing existing fauna.

With the expected increase in water column stratification and nutrient delivery to the GOM, the extent and duration of hypoxia might increase (Section 3.7.3.1). Mortality to adult stages of larger mobile invertebrates might be limited because of their ability to avoid hypoxic waters; however, smaller zooplankton could be affected by hypoxia in several ways. First, more sensitive species, like copepods, might be replaced by smaller more tolerant species (Marcus 2001). Hypoxia might also increase the abundance of jellies, which can tolerate low-oxygen areas (Purcell et al. 2001). In addition, it has been found that hypoxia can disrupt daily zooplankton migrations from the lower to the upper water column, which could affect food intake of zooplankton and their predators (Qureshi and Rabalais 2001).

The increasing inputs of CO_2 into the ocean are expected to reduce oceanic pH and, with it, the availability of calcite and aragonite. Calcifying marine organisms — such as shallow and deepwater corals, echinoderms, foraminiferans, and mollusks — might decline in abundance because they require calcite or aragonite to lend structural support to their exoskeletons (Royal Society 2005).

3.8.5.2 Alaska – Cook Inlet

See Section 3.8.5.1 for a general description of invertebrate groups and their ecological roles, and see MMS (1996b, 2003a) for a comprehensive description of the invertebrate zooplankton community of Cook Inlet. The water column invertebrates in Cook Inlet are similar to those in other subarctic waters (Speckman et al. 2005) and are composed of a mix of oceanic and coastal species (MMS 1996b). Several species of copepods dominate the macrozooplankton assemblage. Measurements of zooplankton productivity indicate a peak in late spring and summer (MMS 1996b). Lower Cook Inlet has a complicated physical and chemical environment as a result of the mixing of fresh and marine water, and the zooplankton community appears to be primarily structured by temperature, salinity, bottom depth, and turbidity (Speckman et al. 2005).

Benthic invertebrates are important trophic links connecting primary producers to higher-trophic-level organisms found in Cook Inlet and the Gulf of Alaska, such as crabs, flatfishes, and cod. In Lower Cook Inlet, there are spatial differences in the compositions of the benthic invertebrate communities related to differences in ice formation, with Arctic species being more common on the western side of Cook Inlet and the temperate species being more common in the eastern portion of Cook Inlet (MMS 1996b, 2003a). In addition, benthic invertebrate species differ by substrate type and tidal zone. The lower rocky intertidal zone contains a diverse mix of echinoderms (sea urchins and sea stars), mollusks (bivaves, limpets, and snails), polychaete worms, and crustaceans (barnacles and crabs). Sandy intertidal sediments are dominated by polychaetes and amphipods, with clams increasing in abundance in deeper waters. Several distinct subtidal communities have been identified on substrates of rock, sand, silt, and/or shell debris (Feder and Jewett 1986). Clams were dominant in sandy subtidal sediment, and clams and polychaetes dominated in muddy sediment. Substrates consisting of shell debris generally have the most diverse communities and are dominated by mollusks and bryozoans (Feder and Jewett 1986). Epifauna (invertebrates on the sediment surface) in the region are primarily crustaceans (tanner crabs, king crabs, pandalid and cragonid shrimp) and echinoderms (sea cucumbers and sea urchins). Studies in the western side of Shelik of Strait indicated that limpets, snails, crabs, chitons, barnacles, and mussels dominated the lower and mid rocky intertidal. Several clam species are found in intertidal and subtidal soft substrates (Nagorski et al. 2007).

3.8.5.2.1 Climate Change. It is predicted that physical and chemical changes to subarctic invertebrate habitat would result from climate change. These changes could alter the existing distribution, composition, and abundance of invertebrates in Cook Inlet, since physical and chemical parameters are the primary influence on invertebrate communities.

For example, the increase in seawater temperature will facilitate a northward expansion of subarctic and temperate invertebrate species. Rising sea water temperatures are also expected to decrease winter ice extent and duration. Currently, ice formation primarily occurs on the western side of Cook Inlet, and changes in benthic invertebrate community structure could result from the reduction in ice scour. Also, hydrologic change can rapidly alter existing invertebrate communities in the water column and benthos if the new chemical conditions are not within the physiological tolerance of the existing communities. Changes in the magnitude, frequency, and timing of river discharge are expected to result from climate change (Arctic Council 2005). Thus, invertebrates in the Cook Inlet Ecoregion where there are strong riverine inputs would likely be affected by alterations in the salinity, temperature, and sediment delivery regime.

Another significant source of physiological stress is the expected increase in ocean acidification. Crustaceans, echinoderms, foraminiferans, and mollusks could have greater difficulty in forming shells, which could result in a reduction in their fitness, abundance, and distribution (Fabry et al. 2009). The loss of shelled invertebrates could affect higher trophic levels, including benthic mollusks and pelagic pteropods, that are critical food sources for birds, fish, and marine mammals. Snow crab and Tanner crab could also be affected as oceanic pH decreases, reducing the availability of the $CaCO_3$ they require for shell formation. The physiological stress and reduction in shell strength associated with ocean acidification could reduce the population of these commercially important invertebrates.

3.8.5.3 Alaska – Arctic

See Section 3.8.5.1 for a general description of invertebrate groups and their ecological roles. At the lowest invertebrate trophic levels, microbes such as bacteria and protists are known to be important in Arctic waters for breaking down and recycling nutrients and organic matter (Hopcroft et al. 2008). Cilliates and dinoflagellates dominate the microzooplankton biomass in the Chukchi Sea, but their role in the Beaufort and Chukchi Seas is not well studied (Hopcroft et al. 2008). The most common water column macroinvertebrates in the Arctic are the copepods (typically *Pseudocalanus* spp.). In the Chukchi Sea, much of the copepod biomass originates in the Bering Sea, while true Arctic species are most common in the Beaufort Sea (Hopcroft et al. 2008). Riverine inputs also create an estuarine zone with a distinct zooplankton assemblage. Other common zooplankton include larvaceans, jellies, euphausiid shrimp, amphipods, pteropod mollusks, and arrow worms. In the Beaufort and Chukchi Seas, invertebrate zooplankton productivity is highly seasonal as a result of the extremely cold winter temperatures. Many invertebrates (i.e., copepods) have adapted by storing lipids for the winter and undergoing a winter dormant period during which they rest in the sediment or lower water column.

Across the Beaufort and Chukchi shelf, the benthic infaunal community is dominated primarily by echinoderms, polychates, sponges, anemones, bivalves, gastropods, and bryozoans (Grebmeier and Dunton 2000; Dunton et al. 2005). Studies in the Beaufort Sea indicated brittle stars, snow crabs (*Chionoectes opilio*), ascidians, mussels, sea anemones, and echinoderms dominated the epifaunal assemblage (NMFS 2010e). Snow crabs are found in across the Beaufort and Chukchi shelf. Logerwell et al. (2011) reported that they were most densely distributed between 100 and 500 m (328 and 1,640 ft) in the Beaufort Sea. Overall, however, larger invertebrate infauna are relatively sparse in much of the Beaufort Sea when compared to their presence in the Chukchi Sea, where echinoderms, crabs, and shrimp are more abundant (Hopcroft et al. 2008).

There are several strong spatial gradients in benthic invertebrate biomass and species composition across the Beaufort/Chukchi shelf. Benthic biomass is higher in Chukchi Sea compared to the Beaufort Sea (Grebmeier et al. 2006). Within the Beaufort Sea, benthic biomass is slightly lower in the eastern and deepwater portions of the Beaufort Sea and slightly higher to the west, adjacent to the Chukchi Sea. South of the Chukchi Sea Planning Area, the Chukchi Sea contains some of the highest benthic biomass in the Arctic (Grebmeier et al. 2006; Hopcroft 2008). The high benthic biomass and richness in the Chukchi Sea have been attributed to currents that move nutrients onto the shallow Chukchi shelf from the Bering Sea, the resulting sudden and intense springtime phytoplankton bloom during a period of relative inactivity for zooplankton, and the subsequent deposition of large amounts of phytoplankton food on the seafloor (Hopcroft et al. 2008). Nearshore infauna diversity and abundance can be low because of ice scour and freshwater inputs. Invertebrate biomass also decreases from the mid-shelf to the slope. For example, trawls in the western Beaufort Sea indicated that invertebrate biomass was dramatically higher between 100 and 500 m (328 and 1,640 ft) than between 40 and 100 m (131 and 328 ft) (NMFS 2010e).

Invertebrate species associated with boulder habitats are located primarily on the Beaufort shelf. These habitats vary according to their post-disturbance successional stage. Pioneer colonizing invertebrates include polychaetes, followed by encrusting bryozoans and hydroids, and ultimately a diverse community of kelp, soft coral, tubeworms, and sponges. Multiple studies have demonstrated that if significantly physically disturbed, communities associated with boulders are slow (2 or more years) to begin recovery and that full recovery of boulder invertebrate communities may take 10 or more years (MMS 2002b; Konar 2007 and references therein).

Sea ice invertebrates include microbes, polychaetes, copepods, nematodes, and amphipods. Like zooplankton, sea ice invertebrates are important in connecting the water column to the benthos by depositing food on the seafloor and by providing habitat for benthic invertebrates in their early life stages (Gradinger and Bluhm 2005). Sea ice invertebrates are also an important food source to certain pelagic fish like Arctic cod.

3.8.5.3.1 Climate Change. It is predicted that physical and chemical changes to Arctic and subarctic invertebrate habitat would result from climate change (Section 3.3). Any of these changes could alter the existing distribution, composition, and abundance of invertebrates, since physical and chemical parameters are the primary influence on invertebrate communities. In general, the increase in seawater temperature will facilitate a northward expansion of subarctic invertebrate species from the Bering Sea. Weslawski et al. (2011) identified the Bering Strait as a major corridor through which new invertebrate species will expand their range northward. Such expansion will likely increase overall invertebrate species diversity in the Arctic, but the new species may displace existing species or alter existing inter-specific species interactions. For example, the movement of large decapod crabs into the Arctic may dramatically alter existing food webs (Weslawski et al. 2011). The change in species composition may be greatest in the eastern Beaufort Sea where Arctic species currently predominate. The timing and duration of copepod recruitment as well as copepod biomass are also likely to be affected by the rise in surface water temperatures.

It is predicted that a decrease in sea ice habitat would result from increasing water temperature. Consequently, the distribution of invertebrates specialized to inhabit sea ice will contract if they are unable to occupy new habitats. Also, the seasonal deposition of food from melting sea ice may be reduced, but settled phytoplankton may make up for the loss as the productivity of open water increases. Overall, an increase in the productivity of water column invertebrates is expected (Hopcroft et al. 2008). The abundance of benthic invertebrates may also increase in nearshore areas with the reduction in ice scour extent and duration and the consequent increase in the area of the seafloor available for colonization by invertebrates (Weslawski et al. 2011). However, loss of sea ice could also increase benthic disturbance from severe weather as the amount of open water increases.

Changes in the magnitude, frequency, and timing of river discharge into the Beaufort and Chukchi Seas are expected to result from climate change (Arctic Council 2005). Invertebrates in marine ecoregions with strong riverine inputs — like the Beaufort Neritic Ecoregion — would likely be affected by alterations in the salinity, temperature, and sediment delivery regime.

Hydrologic change can rapidly alter existing invertebrate communities in the water column and benthos, if the new chemical conditions are not within the physiological tolerance of the existing communities. The greater variability in hydrologic conditions could favor tolerant and opportunistic species, thereby homogenizing invertebrate species composition and decreasing overall species diversity in the Beaufort and Chukchi Seas (Weslawski et al. 2011).

The expected increase in ocean acidification is considered to be another significant source of physiological stress. Crustaceans, echinoderms, foraminiferans, and mollusks could have greater difficulty in forming shells, which could reduce their fitness, abundance, and distribution (Fabry et al. 2008). The loss of shelled invertebrates could affect higher trophic levels. For example, benthic mollusks are critical food sources for birds and marine mammals, and pteropods (pelagic snails) are abundant in Arctic waters and are an important food resource for salmon (Groot and Margolis 1991).

3.9 AREAS OF SPECIAL CONCERN

3.9.1 Gulf of Mexico

Areas of special concern include federally managed areas (e.g., Marine Protected Areas [MPAs], National Marine Sanctuaries, National Parks, National Wildlife Refuges), all of which are discussed in the following sections. In addition, a number of locations that have been given special designations by Federal and State agencies (e.g., National Estuarine Research Reserves, National Estuary Program Sites, and Military and National Aeronautics and Space Administration [NASA] Use Areas) are also included as areas of special concern. Critical habitat for endangered species is discussed in biota-specific sections.

3.9.1.1 Coastal Areas of Special Concern

3.9.1.1.1 Marine Protected Areas. Executive Order 13158 on Marine Protected Areas defines a MPAs as “any area of the marine environment that has been reserved by Federal, State, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein.” Thus MPAs have greater protection than the surrounding waters and can also vary widely in purpose, legal authorities, agencies, management approaches, level of protection, and restrictions on human uses (National Marine Protected Areas Center 2008).

To strengthen and enhance the nation’s system of MPAs, Executive Order 13158 directed the U.S. Department of Commerce and U.S. Department of the Interior, in consultation with other departments, to create a National System of MPAs. Section 5 of the Order calls for Federal agencies to “avoid harm” to National System MPAs and identify any actions that do harm to National System sites. Each Federal agency is responsible for its own implementation of its responsibilities under Section 5. As directed by the Order, the National Marine Protected Areas

Center (http://www.mpa.gov), directed by NOAA, has developed a planning and coordination process for adding existing MPAs into the National System. As described in *Framework for the National System of Marine Protected Areas of the United States of America* (National Marine Protected Areas Center 2008a), to be eligible for National System membership, an MPA must:

1. Meet the definitional criteria of an MPA, including each of its key terms — area, marine environment, reserved, lasting, and protection;

2. Have a management plan;

3. Support at least one priority goal and conservation objective of the national system; and

4. Cultural heritage MPAs also must conform to criteria for including sites on the *National Register of Historic Places*.

The *Framework for the National System of Marine Protected Areas of the United States of America* outlines the working relationship for building National System MPA sites, networks, and systems for areas managed by Federal, State, tribal, or local governments. No existing Federal, State, local, or tribal MPA laws or programs are altered by the National System or the Order, and no new legal authorities were established to designate, manage, or change MPAs.

Most National System MPAs encompass the National Marine Sanctuaries, National Parks, and National Wildlife Refuges, and are therefore managed by existing authorities.

At present, 14 National System MPAs have been designated in the Western and Central GOM Planning Areas, and 7 National System MPAs have been designated in the Eastern Planning Area from the Florida/Alabama border to Tampa Bay (Table 3.9.1-1; Figure 3.9.1-1). Most National System MPAs are National Wildlife Refuges and are described in Section 3.9.1.1.3.

In addition to the National System MPA member sites in Table 3.9.1-1, there are several State-designated and State-managed MPAs, federally managed areas, and partnership areas under State and Federal management that may or may not be eligible for membership in the National System MPA program. A complete listing and descriptions of the locations of these areas can be obtained from the lists on the Marine Protected Areas of the United States website at http://www.mpa.gov/helpful_resources/inventoryfiles/gulf_june_2010.pdf. Florida has 87 State-designated MPAs from the Panhandle to Tampa Bay. The vast majority are Outstanding Florida Waters, although many are also State Parks and aquatic preserves. Louisiana and Mississippi have 26 and 10 State-designated MPAs, respectively, most of which are coastal preserves and wildlife management areas. Texas has nine State-designated MPAs, most of which are State Parks or Wildlife Management Areas. Texas has a large coastline containing numerous and ecologically important bird rookeries, migratory bird stopover sites, unique vegetative communities, and protected species, all of which are found near the Texas coastline.

TABLE 3.9.1-1 National System Marine Protected Area Member Sites in the Western and Central GOM Planning Area and the Eastern GOM Planning Area from Alabama to Tampa, Florida

Site Name[a]	State	Managing Agency[b]
Bon Secour National Wildlife Refuge	AL	USFWS
Jean Lafitte National Historical Park and Preserve, Barataria Preserve	LA	NPS
Flower Garden Banks National Marine Sanctuary	LA	NOAA
Big Branch Marsh National Wildlife Refuge	LA	USFWS
Breton National Wildlife Refuge	LA	USFWS
Delta National Wildlife Refuge	LA	USFWS
Sabine National Wildlife Refuge	LA	USFWS
Shell Keys National Wildlife Refuge	LA	USFWS
Grand Bay National Wildlife Refuge	MS/AL	USFWS
Cedar Keys National Wildlife Refuge	FL	USFWS
Chassahowitzka National Wildlife Refuge	FL	USFWS
Crystal River National Wildlife Refuge	FL	USFWS
Lower Suwannee National Wildlife Refuge	FL	USFWS
Pinellas National Wildlife Refuge	FL	USFWS
St. Marks National Wildlife Refuge	FL	USFWS
St. Vincent National Wildlife Refuge	FL	USFWS
Anahuac National Wildlife Refuge	TX	USFWS
Aransas National Wildlife Refuge	TX	USFWS
Big Boggy National Wildlife Refuge	TX	USFWS
Brazoria National Wildlife Refuge	TX	USFWS
San Bernard National Wildlife Refuge	TX	USFWS

[a] Includes sites designated by the USDOI and NOAA. Sites designated by State, Territory, and Commonwealth agencies are not included but can be obtained from the lists on the Marine Protected Areas of the United States website at http://www.mpa.gov/helpful_resources/inventoryfiles/gulf_may_2011.pdf.

[b] NPS = National Park Service, NOAA = National Oceanic and Atmospheric Administration, USFWS = U.S. Fish and Wildlife Service.

Source: NOAA 2010c.

Federally managed areas that are eligible for MPA status but are not members of the National System MPA consist of Habitat Areas of Particular Concern (see Section 3.7.4.1), offshore banks, chemosynthetic communities, and deepwater corals (see Section 3.7.2.1). National Estuarine Research Reserves are partnership-managed areas under Federal and State management and are described below.

3.9.1.1.2 National Park System. The National Park System ensures the protection and interpretation of the country's natural, cultural, and recreational resources. Descriptions of National Parks given below are based on information for individual parks on the National Park Service (NPS) website (http://www.nps.gov). NPS lands along the coast or in coastal areas of the GOM include the Padre Island National Seashore (Texas), Jean Lafitte National Historic Park

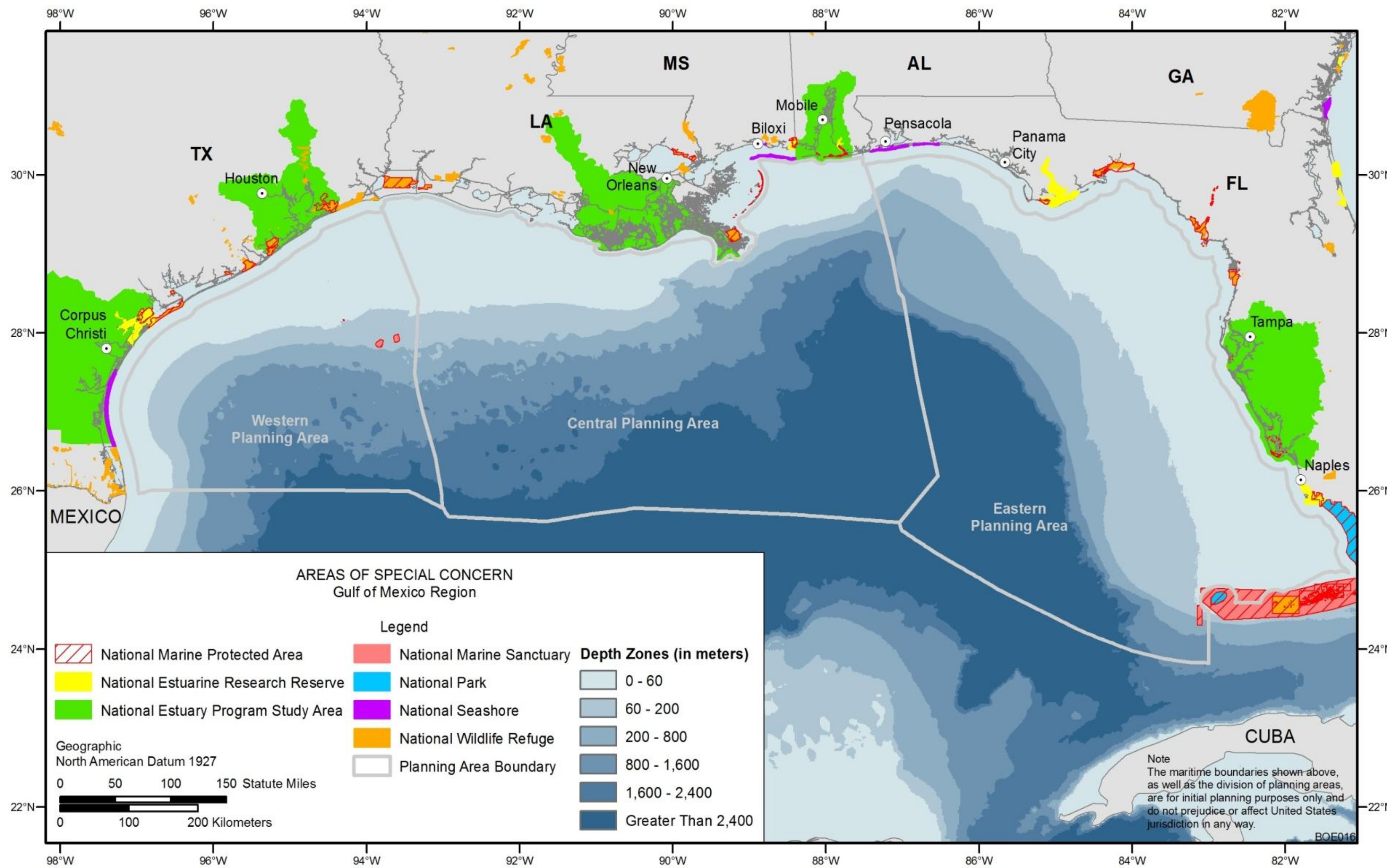

FIGURE 3.9.1-1 Map Showing the Location of Areas of Special Concern in the Western, Central, and Eastern Planning Areas

(Louisiana), Gulf Islands National Seashore (Mississippi and Florida), and DeSoto National Memorial (Florida). More than 177 km (110 mi) of coastal beaches and barrier islands in Texas, Mississippi, and Florida are used by millions of visitors each year at Padre Island National Seashore and Gulf Islands National Seashore. In addition to being a popular tourist destination, Padre Island National Seashore protects the largest portion of undeveloped barrier island in the world, supports a wide variety of flora and fauna, and is the most important nesting site for the Kemp's ridley sea turtle in the United States. Padre Island National Seashore also includes approximately 8,094 ha (20,000 ac) of the Laguna Madre, which is one of only five hypersaline lagoons in the world. Outside of the Central and Western Planning Areas, the Dry Tortugas National Monument is located offshore of the southern tip of Florida in the Eastern Planning Area.

The Gulf Islands National Seashore includes major portions of the barrier islands off the coasts of Florida and Mississippi, including beaches, coastal marshes, maritime forests, and offshore areas. The park also contains historic sites dating to 16th century European exploration and occupation. DeSoto National Memorial contains information on Hernando DeSoto's exploration of Florida in the 16th century and on Florida's history from the Civil War to the present. Oil from the DWH event reached the shoreline of the Gulf Island National Seashore. Cleanup efforts continue and the Seashore remains open. Monitoring efforts are ongoing (http://www.nps.gov/aboutus/oil-spill-response.htm).

The Jean Lafitte National Historic Park comprises six sites located in southern Louisiana: Acadian Cultural Center in Lafayette, Prairie Acadian Cultural Center in Eunice, Wetlands Acadian Cultural Center in Thibodaux, Barataria Preserve in Marrero, Chalmette Battlefield and National Cemetery in Chalmette, and French Quarter Visitor Center in New Orleans. Barataria Preserve covers more than 9,308 ha (23,000 ac) and contains bayous, swamps, marshes, forests, alligators, nutrias, and more than 300 species of birds. The other five sites are dedicated to the history and cultural preservation of southern Louisiana.

3.9.1.1.3 National Wildlife Refuges. The National Wildlife Refuge System is a network of U.S. lands and waters managed by the USFWS specifically for the enhancement of wildlife. There are 27 National Wildlife Refuges located along the coastline or within the coastal areas of the Western and Central GOM Planning Areas and the Eastern Planning Area from the Florida/Alabama border to Tampa Bay (Figure 3.9.1-1 and Table 3.9.1-2). Information on individual refuges can be found at http://www.fws.gov/refuges/refugeLocatorMaps. Most refuges along the GOM coastline were established to provide wintering areas for ducks, geese, coots, and other migratory waterfowl and shorebirds. Threatened and endangered species, including the American alligator and manatee, also use the refuges along the GOM.

Delta NWR, Breton NWR, Grand Bay NWR, and Bon Secour NWR were all contacted by oil from the DWH event (http://www.fws.gov/refuges/RefugeUpdate/MarchApril_2011/oneyear.html). Breton NWR and Bon Secour NWR appear to have been the most affected. Breton NWR was closed immediately following the spill but has since reopened (http://www.fws.gov/home/dhoilspill/pdfs/Breton2010OilSpillFactSheet.pdf). Monitoring efforts at Breton NWR are ongoing. Bon Secour NWR was heavily oiled and samples collected

TABLE 3.9.1-2 National Wildlife Refuges along the GOM Coast from Texas through Tampa Bay, Florida

National Wildlife Refuge	Total Area (ha)[a]
Texas	**141,498**
Anahuac	13,880
Aransas	46,296
Big Boggy	2,023
Brazoria	17,767
Laguna Atascosa	23,402
McFadden	22,258
San Bernard	12,249
Texas Point	3,623
Louisiana	**34,422**
Shell Keys	3
Bayou Sauvage	9,009
Delta	19,749
Breton	3,661
Mississippi	**2,072**
Grand Bay	2,072
Alabama	**3,713**
Grand Bay	1,010
Bon Secour	2,703
Florida (Panhandle to Tampa Bay)	**45,400**
St. Vincent	5,055
St. Marks	27,164
Cedar Keys	361
Chassahowitzka	12,482
Crystal River	19
Pinellas	160
Egmont Key	133
Passage Key	26
Matlacha Pass	159

[a] To convert hectares to acres, multiply by 2.47.

in winter 2010–2011 indicated elevated PAHs in beach sediments (OSAT-2 2011). The models of oil degradation for beaches at Bon Secour suggest alkanes and PAHs would degrade to approximately 15–20% of their current concentration within 2.5 to 5 yr (OSAT-2 2011).

3.9.1.1.4 National Estuarine Research Reserves. The National Estuarine Research Reserve Program was established by the Coastal Zone Management Act of 1972 and is administered by NOAA. One of the primary objectives for establishing this program was to provide research information that could be used by coastal managers and the fishing industry to help assure the continued productivity of estuarine ecosystems. Four estuarine research reserves have been established in the GOM area from Texas to Tampa Bay, as detailed below (Figure 3.9.1-1). Summary descriptions of the reserves described below were gathered through the National Estuarine Research Reserve website (http://nerrs.noaa.gov/ReservesMap.aspx). Detailed site profiles are available at http://nerrs.noaa.gov/BGDefault.aspx?ID=602.

1. Weeks Bay National Estuarine Research Reserve in coastal Alabama includes a small estuary covering about 2,641 ha (6,525 ac). The reserve is composed of open shallow waters, with an average depth of less than 1.5 m (5 ft) and extensive vegetated wetland areas. Freshwater enters from the Fish and Magnolia Rivers, and the reserve connects with Mobile Bay through a narrow opening.

2. The Apalachicola National Estuarine Research Reserve, southeast of Panama City, Florida, covers about 99,553 ha (246,000 ac). It consists of forested flood plains, saltwater and freshwater marshes, barrier islands, and open bays. A Federal Refuge and a State Park are within the reserve boundaries. A commercially important oyster fishery is located in the Apalachicola area.

3. The Grand Bay National Estuarine Research Reserve supports several rare or endangered plant and animal species, numerous important marine fishery resources, diverse habitat types, and important archaeological sites. It contains a diverse range of habitats, including coastal bays, saltwater marshes, maritime pine forests, pine savannas, and pitcher plant bogs. It supports extensive and productive oyster reefs and seagrass habitats, and it serves as a nursery area for many important recreational and commercial marine species, such as shrimp, blue crab, speckled trout, and red drum. Grand Bay NERR received oil from the DWH event. Baseline mapping of sensitive resources such as seagrasses and oyster beds was conducted to determine any long-term impacts from the spill (htpp://grandbaynerr.org/archives/13).

4. The Mission Aransas National Estuarine Research Reserve is located in Aransas and Refugio Counties, Texas, about 48 km (30 mi) northeast of Corpus Christi. It covers about 75,153 ha (185,708 ac) and was designated a reserve in 2006. Habitats present on the site include coastal prairies, coastal and freshwater marshes, ponds, bays, seagrass beds, oyster reefs, mangrove forests, and tidal flats. The University of Texas' Marine Science Institute is

the lead State agency overseeing the site. The site is home to wintering populations of the federally endangered whooping crane (*Grus americana*).

3.9.1.1.5 National Estuary Program. In 1987, an amendment to the Clean Water Act, known as the Water Quality Act (P.L. 100-4), established the National Estuary Program. The purposes of the program are to (1) identify nationally significant estuaries, (2) protect and improve their water quality, and (3) enhance their living resources. Under the administration of the USEPA, comprehensive administration plans are generated to protect and enhance the environmental resources of estuaries designated to be of national importance. The governor of a State may nominate an estuary for the program and may request that a comprehensive conservation and management plan be developed. Over a 5-yr period, representatives from Federal, State, and interstate agencies; academic and scientific institutions; and industry and citizens groups work to define objectives for protecting the estuary, select the chief problems to be addressed in the plan, and ratify a pollution-control and resource-management strategy to meet each objective. The GOM estuaries currently falling within the National Estuary Program include: Coastal Bend Bays and Estuaries, Corpus Christi Bay, Galveston Bay, Barataria-Terrebonne Estuarine Complex, Mobile Bay, Tampa Bay, Sarasota Bay, and Charlotte Harbor (USEPA 2011d; Figure 3.9.1-1).

3.9.1.2 Marine Areas of Special Concern

3.9.1.2.1 Marine Protected Areas. The only National System MPA in the Western and Central GOM Planning Areas located in marine waters is the FGBNMS. The FGBNMS is described below. In addition, there are *de facto* MPAs that are waters where access or activities are restricted by law for reasons other than conservation or natural resource management, such as to protect public health and safety, and public and private infrastructure, as well as those that provide training areas for the military (National Marine Protected Areas Center 2008). Military installations, anchoring sites, navigational channels, oil and gas transfer areas, and safety, security, and restricted areas (e.g., power plants) are all examples of *de facto* MPAs in the northern GOM. Almost 25% of the GOM regional waters (approximately 200,000 km^2 [7,7220 mi^2]) can be considered *de facto* MPAs. The GOM has 217 individual *de facto* MPAs and 64% of the nation's total *de facto* MPA area. Most of these sites are military use areas (Section 3.9.1.2.3) and areas restricted to protect the oil and shipping industries of the region. Most *de facto* MPAs allow multiple commercial and recreational uses with some periodic activity restriction. Fewer than 1% (approximately 100 km^2 [39 mi^2]) of *de facto* MPAs (primarily oil platforms and certain military use areas) are permanent no-access areas (National Marine Protected Areas Center 2008). Military use areas are discussed in more detail below. Maps and additional information on *de facto* MPAs can be found at http://www.mpa.gov/helpful_resources/inventoryfiles/defacto_mpa_report_0608.pdf.

3.9.1.2.2 Marine Sanctuaries. The only National Marine Sanctuary in the Western and Central GOM Planning Areas is the FGBNMS. The FGBNMS is located about 175 km (109 mi) southeast of Galveston, Texas (Figure 3.9.1-1). The area containing both the East and West Banks covers 143 km^2 (55 mi^2) and has 142 ha (351 ac) of reef crest (Gardner et al. 1998). In October 1996, Congress expanded the sanctuary by adding a small third bank, Stetson Bank, which is located about 113 km (70 mi) south of Galveston. The FGBNMS represents the northernmost coral reef system in the United States (Figure 3.9.1-1) and is described in detail in Section 3.7.2.1.2.

The most recent FGBNMS management plan (NOAA 2010d) suggests expanding the current FGBNMS boundary to include banks and topographic features that currently exist outside it but that may be vulnerable to anthropogenic impacts.

BOEM has protected the biological resources of the FGBNMS from potential damage due to oil and gas exploration by establishing a No Activity Zone and other operational restrictions in the vicinity of the banks. BOEM management and protection of the FGB and other topographic features began in 1973 prior to the establishment of the Sanctuary in 1992. Designating the area as a National Marine Sanctuary has provided other protective measures by regulating the following (available at http://flowergarden.noaa.gov/about/regulations.html):

- Injuring, removing, possessing, or attempting to injure or remove a living or nonliving sanctuary resource;
- Feeding fish and certain methods of taking fish;
- The speed, anchoring, and mooring of vessels;
- Destroying sanctuary property, or discharging or depositing outside the sanctuary boundaries polluting materials that could subsequently enter the sanctuary and injure a sanctuary resource or worsen its quality; and
- Altering the seabed or constructing, placing, or abandoning any structure or material on the seabed.

Recent surveys indicate that the FGBNMS appears to be healthy, with a coral cover of 50 to 70% on both the east and west banks and a low incidence of bleaching or other coral disease (Precht et al. 2008; Robbart et al. 2009). Data collected from the east and west banks from 1978 to 2006 do not indicate any long-term trends in the percentage of coral cover (Hickerson et al. 2008; Robbart et al. 2009). Ongoing stressors on the FGBNMS include mechanical disturbance from anchors and discarded fishing gear, coastal runoff, and disease (Hickerson et al. 2008).

3.9.1.2.3 Military and NASA Use Areas. Military Use Areas, established off all U.S. coastlines, are required by the U.S. Air Force, Navy, Marine Corps, and Special Operations Forces for conducting various testing and training missions. Military activities can be quite varied, but they normally consist of air-to-air, air-to-surface, and surface-to-surface naval fleet training, submarine and antisubmarine training, and Air Force exercises (Figure 3.9.1-2).

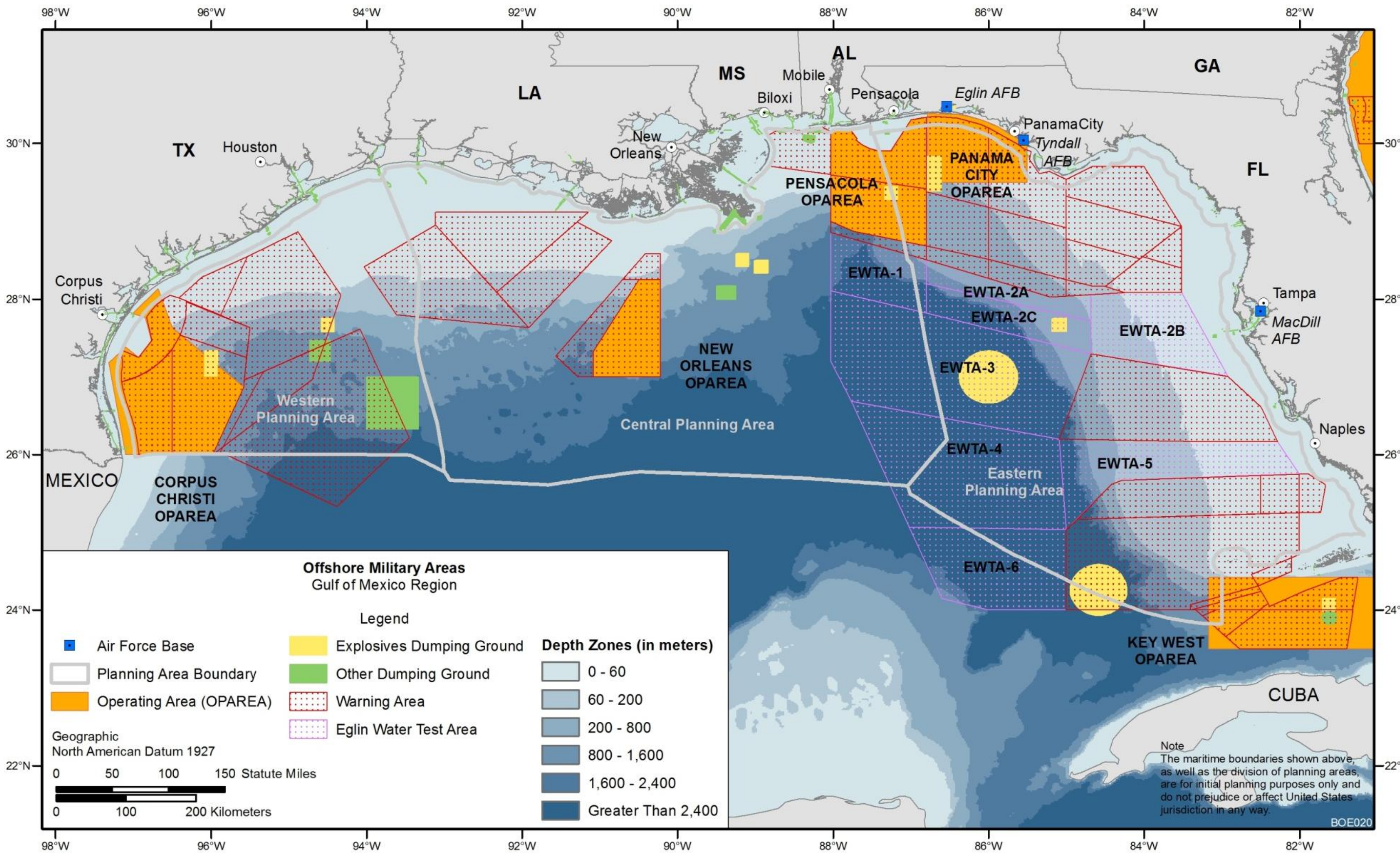

FIGURE 3.9.1-2 Location of Military Use Areas in the GOM

Military dumping areas are also shown in Figure 3.9.1-2. Dumping areas can be classified according to whether spoil, ordinance, chemical waste, or vessel waste is deposited in the area.

The U.S. Air Force has established multiple surface danger zones and restricted areas. Danger zones are defined as water areas used for a variety of hazardous operations (Marine Protected Areas Center 2008; U.S. Fleet Forces 2010). Danger zones may be closed to the public on a full-time or intermittent basis. Restricted areas are water areas defined as such for the purpose of prohibiting or limiting public access. Restricted areas generally provide security for Federal Government property and/or protect the public from the risks of damage or injury that could arise from the Federal Government's use of that area. The regulations pertaining to the identification and use of these areas are found in 33 CFR Part 334. Units of the U.S. Department of Defense (USDOD) and NASA use surface danger zones and restricted areas in coastal and offshore waters for rocket launching, weapons testing, and conducting a variety of training and readiness operations. Most danger zones and restricted areas in the northern GOM are associated with Elgin Air Force Base (AFB) and Tyndall AFB, both of which are located in the Florida Panhandle. The danger zones extend from nearshore areas to hundreds of kilometers off the coast of Florida. There is also a danger zone associated with MacDill AFB in Tampa Bay.

The GOM Range Complex is a combined air, land, and sea space that provides realistic training areas for Navy personnel. In coastal and marine areas, the GOM Range Complex includes military operating areas (OPAREAs) and overlying Special Use Airspaces (SUAs), the Naval Support Activity Panama City Demolition Pond, security group training areas, and supporting infrastructure (U.S. Fleet Forces 2010). Four offshore OPAREAs are located in the northern GOM: Corpus Christi, New Orleans, Pensacola, and Panama City (Figure 3.9.1-2). These offshore surface and subsurface areas total 59,817 km^2 (17,440 NM^2) and include 41,406 km^2 (12,072 NM^2) of shallow ocean area less than 185 m (590 ft) deep (U.S. Fleet Forces 2010). OPAREAs define where the U.S. Navy conducts surface and subsurface training and operations. The Navy conducts various training activities at sea (e.g., surface target sinking exercises and mine warfare exercises) and shakedown cruises for newly built ships.

Aircraft operated by all USDOD units train within SUAs that overlie the OPAREAs, as designated by the Federal Aviation Administration (U.S. Fleet Forces 2010). SUAs, also called warning areas, are the most relevant to the oil and gas leasing program because they are largely located offshore, extending from 5.6 km (3 NM or 3.5 mi) outward from the coast over international waters and in international airspace. These areas are designated as airspace for military activities, but because they occur over international waters, there are no restrictions on nonmilitary aircraft. The purpose of designating such areas is to warn nonparticipating pilots of potential danger. When they are being used for military exercises, the controlling agency notifies civil, general, and other military aviation organizations of the current and scheduled status of the area (U.S. Department of the Navy 2004). Aircraft operations conducted in warning areas primarily involve air-to-air combat training maneuvers and air intercepts, which are rarely conducted at altitudes below 1,524 m (5,000 ft) (U.S. Department of the Navy 2002).

Security group training areas are also located in marine waters of the GOM Range Complex. There are two group training areas: one is located 13 km (8 mi) off the coast of

Panama City, Florida; the other is 13 km (8 mi) off the coast of Corpus Christi, Texas. These areas are used for machine gun and explosives training (U.S. Fleet Forces 2010).

3.9.2 Alaska – Cook Inlet

The Alaska National Interest Lands Conservation Act of 1980 designated certain public lands in Alaska as units of the NPS, NWR, Wild and Scenic Rivers, National Wilderness Preservation, and National Forest systems. This section describes Alaskan lands managed by the NPS, USFWS, and USFS. It also describes MPAs, National Estuarine Research Reserves, National Estuary Program areas, MUAs, and NOAA-designated HCAs.

3.9.2.1 National Park Service Lands

Lands managed by the NPS include National Parks, National Monuments and Preserves, National Historic Areas, and designated Wild and Scenic Rivers. Onshore oil facilities are permissible only on private land holdings within NPS-managed lands. Even in some of these units, development of onshore oil-support facilities is unlikely because of the associated logistical difficulties that are perceived. Subsistence harvesting is allowed in some NPS units and may be affected by offshore oil and gas development.

There are three National Parks and one National Monument that could be affected by OCS oil and gas activities, including accidental spills. The information on each park provided below was gathered from NPS websites for individual parks. More information can be found at http://www.nps.gov/state/ak/index.htm.

The Katmai National Park and Preserve (which, for management purposes, includes the Alagnak Wild River and Aniakchak National Monument and Preserve) encompasses 1.9 million ha (4.7 million ac) (Figure 3.9.2-1). Katmai National Park is located in the Cook Inlet Planning Area on the western shore of Shelikof Strait, about 300 km (186 mi) southwest of Anchorage.

The Aniakchak National Monument and Preserve is located on the Alaskan peninsula about 161 km (100 mi) south of the Cook Inlet Planning Area (Figure 3.9.2-1). The park contains Aniakchak caldera and the Aniakchak River, which flows 43 km (27 mi) from Surprise Lake (inside the Aniakchak caldera) to the Pacific Ocean. Sockeye salmon make spawning runs up the Aniakchak River. The park is relatively pristine because of its remote location and harsh weather, both of which limit the number of visits by humans.

The Lake Clark National Park and Preserve, which borders Cook Inlet, spans 1.6 million ha (4 million ac) and extends roughly 150 km (93 mi) inland. It is a composite of ecosystems representative of many regions of Alaska, including lakes, rivers, and streams. The park receives more than 4,000 visitors annually.

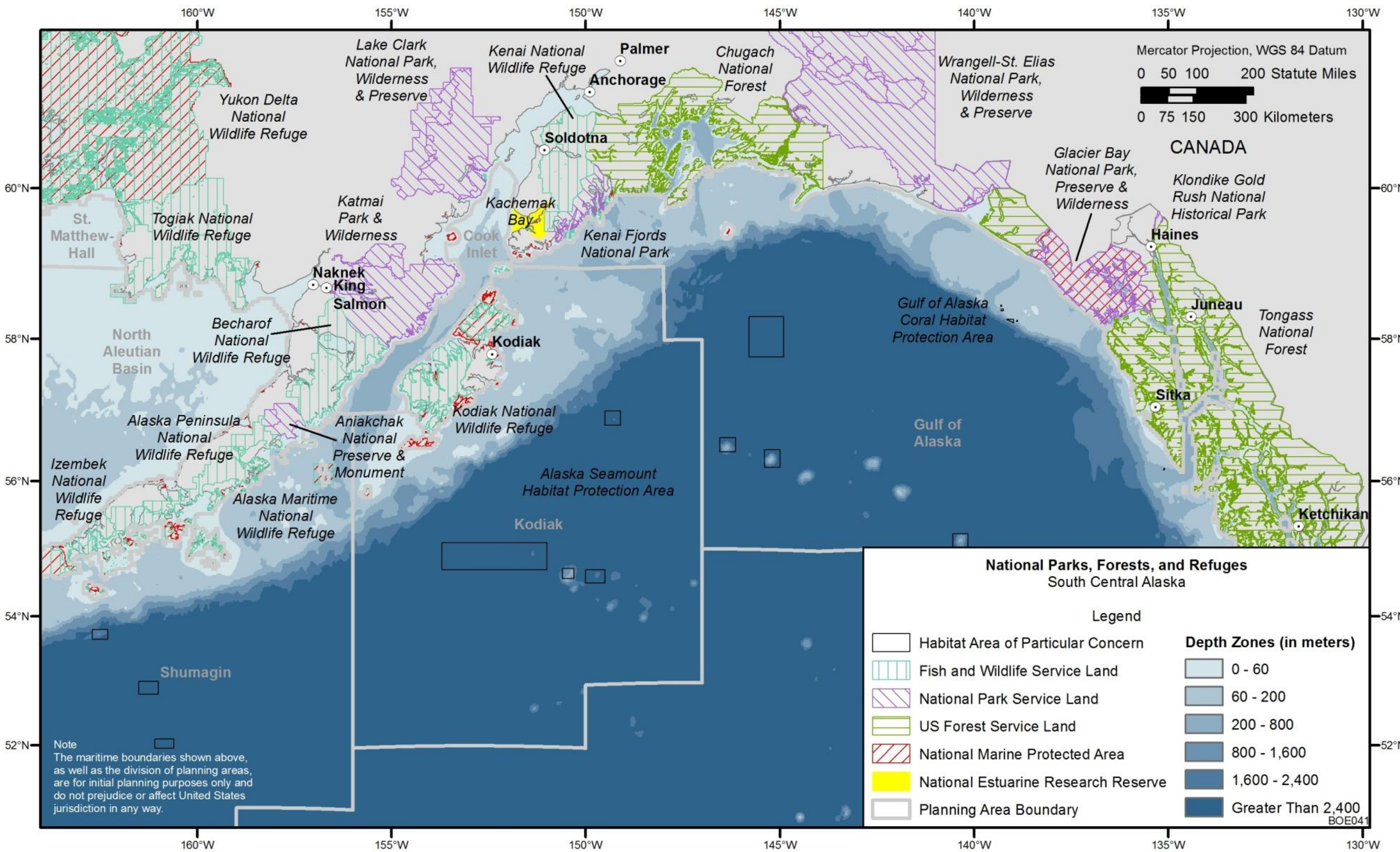

FIGURE 3.9.2-1 Map Showing the Location of Areas of Special Concern in the Cook Inlet Planning Area

Kenai Fjords National Park is east of Cook Inlet on the GOA, but it could be affected by an oil spill associated with OCS activities in Cook Inlet. This park contains the Harding Icefield and 38 glaciers.

3.9.2.2 Fish and Wildlife Service Lands

The USFWS has jurisdiction over NWRs for carrying out the responsibilities of Federal laws. Oil facility development is discretionary on NWRs in Alaska. Potential use of USFWS lands as bases for offshore oil and gas exploration as well as onshore oil and gas development will be determined in part by Title XI (see also Title III) of the Alaska National Interest Lands Conservation Act (ANILCA). Title XI ROWs are issued according to both ANILCA and the NWR System Administration Act of 1966 (16 USC 668dd), as amended by the NWR System Improvement Act of 1997 (P.L. 105-57). Title XI provides a procedural framework for permitting the use of USFWS lands and access to these lands for transportation and utility systems, which includes an application and extensive review process.

Information on each refuge provided below was gathered from NWR websites for individual refuges. More information can be found at http://www.fws.gov/refuges. There are six NWRs in Cook Inlet and the Kenai Peninsula. These include two units of the Alaska Maritime NWR: (1) the GOA Unit, which includes 1,287 km (800 mi) of coast from southeast Alaska's rainforests across the arc of Prince William Sound to Kodiak Island, and (2) the Alaska Peninsula Unit, which extends west more than 644 km (400 mi) from Kodiak Island to the southern tip of the peninsula (Figure 3.9.2-1).

The Alaska Peninsula NWR (managed jointly with the Becharof NWR) encompasses 1.5 million ha (3.7 million ac) and contains a variety of habitats, including mountains, rivers, lakes, volcanoes, and fjords.

The Becharof NWR encompasses roughly 485,623 ha (1.2 million ac), of which 202,343 ha (500,000 ac) is designated wilderness. The Becharof NWR is located south of Katmai National Park and Preserve and contains Becharof Lake. Sockeye spawn in Becharof's rivers, and Becharof Lake serves as a nursery for the world's second-largest run of sockeye salmon. The refuge includes vast areas of pristine wildlife and fish habitat and includes a diversity of mammalian, avian, and fish species.

The Izembek NWR encompasses 121,406 ha (300,000 ac), most of which is forest land containing critical streams and land for salmon, waterfowl, seabirds, and mammalian predators and herbivores. The refuge is located on the Alaska Peninsula near Cold Bay, Alaska, more than 322 km (200 mi) from the Cook Inlet Planning Area. Within the refuge is the Izembek Lagoon, which contains extensive eelgrass beds used by fish and birds as feeding and resting areas. The American Bird Conservancy designated the Izembek Refuge as a Globally Important Bird Area in 2001. Marine mammals, including steller sea lions and gray, minke, killer, and humpback whales, also inhabit or pass through the refuge.

The Kenai NWR encompasses roughly 809,371 ha (2 million ac). The refuge is located on the Kenai Peninsula on the eastern side of upper Cook Inlet. The Kenai NWR attracts many visitors because of its closeness to Anchorage and general accessibility. The area contains important moose habitat and also a rich array of habitats for an estimated 200 different vertebrate species. The refuge, including the rivers (Russian and Kenai), streams, and lakes within its borders, provides important spawning and rearing habitat for trout and all five species of Pacific salmon. The Harding Icefield lies partially within the refuge boundaries and nearby Kenai Fjords National Park. The Chickaloon watershed and estuary is a major waterfowl and shorebird staging area and is the only such area on the refuge. Oil and gas development activities occur on roughly 89,000 ha (220,000 ac).

The Kodiak NWR, encompassing about 768,903 ha (1.9 million ac), covers roughly two thirds of Kodiak Island, Uganik Island, the Red Peaks area on northwestern Afognak Island, and all of Ban Island. Biologists have identified 250 species of fish, mammals, and birds (including both residents and migrants) on the refuge. About 1.5 million marine birds overwinter in nearshore habitats surrounding Kodiak Island. There are 117 salmon streams on Kodiak Island that provide spawning and rearing habitat for all five species of Pacific salmon.

3.9.2.3 Forest Service Lands

Coastal lands managed by the USFS are at risk from potential impacts from outer continental shelf oil and gas development. The U.S. Bureau of Land Management (BLM), in cooperation with the USFS, manages oil/gas lease operations. The USFS has approval authority for the surface-use portion of the Federal oil/gas operation (36 CFR Part 228, Subpart E – Oil & Gas Resources). The USFS will carry out its statutory responsibilities when issuing Federal oil and gas leases and managing subsequent oil and gas operations on National Forest system lands.

The Chugach National Forest borders Prince William Sound and Turnagian Arm and is the closest National Forest (300 km [186 mi]) to the Cook Inlet Planning Area (Figure 3.9.2-1). It encompasses 2.2 million ha (5.5 million ac), of which 567,000 ha (1.4 million ac) have been proposed and are currently managed as wilderness. Though a variety of land uses are permitted on USFS lands (including timber harvest and mining activities), wilderness areas generally are exempt from such “multiple-use” activities. The Chugach Forest Management Plan identifies lands that are open or closed to leasing. Currently, the plan provides for oil and gas exploration and development in the Katalla area.

3.9.2.4 Marine Protected Areas

The Alaska Peninsula Unit and GOA Unit of the Alaska Maritime NWR are the only National System MPAs in the vicinity of the Cook Inlet Planning Area and are described in Section 3.9.2.2. The Alaska Maritime MPA is categorized as a Natural and Cultural Heritage Conservation Area and a Sustainable Production Conservation Area. Commercial fishing and recreational fishing are restricted.

Although not National System MPAs, there are several State and Federal MPAs present in Cook Inlet. Cook Inlet itself is eligible for National System membership, and fishing within Cook Inlet is restricted. There are also several NOAA-designated HCAs and Habitat Protection Areas (HPAs) in the Gulf of Alaska, including three federally managed steller sea lion protection areas: the Gulf of Alaska HCA located near Prince William Sound, the Aleutian Islands Coral HPA, and the Aleutian Islands Habitat HCA located to the west of Cook Inlet. These areas have prohibitions against specific fishing activities or that target certain species. In addition, Cook Inlet and the waters around Kodiak Island contain State marine protected areas that are eligible for MPA membership and that contain shrimp and scallop fishing closure areas and restrictions on types of commercial fishing gear. A detailed map of State and federally eligible MPAs can be found at http://www.mpa.gov/helpful_resources/inventoryfiles/AK_Map_090831_final.pdf.

There are no de facto MPAs (waters whose use is restricted to protect military property, public health, and private and public infrastructure) within Cook Inlet (National Marine Protected Areas Center 2008). However, to the east, there are several de facto MPAs within Prince William Sound. Most are administered by the U.S. Coast Guard to protect shipping. Maps and additional information on de facto MPAs can be found at http://www.mpa.gov/helpful_resources/inventoryfiles/defacto_mpa_report_0608.pdf.

3.9.2.5 Other Areas of Special Concern

There are multiple State parks and State recreation areas near the Cook Inlet Planning Area, many of which border Cook Inlet or are located in areas that could be contacted by accidental oil spills. Such areas include Captain Cook State Recreation Area, Clam Gulch State Recreation Area, Chugach State Park, Kachemak Bay State Park and State Wilderness Park, and Ninilchik State Recreation Area.

Kachemak Bay, Alaska, is a National Estuarine Research Reserve located in Cook Inlet on the southern end of the Kenai Peninsula. The reserve covers 149,734 ha (370,000 ac), and the bay itself has more than 515 km (320 mi) of shoreline. There is a variety of marine and estuarine habitat in the reserve, including mudflats, rock shore, beaches, open water, and submerged aquatic vegetation. Marine mammals use the bay heavily, as do commercially important fish and shellfish. More information on the Kachemak Bay NERR can be found at http://nerrs.noaa.gov/Reserve.aspx?ResID=KBA.

There are no military use restrictions (i.e., danger zones and restricted areas) in the waters of the Cook Inlet Planning Area (National Marine Protected Areas Center 2008). The closest danger zone is Blying Sound, which is managed by the U.S. Navy and located to the east of Cook Inlet near Prince William Sound. The Blying Sound Danger Zone is rarely activated, and there are no use restrictions for most of the year.

3.9.3 Alaska – Arctic

The Alaska National Interest Lands Conservation Act of 1980 designated certain public lands in Alaska as units of the National Park, NWR, Wild and Scenic Rivers, National Wilderness Preservation, and National Forest systems. This section describes Alaskan lands managed by the NPS and USFWS. There are no USFS lands adjacent to the Beaufort or Chukchi Sea Planning Areas. Also described are MPAs, National Estuarine Research Reserves, National Estuary Program Areas, Military Use Areas, and NOAA-designated HCAs.

3.9.3.1 National Park Service Lands

The Iñupiat Heritage Center in Barrow, Alaska, is the only NPS-managed area along the coast of the Beaufort and Chukchi Planning Areas (Figure 3.9.3-1). The Iñupiat Heritage Center uses exhibits, classes, performances, and educational activities to promote and protect Iñupiaq culture, history, and language. More information on the Iñupiat Heritage Center is available at http://www.nps.gov/inup/index.htm. The Cape Krusenstern National Monument is located along the northern shore of Hope Basin, about 150 km (93 mi) south of the Chukchi Planning Area. The Bering Land Bridge National Preserve is located along the southern shore of Hope Basin, about 300 km (186 mi) south of the Chukchi Sea Planning Area (Figure 3.9.3-1). Also located in Hope Basin are the deltas of Noatak and Kobuk National Park Units. More information on these parks is available at http://www.nps.gov.

Onshore oil facilities are permissible only on private land holdings within NPS-managed lands. In some of these units, development of onshore oil-support facilities is unlikely because of the logistical difficulties perceived. In addition, subsistence harvesting is allowed in some NPS units.

3.9.3.2 Fish and Wildlife Service Lands

The Arctic NWR and the Chukchi Sea Unit of the Alaska Maritime NWR are the closest NWRs to the Beaufort and Chukchi Sea Planning Areas. The Arctic NWR consists of about 7.65 million ha (18.9 million ac) of land in northeastern Alaska along the Beaufort Sea coast (Figure 3.9.3-1). An additional 277,000 ha (684,000 ac) are either selected for conveyance or have been conveyed, under the terms of the Alaska Native Claims Settlement Act of 1971 (ANCSA), to the State or to Native corporations. All federally owned land within the refuge is currently designated as wild rivers, or minimal or wilderness management status. Under the ANILCA, production of oil and gas from the Arctic NWR is prohibited, and no leasing or other development leading to production of oil and gas can be undertaken until authorized by an Act of Congress. However, under the same Act, 607,028 ha (1.5 million ac) along the northern coast, known as the 1002 Area, has been set aside for further study and possible oil development, per ANILCA (ANILCA Sec. 1002). More information on the Arctic NWR is available at http://arctic.fws.gov.

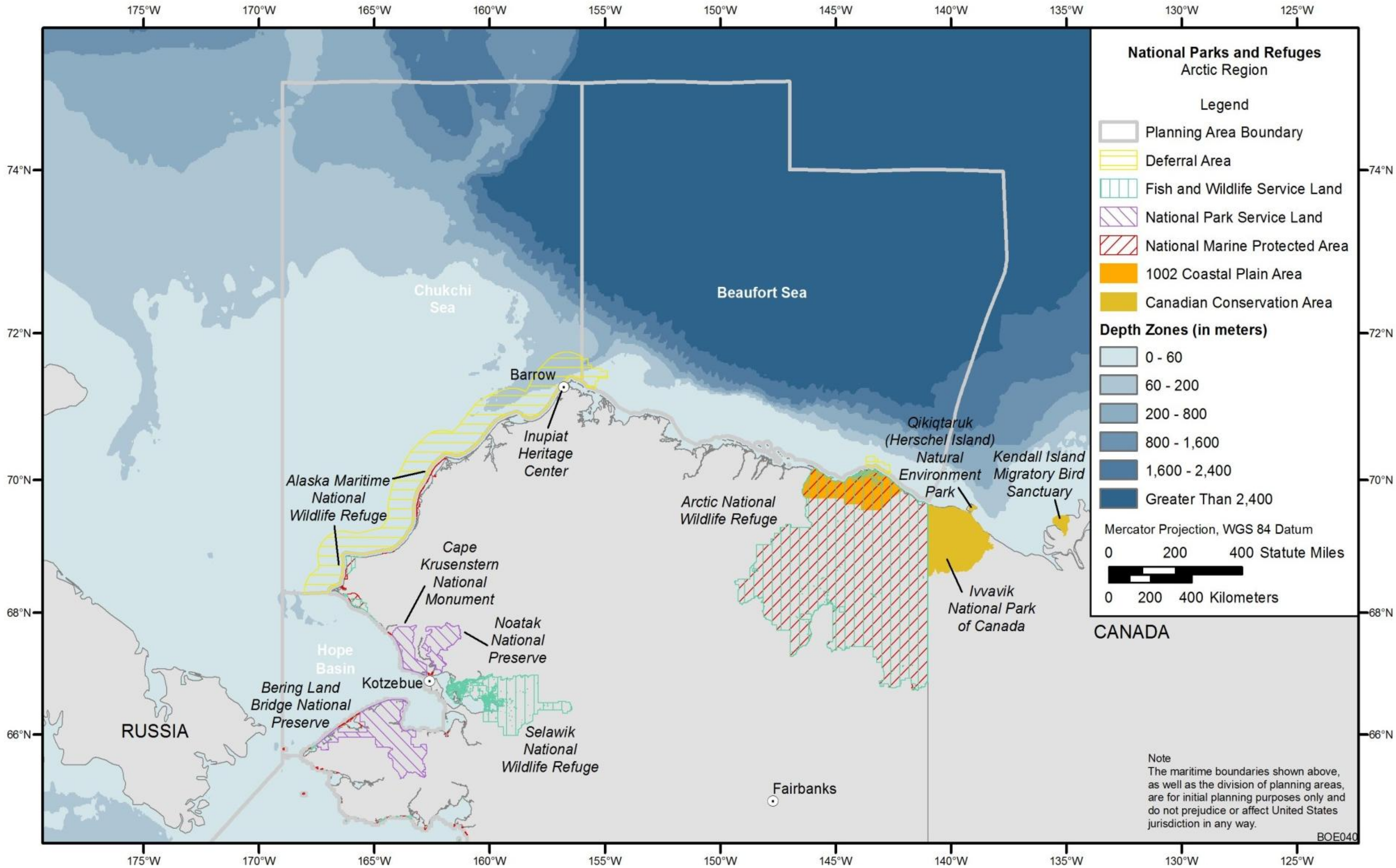

FIGURE 3.9.3-1 Map Showing the Locations of Areas of Special Concern in the Beaufort and Chukchi Sea Planning Areas

The Chukchi Sea Unit of the Alaska Maritime NWR includes coastal and offshore islands and extends 805 km (500 mi) from south of Barrow to south of Cape Thompson (Figure 3.9.3-1). The Chukchi Sea Unit contains several islands and coastal habitats important to marine birds. More information on the Chukchi Sea Unit of the Alaska Maritime NWR is available at http://alaskamaritime.fws.gov.

3.9.3.3 Marine Protected Areas

The Arctic NWR and the Chukchi Sea Unit of the Alaska Maritime NWR are the two National System MPAs in or near the Beaufort and Chukchi Sea Planning Areas and are described in Section 3.9.3.2 (Figure 3.9.3-1). Both NWRs are classified as Natural and Cultural Heritage Conservation Areas and Sustainable Production Conservation Areas. Commercial fishing is prohibited in the Arctic NWR and is restricted in the Chukchi Sea Unit of the Alaska Maritime NWR. There are no State MPAs or *de facto* MPAs in the Beaufort and Chukchi Planning Areas (http://www.mpa.gov/helpful_resources/inventoryfiles/AK_Map_090831_final.pdf).

3.9.3.4 Other Areas of Special Concern

There are no National Estuarine Research Reserves, National Estuary Program Areas, or Habitat Conservation Areas in or adjacent to the Beaufort and Chukchi Planning Areas. There are four active U.S. Air Force radar sites located on the coast bordering the Beaufort and Chukchi Sea Planning Areas. They are all Long-Range Radar Sites (LRRSs): Cape Lisburne LRRS, Point Barrow LRRS, Oliktok LRRS, and Barter Island LRRS. Each site has restricted areas within certain facilities. Access to each is only for personnel on official business and with approval of the commander of the USAF’s 611th Air Support Group.

A pipeline linking the Chukchi Sea Planning Area to the North Slope will likely cross the Bureau of Land Management NPR-A. Oil and gas leasing in the NPR-A is authorized under the Naval Petroleum Reserves Production Act of 1976 (42 USC 6501 *et seq.*), as amended, including the Department of the Interior and Related Agencies Appropriation Act of 1981 (94 Stat. 2964). Several lease tracts of NPR-A lands have been sold by BLM for oil and gas development (http://www.blm.gov/ak/st/en/prog/energy/oil_gas/npra.html).

Other areas of special concern include Ivvavik National Park, Herschel Island Territorial Park, and Kendall Island Bird Sanctuary, all of which are located in Canada on the eastern side the Beaufort Sea Planning Area.

3.10 POPULATION, EMPLOYMENT, AND INCOME

Offshore waters of the Western, Central, and Eastern GOM Planning Areas lie adjacent to coastal Texas, Louisiana, Mississippi, Alabama, and Florida. Although economic and demographic impacts of OCS oil and gas activity occur in other States in the U.S., the majority of impacts occur in the coastal States adjacent to the GOM. For the purposes of this analysis, the GOM coastal region consists of counties (and parishes in Louisiana) in each of the five States whose social and economic well-being is directly or indirectly affected by the OCS oil and gas industry. In this analysis, these counties (and parishes in Louisiana) have been grouped into labor market areas (LMAs), defined on the basis of inter-county commuting patterns using a method suggested by Tolbert and Sizer (1996). There are 129 counties in the 23 Labor Market Areas in the five States located along the GOM coast (MMS 2006b). Counties in the LMAs adjacent to the Western GOM Planning Area are all within Texas and include the cities of Brownsville, Corpus Christi, Victoria, Brazoria, Houston-Galveston, and Beaumont-Port Arthur. Counties in the LMAs adjacent to the Central GOM Planning Area include Lake Charles, Lafayette, Baton Rouge, Houma, and New Orleans, Louisiana; Biloxi-Gulfport, Mississippi; and Mobile, Alabama. Counties in the LMAs adjacent to the Eastern Planning Area are all within Florida and include Pensacola, Panama City, Tallahassee, Lake City, Gainesville, Ocala, Tampa-St. Petersburg, Sarasota, Ft. Myers, and Miami.

The south central Alaska region (which corresponds with the Cook Inlet Planning Area) is the most densely populated part of Alaska and includes Anchorage Municipality and the entirety of the Kenai Peninsula, Kodiak Island, and Matanuska-Susitna Boroughs. The area corresponds to the area where many workers on offshore oil and gas platforms would live, at least temporarily if they live permanently outside Alaska, and spend their wages and salaries when they are in residence, and the area in which much of the oil and gas infrastructure associated with development in Cook Inlet and many of the supporting industries would be located. The Arctic region (Beaufort and Chukchi Sea Planning Areas) consists of the North Slope Borough and the Northwest Arctic Borough. The area corresponds to the area where some of the workers on the offshore oil and gas platforms would live, at least temporarily if they live permanently elsewhere in Alaska or the U.S., and spend their wages and salaries when they are in residence, and the area in which much of the oil and gas infrastructure associated with development would be located.

3.10.1 Population

3.10.1.1 Gulf of Mexico

Population in the counties in the GOM coast region increased at an average annual rate of 1.6% between 1980 and 1990, 1.2% between 1990 and 2000, and 1.5% between 2000 and 2009 (Table 3.10.1-1). Total population in 2009 was 23.2 million. Within the region, recent annual population growth has been higher in the Texas counties, with growth of 2% between 1990 and 2000 and 2.1% between 2000 and 2009. Population in the Mississippi counties grew annually at 1.7% between 1990 and 2000, slowing to 0.2% between 2000 and 2009, while growth rates in the Florida counties have been higher between 2000 and 2009 compared to the previous period; population growth was negative in the Alabama counties between 1990 and 2000.

As is the case for the U.S. population as a whole, there is a relative decline in lower age cohorts over time (Table 3.10.1-2), while the region has shown a steady improvement in the level

TABLE 3.10.1-1 Gulf of Mexico Coastal Region Population (thousands)

State	1980	1990	Average Annual Percent Change (1980–1990)	2000	Average Annual Percent Change (1990–2000)	2009	Average Annual Percent Change (2000–2009)
Texas	4,931.67	5,726.76	1.5	6,969.83	2.0	8,376.1	2.1
Louisiana	3,021.66	3,056.77	0.1	3,343.69	0.9	3,354.07	0.0
Mississippi	370.07	389.02	0.5	458.67	1.7	466.59	0.2
Alabama	581.23	609.33	0.5	599.4	–0.2	647.09	0.9
Florida	6,424.37	8,178.85	2.4	8,955.93	0.9	10,320.23	1.6
Total region	15,329.00	17,960.74	1.6	20,327.54	1.2	23,164.08	1.5

Source: USCB 2011d.

TABLE 3.10.1-2 Gulf of Mexico Coastal Region Population Composition

Population Segment	1980	1990	2000
Total Population	15,329,000	17,960,740	20,327,536
Age Structure (%)			
Under 5	7.4	7.6	7.0
5 to 14	15.4	14.5	14.7
15 to 24	18.1	14.2	13.7
25 to 34	16.3	16.9	13.8
35 to 44	11.1	14.6	15.6
45 to 54	9.7	9.8	13.0
55 to 64	9.5	8.6	8.8
65+	12.6	13.8	13.5
Education of Persons Age 25+ (%)			
0 to 8 yr schooling	20.5	12.6	9.6
9 to 11 yr schooling	15.8	15.9	14.1
High school graduates	32.1	28.6	27.8
13 to 15 yr schooling	15.9	24.4	26.9
College graduates	15.6	18.4	21.6

Source: MMS 2006b.

of educational attainment; the percentage of persons having attended or graduated from college increased from 31% in 1980 to 48% in 2000.

3.10.1.2 Alaska – Cook Inlet

Population in the south central Alaska region increased at an average annual rate of 3.5% between 1980 and 1990, 1.8% between 1990 and 2000, and 1.5% between 2000 and 2009 (Table 3.10.1-3). Total population in Alaska in 2009 was 698,473. Within the region, recent annual population growth has been higher in the Matanuska-Susitna Borough, with growth of 8.3% between 1980 and 1990 and 4.1% between 1990 and 2000, and 4.1% between 2000 and 2009. Population in Kenai Peninsula grew annually at 4.9% between 1980 and 1990, slowing to 2.0% between 1990 and 2000. Recent growth rates in Anchorage have also declined, from 2.6% between 1980 and 1990 to 1.4% between 1990 and 2000. Growth rates in Anchorage and Kenai Peninsula between 2000 and 2009 are similar to those experienced in the State as a whole.

3.10.1.3 Alaska – Arctic

Population in the Arctic region increased at an average annual rate of 3.0% between 1980 and 1990, 1.9% between 1990 and 2000, and –0.3% between 2000 and 2009 (Table 3.10.1-3). Total population in the Northwest Arctic Borough was 7,444 in 2009, with 6,752 residents in the North Slope Borough.

TABLE 3.10.1-3 Alaska Regional Population (thousands)

Borough, Region, and State	1980	1990	Average Annual Percent Change (1980–1990)	2000	Average Annual Percent Change (1990–2000)	2009	Average Annual Percent Change (2000–2009)
Anchorage	174,431	226,338	2.6	260,283	1.4	286,174	1.0
Kenai Peninsula	25,282	40,802	4.9	49,691	2.0	54,665	1.0
Kodiak Island	9,939	13,309	3.0	13,913	0.4	13,946	–0.4
Matanuska-Susitna	17,816	39,683	8.3	59,322	4.1	88,379	4.1
Total region	**227,468**	**320,132**	**3.5**	**383,209**	**1.8**	**442,564**	**1.5**
North Slope	4,199	5,979	3.6	7,385	2.1	6,752	–1.0
Northwest Arctic	4,831	6,113	2.4	7,208	1.7	7,444	0.3
Total region	**9,030**	**12,092**	**3.0**	**14,593**	**1.9**	**14,196**	**–0.3**
Alaska	**401,851**	**550,043**	**3.2**	**626,932**	**1.3**	**698,473**	**1.2**

Sources: Department of Labor and Workforce Development 2011; USCB 2011d.

3.10.2 Community Population and Income

3.10.2.1 Alaska – Cook Inlet

Anchorage Municipality had 280,389 residents over the period 2005–2009, almost 45% of the total population of Alaska (Table 3.10.2-1). Median household income in Anchorage was $70,151 over the period 2005–2009, per capita income stood at $33,436 over the same period. Only 7.8% of individuals in the borough were living in poverty, and 5.6% of the population classified themselves as American Indian or Alaska Native.

Although Kenai Peninsula Borough had 53,052 residents, of the 22 communities in the borough, only three had more than 3,000 residents over the period 2005 to 2009 (Kenai, 7,661; Kalifornsky, 7,020; Homer, 5,667; Nikiski 4,683; Soldotna 4,266, and Seward 3,083), constituting 37% of the population of the Borough (Table 3.10.2-1). While five communities had median household incomes of more than $60,000 over the period 2005–2009 (Halibut Cove, $127,010; Kasilof, $77,188; Salamatof, $72,958; Nikiski, $70,000; and Kalifornsky, $66,652), there were nine communities with median household income of less than $40,000. Six communities in the borough had per capita incomes higher than the borough community average over the period 2005–2009 ($26,940), while 15 communities had per capita incomes less than the borough average over the same period; per capita incomes in three communities stood at half the borough average.

The percentage of individuals living in poverty was greater than the borough average in 11 communities, with a higher number of individuals in two communities (Clam Gulch, 45.1%, and Port Graham, 40.5%). Two of the larger communities in the borough, Nikiski and Seward, had higher than average poverty levels. Three communities in the borough (Tyonek, 100%; Nanwalek, 97.2%; and Port Graham, 82.4%) had a high percentage of American Indian or Alaska Natives, with higher than average percentages in six other communities.

Population in the Kodiak Island Borough is concentrated in Kodiak, with 6,291 residents between 2005 and 2009 constituting more than 48% of the population of the borough. Two communities had median household incomes of more than $50,000 over the period 2005–2009 (Kodiak, $57,930, and Larsen Bay, $54,375), while two communities had median household incomes of less than $10,000. Two communities in the borough had per capita incomes higher than the borough community average over the period 2005–2009 ($26,862), while five communities had per capita incomes less than the borough average over the same period, and per capita incomes in one community stood at less than half the borough average.

The percentage of individuals living in poverty was higher than the borough average in six communities, with a high number of individuals in two communities (Karluk, 71.7%; Old Harbor, 39.9%). Two communities in the borough, Karluk (100%) and Akhiok (90.1%), had a high percentage of American Indian or Alaska Natives, with higher than average percentages in four other communities.

TABLE 3.10.2-1 South Central Alaska Region Community Population, Income, and Poverty Status (2005–2009 Average)

Community	Total Residents	Median Household Income (2009 $)	Per Capita Income (2009 $)	Percent of Individuals Living in Poverty	Percent American Indian/ Alaska Native
State of Alaska	683,142	64,635	29,382	9.6	13.5
Anchorage					
Anchorage	280,389	70,151	33,436	7.8	5.6
Kenai Peninsula Borough	53,052	55,966	26,940	9.7	6.9
Anchor Point	1,743	50,710	25,615	7.0	2.5
Clam Gulch	104	32,639	25,075	45.1	0.0
Cohoe	808	52,125	29,090	9.3	5.3
Fox River	559	51,750	12,735	18.6	0.0
Fritz Creek	1,865	44,773	20,694	7.9	1.9
Halibut Cove	60[a]	127,010[a]	89,895[a]	0.0[a]	0.0[a]
Happy Valley	498	51,875	25,191	16.4	2.2
Homer	5,667	54,730	30,317	8.2	3.0
Kalifornsky	7,020	66,652	29,789	11.3	8.5
Kasilof	370	77,188	36,044	7.0	5.4
Kenai	7,661	51,875	27,597	8.1	4.5
Nanwalek	179	29,306	7,731	29.1	97.2
Nikiski	4,683	70,000	25,713	14.8	8.7
Nikolaevsk	332	44,333	17,797	9.0	5.1
Ninilchik	490	42,917	26,121	12.0	5.9
Port Graham	153	26,875	11,939	40.5	82.4
Salamatof	969	72,958	19,158	8.1	12.4
Seldovia City	326	51,111	28,378	7.7	17.5
Seldovia Village	109	50,417	20,939	12.8	32.2
Seward	3,083	44,457	18,189	13.5	17.6
Soldotna	4,266	47,031	26,686	9.1	9.1
Tyonek	164	22,813	14,149	28.7	100.0
Kodiak Island Borough	13,147	59,655	26,862	10.6	15.4
Akhiok	101	9,107	10,556	23.8	90.1
Karluk	53	6,250	7,502	71.7	100.0
Kodiak	6,291	57,930	24,058	10.8	10.9
Larsen Bay	79	54,375	43,038	1.3	69.6
Old Harbor	233	22,813	10,910	39.9	68.7
Ouzinkie	214	48,333	23,698	13.1	50.5
Port Lions	153	38,750	29,271	6.5	79.1
Matanuska-Susitna Borough	82,099	66,052	24,906	10.3	4.0
Houston	1,628	43,750	20,957	15.0	1.7
Palmer	7,696	60,000	21,105	14.4	7.8
Wasilla	9,616	53,977	24,221	14.2	3.4

[a] 2000 data.

Source: USCB 2011e.

Population in the Matanuska-Susitna Borough is dispersed among a large number of small, unincorporated communities. The largest incorporated community, Wasilla, had 9,616 residents between 2005 and 2009, and Palmer had 7,696 residents. The population in these communities constituted 21% of the population of the borough. Two communities had median household incomes of more than $50,000 over the period 2005–2009 (Palmer, $60,000; Wasilla, $53,977).

The percentage of individuals living in poverty was slightly higher than the borough average in each incorporated community. Palmer (7.8%) had a higher than average percentage of American Indian or Alaska Natives.

3.10.2.2 Alaska – Arctic

Population in the North Slope Borough is concentrated in Barrow, with 4,078 residents between 2005 and 2009 constituting 61% the population of the borough (Table 3.10.2-2). Two communities had median household incomes of more than $70,000 over the period 2005–2009 (Nuiqsut, $85,156; Point Hope, $73,438), while two communities had median household incomes of less than $50,000. One community in the borough had per capita incomes higher than the borough average over the period 2005–2009 ($24,125), while five communities had per capita incomes less than the borough average over the same period. In the Northwest Arctic Borough, population is concentrated in Kotzebue, with 3,152 residents between 2005 and 2009, constituting 42% of the Borough population. Three communities had median household incomes of more than $60,000 over the period 2005–2009 (Kobuk, $88,333; Kotzebue, $69,306; and Noatak, $63,125), while one community (Deering, $21,653) had a median household income of less than $30,000. One community in the borough had per capita incomes higher than the borough average over the period 2005–2009 ($20,001), while ten communities had per capita incomes less than the borough average over the same period.

The percentage of individuals living in poverty in the North Slope Borough was higher than the borough average in two communities. All but one of communities in the borough had a high percentage of American Indian or Alaska Natives, with a lower than average percentage in Barrow. In the Northwest Arctic Borough, the percentage of individuals living in poverty was higher than the borough average in six communities. All but three of communities in the borough had a high percentage of American Indian or Alaska Natives.

3.10.3 Employment, Unemployment, and Earnings

3.10.3.1 Gulf of Mexico

Employment in the GOM coast region in 2009 was concentrated in Florida (4.5 million employed in 2009) and Texas (3.6 million); together these States provide more than 81% of employment in the region (10.1 million) (Table 3.10.3-1). Unemployment rates for 2009 vary across the GOM coast region; the highest rates were 10.3% in Alabama and Florida, with rates

TABLE 3.10.2-2 Arctic Region Community Population, Income, and Poverty Status (2005–2009 Average)

Community	Total Residents	Median Household Income ($)	Per Capita Income ($)	Percent of Individuals Living in Poverty	Percent American Indian/Alaska Native
State of Alaska	683,142	64,635	29,382	9.6	13.5
North Slope Borough	6,716	66,556	24,125	14.8	67.5
Barrow	4,078	67,411	27,786	17.9	54.9
Kaktovik	260	44,375	19,022	10.4	87.3
Nuiqsut	366	85,156	17,849	0.6	94.3
Point Hope	875	73,438	18,825	8.0	80.7
Point Lay	194	46,875	14,067	16.8	99.0
Wainwright	534	68,750	20,063	12.7	94.2
Northwest Arctic Borough	7,430	57,885	20,001	19.2	80.6
Ambler	279	41,406	14,741	40.5	82.4
Buckland	491	44,688	10,478	19.4	98.4
Deering	78	21,563	14,565	10.3	75.6
Kiana	344	35,000	15,581	32.3	92.2
Kivalina	446	59,821	13,727	12.3	96.7
Kobuk	90	88,333	16,130	16.7	82.2
Kotzbue	3,152	69,306	22,535	15.5	70.8
Noatak	506	63,125	15,365	9.3	78.7
Noorvik	676	46,042	13,766	22.1	90.7
Selawik	801	36,563	10,633	33.0	91.3
Shungnak	303	36,875	9,090	26.1	98.7

Source: USCB 2011e.

between 8.1% and 8.2% in Texas and Mississippi, and a lower rate of 6.5% in Louisiana. The average for the region as a whole was 8.9%.

The distribution of earnings in the GOM coast region reflects the concentration of employment across the five States, the $433.1 billion in combined compensation in Florida ($218.6 billion) and Texas ($214.5 billion) representing more than 80% of earnings in the region as a whole in 2009 ($537.7 billion).

3.10.3.2 Alaska – Cook Inlet

Employment in the south central Alaska region in 2009 was concentrated in Anchorage (144,403 employed in 2009), which provides almost 83% of employment in the region (188,218) (Table 3.10.3-2). Unemployment rates for 2009 vary across the south central Alaska region; the

TABLE 3.10.3-1 Gulf of Mexico Coastal Region Labor Force, Unemployment, Earnings, and Employment Composition

Employment	Alabama	Florida	Louisiana	Mississippi	Texas	Total
Labor Force (2009)						
Total	283,507	5,073,188	1,554,441	210,766	3,964,812	11,086,714
Employed	254,298	4,553,309	1,453,757	193,507	3,644,160	10,099,031
Unemployment rate	10.3%	10.3%	6.5%	8.2%	8.1%	8.9%
Earnings ($billion)	12.2	218.6	82.1	10.2	214.5	537.7
Employment by Industrial Sector (2008)						
Farm employment[a]	6,875	79,691	31,553	6,085	86,928	211,132
Non-farm proprietors	75,417	1,306,323	395,915	47,781	1,019,572	2,845,008
Forestry and fishing	1,936	26,788	11,600	2,326	18,126	60,777
Mining	1,483	8,609	54,474	1,577	142,824	209,267
Utilities	1,633	14,275	5,954	1,809	22,060	45,731
Construction	32,661	395,711	165,576	23,982	398,417	1,016,348
Manufacturing	26,469	195,115	121,830	24,228	329,400	697,042
Wholesale and retail trade	55,713	864,588	268,537	30,277	668,588	1,887,704
Transportation and warehousing	12,958	189,625	81,448	6,093	200,447	490,571
Finance, insurance, and real estate	31,960	644,080	151,177	15,803	403,318	1,246,339
Services	145,577	2,631,238	818,446	93,704	1,933,388	5,622,353
Federal civilian government	3,054	75,075	22,278	9,515	46,285	156,207
Federal military government	3,935	63,428	26,600	13,196	26,275	133,434
State and local government	39,067	595,626	241,896	30,478	493,954	1,401,021

[a] Farm employment includes farm proprietors and agricultural services employment.

Sources: USDOL 2011; USDOC 2011a,b.

highest rate was 10.1% in Anchorage, with rates between 6.6% and 7.3% in Anchorage and Kodiak Island. The average for the region as a whole was 7.2%.

The distribution of earnings in the south central Alaska region reflects the concentration of employment across the four boroughs, the $11.2 billion in compensation in Anchorage representing almost 82% of earnings in the region as a whole in 2009 ($13.6 billion).

Personal incomes in Alaskan Native villages are lower than in the State as a whole, and unemployment, especially in smaller villages, is high, particularly during the winter when there is little alternate market-based activity. Because of the key role of subsistence in many village economies, economic data that is collected for these communities may not fully represent their economic well-being. For example, many transactions between individuals involving the exchange of subsistence products that would otherwise provide income if they took place in the marketplace are not reflected in personal income statistics. Similarly, unemployment data may not reflect the extent to which additional economic activity may be required if subsistence activities provide a sufficient alternative to participation in the marketplace. In addition, the

TABLE 3.10.3-2 South Central Alaska Region Labor Force, Unemployment, Earnings, and Employment Composition

Employment	Anchorage	Kenai Peninsula	Kodiak Island	Matanuska-Susitna	South Central Alaska Region Total
Labor Force (2009)					
Total	154,562	27,045	6,611	42,425	230,643
Employed	144,303	24,326	6,127	38,497	213,253
Unemployment rate	6.6	10.1	7.3	9.3	8.3
Earnings ($b)	11.2	1.0	0.4	1.0	13.6
Employment by Industrial Sector, 2008					
Farm employment[a]	0	225	0	574	799
Non-farm proprietors	37,222	11,742	2,613	12,001	63,578
Forestry and fishing	1,232	2,095	976	832	5,135
Mining	3,811	1,489	24	345	5,669
Utilities	557	263	42	143	1,006
Construction	12,393	2,366	349	3,630	18,738
Manufacturing	2,750	1,035	1,616	658	6,059
Wholesale and retail trade	26,606	3,610	885	5,291	36,392
Transportation and warehousing	12,404	1,233	316	1,360	15,313
Finance, insurance & real estate	15,768	2,139	329	2,484	20,720
Services	85,191	11,782	2,869	13,653	113,496
Federal civilian government	9,464	405	345	207	10,421
Federal military government	13,425	462	1,049	595	15,531
State and local government	20,302	4,655	1,108	3,630	29,695

[a] Farm employment includes farm proprietors and agricultural services employment.

Sources: USDOL 2011; USDOC 2011a, b.

large differences in prices between urban and rural Alaska may exaggerate the corresponding differences in economic well-being depending on the extent to which local community members in rural areas have to participate in the local market economy for key consumer items, such as food, clothing, and energy, and the extent to which these items can be obtained through participation in subsistence activities.

A significant portion of income for lower-income Alaskans is the Alaska Permanent Fund Dividend, an annual per capita payment from a savings account established in 1976 using a portion of royalties paid to the State from oil production on State land. Although the fund principal is constitutionally protected from being spent, the majority of the earnings from the fund are distributed to every State resident as an annual cash payment. Dividends were first paid in 1982, and the annual payment has become a growing portion of per capita personal income in the State (USDOI 2002).

3.10.3.3 Alaska – Arctic

Employment by place of residence in the North Slope Borough in 2009 was 5,140 (Table 3.10.3-3); in the Northwest Arctic Borough employment stood at 2,623 (Table 3.10.3-3). The unemployment rate for the North Slope Borough 2009 was 4.7%, and earnings were $1.4 billion; the unemployment rate for the Northwest Arctic Borough in 2009 was 12.0%, and earnings were $0.2 billion.

Personal incomes in Alaskan Native villages are lower than in the State as a whole, and unemployment, especially in smaller villages, is high, particularly during the winter when there is little alternate market-based activity (see Section 3.10.3.2). A significant portion of income for many Alaskans is the Alaska Permanent Fund Dividend, an annual per capita payment from a savings account established in 1976 using a portion of royalties paid to the State from oil production on State land (see Section 3.10.3.2).

3.10.4 Employment by Industry

3.10.4.1 Gulf of Mexico

The largest employing sectors in the GOM coast region in 2008 were services (43.1% of total employment), retail and wholesale trade (14.5%), and State and local government (10.7%) (Table 3.10.3-1). The share of total State employment in services — wholesale and retail trade and finance and insurance and real estate — was slightly higher than the GOM coast average in Florida, and the share of employment in State and local government was slightly higher in Louisiana and Mississippi.

In addition to sectoral employment distributions, counties on the GOM coast can be classified into economic types indicating primary land use patterns. Using this approach, only 5 of the 129 counties in the GOM coast region are classified as farming-dependent; 9 counties are defined as mining-dependent, suggesting the importance of oil and gas development to these local economies (MMS 2005b). Manufacturing dependence is noted for another 27 of the counties. Local school districts and public facilities, such as hospitals and prisons, are often the largest employers in sparsely populated rural areas; 16 rural counties and 14 metropolitan counties are classified as government employment centers. Another 21 counties have economies tied to service employment. Thirty-nine of the 132 counties are considered major retirement destinations, and 7 of the rural counties are classified as recreation-dependent.

3.10.4.2 Alaska – Cook Inlet

The largest employing sectors in the south central Alaska region in 2008 were services (41.0% of total employment), with retail and wholesale trade at 13.1% and State and local government at 10.7% (Table 3.10.3-2). Of the share of total State employment in services, wholesale and retail trade was slightly higher than the south central Alaska region average in

TABLE 3.10.3-3 Arctic Region Labor Force, Unemployment, Earnings, and Employment Composition

Employment	North Slope Borough	Northwest Arctic Borough	Arctic Region Total
Labor Force (2009)			
Total	5,394	2,980	8,374
Employed	5,140	2,623	7,763
Unemployment rate	4.7	12.0	7.3
Earnings ($b)	1.4	0.2	1.6
Employment by Industrial Sector, 2008[a]			
Farm employment[b]	0	0	0
Forestry and fishing	25	68	93
Mining	8,342	135	8,477
Utilities	61	15	76
Construction	272	201	473
Manufacturing	12	10	22
Wholesale and retail trade	498	241	740
Transportation and warehousing	207	197	404
Finance, insurance and real estate	890	217	1,107
Services	5,043	983	6,025
Federal civilian government	24	47	71
Federal military government	46	52	98
State and local government	1,757	1,102	2,859

[a] As labor force data is by place of residence, and employment by sector is by place of work, not all individuals working in the North Slope Borough are included in the labor force statistics, with many employees commuting to the Borough from other parts of Alaska and the United States.

[b] Farm employment includes farm proprietors and agricultural services employment.

Sources: USDOL 2011; USDOC 2011a, b.

Anchorage, and the share of employment in State and local government was slightly higher in the Kenai Peninsula Borough and in the Kodiak Island Borough. Employment in manufacturing and military employment was more important in the Kodiak Island Borough than elsewhere in the region.

3.10.4.3 Alaska – Arctic

The largest employing sectors by place of work in the Arctic region in 2008 were mining (including oil and gas) with 8,477 people employed (49.3% of total employment), services with 6,025 employees (35.0%), and State and local government with 2,859 employees (16.6%) (Table 3.10.3-3). Between 2001 and 2007, approximately 70% of North Slope workers in the oil and gas industry in 2001 and 2006 commuted to and from permanent residences elsewhere in Alaska, primarily in south central Alaska and Fairbanks (MMS 2008b).

The North Slope Borough itself is the largest employer of the resident workforce through government positions, primarily in Barrow; Borough-provided services; and Capital Improvement Program construction projects (MMS 2006b). The regional and village corporations established by the ANCSA also provide local employment.

3.10.5 Oil and Gas Employment

3.10.5.1 Gulf of Mexico

Oil and gas employment in the GOM coast States is concentrated in Texas, with 1,639 establishments employing roughly 38,549 people in 2008, representing nearly 62% of oil and gas industry employment in the GOM States (62,314) (USCB 2011f). Louisiana is second most important State, with 767 establishments employing 23,061 people. The Houston LMA had the largest oil and gas sector employment in the GOM coast in 2004, with 564 establishments employing roughly 11,882 people, followed by the New Orleans LMA, where 70 establishments employed 3,578 people (MMS 2006b).

3.10.5.2 Alaska – Cook Inlet

Oil and gas employment in the south central region in 2007 stood at 8,636, with 3,418 employed directly in oil and gas extraction activities, pipeline and refinery activities, and 5,218 in support activities (AOGA 2011). Oil and gas employment was concentrated in Anchorage, where there were 5,192 total employees, with 1,649 direct and 3,543 support workers. Kenai Peninsula (2,213) and Matanuska-Susitna (1,231) supported lower levels of oil and gas employment.

3.10.5.3 Alaska – Arctic

Large numbers of Arctic region oil and gas workers reside in other parts of Alaska and the U.S., relocating temporarily to work locations in the Arctic region as required. Employment statistics are typically presented by place of residence, meaning that oil and gas employment for the Arctic region on this basis would be relatively small. Employment by place of work data show that there were 7,540 oil and gas workers in the Arctic region in 2007, all of whom were located in the North Slope Borough (AOGA 2011). Of these workers, 1,741 were employed directly in oil and gas extraction activities, pipeline and refinery activities, and 5,799 in support activities.

3.10.6 Population, Labor Force, and Income Projections

3.10.6.1 Gulf of Mexico

Projections of demographic and economic data assume the continuation of existing social, economic, and technological trends at the time of the forecast, including employment associated with the continuation of current OCS leasing activity, as well as the continuation of trends in other industries important to the region. Projections in this section are based on growth rates provided in MMS (2006b) and the most recent population employment and earnings data.

The GOM coast region is projected to experience average annual increases in population of 1.3% between 2010 and 2020, with slightly lower average annual rate of 1.2% over the period 2020 to 2030 (Table 3.10.6-1). Differences in age structure, as well as net migration, among the coastal commuting zone areas could create variations in population growth within the GOM coast region. Southern Florida and western Texas areas are projected to have the highest growth rates, exceeding those expected for Louisiana and Mississippi.

Average annual growth in employment of 1.5% between 2010 and 2030 is primarily driven by growth in services, and while the farming labor force is not expected to experience a high growth rate over the period, related activities in agricultural services are projected to realize rapid growth rates over the 25-yr period (MMS 2006b).

Earnings in the GOM coast region (in 2009 dollars) are projected to grow at an average annual rate of 2.4% between 2005 and 2025, and 2.5% between 2025 and 2030. Earnings in services are projected to increase rapidly during this period, contributing more to this increase than any other industry. In other industries, such as manufacturing, rapid growth in projected average wages compensate for moderate employment growth, making these industries strong contributors to overall regional income (MMS 2006b).

3.10.6.2 Alaska – Cook Inlet

Projections of demographic and economic data assume the continuation of existing social, economic, and technological trends at the time of the forecast, including employment associated with the continuation of current OCS leasing activity, as well as the continuation of trends in other industries important to the region. Projections in this section are based on population forecasts provided by the State of Alaska (Alaska Department of Labor and Workforce Development 2007) and employment and earnings data for 2009.

The south central Alaska region is projected to experience average annual increases in population of 1.27% between 2010 and 2020, with a slightly lower average annual rate of 1.07% over the period 2020 to 2030 (Table 3.10.6-2). Differences in age structure, as well as net migration, could create variations in population growth within the south central Alaska region. Between 2010 and 2020, Matanuska-Susitna (2.83%) and Anchorage (0.94%) are projected to have higher growth rates in the region, with lower rates in the Kenai Peninsula (0.77%). Rates in

TABLE 3.10.6-1 Gulf of Mexico Coastal Region Projections

Regional Characteristics	2010	2015	2020	2025	2030
Population	23,478,203	25,067,221	26,702,229	28,398,512	30,19 5,698
Employment	10,253,294	11,049,871	11,907,349	12,835,229	13,842,305
Earnings ($billion 2009)	550.8	620.9	700.0	789.7	891.7

Sources: MMS 2005b, 2006b.

TABLE 3.10.6-2 South Central Alaska Region Projections

Regional Characteristics	2010	2015	2020	2025	2030
Population	444,735	473,994	504,529	534,084	561,076
Employment	214,416	228,115	242,476	256,434	269,103
Earnings ($billion 2009)	13.8	14.5	15.3	16.1	16.7

Sources: MMS 2006b; Department of Labor and Workforce Development 2007.

Kodiak Island are expected to decline, by 0.32% between 2010 and 2020 and by 0.63% between 2020 and 2030.

Based on unemployment and labor force participation rates from 2009, employment in the south central Alaska region is expected to grow from 214,416 in 2010 to 269,103 in 2030, with the majority of employment growth occurring in Anchorage during this period. Growth rates over the 25-yr period will be driven primarily by growth in mining (including oil and gas), fisheries, and services (MMS 2006b). Earnings in the south central Alaska region (in 2009 dollars) are projected to grow from $13.8 billion in 2010 to $16.7 billion in 2030, with earnings growth concentrated in Anchorage.

3.10.6.3 Alaska – Arctic

Projections of demographic and economic data assume the continuation of existing social, economic, and technological trends at the time of the forecast, including employment associated with the continuation of current OCS leasing activity, as well as the continuation of trends in other industries important to the region. Projections in this section are based on population forecasts provided by the State of Alaska (Alaska Department of Labor and Workforce Development 2007) and employment and earnings data for 2009.

The Arctic region is projected to experience average annual increases in population of 1.08% between 2010 and 2020, with a slightly lower average annual rates of 0.95% over the period 2020 to 2030 (Table 3.10.6-3). Differences in age structure, as well as net migration, could create variations in population growth within the Arctic region.

Based on unemployment and labor force participation rates from 2009, employment in the Arctic region is expected to grow from 5,550 in 2010 to 10,091 in 2030. Growth rates over the 25-yr period are driven primarily by growth in mining (including oil and gas), fisheries, and services (MMS 2006b). Earnings in the Arctic region (in 2009 dollars) are projected to grow from $1.7 billion in 2010 to $2.1 billion in 2030.

3.10.7 Economic Impacts of the Deepwater Horizon Event

The DWH event has produced significant economic impacts throughout the GOM region, affecting population, employment, and regional earnings and incomes. Impacts coming as a result of lost production will have indirect impacts in the various industries serving oil and gas production and providing retail and other services to oil and gas workers. The 6-month moratorium imposed in May 2010 on all deepwater drilling projects is projected to reduce GOM production by roughly 31,000 bbl per day in the fourth quarter of 2010 and 82,000 bbl per day in 2011 (EIA 2010b), and could lead to the loss of 8,200 jobs in oil and gas and associated sectors in the GOM coast region, $487 million in lost wages, and $98 million in State and local tax revenues (Mason 2011). Short-term losses to the tourism and recreation industry are also expected (see Section 3.13.6).

The relative decline in the housing market in the GOM coastal States, in part a result of the 2008 U.S. housing crisis, may have been further compounded by the event, although the impact of the event is still being investigated. In some coastal communities in Louisiana, for example, stigmatization and uncertainty surrounding coastal housing markets as a result of the spill may have contributed to a reported 5–15% decrease in housing value in Louisiana in 2010, with losses of 14% reported for 2011 (Housing Predictor 2012). Immediately after the event, losses of at least 35% were projected for Louisiana and Mississippi (Housing Predictor 2010). The loss of beach amenities associated with the event could result in property value loss of between $648 and $3 billion in Florida, Alabama, and Mississippi (CoreLogic 2010). In addition, jurisdictions in coastal communities may have experienced a decline in property taxes

TABLE 3.10.6-3 Arctic Region Projections

Regional Characteristics	2010	2015	2020	2025	2030
Population	15,002	15,887	16,699	17,449	18,348
Employment	8,267	8,755	9,194	9,597	10,091
Earnings ($billion 2009)	1.7	1.8	1.9	2.0	2.1

Sources: MMS 2006b; Alaska Department of Labor and Workforce Development 2007.

as a result of the spill, in addition to the negative impact of the housing market crisis on property taxes in these areas, which could mean a reduction in services or a necessary increase in revenue to maintain current levels of public service provision. States that are more dependent on sales taxes from tourist activity (e.g., Florida) may experience more of an impact than other States.

The long-term economic and financial impact in the GOM coast States may be offset to some extent by the short-term economic boom associated with oil spill cleanup efforts. In some communities, cleanup crews have replaced oil field workers and fishermen in some hotels and restaurants, and some fishermen have used their boats to assist cleanup activities. Companies that specialize in booms, chemical dispersant, hazardous materials training, and other spill-related services have experienced a significant boom in business. In communities where cleanup operations are based, such as Louisiana's Plaquemines Parish, State revenue increased by 80% as rental properties, hotels, restaurants, and other facilities were besieged by cleanup personnel (Associated Press 2010). For the 20,000 workers hired by BP in response to the oil spill, many have taken up staging areas along the coast in Florida, Alabama, Mississippi, and Louisiana (Seaford 2011).

Timely payment of damage claims may also mitigate some of the impacts in smaller fishing communities where property damage has occurred. To assist those affected by the event, BP established a $20 billion compensation fund, and by September 2010, the fund had already paid more than $240 million to 19,000 claimants (Kollewe 2010).

The full extent, magnitude, and duration of spill-related socioeconomic impacts on the GOM will continue to be evaluated. BOEM will continue to update baseline population, employment, and regional income numbers in future documents as new information becomes available from Woods & Poole Economics, Inc., the U.S. Department of Labor's Bureau of Labor Statistics, individual State data, and published reports. This information, however, is not needed at the programmatic stage to make a reasoned choice among alternatives (see Section 1.4, Analytical Issues).

3.11 LAND USE AND INFRASTRUCTURE

3.11.1 Gulf of Mexico

There are five coastal States within the GOM region containing approximately 2,600 km (1,600 mi) of coastline. Land use is a heterogeneous mix of urban areas; manufacturing, marine, shipping, agricultural, and oil and gas activities; recreational areas; and tourist attractions. There are numerous urban areas in the region, and a complexity of land uses associated with urbanization can be found there. The area is composed of 67 metropolitan and 65 rural counties. The GOM coastal region contains one of the United States' ten most populous cities (Houston) (as of 2010; Mackum and Wilson 2011), approximately16% of the nation's coastal population (as of 2008; Wilson and Fischetti 2010), and 12 of the nation's 20 largest ports (USACE 2010).

The GOM region contains a mix of bays, estuaries, wetlands, barrier islands, and beaches of great environmental and economic value. Some of these areas support fishing, shrimping, and related economic activities, and although accessibility is sometimes limited, many of these areas are very popular for recreation and tourism. Along the GOM coast are numerous State Parks and beaches as well as units of both the NPS and the USFWS. For a listing and discussion of many of these areas, see Section 3.9 (Areas of Special Concern). Notable features in the area include Padre Island National Seashore, the Atchafalaya Basin, the Mississippi Delta, Mobile Bay, and Everglades National Park.

All of the States in the GOM region participate in the National Coastal Zone Management (CZM) Program and have taken various approaches to managing their coastal lands. The National CZM Program is a voluntary partnership between the Federal Government and U.S. coastal and Great Lakes States and territories (States) authorized by the Coastal Zone Management Act of 1972 (CZMA) to address national coastal issues. Key elements of the National CZM Program include the following:

- Protecting natural resources;
- Managing development in high hazard areas;
- Giving development priority to coastal-dependent uses;
- Providing public access for recreation; and
- Coordinating State and Federal actions.

The coastal area of the States in the GOM region is very diverse. Military facilities and training areas in this region are discussed in Section 3.9.2.3. Areas of Special Concern, including the National Marine Sanctuaries, National Parks, National Wildlife Refuges, and National Marine Protected Areas, are discussed in Section 3.9. The States along the GOM coast have authority over submerged lands out to approximately 5.6 km (3 NM [3.5 statute mi]) with the exception of Texas and Florida, which have jurisdiction out to approximately 14.5 km (3 leagues [9 statute mi]).

The U.S. Department of Agriculture's Economic Research Service (ERS) classifies nonmetropolitan counties into economic types that indicate primary land use patterns (ERS 2011). Land use patterns for counties near the GOM (as of 2004, the latest year for which figures are available) are shown in Figure 3.11.1-1. Five of the 90 nonmetropolitan counties are classified by ERS as farming-dependent. Eight counties are defined as mining-dependent, suggesting the importance of oil and gas activities to these local economies. Manufacturing dependence is noted for another 25 of the nonmetropolitan counties; while 30 of the 90 nonmetropolitan counties are classified by ERS as government employment centers, and 18 of the nonmetropolitan counties have economies tied to service employment. The ERS also classifies counties in terms of their status as a retirement destination. Thirty-eight of the 90 nonmetropolitan counties are considered major retirement destinations by ERS. Of these,

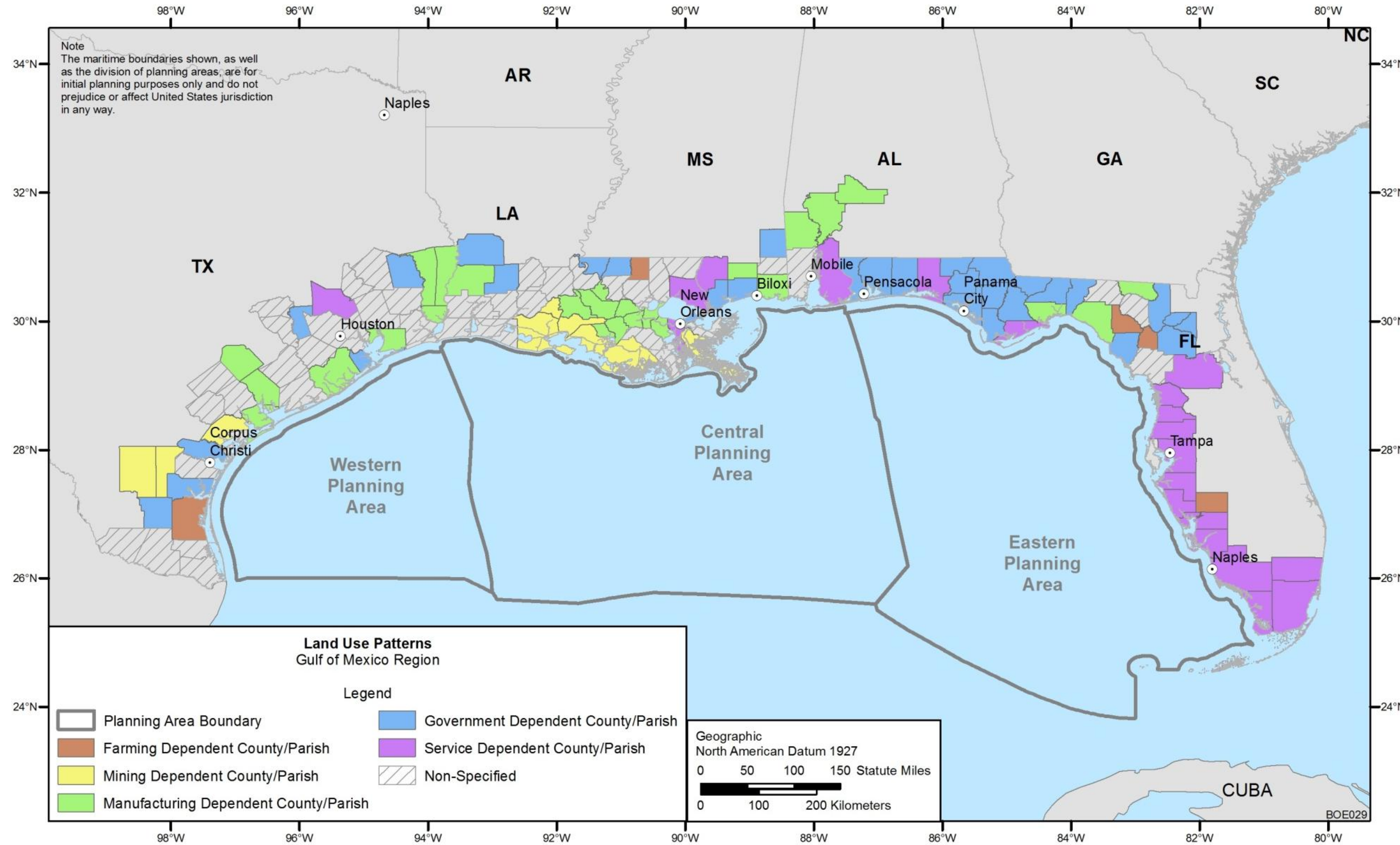

FIGURE 3.11.1-1 Land Use Patterns for Coastal Counties in the GOM Region

ten are inshore of the Eastern GOM Planning Area where little offshore development has taken place (see Figure 3.11.1-2).

Oil and gas development and production play an important role in determining land uses in many communities surrounding the GOM. These are the locations from which offshore operations are staged and where the exploration and production equipment, personnel, and supplies used for oil and gas operations on the OCS in the GOM originate (Louis Berger Group, Inc. 2004). The use of these facilities and trends in new facility development closely follow the level of activity in offshore drilling, with increased deepwater drilling having provided an important stimulus for increased facility use and development in recent decades. Because of the large size of the structures involved, construction and servicing of remote deepwater facilities require deeper ports than nearshore operations. There are several ports with deepwater access along the GOM coast, with deepwater development activities occurring around these ports. With the expansion of deepwater activities, some onshore facilities have migrated to these ports and nearby areas that have capabilities for handling deepwater vessels, which require more draft (see Figure 3.11.1-3). As previously indicated, the GOM contains 12 of the nation's 20 largest ports (USACE 2010).

The western and central portions of the GOM region (offshore Texas, Louisiana, Mississippi, and Alabama) are major offshore oil and gas areas, and most of the equipment and facilities supporting offshore GOM oil and gas operations are located in these areas. Only limited offshore activities (i.e., exploratory activities, a single major project) have occurred in the eastern portion of the region, and there is very little infrastructure in place to support exploration and development of offshore oil and gas off the GOM coast of Florida. Current data indicate there are more than 3,900 fixed structures located in the GOM at depths up to 518 m (1,700 ft) (Dismukes 2011).

Oil and gas activities on the OCS are supported by onshore infrastructure industries consisting of thousands of contractors responsible for virtually every facet of the activity, including supply, maintenance, and crew bases. These contractors are hired to service production areas, provide material and manpower support, and repair and maintain facilities along the coasts. Nearly all of these support industries are found near ports.

There are hundreds of onshore facilities in the GOM region that support the offshore industry. Platform fabrication facilities are located along the GOM from the Texas-Mexico border to the Florida Panhandle, and employ large numbers of workers during periods of active development. Shipbuilding and repair facilities are located in key ports along the GOM coast.

Other offshore support industries are responsible for such products and services as engine and turbine construction and repair, electric generators, chains, gears, tools, pumps, compressors, and a variety of other tools. In addition, drilling muds, chemicals, and fluids are produced and transported from onshore support facilities, and these materials and other equipment are stored in warehouses near GOM ports. Many types of transportation vessels and helicopters are used to transport workers and materials to and from OCS platforms. Crew quarters and bases are also near ports, but some helicopter facilities are located farther inland.

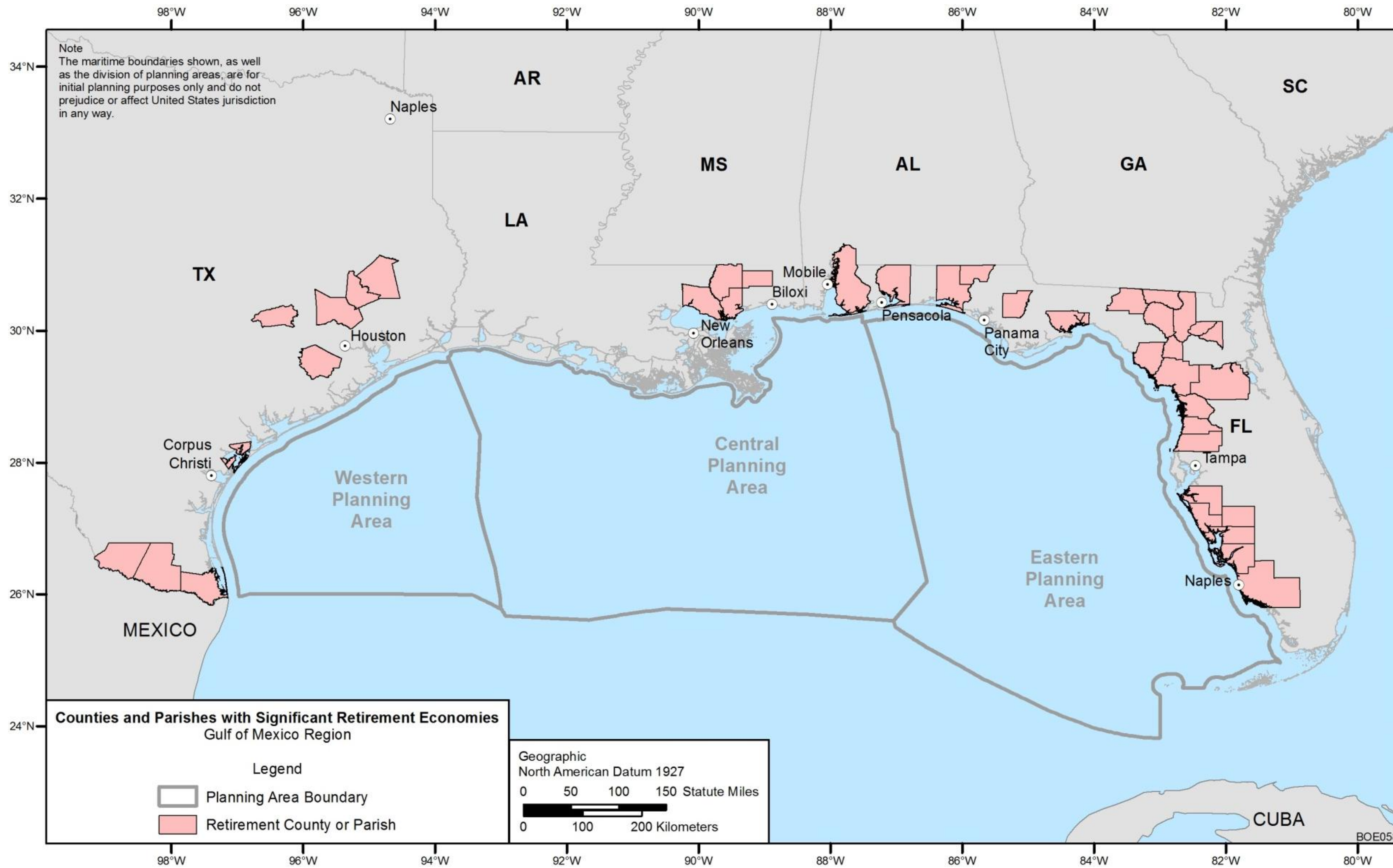

FIGURE 3.11.1-2 Counties with Significant Retirement Economies in the GOM Region

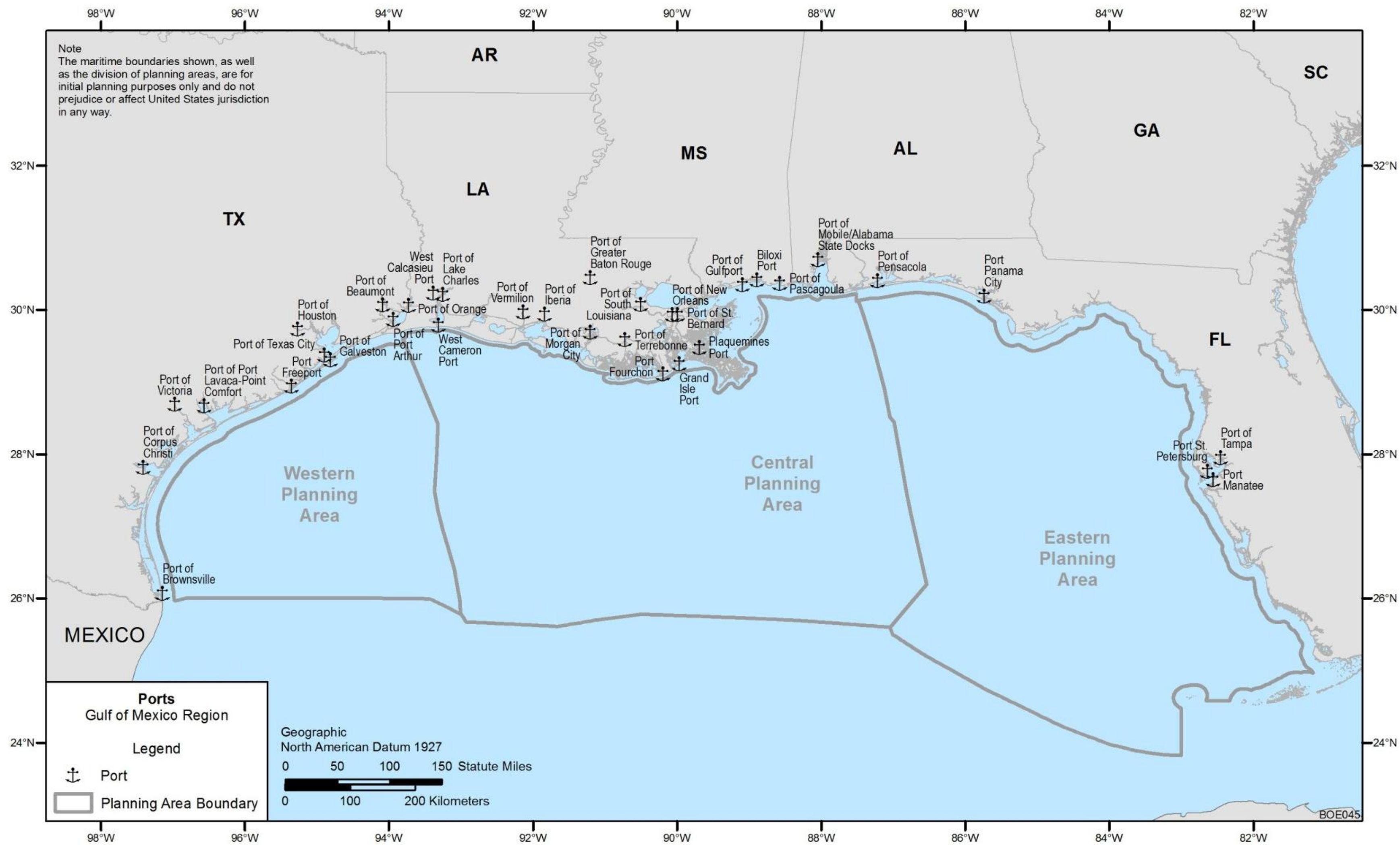

FIGURE 3.11.1-3 GOM Port Facilities

Existing OCS-related infrastructure in the region includes:

- *Port Facilities.* Major maritime staging areas for movement between onshore industries and infrastructure and offshore leases.
- *Platform Fabrication Yards.* Facilities in which platforms are constructed and assembled for transportation to offshore areas. Facilities can also be used for maintenance and storage.
- *Shipyards and Shipbuilding Yards.* Facilities in which ships, drilling platforms, and crew boats are constructed and maintained.
- *Support and Transport Facilities.* Facilities and services that support the offshore activities. This includes repair and maintenance yards, supply bases, crew services, and heliports.
- *Pipelines.* Infrastructure that is used to transport oil and gas from offshore facilities to onshore processing sites and ultimately to end users.
- *Pipe Coating Yards.* Sites that condition and coat pipelines used to transport oil and gas from offshore production locations.
- *Natural Gas Processing Facilities and Storage Facilities.* Sites that process natural gas and separate its component parts for the market, or that store processed natural gas for use during peak periods.
- *Refineries.* Industrial facilities that process crude oil into numerous end-use and intermediate-use products.
- *Petrochemical Plants*. Industrial facilities that intensively use oil and natural gas and their associated byproducts for fuel and feedstock purposes.
- *Waste Management Facilities*. Sites that process drilling and production wastes associated with offshore oil and gas activities (Dismukes 2011).

Figures 3.11.1-4 and 3.11.1-5 show key onshore infrastructure including ports, supply bases, shipyards, platform fabrication yards, pipe yards, oil refineries, gas processing facilities, helicopter pads, pipelines, and other infrastructure.

A short description of each type of infrastructure facility can be found below. Unless otherwise indicated, the following information is from the MMS study, *Deepwater Program: OCS-Related Infrastructure in the Gulf of Mexico Fact Book* (Louis Berger Group, Inc. 2004) and its update, *Infrastructure Fact Book, Volume I: OCS-Related Energy Infrastructure and Post-Hurricane Impact Assessment* (Dismukes 2011); more detailed information can be found in these two reports.

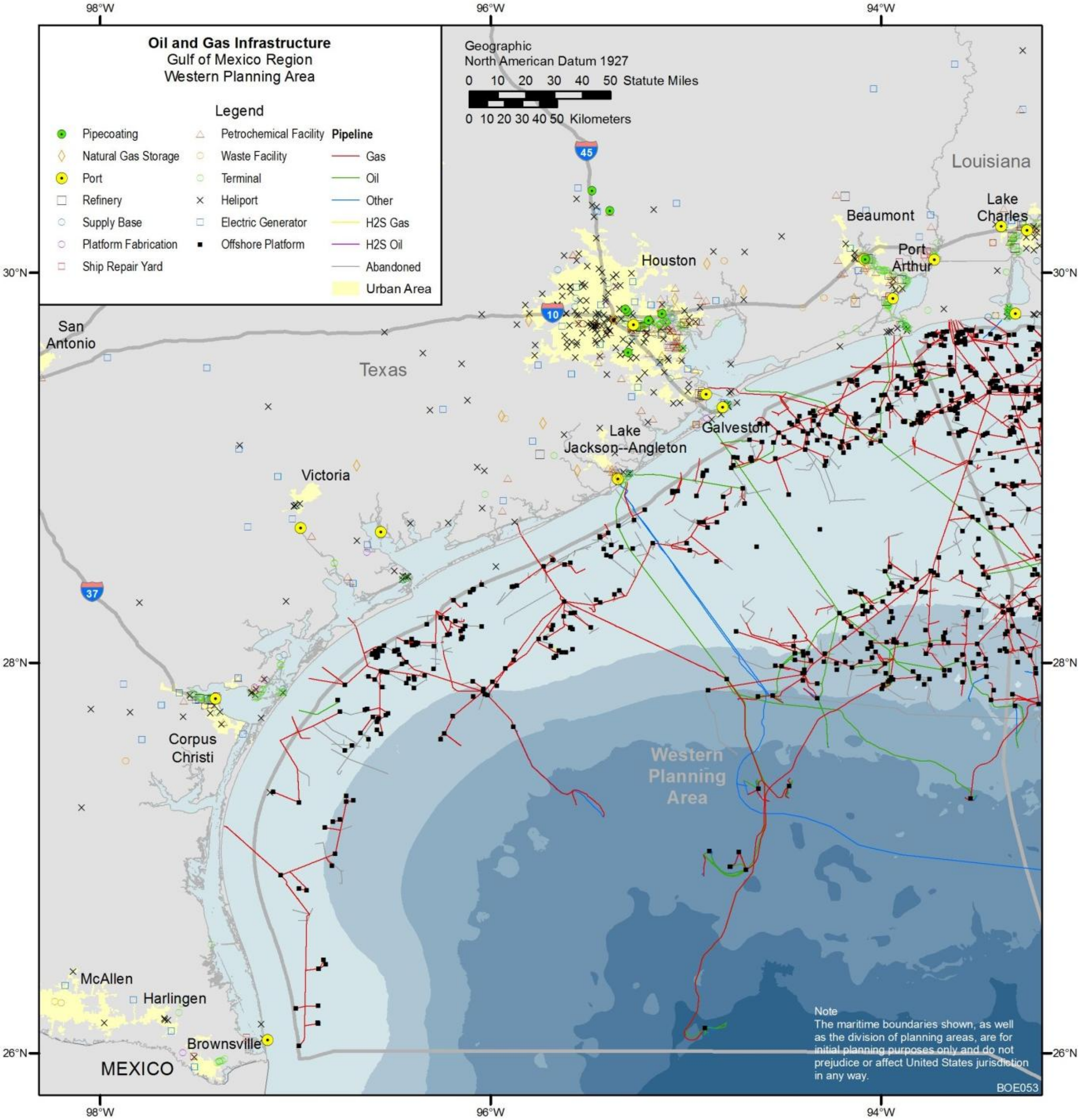

FIGURE 3.11.1-4 Oil and Gas Infrastructure Locations in the GOM Region Western Planning Area

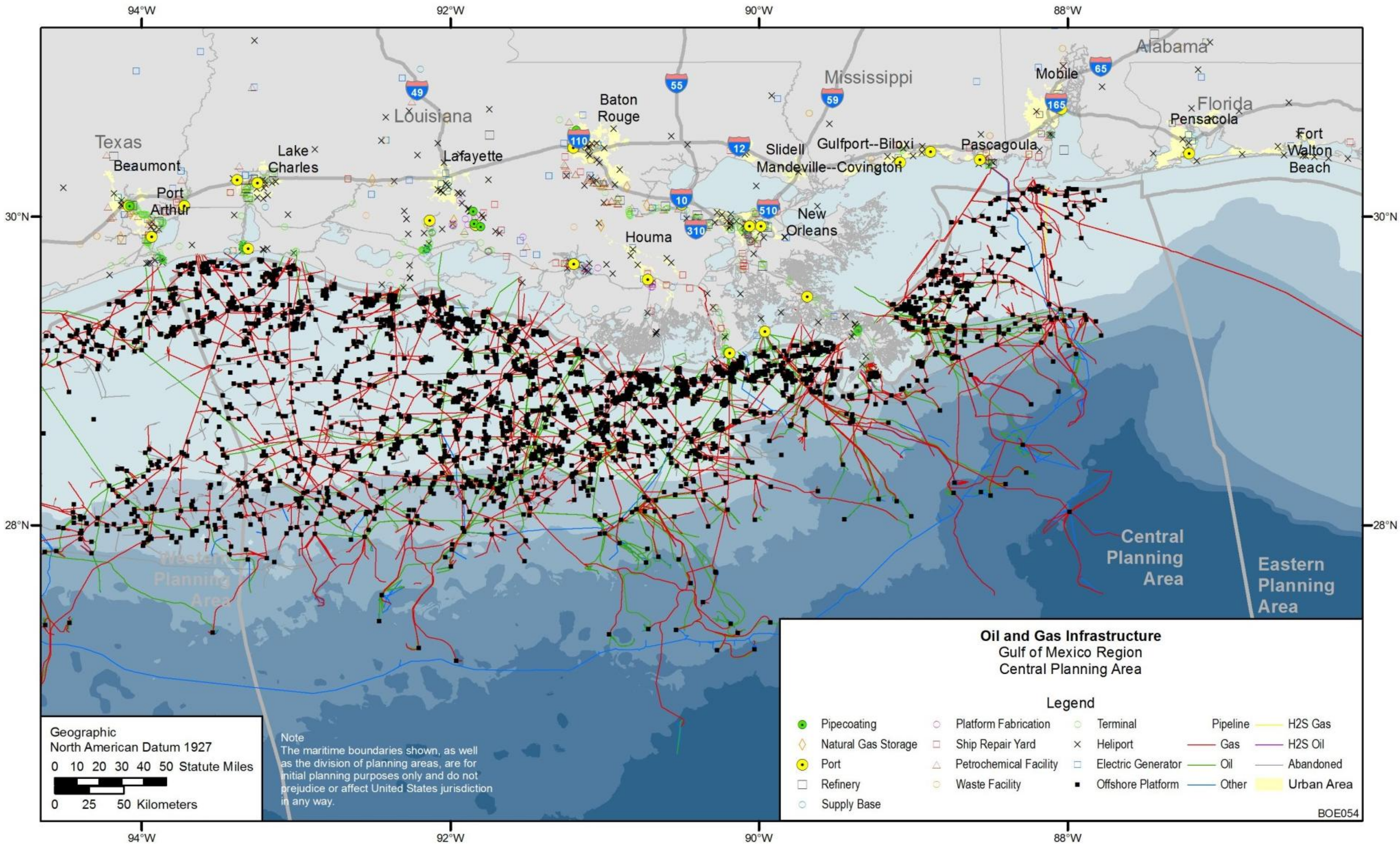

FIGURE 3.11.1-5 Oil and Gas Infrastructure Locations in the GOM Region Central Planning Area

3.11.1.1 Ports

States along the GOM provide substantial amounts of support to service the OCS oil and gas industry. Service bases and other industries at many ports offer a variety of services and support activities to assist the industry. Personnel, supplies, and equipment must come from the land-based support industry and pass through a port to reach drilling sites. In addition to servicing the offshore oil and gas industry, a number of GOM ports also are commercial ports, such as those in: Mobile, Alabama; Pascagoula, Mississippi; Lake Charles, Morgan City, Plaquemines and Venice, Louisiana; and Corpus Christi, Freeport, Galveston, and Port Arthur, Texas. Other ports include a combination of local recreation and offshore service activity.

GOM ports include a wide variety of shore-side operations from intermodal transfer to manufacturing. The ports vary widely in size, ownership, and functional characteristics. Private ports operate as dedicated terminals to support the operation of an individual company. They often integrate both fabrication and offshore transport into their activities. Public ports lease space to individual business ventures and derive benefit through leases, fees charged, and jobs created. GOM ports, including deepwater ports, are shown in Figures 3.11.1-3.

3.11.1.2 Platform Fabrication Yards

Offshore drilling and production platforms are fabricated onshore at platform-fabrication yards and then towed to an offshore location for installation. Production operations at fabrication yards include cutting and welding of steel components, construction of living quarters and other structures, and assembly of platform components. According to the Atlantic Communications 2006 Gulf Coast Oil Directory, there are more than 80 platform fabrication yards located in the GOM region, with the concentration in Louisiana and Texas (as cited in Dismukes 2011). The distribution of fabrication yards within the region is shown in Figures 3.11.1-4 and 3.11.1-5.

Because platform fabrication yards must be located on navigable channels large enough to allow for towing of bulky and long structures such as offshore drilling and production platforms, most fabrication yards in the region are located along the Intracoastal Waterway and within easy access of the GOM. A number of these plants have deep channel access to their facilities, which allows them to handle the deeper draft vessels used for deepwater operations.

Because of the size of the fabricated product and the need to store a large quantity of materials such as metal pipes and beams, fabrication yards typically occupy large areas, ranging from just a few acres to several hundred acres. Typical fabrication yard equipment include lifts and cranes, various types of welding equipment, rolling mills, and sandblasting machinery. Besides large open spaces required for jacket assembly, fabrication yards also have covered warehouses and shops.

Fabrication yards typically specialize in the production of one type of platform or one type of platform component. Few facilities have complete capabilities for all facets of offshore projects, and yards may cooperate in the development of platforms. Despite the large number of platform fabrication facilities in the GOM region, only a few facilities can handle large-scale fabrication. Recently, in an attempt to diversify their activities, many fabrication yards have expanded their operations into areas such as maintenance and renovations of drilling rigs, fabrication of barges and other marine vessels, drydocking, and surveying of equipment.

3.11.1.3 Shipyards

A 2007 report from USDOT indicated that only 28 private shipyards with major shipbuilding and repair bases were present within the GOM. This figure represented active shipbuilding yards, other shipyards with building positions, repair yards with dry dock facilities, and topside repair yards (USDOT 2007). A private count of shipyards dated August 2011 indicated that there were 80 shipyards[14] located on the GOM coast (MarineLog 2011).

In addition to the major shipyards, there are about 2,600 other companies that build or repair other craft such as tugboats, supply boats, ferries, fishing vessels, barges, and pleasure boats. Major shipyards in the GOM region are located primarily in Texas and Louisiana; however, several are located in Pascagoula, Mississippi, and other locations east of the Mississippi River (USDOT 2004). Recent high demand, driven in part by the expansion of deepwater oil and gas operations, has led to the expansion of capacity by smaller shipyards, which are building more and larger vessels that are technologically more sophisticated. This expansion has been accompanied by development of new pipe and fabrication shops, drydock extensions, military work enhancement programs, automated steel process buildings, and expanded design programs. The distribution of shipyards within the region is shown in Figures 3.11.1-4 and 3.11.1-5.

3.11.1.4 Support and Transport Facilities

A variety of facilities and services support offshore activities by providing supplies, equipment repair and maintenance services, services for crews, and transportation, including boats and heliports. Figures 3.11.1-4 and 3.11.1-5 show the distribution of various support and transport facilities in the GOM region.

The main types of vessels used in the GOM offshore industry include anchor handling towing supply (AHTS), offshore supply vessels (OSVs), and crewboats. There is a large fleet of offshore tugs (AHTS vessels) whose sole job is to tow rigs from one location to another and to position the rig's anchors. Offshore supply vessels deliver drilling supplies such as liquid mud, dry bulk cement, fuel, drinking water, drill pipe, casing, and a variety of other supplies to drilling rigs and platforms. Crewboats transport personnel to, from, and between offshore rigs and

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[14] Shipyards consist of builders of large oceangoing naval and/or commercial ships; builders of mid-sized oceangoing ships, rigs, oceangoing barges; and builders of small ships, boats, and barges for coastal or inland service. It does not include repairers, builders of aluminum boats, or builders of yachts. The number was determined by hand counting the individual addresses listed for each of the facilities (MarineLog 2011).

platforms. There are a variety of other types of vessels used by the oil and gas industry, and these vessels originate in a variety of locations along the GOM coast at or near ports.

Helicopters are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. Helicopters are routinely used for normal crew changes and at other times to transport management and special service personnel to offshore exploration and production sites. In addition, equipment and supplies are sometimes transported. For small parts needed for an emergency repair or for a costly piece of equipment, it is more economical to get it to and from offshore fast rather than by supply boat.

3.11.1.5 Pipelines

Locations where offshore pipelines cross the shoreline to land are referred to as pipeline landfalls. In the GOM region, about 60% of OCS pipelines entering State waters tie into existing pipeline systems and thus do not require pipeline landfalls. Only a small percentage of onshore pipelines in the region are a direct result of oil and gas activities on the OCS. There are more than 100 active OCS pipelines making landfall (about 80% of these are in Louisiana), resulting in about 200 km (124 mi) of pipelines onshore. About 80% of the onshore length of OCS pipelines is in Louisiana, and about 20% are in Texas. The distribution of pipelines by State is shown in Figures 3.11.1-4 and 3.11.1-5.

Inland, the pipeline network in the GOM coast States is extensive. Pipelines transport crude oil and natural gas to processing plants and refineries, natural gas from producing States in the GOM region to users in other States, refined petroleum products such as gasoline and diesel from refineries in the GOM region to markets all over the country, and chemical products.

3.11.1.6 Pipecoating Plants and Yards

Pipecoating plants are facilities where pipe surfaces are coated with metallic, inorganic, and organic materials to protect against corrosion and abrasion. These facilities generally do not manufacture or supply pipe, although some facilities are associated with mills where certain kinds of pipes are manufactured. More typically, the manufactured pipe is shipped by rail or water to pipecoating plants or their pipe yards. The coated pipe is stored at the pipe yard until it is needed offshore. It is then placed on barges or layships where the contractors weld the pipe sections together and clean and coat the newly welded joints. Finally, the pipe is laid.

Pipecoating plants in the GOM region are located primarily in Texas and Louisiana, with a small number of plants in the eastern GOM States. In recent years, pipecoating companies have been expanding capacity or building new plants to respond to increased demand from deepwater oil and gas operations. The distribution of pipecoating plants within the region is shown in Figures 3.11.1-4 and 3.11.1-5.

3.11.1.7 Natural Gas Processing Plants and Storage Facilities

After raw gas is brought to the Earth's surface (either dissolved in the crude oil, combined with crude oil deposits, or from separate non-oil-associated deposits), it is processed at a gas processing plant to remove impurities and to transform it into a sellable commodity. Centrally located to serve different fields, natural gas processing plants have two main purposes: (1) remove essentially all impurities from the gas and (2) separate the gas into its useful components for eventual distribution to consumers. After processing, the gas is then moved into a pipeline system for transportation to an area where it is sold. Because natural gas reserves are not evenly spaced across the continent, an efficient, reliable gas transportation system is essential.

As of 2006, there were 249 gas processing plants in the GOM States, representing 58% of U.S. gas processing capacity. The distribution of these plants by State is shown in Figures 3.11.1-4 and 3.11.1-5. More than half of the current natural gas processing plant capacity in the United States is located near the GOM coast in Texas and Louisiana. Four of the largest capacity natural gas processing/treatment plants are found in Louisiana, while the greatest number of individual natural gas plants is located in Texas. In 2006, Louisiana led the United States in processing capacity, followed closely by Texas. In Alabama, Mississippi, and the eastern portion of south Louisiana, new larger plants and plant expansions were built to serve new offshore production, increasing the average plant capacity significantly (EIA 2006).

3.11.1.8 Refineries

A refinery is a complex industrial facility designed to produce various useful petroleum products from crude oil. Refineries vary in size, sophistication, and cost depending on their location, the types of crude they refine, and the petroleum products they manufacture. One-third of operable U.S. petroleum refineries are located in Alabama, Louisiana, Mississippi, and Texas. Most of the GOM region's refineries are located in Texas and Louisiana. As of 2010, Texas had 23 operating refineries, with a combined crude oil capacity of 4.7 million bbl/day, while Louisiana had 17 operating refineries with 3.2 million bbl/day of capacity, with the combined capacity of the two States representing more than 40% of total operating U.S. refining capacity (EIA 2010a). The distribution of these refineries within the region is shown in Figures 3.11.1-4 and 3.11.1-5.

3.11.1.9 Petrochemical Plants

The chemical industry converts raw materials such as oil, natural gas, air, water, metals, and minerals into more than 70,000 different products. The industrial organic chemical sector includes thousands of chemicals and hundreds of processes. The non-fuel components derived from crude oil and natural gas are known as petrochemicals. The processes of importance in petrochemical manufacturing are distillation, solvent extraction, crystallization, absorption, adsorption, cracking, reforming, alkylation, isomerization, and polymerization. Laid out like industrial parks, most petrochemical complexes include plants that manufacture any combination of primary, intermediate, and end-use products. Chemical manufacturing facility sites are typically chosen for their access to raw materials and to transportation routes. And, because the chemical industry is its own best customer, facilities tend to cluster near such end-users.

As of 2007, there were 56 petrochemical manufacturing establishments in the United States, 32 of which were in Texas and Louisiana (USCB 2011a). As of 2007, Texas (with 26 petrochemical manufacturing facilities) and Louisiana (with six petrochemical manufacturing facilities) contain more facilities than any other States in the United States. Alabama also had two petrochemical manufacturing facilities, primarily because petroleum and natural gas feedstocks are available from refineries. The distribution of these plants within the region is shown in Figures 3.11.1-4 and 3.11.1-5.

3.11.1.10 Waste Management Facilities

A number of different types of waste are generated as a result of offshore exploration and production activity. The physical and chemical characters of these wastes make certain management methods preferable over others. The infrastructure network needed to manage the spectrum of waste generated by OCS exploration and production activities and returned to land for management can be divided into three categories:

1. Transfer facilities at ports, where the waste is transferred from supply boats to another transportation mode, either barge or truck, toward a final point of disposition;

2. Special-purpose, oil field waste management facilities, which are dedicated to handling particular types of oil field waste; and

3. Generic waste management facilities, which receive waste from many American industries, with waste generated in the oil field being only a small part.

Regulations governing waste management facilities regarding storage, processing, and disposal vary depending on the type of waste. Waste management facilities in the GOM region that handle OCS oil and gas activity-related waste include transfer facilities, commercial salt dome disposal facilities, and landfills. Locations of major waste management facilities within the region (not including landfills) are shown in Figures 3.11.1-4 and 3.11.1-5.

3.11.1.11 Effects of Deepwater Horizon Event

As a result of the DWH event, land use experienced a short-term impact because temporary waste staging areas and decontamination areas were set up to handle the spill-related waste.

The impacts of the drilling moratorium put in place after the DWH event and subsequent permitting delays have affected some GOM ports and OCS infrastructure. Demand for services and supplies has dropped as a result. Some companies have removed a large portion of their equipment from Port Fourchon, and there has been a substantial decrease in helicopter flights and servicing of rigs. Many companies have had to cut staff hours and salaries. Support services companies, such as chemical suppliers and welders, have also been affected (Lohr 2010). The effects of this decreased demand will ripple through the various infrastructure categories (e.g., fabrication yards, shipyards, port facilities, pipecoating facilities, gas processing facilities, and waste management facilities) and will affect the oil and gas support sector businesses (e.g., drilling contractors, offshore support vessels, helicopter hubs, and mud/drilling fluid/lubricant suppliers).

It is too early to determine substantial, long-term changes in routine event impacts on land use and infrastructure as a result of the DWH event. BOEM anticipates that these changes will become apparent over time, and it will continue to monitor all resources for changes that are applicable to land use and infrastructure. This information, however, is not needed at the programmatic stage to make a reasoned choice among alternatives (see Section 1.4, Analytical Issues).

3.11.1.12 Climate Change

Coastal Louisiana provides an unstable land surface for development in many areas because of ongoing subsidence, exposure to tropical storms and hurricanes, and upstream and downstream alterations of the hydrology and sediment load and redistribution processes of the Mississippi River (see Section 3.4.4.1, Marine and Coastal Habitats). Even without considering the effects of climate change, coastal Louisiana is expected to undergo considerable landscape change during the life of the Program as a result of these processes. A 2004 U.S. Geological Survey (USGS) report includes projections of the areas of coastal Louisiana that are expected to experience land loss and land gain by 2050, a date that nearly coincides with the end of the 40–50-yr life of the Program (Barras et al. 2004). Projected areas of land gain and loss are shown in Figure 3.11.1-6 along with the locations of existing coastal OCS-related infrastructure. A visual inspection of the map shows a clear association between infrastructure locations and land loss in some areas.

The authors of the 2004 USGS report did not consider the effects of climate change on coastal processes that are expected to occur between now and 2050 as a factor affecting land loss (Barras et al. 2004). The USGS developed the data shown in Figure 3.11.1-6 by projecting into the future land loss patterns and rates that have been observed and studied for more than two decades. Climate change related effects that could affect land loss patterns include projected acceleration in the rate of rise of sea level, increase in the frequency and intensity of tropical weather systems in the GOM, and possible alterations in the hydrology and hydraulics of the Mississippi River system (IPCC 2007a; Barras et al. 2004). The USGS projections should therefore be considered a minimum land loss scenario for the year 2050 because the climate change effects that were not considered in the analysis, such as accelerated submergence and increased occurrence of large storms, should act to favor land loss over land accretion.

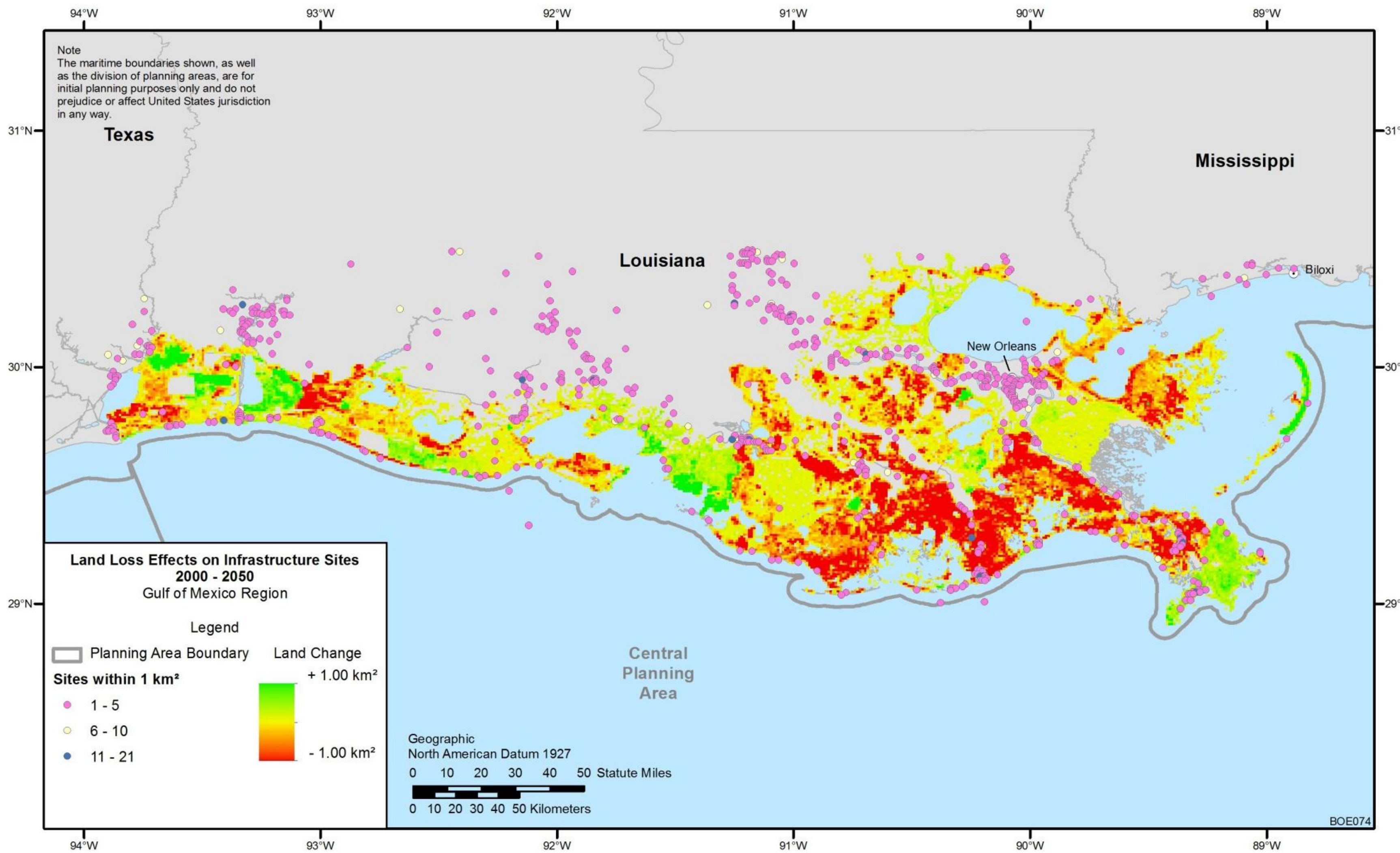

FIGURE 3.11.1-6 Land Loss Effects on Infrastructure Sites 2000-2050, GOM Region

Table 3.11.1-1 lists the types of infrastructure facilities discussed in the previous parts of this section in decreasing order of the percentage of facilities of that type that are projected to be affected by land loss. A facility was considered potentially affected by land loss if its location occurred within the 1-km^2 (0.4-mi^2) cell that the original USGS data projected would experience land loss by 2050. The table shows that 38% of all terminal locations (or 145 individual terminals) are located in cells projected to experience land loss. Only 2% of electric generator locations, in contrast, are located in cells projected to experience land loss. The table also shows that all petrochemical plants, pipe coating yards, and gas storage and processing facilities, and nearly all electric generator facilities are located in areas where land loss is not expected to occur and therefore this would not be an issue affecting the viability of these kinds of facilities.

This analysis suggests that land conditions in coastal Louisiana could become more unsuitable for some infrastructure uses during the life of the Program. Based on the data analyzed, terminals, ship repair yards, and service bases have the highest percentages of facility sites located in areas expected to experience land loss. These facilities are also located in areas expected to experience a relatively large amount of land loss, averaging nearly 10% of the nearby land, and would therefore likely be the most affected by the land changes expected to occur by 2050. As mentioned previously, the effects of climate change during the Program will likely act to increase the land loss amounts shown in the table.

This analysis focuses on land loss in coastal Louisiana. These are the result of ongoing coastal processes. Climate change will in all probability exacerbate land loss, but there are no quantified projections of land loss resulting from climate change. The intent of the analysis is to illustrate the potential effect on the viability of existing OCS-related coastal infrastructure during the life of the Program.

TABLE 3.11.1-1 Land Loss Effects on OCS-Related Facilities

Facility Type	Percent of Facilities with Local Land Loss	Number of Sites Affected	Average Percent of Nearby Land Loss
Terminals	38	145	10
Ship repair yard	32	25	10
Services bases	32	18	7
Heliports	23	45	6
Ports	18	3	10
Waste handling sites	15	5	20
Platform fabrication	14	5	4
Refineries	13	2	7
Electric generators	2	4	2
Petrochemical plants	0	0	0
Pipe coating yards	0	0	0
Gas storage and processing	0	0	0

The analysis suggests that this possibility exists and that the potential effect varies among infrastructure facility types. The effects of land loss and submergence on OCS-related infrastructure in coastal Louisiana have already begun to be addressed by the LA 1 Coalition, a non-profit organization working to improve transportation along the energy corridor through coastal Louisiana to the GOM. They have evaluated highway closures that could occur along LA 1 highway, a critical transportation link for OCS-related service and support bases, as a result of coastal submergence by 2050. Their analysis suggests that by 2030 critical sections of the highway could be closed up to 6% of the time and that by 2050 closures could occur 55% of the time (LA1 Coalition 2011). Such closures could have large effects on the OCS industry because of the high volume of OCS-related support and service products and materials transported across the highway.

3.11.2 Alaska – Cook Inlet

The Municipality of Anchorage, the Kenai Peninsula Borough, and the Matanuska-Susitna Borough in south central Alaska, along with the Kodiak Island Borough along the southern Cook Inlet, are the population centers of the State, with 60–65% of its population (USCB 2011b). Anchorage is the State center for scheduled aircraft and the regional center for chartered aircraft. Anchorage has a cargo facility that is served by a railroad connecting it to Alaska's interior and the port at Seward. Anchorage is home to two military bases and the center for the State's overall road network. As of 2010, the Municipality of Anchorage had a year-round population of approximately 291,826 (USCB 2011b).

The Cook Inlet and Kenai Peninsula area has an extensive road network and is served by the Ted Stevens Anchorage International Airport in Anchorage, as well as numerous smaller airfields and facilities. The more remote west side of Cook Inlet is not connected to the road system, and is home to the village of Tyonek, Alaska, a number of commercial set-net fish sites, and a number of oil camps.

The lands in the vicinity of the Cook Inlet Planning Area include large National Parks, National Wildlife Refuges, and a National Forest, including the Lake Clark National Park and Preserve, the Katmai Park and Preserve, the Kenai Fjords National Park, the Kenai National Wildlife Refuge, the Kodiak National Wildlife Refuge, and the Chugach National Forest (for a listing and discussion of these areas, see Section 3.9.2). The region also has numerous smaller State and municipal parks and refuges, and is economically important as a transportation hub, business center, tourism destination, and area of oil and gas activities.

The Port of Anchorage is the fourth largest port in Alaska (after Valdez, Nikiski, and Kivalina), and was ranked as the 96th largest port in the United States in 2009 (USACE 2010). The Port of Anchorage generally is limited to the use of barges and small container ships because of its shallow water depths and extreme tide variations. The port also serves as a staging and fabrication site for modules that are shipped to the North Slope for use in oil and gas activities.

Two ports are located on the east side of Cook Inlet, the Port of Homer in Kachemak Bay and a collection of special-purpose docks located in and around the town of Nikiski (formerly

Nikishka). The Port of Nikiski is the second largest port in Alaska (after Valdez), and was ranked as the 76th largest port in the United States in 2009 based on the port tonnage (USACE 2010).

Oil and gas are produced both onshore and offshore on State lands in the region; however, there are currently no active Federal leases in Cook Inlet. There are 16 active offshore production platforms in the Cook Inlet (Cook Inlet Regional Citizens Advisory Council 2011) on State submerged lands, north of the Cook Inlet Planning Area. There are onshore treatment facilities along the shores of the upper Cook Inlet and approximately 356 km (221 mi) of undersea pipelines, 126 km (78 mi) of oil pipeline, and 240 km (149 mi) of gas pipeline. These facilities, in addition to onshore pipelines, are listed in Tables 3.11.2-1 and 3.11.2-2 and shown in Figure 3.11.2-1.

Existing Cook Inlet region crude oil production (offshore and onshore) is handled through the Trading Bay production facility (Figure 3.11.2-1) and the Tesoro Refinery. Cook Inlet–produced gas is consumed by a variety of users: it is burned for electric power at Chugach Electric Association's Beluga power-generation plant or transported to Anchorage for local usage.

The Trading Bay facility pipelines its received crude oil production to the Drift River tanker-loading facility at the Drift River Terminal. Facilities on both the Kenai Peninsula and in Anchorage have been used to fabricate large support modules for oil and gas development and production. With oil reserves mostly depleted, development in Cook Inlet in recent years has focused on natural gas; however, the Nikiski liquefied natural gas (LNG) plant, the only LNG export facility in the United States, closed in February 2011 (Bluemink 2011). The Agrium U.S., Inc., chemical plant, which also utilized Cook Inlet-produced gas, closed in 2008 (Agrium, Inc. 2007).

Since 1996, all Drift River tanker loadings are transported to the Tesoro Nikiski refinery, north of the city of Kenai. The Tesoro Refinery can process up to 72,000 barrels per day (bpd). The refinery produces ultra low sulfur gasoline, jet fuel, ultra low sulfur diesel, heating oil, heavy fuel oils, propane, and asphalt. Crude oil is delivered by double-hulled tankers via the Cook Inlet and Kenai Peninsula pipelines. A 114-km (71-mi), 40,000 bpd common-carrier products pipeline transports jet fuel, gasoline, and diesel to the Port of Anchorage and the Anchorage International Airport. Wholesale delivery occurs through terminals in Kenai, Anchorage, Fairbanks, and Tesoro's Nikiski dock (Tesoro Corporation 2011).

In addition to oil- and gas-related activities, the Cook Inlet Planning Area and the land surrounding it are also important for commercial and recreational fisheries and hunting, as well as tourism and recreation. Subsistence use patterns of Cook Inlet are varied. As shown in Section 3.14.2, both urban and rural populations participate in hunting and fishing activities.

While facilities are present to support exploration and development of offshore oil and gas resources, existing and planned activities associated with exploration activities still would need to be consistent with current, local plans and initiatives. Within the State, Alaska Statutes provide certain cities and boroughs (i.e., municipalities) the authority for planning and land use

TABLE 3.11.2-1 Past and Present Operational Gas Pipelines in Cook Inlet and Cook Inlet Basin

ID	Current Operator	Location of Field or Pool	Location	Installed	Length in Miles[a]	Line Diameter in Inches
Offshore Cook Inlet Pipelines						
a	Unocal	Offshore	Baker to Platform A	1965	2.5	8
b	Cross Timbers	Offshore	Platform A to C	1967	2.2	8
c	Cross Timbers	Offshore	Platform C to Dillon	1967	2.2	8
d	Unocal	Offshore	Dillion to shore	1966	5.6	8
e	Unocal	Offshore	Grayling to shore	1967	6.0	10
f	Unocal	Offshore	King Salmon to shore	1967	7.0	8
g	Unocal	Offshore	Dolly Varden to shore	1967	5.7	8
h	Unocal	Offshore	Steelhead to shore	1986	6.5 (13)	2–10 lines
i	Unocal	Offshore	Monopod to shore	1966	9.0	8
j	Unocal	Offshore	Spurr to shore	1968	8.4	6
k	Marathon	Offshore	Spark to shore	1968	7.2	6
l	Unocal	Offshore	Anna to Bruce	1966	1.6	8
m	Unocal	Offshore	Bruce to shore	1974	5	6
n	Unocal	Offshore	Granite Point to shore	1966	6.0	8
o	Phillips	Offshore	Tyonek “A” to shore	1968	13 (26)	2–10 lines
p	Marathon	Offshore	Marine CIGGS, Granite Point to Nikiski[b]	1972	21 (42)	2–10 lines
Onshore Kenai Peninsula Pipelines						
q	Kenai Pipeline	Onshore	Swanson River to Nikiski	1960	19.2	16
r	Marathon	Onshore	Beaver Creek Field to Enstar Royalty Line	1982	4	12
s	Phillips	Onshore	Onshore continuation of Tyonek “A” to Nikiski	1968	26	16
t	Marathon	Onshore	Kenai Gas Field to Nikiski	1965	17	20
u	Enstar	Onshore	Kenai Mainline: Kenai Gas Field to Anchorage	Various[c]	71 (142)	2–12 lines
v	Military Pipeline (Enstar Lease)	Onshore	Anchorage to Whittier	1966[d]	47	8
w	Marathon	Onshore	Kenai Gas Field to Enstar Kenai Mainline	1965[e]	3	8
x	Enstar	Onshore	Enstar Royalty Line: Nikiski to Enstar Kenai Mainline	1978	25	8

TABLE 3.11.2-1 (Cont.)

ID	Current Operator	Location of Field or Pool	Location	Installed	Length in Miles[a]	Line Diameter in Inches
Onshore West Cook Inlet Pipelines						
y	Unocal	Onshore	Stump Lake and Ivan River Fields to Entar	1990	14	6 and 8
z	Forest Oil	Onshore	West Forelands #1 Well to Trading Bay	1994	5	6
aa	Enstar	Onshore	Lewis River Field to Enstar West Cook Mainline	1984	4	4
bb	Enstar	Onshore	West Cook Mainline, Beluga Gas Field to Anchorage	1984	99	20
cc	Marathon	Onshore	West Side CIGGS, Trading Bay to Granite Point	1972	27	16
dd	Marathon	Onshore	Granite Point to Beluga	1990	16.1	16

[a] Roughly estimated, there are 486 route miles for all gas pipelines offshore and onshore in the Cook Inlet region. Considering dual pipelines, actual pipe length is approximately 598 miles. These figures do not include gathering and connection pipelines that are internal to a field. To convert miles to kilometers, multiply by 1.6.

[b] CIGGS = Cook Inlet Gas Gathering System.

[c] Kenai Mainline pipeline: segments placed into service in various years beginning in 1961. Latest initial pipeline pressure test occurred in 1978.

[d] Year of Enstar pressure test and operational assumption.

[e] Pipeline not in use.

Sources: Robertson 2000; MMS 2002a, 2003c.

TABLE 3.11.2-2 Past and Present Operational Oil and Liquid Petroleum Pipelines in Cook Inlet and Cook Inlet Basin

ID	Current Operator	Location of Field or Pool	Location	Installed	Length in Miles[a]	Line Diameter in Inches
Offshore Cook Inlet Pipelines						
a	Cross Timbers	Offshore	A to shore	1965	7.0 (14)	2–8 lines
b	Cross Timbers	Offshore	C to A	1967	2.2	8
c	Unocal	Offshore	Baker to A	1965	2.5	8
d	Unocal	Offshore	Grayling to shore	1967	6.0	10
e	Unocal	Offshore	King Salmon to shore	1967	7.0	8
f	Unocal	Offshore	Dolly Varden to shore	1967	5.7	8
g	Unocal	Offshore	Steelhead to shore	1986	6.5	8
h	Unocal	Offshore	Monopod to shore	1966	9.0	8
i	Unocal[a]	Offshore	Spurr to shore[b]	1968	8.4	6
j	Marathon	Offshore	Spark to shore[b]	1968	7.2	6
k	Unocal	Offshore	Anna to Bruce	1966	1.6	8
l	Unocal	Offshore	–	1966	1.6	8.625
m	Unocal	Offshore	Granite Point to shore	1966	6.0	8
Kenai Peninsula Pipelines						
n	Tesoro	Onshore	Tesora Refinery to the Port of Anchorage	1974	70	10
o	Tesoro	Onshore	Nikiski Terminal to Tesoro Refinery	1983	<1	24
p	Kenai	Onshore	Swanson River to Kikiski	1960	19.2	8
West Cook Inlet Pipelines						
q	Cook Inlet Pipeline	Onshore	Drift River loading lines	1966	3.6	30 and 42
r	Cook Inlet Pipeline	Onshore	Granite Point to Drift River	1966	42.0	20 and 12
s	Forest Oil	Onshore	West McArthur to Trading Bay	1994	3.12	8

[a] Roughly estimated, there are 211 route miles for actual pipeline route and 218 miles of actual pipe length. This estimate does not take into account gathering lines that are internal to a producing field. To convert miles to kilometers, multiply by 1.6.

[b] Spurr and Spark oil pipelines are shut in. Marathon only operates gas lines.

Sources: Robertson 2000; MMS 2003c.

regulation (Alaska Department of Commerce 2007; Freer 2003); activities that occur within the boundaries of the coastal zones of these municipalities, including their offshore coastal zones, would require permitting and approval from the relevant municipality prior to those activities proceeding (MMS 2003a). The Inlet is primarily comprised of land located within the Kenai Peninsula Borough, with some portions within the Municipality of Anchorage, the Kodiak Island Borough, and other governmental jurisdictions.

Furthermore, much of the land within the Cook Inlet is managed by Federal land management agencies; for instance, approximately 65% of the Kenai Peninsula Borough is Federal land (Kenai Peninsula Borough 2005) (see Figure 3.9.3-2). Therefore, each of these agencies and their respective regulations would need to be considered for exploration and production activities that might affect lands or waters managed by the agencies.

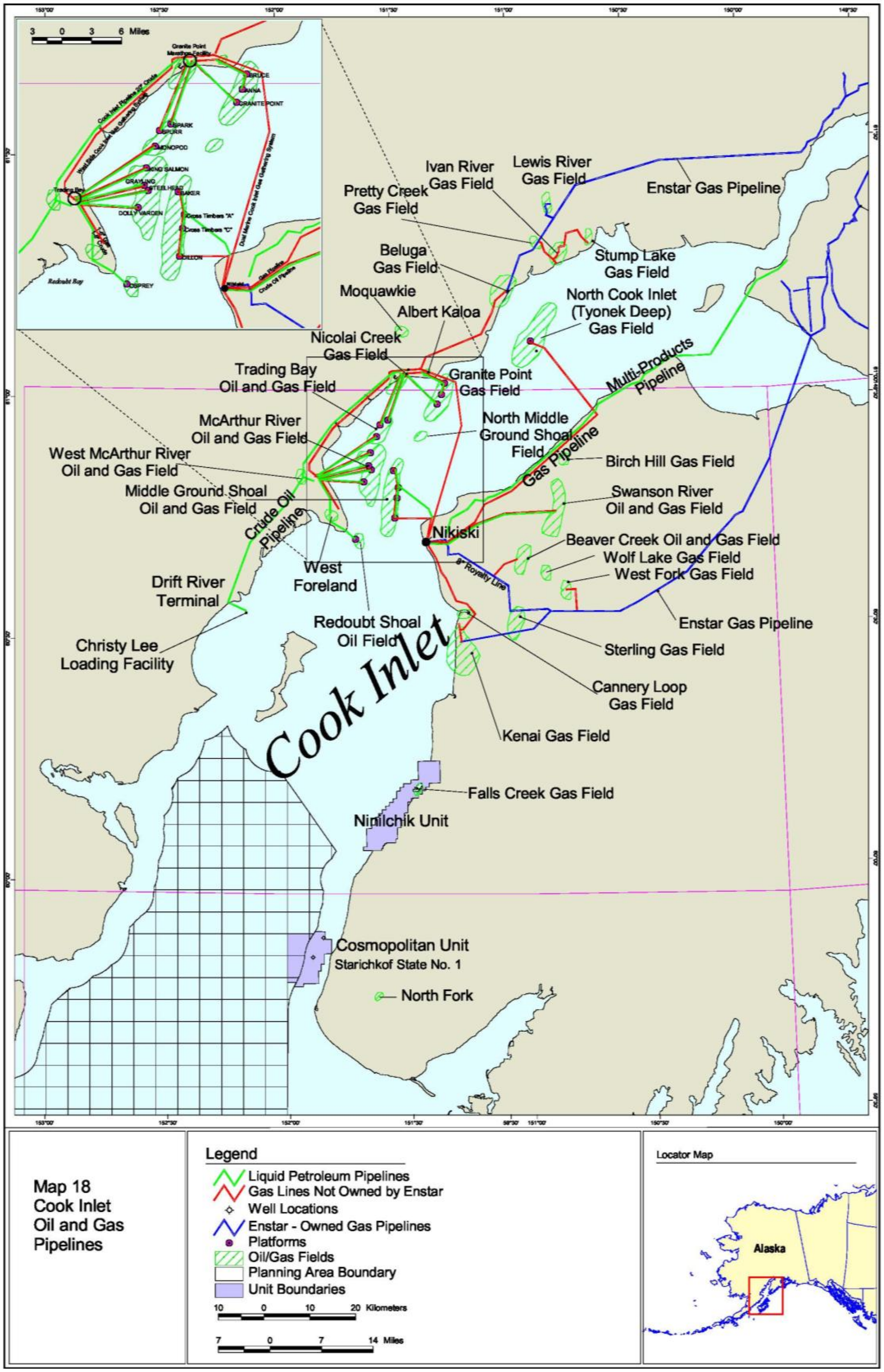

FIGURE 3.11.2-1 Oil and Gas Fields and Infrastructure Locations in Cook Inlet

3.11.2.1 Climate Change

One of the primary ecological drivers within Cook Inlet is climate, as it helps shape the land, as well as influences the ground cover. Current evidence suggests that the climate in Alaska is undergoing an unusual degree of change; records, for instance, show that temperatures in Anchorage have increased approximately 2.2°C (4.0°F) over the last 41 years and up to 4.5°C (8.2°F) in winter months since the 1960s. Estimates for this area of Alaska indicate that in the coming years, precipitation will increase slightly in the fall and winter and by up to 10% in the spring and summer (Nature Conservancy 2003). Climate change in these regions is associated with the loss of ice-cover and permafrost, as well as a slow rise in sea level; these changes in turn influence the infrastructure and land use planning decisions.

In response to these potential changes, communities within Cook Inlet have adapted new strategies, including analyses to further evaluate the vulnerability of the existing infrastructure. In 2007, for instance, the Kenai Peninsula Borough adopted a resolution to address the local climate change impacts, which indicated the need for a borough-wide plan in order to address "both short-term and long-term impacts to the natural environment and surrounding communities, including increased risks of forest fire, floods, and coastal erosion" (Kenai Peninsula Borough 2008).

3.11.3 Alaska – Arctic

The Arctic region includes the Beaufort Sea Planning Area and the Chukchi Sea Planning Area. Only the Beaufort Sea Planning Area has a well-developed oil and gas industry infrastructure on adjacent land and in State waters.

Land use in much of the Arctic region is not intense, with much of the region being used primarily for subsistence pursuits, except for the oil- and gas-related activities described above. There are only a few small communities located in the area, the largest of which is the city of Barrow, with an estimated population of about 4,212 persons (USCB 2010). Barrow is the economic, transportation, and administrative center for the North Slope Borough. The North Slope Borough includes other communities adjacent to the Chukchi and Beaufort Sea Planning Areas, including Point Hope, Point Lay, Wainwright, Nuiqsut, and Kaktovik, each with populations under 1,000 persons. Deadhorse is an unincorporated oil field service community at the end of the Dalton Highway, with fewer than 50 permanent residents, but with up to 2,000 or more oil workers present at a given time.

Various Federal agencies oversee large amounts of land in the North Slope Borough. federally managed lands include the Arctic National Wildlife Refuge (USFWS), Gates of the Arctic National Park (NPS), the National Petroleum Reserve-Alaska (BLM), and a number of Chukchi Sea coastal headlands and islands administered by the Alaska Maritime National Wildlife Refuge (USFWS) (for a listing and discussion of these areas, see Section 3.9.3).

Transportation-related infrastructure is minimal, but concentrated in the Prudhoe Bay oil field area. Marine shipping to North Slope communities is by barge and by lightering (transferring cargo between vessels of different sizes) of cargo to shore because of the shallow coastal waters and the lack of dredging and heavy-lift equipment. Heavy-lift cranes and protected small boat shelters are found only at Prudhoe Bay's West Dock. The communities within this region are not connected by a permanent road system. Paved and unpaved roads are generally limited to the area within communities. During the winter, village residents travel to other villages via snowmobile. However, the residents of the community of Nuiqsut are close enough to active oil fields that they can use winter ice roads to access Prudhoe Bay and then travel down the Dalton Highway into the interior of Alaska.

Airports and related service facilities are also limited. Airports at Barrow, Kotzebue, and Deadhorse have scheduled jet service and are owned and maintained by the State of Alaska. ConocoPhillips maintains an airport near its operating headquarters at Ugnu-Kuparuk. This airfield serves chartered corporate passenger and cargo jets, as well as other types of air traffic. The most active airfield in Arctic Alaska is the Deadhorse airport, with most flights at that airport related to oil field activities. The second-most active facility is Barrow's Wiley Post–Will Rogers Airport; there are other smaller airports at Nuiqsut and other locations in the region as well.

Exploration activities moved offshore into the Beaufort and Chukchi seas in the 1970s, and development and production in the nearshore Beaufort Sea began in the early 1980s. Individual oil pools have been developed together as fields that share common wells, production pads, and pipelines. As of 2007, 35 fields and satellites had been developed on the North Slope and nearshore areas of the Beaufort Sea and were producing oil. Over time, fields also have been grouped into production units with common infrastructure, such as processing facilities (MMS 2008b).

Oil and gas infrastructure occurs intermittently along the Arctic coast from the northeast corner of the NPR-A to the Canning River. The core of production activity occurs in an area between the Kuparuk field and the Sagavanirktok River. The Prudhoe Bay/Kuparuk oil field infrastructure is served by nearly 483 km (300 mi) of interconnected gravel roads. These roads serve more than 644 km (400 mi) of pipeline routes and related processing and distribution facilities.

According to BLM (as cited in MMS 2008b), as of 2007, oil and gas activities had resulted in the development of 202 ha (500 ac) of peat roads, 3,642 ha (9,000 ac) of gravel roads and pads, 2,428 ha (6,000 ac) of gravel mines, and 809 ha (2,000 ac) of other facilities on the North Slope. Few of these acres had been restored to their original condition.

Oil and gas exploration activities are ongoing in the northeast NPR-A. No permanent roads have been constructed into the NPR-A; all activities there are currently supported by ice roads. Some lands within the NPR-A have special designations, including the Teshekpuk Lake, Kasegaluk Lagoon, Colville River, and Utukok Uplands Special Areas, established in recognition of the areas' outstanding wildlife resources, including geese and other birds, caribou, bears, fish, and other animals.

In 2008, the BLM issued a record of decision (ROD) for the Northeast NPR-A making nearly 17,800 km^2 (4.4 million acres) available for oil and gas leasing, though it deferred leasing on 1,740 km^2 (430,000 acres) north and east of Teshekpuk Lake for 10 yr. The decision also established performance-based stipulations and required operating procedures (ROPs), which apply to oil and gas and, in some cases, to other activities (BLM 2008).

The Prudhoe Bay/Kuparuk area is also served by the Dalton Highway. This road extends more than 644 km (400 mi) from Livengood (121 km [75 mi] north of Fairbanks) to Deadhorse. The Trans-Alaska Pipeline System (TAPS) roughly parallels much of the Dalton Highway.

Because new facilities would be necessary to develop offshore oil and gas resources, exploration and production activities would need to be coordinated with local jurisdictions in order to ensure consistency with local land use plans, zoning regulations (if present), and future land use initiatives. Alaska Statutes provide certain cities and boroughs (i.e., municipalities) the authority for planning and land use regulation; as such, planning commissions and/or city councils may review projects that would impact a municipality under its jurisdiction. Comments or recommendations may be provided to the agencies undertaking the action in order to account for local needs, or if local permits are needed (Alaska Department of Commerce 2007; Freer 2003).

Furthermore, a significant percentage of the land near the Beaufort and Chukchi Seas is owned by the Federal government, although it is located within the North Slope Borough. For instance, more than half of the North Slope Borough’s land is included with the NPR-A and the ANWR. Other major landholders include the State, the Arctic Slope Regional Corporation, and eight Native village corporations (MMS 2010). Each of these agencies and their respective regulations would need to be considered for exploration and production activities that might affect lands or waters managed by the agencies.

3.11.3.1 Climate Change

Within the Arctic, impacts of climate change already have been recorded. Average Arctic temperatures, for instance, have increased at almost twice the global average rate in the past 100 years (IPCC 2007a). Observed decreases in snow and ice extent also are consistent with the indication of warming temperatures. Data since 1978, for example, has shown that annual average Arctic sea ice extent has shrunk by approximately 2.7% per decade, with larger decreases in the summer. Temperatures at the top of the permafrost layer generally have increased since the 1980s in the Arctic by up to 3°C (5.4°F) (IPCC 2007a). These changes have resulted in adaptations to local infrastructure and land use due to inundation, storm surge, erosion, and other coastal hazards.

Due to the anticipated effects of climate change, communities within the Arctic have initiated studies to account for potential damage to local infrastructure. For example, in Kivalina, the community has experienced severe erosion from sea storms, which particularly occur in late summer or fall. These storms can cause a sea level rise of approximately 3 m (10 ft) or more, and when combined with high tide, the storm surge can be accompanied by waves that contain ice. As a result of these climatic changes, the village of Kivalina had initiated studies to determine the costs of relocating the village and its associated infrastructure (GAO 2003). Other communities within the Arctic receiving Federal assistance to address flooding and erosion concerns include, but are not limited to, Point Hope, Barrow, and Kaktovik (GAO 2003).

3.12 COMMERCIAL AND RECREATIONAL FISHERIES

3.12.1 Commercial Fisheries

3.12.1.1 Gulf of Mexico

Commercial fisheries are very important to the economies of the GOM coast States; in 2009, commercial fishery landings in the GOM, which includes western Florida, Alabama, Mississippi, Louisiana, and Texas, reached almost 649,000 metric tons, which was worth more than $629 million (NMFS 2011d). When related processor, wholesale, and retail businesses are included, the GOM seafood industry supports more than 200,000 jobs with related income impacts of $5.5 billion. Louisiana led the GOM coast States in total landings and value in 2009, with 455,931 metric tons worth $284 million. Mississippi was second, with landings exceeding 104,456 metric tons, worth $47 million, followed by Texas (45,132 metric tons, worth $150 million), Florida’s west coast (29,626 metric tons, worth $116.1 million), and Alabama (13,469 metric tons, worth $41 million) (NMFS 2011d).

Commercially important species groups in the GOM include oceanic pelagic (epipelagic) fishes, reef (hard bottom) fishes, coastal pelagic species, and estuarine-dependent species (Table 3.12.1-1). On the basis of reported commercial fishery landing data, the two most valuable commercial fisheries in the GOM were white and brown shrimp, which accounted for 25% and 23%, respectively, of the entire GOM commercial fishery in 2009 (NMFS 2010f; Table 3.12.1-1). Other invertebrates such as blue crab, spiny lobster, and stone crab (*Menippe* spp.) also contributed significantly to the value of commercial landings. Finfish species that contributed substantially to the overall commercial value of the GOM fisheries in 2009 included menhaden ($60.6 million), red grouper ($10.5 million), red snapper ($7.9 million), and yellowfin tuna ($7.9 million). In terms of landing weight, Atlantic menhaden far surpassed other commercial fish species in the GOM, accounting for approximately 70% of the total weight of landed commercial species (Table 3.12.1-1). However, Atlantic menhaden accounted for only about 9.6% of the total value of the GOM commercial fishery.

Each species or species group is caught using various methods and gear types. Shrimps are taken by bottom trawling; menhaden are caught in purse nets; yellowfin tuna are caught on surface longlines; snapper and grouper are caught by hook and line; and pots and traps are used for crab, spiny lobster, and some fish species. Generally, the GOM fishing activities with the highest potential for interactions (or conflicts) with OCS oil and gas activities (e.g., oil and gas operations) are bottom trawling (potential for snagging on pipelines, cables, and debris) and

TABLE 3.12.1-1 Total Weights and Values of Commercially Important Fishery Species in the GOM Region

Species	Weight (metric tons)	Weight (pounds)	Value ($)	% Weight	% Value
Menhaden	454,761.20	1,002,566,613	60,603,671	70.1	9.6
Shrimp, brown	55,887.10	123,208,776	142,752,499	8.6	22.7
Shrimp, white	51,988.20	114,613,215	155,736,392	8.0	24.7
Crab, blue	26,823.20	59,134,370	43,673,691	4.1	6.9
Oyster, eastern	10,226.60	22,545,582	72,455,368	1.6	11.5
Crayfish	8,437.20	18,600,732	14,980,231	1.3	2.4
Mullet, striped	4,691.20	10,342,230	5,580,700	0.7	0.9
Shrimp, pink	3,485.80	7,684,797	14,202,829	0.5	2.2
Stone crab claws	2,389.80	5,268,490	17,567,663	0.4	2.8
Black drum	2,257.80	4,977,457	3,827,342	0.3	0.68
Red grouper	1,988.80	4,384,414	10,481,382	0.3	1.7
Lobster, Caribbean spiny	1,791.50	3,949,586	12,173,600	0.3	1.9
Vermillion snapper	1,722.20	3,796,731	8,230,448	0.3	1.3
Red snapper	1,134.30	2,500,630	7,963,886	0.2	1. 3
Bait and feed fish	1,120.50	2,470,199	471,243	0.2	0.1
Yellowfin tuna	1,118.20	2,465,234	7,935,150	0.2	1.3
Shrimp, Dendrobranchiata	1,080.60	2,382,249	9,950,718	0.2	1.6
Total	648,613.40	1,429,933,053	629,276,230		

Source: NMFS 2010f.

surface longlining (potential for space use conflicts with seismic survey vessels and possible entanglement with thrusters on dynamically positioned drillships). The portion of commercial fishery landings that occurred in nearshore and offshore waters of the GOM States is presented in Table 3.12.1-2.

Fishery statistics for major U.S. ports in the GOM region are presented in Table 3.12.1-3. In terms of reported total landing weight, the top U.S. ports in the GOM region in 2009 were Empire-Venice, Louisiana; Intracoastal City, Louisiana; and Pascogoula-Moss Point, Mississippi. GOM ports with the highest reported total catch values were Empire-Venice, Louisiana ($67.2 million), and Dulac-Chauvin, Louisiana ($50.9 million).

The DWH event had immediate effects on the GOM fishing industry between April and November 2010, with up to 40% of Federal waters being closed to commercial fishing in June and July (CRS 2010). Portions of Louisiana, Alabama, Mississippi, and Florida State waters have also been closed. These areas are some of the richest fishing grounds in the GOM for major commercial species such as shrimp, blue crab, and oysters, and as prices for these items have increased, imports of these species have likely taken the place of lost GOM coast production. NOAA continued to reopen areas to fishing once chemical tests revealed levels of hydrocarbons or dispersants in commercial species were not of concern to human health. Extensive sampling of commercially and recreationally important fish and shellfish in Federal

TABLE 3.12.1-2 Value of Gulf Coast Fish Landings by Distance from Shore and State for 2009 ($1,000)

	Distance from Shore (mi)	
State	0–3	3–200
Florida (GOM)	11,319	36,390
Alabama	2,006	1,637
Mississippi	18,211	456
Louisiana	64,164	13,213
Texas	2,443	5,045
Total	98,143	56,741

Source: http://www.st.nmfs.noaa.gov/st1/commercial/landings/ds_8850_bystate.html.

TABLE 3.12.1-3 Reported Total Landing Weights and Values for Major Ports in the GOM Region in 2009

Rank[a]	Port	State	Total Landing (million lb)	Total Landing (million $)
2	Empire-Venice	LA	411.8	67.1
5	Intracoastal City	LA	244.7	30.2
6	Pascagoula-Moss Point	MS	217.4	18.6
7	Cameron	LA	178.8	No data
22	Dulac-Chauvin	LA	42.4	50.9
27	Brownsville-Port Isabel	TX	27.0	41.0
28	Lafitte-Barataria	LA	25.9	25.9
29	Golden Meadow-Leeville	LA	25.6	27.4
33	Galveston	TX	22.0	35.0
34	Bayou La Batre	AL	21.0	30.0
37	Palacios	TX	20.0	27.0
43	Port Arthur	TX	16.0	27.0
46	Delacroix-Yscloskey	LA	13.4	19.7
47	Gulfport-Biloxi	MS	12.9	19.3

[a] Rank among all U.S. commercial fishing ports based on landings.

Source: http://www.st.nmfs.noaa.gov/st1/fus/fus09/02_commercial2009.pdf.

waters for PAHs and dispersants found no evidence of PAH or dispersant contamination except in a few areas off the Louisiana coast (Ylitalo et al. 2012). In addition, a review of the safety of GOM seafood found that PAH concentrations were well below levels of concern set by the Food and Drug Administration (Gohlke et al. 2011). However, others have argued that risks from consumption of GOM seafood may exist for vulnerable populations such as pregnant women, children, and individuals that consume a large amount of seafood (Rotkin-Ellman et al. 2012).

The impact of the DWH event on fishery landings is still being investigated (McCrea-Strub et al. 2011). This information, however, is not needed at the programmatic stage to make a reasoned choice among alternatives (see Section 1.4, Analytical Issues). Because consumer perceptions of GOM seafood and seafood products may affect demand, future sales of GOM fisheries production may be lost (CRS 2010).

3.12.1.2 Alaska – Cook Inlet

Commercial fisheries of the Gulf of Alaska and Cook Inlet are diverse and chiefly target groundfish, Pacific halibut, Pacific salmon, herring, crab, shrimp, clams, scallops, sea urchins, and sea cucumbers. An assortment of gear, such as gill nets, seines, purse seines, trawls, dredges, pots, jigs, and/or diving equipment, is employed to harvest the various target species. The groundfish fisheries accounted for the largest share ($640 million; 48%) of the ex-vessel value of all commercial fisheries in Alaska in 2009 (Hiatt et al. 2010). The Pacific salmon fishery is the second most valuable ($345 million) with 26% of the total Alaska ex-vessel value. The value of the shellfish fishery was $195 million, or 15% of the total for Alaska (Hiatt et al. 2010). Fisheries in the Gulf of Alaska are described in Hiatt et al. (2010), including gear, geographic distribution, fisheries effort, and existing economic conditions.

The State of Alaska divides Cook Inlet into the Lower Cook Inlet (LCI) Management Area comprised of all waters west of the longitude of Cape Fairfield, north of the latitude of Cape Douglas, and south of the latitude of Anchor Point; and the Upper Cook Inlet (UCI) Management Area, which consists of Cook Inlet north of the latitude of the Anchor Point Light. All five species of Pacific salmon, razor clams, Pacific herring, and smelt are commercially harvested in UCI. The LCI area supports commercial fisheries for salmon, groundfish, and scallops, but herring, king crab, Dungeness crab, and shrimp fisheries are currently restricted or closed while stocks rebuild. There are also gear restrictions in Cook Inlet, where the use of non-pelagic trawl gear is prohibited north of a line extending between Cape Douglas (58°51.10' N latitude) and Point Adam (59°15.27' N latitude).

Groundfish are primarily harvested by trawl, although hook and line (including longline and jigs) and pot gear are also used. In general, groundfish fisheries in the U.S. EEZ (5.6–370 km [3–200 NM] offshore) fall under Federal authority, while the State of Alaska manages groundfish within State territorial (0–5.6 km [0–3 NM]) waters (Trowbridge et al. 2008). The ADFG, Division of Commercial Fisheries, manages all commercial groundfish fisheries in Cook Inlet, where groundfish are typically harvested in the LCI Management Area. Commercial fisheries of groundfish in State waters have historically targeted Pacific cod, pollock, sablefish, ling cod, and rockfish (Trowbridge et al. 2008).

Pacific halibut fishery grounds occur throughout the entire Gulf of Alaska shelf. The commercial fishery is conducted exclusively using hook and line (NMFS 2004). The Pacific halibut fishery is managed by the International Pacific Halibut Commission (http://www.iphc.washington.edu/halcom).

The Pacific salmon commercial fisheries in State waters of the Gulf of Alaska are important to the economy of the region and are the second most valuable fisheries in Alaska ($345 million in 2009 [Hiatt et al. 2010]). The UCI supports gill net fisheries targeting Chinook, coho, pink, chum, and sockeye salmon. The LCI fisheries use gill net or seine gear and target pink, chum, and sockeye salmon. Total salmon harvest in LCI and UCI was approximately 4.07 million fish ($35.0 million ex-vessel value) in 2010 (Hammarstrom and Ford 2011; Shields 2010b). Pink salmon and sockeye salmon dominate the Cook Inlet salmon fishery by weight and monetary value. Commercial fishing seasons in these areas for salmon are species-specific and are published on the ADFG, Commercial Fisheries Division, website (http://www.cf.adfg.state.ak.us).

Pacific herring are targeted for food, bait, or herring roe. Depending on the area, herring harvested as food or bait may be commercially fished using trawl, seine, or gill net gear. Sac roe may be harvested using seine, purse seine, or gill net gear. In Cook Inlet, herring harvests are greatest in Kamishak Bay. Over the last decade, the abundance of Pacific herring has been stable, but historically very low, and the commercial Pacific herring fishery in LCI was closed during 2010 for the 12th successive season (Hammarstrom and Ford 2011). The decline in herring may be attributable to the protozoan pathogen *Ichthyophonus*. In the UCI Management Area, eulachon and smelt are commercially harvested. The smelt harvest in the UCI has generally increased from 1978 (0.2 tons) to 2010 (63 tons [Shields 2010b]). Smelt are primarily sold as bait and have low commercial value.

Commercial fisheries of crab and shrimp in the Gulf of Alaska are managed by the State of Alaska. Four species of king crab are harvested: red, blue, golden, and scarlet. Other commercially important crabs include golden king crabs, Tanner crabs, snow crabs, and Dungeness crabs. Commercial crab fisheries of the Gulf of Alaska chiefly operate in the following areas: Yakutat (king crab), Kodiak (Dungeness and Tanner crabs), and the Alaska Peninsula (Dungeness and Tanner crabs). Shrimp fisheries conducted in the Gulf of Alaska use pot, trawl, or otter-trawl gear. The commercial fisheries operate primarily in the Yakutat, Prince William Sound/Copper River, Kodiak, Chignik, and Alaska Peninsula areas. Cook Inlet historically supported king crab, Dungeness crab, and shrimp fisheries, but these fisheries are currently closed while stocks rebuild.

Commercial fisheries of bivalves (scallops or clams) occur in the Prince William Sound/Copper River, Cook Inlet, Kodiak, and Alaska Peninsula areas. Scallops are harvested using dredging gear. Razor clams are harvested exclusively by hand digging on the west shore of upper Cook Inlet, principally from the Polly Creek and Crescent River sandbar areas (Shields 2010b). The 2010 harvest of razor clams was approximately 380,000 lb and valued at $235,000. Steamer clams are also harvested in Cook Inlet.

Diver-based fisheries targeting sea cucumbers also exist around Chignik and Kodiak Island. Currently, each fishery is a competitive limited entry fishery. More information is available at http://www.adfg.alaska.gov/index.cfm?adfg=commercialbyfisherydive.main.

3.12.1.3 Alaska – Arctic

The Arctic Management Area, consisting of the U.S. EEZ of the Chukchi and Beaufort Seas from 6 km (3 NM) offshore the coast of Alaska is currently closed to commercial fishing (NPFMC 2009). In the State waters of the Beaufort Sea, there is a single commercial fishery targeting cisco and whitefish in the Colville River Delta that operates in the summer months. Markets for these fish are primarily regional, although some fish are sent to Anchorage and to more distant markets (NPFMC 2009). In the Chukchi Sea, there is a relatively small summer salmon fishery (MMS 2006a).

Although commercial fishing is limited in the Beaufort and Chukchi Sea Planning Areas, commercial fishing in the Arctic may become more viable if predicted warming trends continue. There is evidence that commercially harvested species such as snow crab, walleye pollock, and yellowfin sole are expanding northward (NMFS 2009b). Consequently, in the coming decades, commercially viable populations of fish and shellfish may develop in the Arctic. However, the development of a fishery in Federal waters is dependent upon Federal approval of commercial fishing activity.

3.12.2 Recreational Fisheries

3.12.2.1 Gulf of Mexico

Data collected by the National Marine Fisheries Service (NMFS) for Alabama, Florida, Louisiana, and Mississippi indicate that more than 4.5 million people engaged in some form of recreational fishing in the GOM States in 2010 (Table 3.12.2-1). Of the four States, western Florida had the highest number of anglers and fishing trips in 2010 (3.0 million), followed by Louisiana (0.8 million), Alabama (0.6 million), and Mississippi (0.2 million). Almost 67% of the fishing trips in the GOM coast left out of west Florida, followed by Louisiana (17%), Alabama (7%), Mississippi (5%), and Texas (4%). These anglers took more than 23 million trips and caught more than 173 million fish (NMFS 2011e). Although data on recreational fishing is not available at the same level of detail for Texas as it is for other GOM States, in 2004, it is estimated that 1,059,634 fishing license holders fished for one or more days in Texas (Tseng et al. 2006).

The most popular mode of fishing in all GOM States was private/rental boat, comprising 59.7% of trips in each State, followed by fishing from shore (37.5%) and fishing from charter vessels (2.8%) (Table 3.12.2-2). More than 69% of anglers fishing from shore confined their trips to inland waters, the remaining trips taking place within 16 km (10 mi) of shore. Most anglers (75.6%) using private or rental boats also preferred inland waters for their trips, or fished

TABLE 3.12.2-1 Estimated Number of People Participating in GOM Marine Recreational Fishing, 2010[a,b]

	Coastal	Non-Coastal	Out-of-State	Total
West Florida	1,542,556	0	1,473,928	3,016,485
Louisiana	601,240	66,340	118,292	785,872
Alabama	193,721	138,730	218,532	550,982
Mississippi	136,504	28,542	49,804	214,850
GOM Total	2,474,021	233,612	1,860,556	4,568,189

[a] "Coastal," "non-coastal," and "out-of-State" refer to place of residence of participants in marine recreation in each State.

[b] Data for Texas is not collected in the same level of detail as for the other GOM States.

Source: NMFS 2011e.

TABLE 3.12.2-2 Estimated Number of Trips and Trip Range by Trip Mode in GOM Marine Recreational Fishing, 2010

Fishing Mode	Trip Range	Number of Trips
Shore fishing	5 km (3 mi) or less	680,556
	Less than 16 km (10 mi)	1,707,550
	Inland	5,402,102
Total	–	7,790,208
Charter boats	5 km (3 mi) or less	10,378
	More than 5 km (3 mi)	21,892
	Less than 16 km (10 mi)	157,977
	More than 16 km (10 mi)	206,673
	Inland	175,939
Total	–	572,859
Private or rental boat	5 km (3 mi) or less	219,504
	More than 5 km (3 mi)	126,227
	Less than 16 km (10 mi)	2,132,905
	More than 16 km (10 mi)	540,061
	Inland	9,376,983
Total	–	12,395,680

Source: NMFS 2011e.

less than 16 km (10 mi) from the coast (17.2%). Only 30.7% of charter boats trips were made inland, while 36.1% were made more than 16 km (10 mi) from the coast, and 27.6% of trips were less than 16 km (10 mi) from shore.

A large majority of angling trips in Mississippi (98.6%) and Louisiana (97.7%) were made in inland waters in 2010, as opposed to waters up to 5 km (3 mi) from shore and farther distances. In Florida (66.2%) and Alabama (46.5%), inland trips were less important, with the more trips in Alabama made to State and Federal waters (46.7% and 6.8%, respectively), and to the same waters in Florida (28.5% and 5.3%, respectively).

Of the 145.3 million fish caught in the four GOM coast States in 2010, the majority (95.3 million, 65.6% of the total) were landed in Florida; landings by weight are more evenly distributed across the four States, with 41.8% of landings in Florida, 40.1% in Louisiana, 12.8% in Alabama, and 5.3% in Mississippi (Table 3.12.2-3). Almost all landings were made in inland waters in Mississippi (98.6%) and Louisiana (94.8%). While the inland catch was important in Alabama (50.0%) and Florida (44.0%), the offshore catch was larger in these States, with 34.1% of the total catch landed up to 5 km (3 mi) from shore, and 16% at more than 5 km (3 mi) in Alabama and 28.7% at less than 16 km (10 mi), and 27.3% at more than 16 km (10 mi) in Florida.

Types of fish caught in 2010 varied by State and by distance from shore (Table 3.12.2-3). In Alabama and Louisiana, drum, seatrout and herring were popular fish less than 5 km (3 mi) from shore, with shark, ray, and snapper caught at this distance in Mississippi. Snapper were commonly caught more than 5 km (3 mi) from shore in Alabama, Louisiana, and Mississippi, together with drum and seatrout in Louisiana. Jack, catfish, and tuna were also caught up to 16 km (10 mi) from shore in Florida. Inland species caught in Alabama were drum, mullet, flounder, and porgy, with seatrout also caught in Mississippi and catfish in Louisiana. In Florida, porgy, mullet, seatrout, and mackerel were popular. Most fishing occurred in State and inland waters (NMFS 2010f).

In 2004, a total of 1,276,667 Texas resident fishing licenses were purchased (Tseng et al. 2006). It is estimated that 1,059,634 (or 83%) of these license holders actually fished one or more days in Texas during the year. Of those who fished, 74% participated in freshwater fishing and 61% participated in saltwater fishing. Freshwater anglers fished an average of 27 days, while saltwater anglers fished an average of 20 days (Tseng et al. 2006).

When freshwater anglers were asked to name the fish they prefer to catch in Texas, 52% indicated a first-choice preference for black bass. Other species preferred by freshwater anglers included largemouth bass, catfish, crappie, and temperate basses (white bass, striped bass, and hybrid striped bass). Most saltwater anglers in Texas (40%) indicated a first-choice preference for red drum, followed by speckled trout, the drum family, and flounder (Tseng et al. 2006).

Recreational fishing off Alabama, Mississippi, Louisiana, and Texas often occurs around oil and gas platforms. BOEMRE supports and encourages the reuse of obsolete oil and gas facilities as artificial reefs and will grant a lessee/operator a departure from removal requirements provided that (1) the structure becomes part of a State artificial reef program that

TABLE 3.12.2-3 Estimated Number of Trips and Catch Weights in GOM Marine Recreational Fishing, 2010

	Number of Angler Trips	Catch (pounds)	Major Fish Types Caught
Alabama			
≤5 km (3 mi)	836,397	2,582,437	Drum, seatrout, herring
>5 km (3 mi)	121,006	1,210,837	Snapper
Inland	832,027	3,789,035	Drum, mullet, flounder, porgy
Total	1,789,430	7,582,309	
West Florida			
≤16 km (10 mi)	3,998,432	7,094,311	Herring, drum, seatrout, jack, catfish, seabass, tuna, snapper
>16 km (10 mi)	746,735	6,748,134	Snapper, grunt, herring
Inland	9,287,570	10,875,884	Porgy, mullet, tuna, mackerel
Total	14,032,737	24,718,329	
Louisiana			
≤5 km (3 mi)	61,274	771,959	Drum, seatrout
>5 km (3 mi)	22,980	450,170	Snapper, drum, seatrout
Inland	3,634,782	22,460,692	Drum, seatrout, porgy, catfish
Total	3,719,036	23,682,821	
Mississippi			
≤5 km (3 mi)	12,767	34,924	Shark, ray, snapper
>5 km (3 mi)	4,132	9,237	Snapper
Inland	1,200,644	3,093,236	Drum, seatrout, flounder, porgy
Total	1,217,543	3,137,397	

Source: NMFS 2011e.

complies with the criteria in the National Artificial Reef Plan; (2) the responsible State agency acquires a permit from the U.S. Army Corps of Engineers and accepts title and liability for the reefed structure once removal/reefing operations are concluded; (3) the operator satisfies any U.S. Coast Guard navigational requirements for the structure; and (4) the reefing proposal complies with Regional Engineering, Stability, and Environmental Reviewing Standards and Reef Approval Guidelines (http://www.gomr.boemre.gov/homepg/regulate/environ/rigs-to-reefs/Rigs-to-Reefs-Policy-Addendum.pdf).

The DWH event had immediate effects on recreational fishing in the GOM. By July 14, 2010, NOAA had closed 217,370 km^2 (83,927 mi^2) of the GOM to commercial and recreational fishing, or approximately 35% of the federally managed waters in the GOM (CRS 2010). Portions of Louisiana, Alabama, Mississippi, and Florida State waters have also been closed. These areas are some of the richest fishing grounds in the GOM for major species caught by recreational fishermen. Bookings and trips for recreational fishing charters have decreased, especially in Louisiana, and sport fishing tournaments have been cancelled (CRS 2010).

3.12.2.2 Alaska – Cook Inlet

Recreational fishing in the south central Alaska region includes marine sport fishing, freshwater fishing, and shellfish gathering activities, which together contribute substantially to the area's economy. Sport fishing in lower Cook Inlet is primarily for Pacific salmon, rockfish, cod, and Pacific halibut. Shellfish are collected near the shoreline as well. Kachemak Bay is particularly popular for recreational fishing, with halibut sport fishing in the Bay producing $8.7 million in angler expenditures in 1986 (Jones and Stokes Associates 1987), and for shellfish gathering. There is also a substantial salmon fishery in Kachemak Bay and in the rivers and streams flowing into Cook Inlet. Salmon fishing in the Kenai River, for example, generated up to $70 million annually in 1997 (Dorava 1999), while red salmon fishing in the Russian River generated $5.2 million in angler spending in 1986 (Jones and Stokes Associates 1987). Razor clams and other clams are gathered in Kachemak Bay and at various locations along the western side of the Kenai Peninsula and the shorelines bordering Cook Inlet.

In northern Cook Inlet, on the western bank, there exist recreational fisheries for razor clams and several species of hardshell clams, as well as Tanner crab and Dungeness crab. Extensive freshwater fishing also occurs throughout south central Alaska, and all five species of Pacific salmon can be found there, as well as trout, Arctic grayling, Dolly Varden, and northern pike. The Susitna River drainage is particularly important for recreational fishing in northern Cook Inlet.

3.12.2.3 Alaska – Arctic

There is little data on recreational fishing in the Beaufort and Chukchi Seas. The North Pacific Fishery Management Council concluded that there are few recreational fisheries in the Beaufort and Chukchi Sea Planning Areas. Sport fishing likely occurs at the larger population centers such as Barrow (NPFMC 2009). Any recreational fisheries that do occur in State waters would be regulated by Alaska State law. The available data is not adequate to determine the population trends in recreational and subsistence harvests in the Arctic Management Area.

3.13 TOURISM AND RECREATION

3.13.1 Recreational Resources

3.13.1.1 Gulf of Mexico

The GOM coastal zone is one of the major recreational regions of the United States, with marine fishing and beach-related activities particularly popular. The tourist industry contributed 620,000 jobs and more than $9 billion in wages to the GOM region (NMFS 2011e). The coasts of Florida, Alabama, Mississippi, Louisiana, and Texas offer diverse natural and developed landscapes and seascapes, and the beaches, barrier islands, estuarine bays and sounds, river deltas, and tidal marches are visited by residents of the GOM coast States and by tourists from throughout the United States and overseas. Publicly owned and administered areas (such as national seashores, parks, beaches, and wildlife lands), as well as specially designated preservation areas (such as historic and natural sites and landmarks, wilderness areas, wildlife sanctuaries, and scenic rivers), attract residents and visitors throughout the year. Commercial and private recreational facilities and establishments, such as resorts, marinas, amusement parks, and ornamental gardens, are also popular with tourists and in-State visitors. In 2000, Florida was the most important destination for marine recreation, with more than 22 million people participating in the State (NOAA 2005). Texas ranked fifth, with a little under 6.2 million participants, while in Alabama, Louisiana, and Mississippi (2.5 million, 2.2 million, and 1.8 million, respectively) participation was lower, but still significant.

3.13.1.2 Alaska – Cook Inlet

Opportunities for recreational activities such as hunting, hiking, boating, wildlife viewing, and sightseeing are abundant in the Cook Inlet area. Tour ships from the lower 48 States regularly traverse southeast Alaska, and many independent travelers use the Alaska Maritime Highway (ferry) system to access the subregion. Helicopter and small aircraft sightseeing tours have developed locally, along with a generally robust tourism sector. This includes a fleet of small regional tour ships, river jet-boat tours, fishing charters, bed-and-breakfast operations, and associated tourism-based enterprises (MMS 2006b).

The Kenai Peninsula and Prince William Sound are in close proximity to Cook Inlet and Anchorage, which is the population and logistical center of the State. Thus, these areas receive the heaviest recreational use, both by residents and nonresidents. The Kenai Peninsula has a developed road system and is directly connected to Anchorage. Prince William Sound also is connected by road to Anchorage via Whittier. Local boat tours of Prince William Sound and Kenai Fjords National Park are popular attractions. Cook Inlet and rivers and streams in the area, especially the Kenai River, are heavily fished by sport fishers. The Kenai Peninsula also is a popular hunting area. The Chugach National Forest attracts hikers, campers, and other users. An extensive tourism infrastructure is centered in Anchorage and extends into the surrounding region (MMS 2006b).

3.13.1.3 Alaska – Arctic

Tour groups to the North Slope Borough, primarily visiting Barrow or Deadhorse, make up most of the nonresident recreational activity. Both locations have lodging available, and Barrow has developed a limited tourism sector. Travel to these areas primarily is by air, although bus tours occasionally arrive via the Dalton Highway between Deadhorse and Fairbanks. Hikers and river rafters also visit the Arctic National Wildlife Refuge and other areas, using scheduled (to Kaktovik) or chartered (for remote locations) airplanes for access. An increasing number of cruise ships enter the Chukchi and Beaufort Seas, and a growing number of hikers and rafters visit coastal areas of the Chukchi; lodging is currently available in Kaktovik. Gates of the Arctic National Park receives limited visitation, accessed through Anuktuvuk Pass or by chartered airplane. Hunters also visit the area using aircraft for access, and some hunters may enter the area using the Dalton Highway (MMS 2006b).

3.13.2 Beach Recreation

3.13.2.1 Gulf of Mexico

With 408 beaches in 22 coastal counties located on the GOM coast (USEPA 2004), beach visitation was the most important marine recreation activity, attracting tourists and residents for fishing, swimming, shelling, beachcombing, camping, picnicking, bird watching, and other activities. The Florida coast is the second longest in the United States, consisting of 13,518 km (8,400 mi) of tidally influenced shoreline, with approximately 1,328 km (825 mi) of sandy beaches on the Atlantic Ocean and GOM, attracting 15.2 million visitors in 2000. Tourists visiting Florida's beaches in 2000 spent approximately $21.9 billion, producing an indirect economic effect of $19.7 billion and a total economic impact of $41.6 billion (Florida Sea Grant 2005). Texas has 1,004 km (624 mi) of GOM coast, about 772 km (480 mi) of which are beach (National Resources Defense Council 2004), with 166 distinct beaches in 14 counties (USEPA 2004). Texas ranks fifth, with 3.9 million visitors. Most marine recreation occurs in Harris, Nueces, Cameron, and Galveston counties (NOAA 2005).

Louisiana has about 639 km (397 mi) of coastline and 12,426 km (7,721 mi) of tidal shoreline, behind only Alaska and Florida in length of marine shore. Louisiana's coastline is primarily wetlands, and much of the State's 19,829 km^2 (7,656 mi^2) of estuarine water is largely inaccessible to swimmers. There are 16 coastal beaches in seven counties along the GOM, half of which are in Cameron Parish (USEPA 2004). Louisiana beaches are primarily used by local and State residents, and use is highest during the spring and summer seasons (Louisiana Department of Health and Hospitals 2005). Over 600,000 visitors visited Louisiana beaches in 2000 (NOAA 2005). Mississippi's coastline on the GOM includes 578 km (359 mi) of beach bays, inlets, and promontories, and a series of low barrier islands, the largest being Cat, Ship, Horn, and Petit Bois Islands. The 12 coastal beaches in Harrison County, 6 in Jackson, and 3 in Hancock County (USEPA 2004) had over 1.0 million visitors in 2000 (NOAA 2005). Alabama has approximately 80 km (50 mi) of Gulf Beach (52 km [32 mi] in Baldwin County and 26 km [16 mi] on Dauphin Island) and an estimated 105 to 113 km (65 to 70 mi) of bay beaches, including Mobile Bay, Mississippi Sound, Perdido Bay, and Wolf Bay (Alabama Department of Environmental Management 2005) with a total of 95 coastal beaches in the State, 90 of which are in Baldwin County (USEPA 2004). In 2003, visitors to Baldwin County contributed more than $1.8 billion to the economy of the State (Gulf Shores and Orange Beach Tourism 2011), with more than 1.2 million visitors having visited Alabama beaches (NOAA 2005).

3.13.3 Recreational Benefits of Offshore Oil and Gas Platforms

3.13.3.1 Gulf of Mexico

The more than 4,000 petroleum structures in the northern GOM have provided significant benefits to recreational fishing (Brashier 1988). Witzig (1986) found that approximately 60% of the fish caught near structures within 5 km (3 mi) of the shore were kept, compared to less than 10% caught at sites with no oil and gas structures. The proportion of the catch kept on fishing trips greater than 5 km (3 mi) from shore was over 70% for trips to sites with oil and gas structures and approximately 35% to sites with no structures. Gallaway and Lewbel (1982) determined that structures constitute approximately 28% of the known hard bottom habitat off the Louisiana and Texas coasts.

Of the 11,911 boats observed fishing near major offshore structures off the Louisiana coast between April 1980 and March 1981, 10,881 were recreational boats (Ditton and Auyong 1984). This included 8,983 private fishing boats, 1,624 charter/party fishing boats, and 274 scuba boats. One charter boat operator in the northern GOM stated that he takes more than 10,000 people deep sea fishing annually, with all fishing activities on these trips conducted while tied up to oil and gas structures. Approximately one-quarter of all the offshore wean fishing originating in Texas, Louisiana, and Mississippi was directly associated with oil and gas structures. Ditton and Graefe (1978) found that oil and gas structures off the Texas coast attracted 87% of the boats and 50% of all offshore recreational fishing.

Research on sport fishing in the central GOM region suggests fishermen are often prepared to travel distances of up to 42 km (26 mi) to take advantage of reef fisheries established on oil and gas structures (Myatt and Ditton 1986), while Stanley and Wilson (1989) found larger travel distances of up to 80 km (50 mi) for platforms established under the Louisiana Artificial Reef Initiative, with distances travelled sometimes being as high as 167 km (104 mi). The highly specialized marine recreational fisherman profiled by Stanley and Wilson (1989) used equipment with sophisticated navigational and safety equipment in order to use reef structures located further offshore. Beyond 161 km (100 mi), structures have been used by fishermen drawn to deepwater habitat or for charter and commercial uses. More distant offshore locations were also found to benefit the tournament fishing community, who were prepared for more offshore travel than were non-tournament anglers (Gordon 1993).

Hiett and Milon (2001) estimated demand, expenditures, and economic impact associated with recreational fishing and diving near offshore oil and gas structures and artificial reefs created from these structures in Alabama, Mississippi, Louisiana, and Texas. Data came from field surveys of fishermen and divers using private, charter, and party boats. A subsample from each group received follow-up telephone interviews to obtain expenditure data. The survey data were combined with information from regional surveys of fishermen to generate State and regional estimates of aggregate expenditures. To expand the results from the sample to an estimate of impacts for the region, the authors relied on information from an annual survey conducted by the National Marine Fisheries Service. Their resulting estimates were that

$324.6 million in economic activity and 5,560 jobs in coastal counties of the GOM region resulted annually from fishing and diving activities near oil and gas structures.

3.13.3.2 Alaska – Cook Inlet and Arctic

Although offshore oil and gas structures in State waters may provide benefits to recreational fishermen and for diving, there is little documentation of visitation numbers, either by charter vessel or individual boating trips, and the distribution of fishing trips according to the depth of structures. Given the climatic restrictions on recreational fishing and especially on diving in the Arctic, the number of visitor trips to offshore areas is not known, but is likely to be small.

3.13.4 Recreation and Tourism Employment

3.13.4.1 Gulf of Mexico

Recreation and tourism are major sources of employment along the GOM coast, with total employment of 1,015,662 in these sectors (Table 3.13.5-1). The greatest concentration of tourism-related employment in 2008 was in Florida, with 46% of GOM coast region employment in the tourism and recreation sectors. Within the State, tourism-related employment is concentrated in the Miami and Tampa-St. Petersburg LMAs (MMS 2006b). Elsewhere in the GOM coast region, Texas had 31.9% of regional employment in tourism and recreational activities and Louisiana had 16.2%, with employment concentrated in the Houston-Galveston LMA and the New Orleans LMA (MMS 2006b).

3.13.4.2 Alaska – Cook Inlet

Recreation and tourism are major sources of employment in the south central Alaska region, with total employment of 21,302 in these sectors (Table 3.13.5-2). The greatest concentration of tourism-related employment in 2008 was in Anchorage, with 78.4% of south central Alaska region employment in the various tourism and recreation sectors.

3.13.4.3 Alaska – Arctic

Recreation and tourism are not major sources of employment in the Arctic region, with total employment of 619 in these sectors (Table 3.13.5-3). The greatest concentration of tourism-related employment in 2008 was in North Slope Borough, with 79% of Arctic region employment in the various tourism and recreation sectors.

TABLE 3.13.4-1 GOM Coastal Region Recreation and Tourism Employment Composition, 2008

Employment	Alabama	Florida	Louisiana	Mississippi	Texas	Total
Sporting goods retailers	353	6,155	2,715	224	6,269	15,716
Scenic tours	50	1,440	599	25	781	2,895
Automotive rental	221	9,582	2,406	110	4,866	17,185
Museums and historic sites	277	3,049	2,272	87	3,725	9,410
Amusement and recreation	2,085	44,670	14,052	4,036	24,801	89,644
Hotels and lodging places	3,001	74,192	24,351	14,895	27,087	143,526
RV parks and campsites	93	1,336	446	102	759	2,736
Eating and drinking places	21,542	326,287	117,648	13,333	255,740	734,550
Total	27,622	466,711	164,489	32,812	324,028	1,015,662

Source: USCB 2011f.

TABLE 3.13.4-2 South Central Alaska Region Recreation and Tourism Employment Composition, 2008

	Anchorage	Kenai Peninsula	Kodiak Island	Matanuska-Susitna	South Central Alaska Region Total
Sporting goods retailers	498	10	10	96	614
Scenic tours	175	80	10	60	325
Automotive rental	324	14	10	10	358
Museums and historic sites	156	60	60	4	280
Amusement and recreation	1,511	204	60	237	2,012
Hotels and lodging places	3,076	439	59	265	3,839
RV parks and campsites	60	60	10	43	173
Eating and drinking places	10,894	1,167	295	1,345	13,701
Total	16,694	2,034	514	2,060	21,302

Source: USCB 2011f.

TABLE 3.13.4-3 Arctic Region Recreation and Tourism Employment Composition, 2008

	North Slope Borough	Northwest Arctic Borough	Arctic Region Total
Sporting goods retailers	0	0	0
Scenic tours	0	0	0
Automotive rental	0	0	0
Museums and historic sites	0	0	0
Amusement and recreation	53	60	113
Hotels and lodging places	61	10	71
RV parks and campsites	0	0	0
Eating and drinking places	375	60	435
Total	489	130	619

Source: USCB 2011f.

3.13.5 Impact of Oil Spills on Recreation and Tourism

Oil from the DWH event reached many central GOM beaches, and visits to these areas in the immediate aftermath of the accident have decreased significantly; cancellations were reported for areas that are clear of oil, with the spill contributing to negative perceptions of the GOM region (CRS 2010). To counter these perceptions, BP has funded tourism promotion programs in Alabama, Mississippi, and Florida (CRS 2010). Although oil spills can have potentially devastating impacts on the marine and coastal environment, evidence of the longer-term impacts of spills on tourism and recreation in coastal areas impacted by oil spills is inconclusive. This information, however, is not needed at the programmatic stage to make a reasoned choice among alternatives (see Section 1.4, Analytical Issues).

Following the *Exxon Valdez* oil spill, visitor spending decreased 8% in south central Alaska and by 35% in southwest Alaska, resulting in an overall loss of $19 million in visitor spending (Alaska Visitor Statistics Program 1990a). Of all visitors who did travel to Alaska, 16% indicated that the spill influenced their trip planning; nearly half indicated they avoided Prince William Sound during their trip. One in 5 visitors to southwest and south central Alaska stated that their plans were affected significantly more than for other regions of the State. Independent visitors were more affected than package visitors, particularly those who planned to purchase sightseeing packages on arrival in Alaska (Alaska Visitor Statistics Program 1990b).

Another study found that 9% of high potential visitors reported the spill impacted travel into Alaska. As a result, 4% either changed or postponed their trip to Alaska in 1989. Of the population, 8% reported the spill impacted interest in travel to Alaska. As a result, 1% canceled, changed, or postponed a trip to Alaska in 1989. By March 1990, 5% of the general population reported the spill impacted interest in travel to Alaska, with 1% indicating that they did not want to travel to Alaska (Alaska Visitors Association 1990). The same research showed an estimated decline in visitation of 9,400 in the summer of 1989, representing a loss of $5.5 million in in-State expenditures. The 428,200 tourists visiting for vacation and pleasure or to visit friends and relatives in the summer of 1989 represents 97.8% of the total number of visitors who would have come to Alaska, meaning that only 2.2% of all vacation visits were negatively affected by the spill (Alaska Visitors Association 1990).

Perceptions of the extent of the impacts of the spill on the Alaskan economy seem to be in conflict with the results of visitor surveys. Using interviews, executives of tourist-affected businesses and relevant government agencies and organizations (The McDowell Group 1990) found decreased resident and nonresident vacation and pleasure visitor traffic in the spill-affected areas of Valdez, Homer, Cordova, and Kodiak due to lack of available accommodation, charter boats, and air taxis. Of the businesses surveyed in spill-affected areas, 43% felt their business had been significantly or completely affected by the oil spill. A severe labor shortage occurred in the visitor industry throughout the State due to traditional service industry workers seeking high-paying spill cleanup jobs, resulting in a higher cost of doing business among visitor industry businesses. Fifty-nine percent of businesses in the most spill-affected areas reported spill-related cancellations and 16% reported business was less than expected due to the spill. Business segments most negatively affected by the spill included lodges and resorts, Alaska-based tour companies, guided outdoor activities, and charter and sightseeing boats. These businesses did not have the opportunity to reap spill benefits (such as spending for accommodations) because they were located away from spill cleanup operations or operated a business that could not serve cleanup needs (The McDowell Group 1990).

There were major positive effects of the *Exxon Valdez* spill, with spill-related business in some major cleanup areas, and in recreation-related business sectors, such as hotels/motels, car and RV rental, air taxi and boat charters. This business offset the lack of vacation and pleasure business normally experienced in these areas (The McDowell Group 1990; USDOI 2002).

A study by Ellis et al. (1991) used the model proposed by David M. Dornbusch and Company (1987) to evaluate the impacts of the Huntingdon Beach, California, spill of 1990. The model was used to predict changes in beach recreational patterns in response to the closure of beaches due to an oil spill, with the results compared to independent estimates of actual impacts generated by the spill. As a result of cleanup activities and natural variations in terrain, individual beaches were closed for different lengths of time. Average beach closure times of 13.5 days in February and 3.1 days in March were used in the Dornbusch model. This results in a total of 2.28% of yearly beach attendance lost due to closures by the spill.

In the area most physically impacted by the spill, the Dornbusch model estimated a loss in water-based recreation (water-enhanced plus water-dependent) of 720,210 user days, representing a total loss of 2.28% of the yearly recreation days. Immediately south of the impacted area, there was an estimated decrease of 5,448 user days for water-based beach recreation, while immediately north of the impacted area, there was an estimated increase of 46,680 user days. There were significant increases in attendance in other beach areas. The associated consumer surplus changes for the impacted beach areas were $4,959,012 for combined water-dependent and water-enhanced recreation in the main area of impact, an increase of $253,695 in the area immediately south, and a decrease of $56,661 for the area immediately to the north. Total statewide consumer surplus decreased by $1,106,667, a 3.4% decrease from the baseline value of $32,355,916.

Oil spills present a unique set of impacts on recreation relative to the various forms of OCS development activity (A.T. Kearney, Inc. 1991). Whereas industrial development and other scenarios create permanent aesthetic impacts, oil spills are random events that have impacts for only a limited period of time. An oil spill is not considered to have a long-term impact on tourism, but would have larger impacts in the period immediately following an accident and smaller residual impacts in the succeeding months. While it is recognized that long-term ecological effects may occur, past experience with spills indicates that visitation returns to baseline levels within a number of years.

More recent research has focused on the relationship between the possibility of oil spills and the potential for a spill to degrade marine resources and inhibit recreation and tourism. Pulsipher et al. (1999) examined the social and economic impacts of a 5,000 bbl oil spill that occurred offshore in the Lake Barre region of the Louisiana coast in 1997. Based on interviews and information obtained from Texaco (responsible for cleanup), the cleanup contractors, and local area officials, business owners, and residents, the short-term social and economic effects were quite small. The major negative effect was a concern about long-term impacts on marine resources (shrimp, oysters, and fish), but there was no local consensus about whether such effects had occurred.

Although much has been learned in the aftermaths of major oil spills in the past several decades, and the nature and extent of their impacts, despite the attenuation of information from the media and other sources, social amplification of risk has tended to reduce public acceptance of the continued risk of oil production and oil transport by sea, at least in the short term (Leschine 2002) with the consequent potential impacts on recreation and tourism.

3.14 SOCIOCULTURAL SYSTEMS AND SUBSISTENCE

Sociocultural systems consist of the beliefs, ideas, tools, and behavioral patterns including social structure, culture, and institutional organizations that humans use to adapt to their physical and social environments. The sociocultural systems considered here are mostly associated with ethnic and social groups living along the coasts of the GOM and Alaska. While these coasts share the potential for offshore oil and gas development, they are ethnically and demographically dissimilar and are treated somewhat differently here. For example, the northern coast of Alaska is sparsely inhabited. Widely spaced Alaska Native communities dot the coast. They are largely isolated from enclaves of transient oil and gas workers. Few are employed in the oil and gas industry, while many are culturally and economically reliant on subsistence hunting and fishing. While subsistence harvesting exists along the GOM coast, it is of minor cultural and socioeconomic importance. Unlike Alaska's north coast, the offshore oil and gas industry is well developed and draws the majority of its workforce from the GOM coast counties. This relationship is discussed in the sections that follow. South central Alaska supports a more ethnically diverse population than the North Slope and includes isolated Alaska Native villages, ethnically diverse towns and cities dependent on commercial fishing, and a well-developed offshore oil and gas industry along with its supporting infrastructure.

3.14.1 Gulf of Mexico

3.14.1.1 Sociocultural Systems

The counties along the U.S. coast of the GOM are home to a large and heterogeneous mix of cultures, subcultural groups, and populations. Within this region, the effects of the offshore oil and gas industry are felt most directly by populations residing within the coastal community commuting zone where industry-support facilities are located and the people who work at them reside (see Figure 3.14.1-1). Coastal cultures and populations include Hispanic enclaves in southern Texas, Acadian (Cajun) and Native American populations in the bayou country of southern Louisiana, Vietnamese communities along the coast of Texas, Louisiana, and Mississippi, and substantial Caucasian and African American populations (see tables and maps in Sections 3.10.1 and 3.15.1). Native American populations include federally recognized (Table 3.14.1-1) and State-recognized tribes (Table 3.14.1-2). The metropolitan areas of the GOM coast are located in estuaries and are set back from the open coast. They have well-developed port facilities, with waterborne commerce playing an important role in their economies. Cities such as Houston and New Orleans and their surrounding suburban communities have served as destinations of opportunity and have attracted racially and ethnically diverse populations. However, many smaller communities maintain sociocultural environments that are less diverse, often supporting a single or small number of cultural groups in their most important activities. Beginning in the 1930s (and increasingly after World War II), coastal populations have been involved in the oil and gas industry to varying degrees.

Involvement in oil and gas industry activities has been uneven along the coast. Some areas are heavily involved, while other communities have little or no involvement. There is thus variability in the effects of the ups and downs of the industry's business cycle. However, there do appear to have been aggregate effects. These include rapid migration of workers in and out of communities, volatility in social problems, and volatility in income distribution patterns. Communities with dense social networks based on kinship, culture, and other enduring relationships are less affected by industry volatility (Tootle et al. 1999).

The most heavily affected areas are located within the States of Texas and Louisiana, where both upstream and downstream activities are concentrated. Beginning in the early 1930s, the oil industry attracted new workers to Louisiana, affecting the ethnic composition, self-identity, and cultural persistence of groups already in the area and contributing to a rich ethnic mix, as both the immigrants and receiving communities adjusted socially and culturally through the assimilation process. Industry development has also affected the identity of existing ethnic groups. Blue collar jobs in the oil and gas industry have helped to maintain the Cajun culture in Louisiana. However, involvement in the oil and gas industry has affected some aspects of certain cultures. For example, the discouragement of the use of Cajun French on oil rigs and supply boats has reduced the usage of this language in coastal Louisiana (Henry and

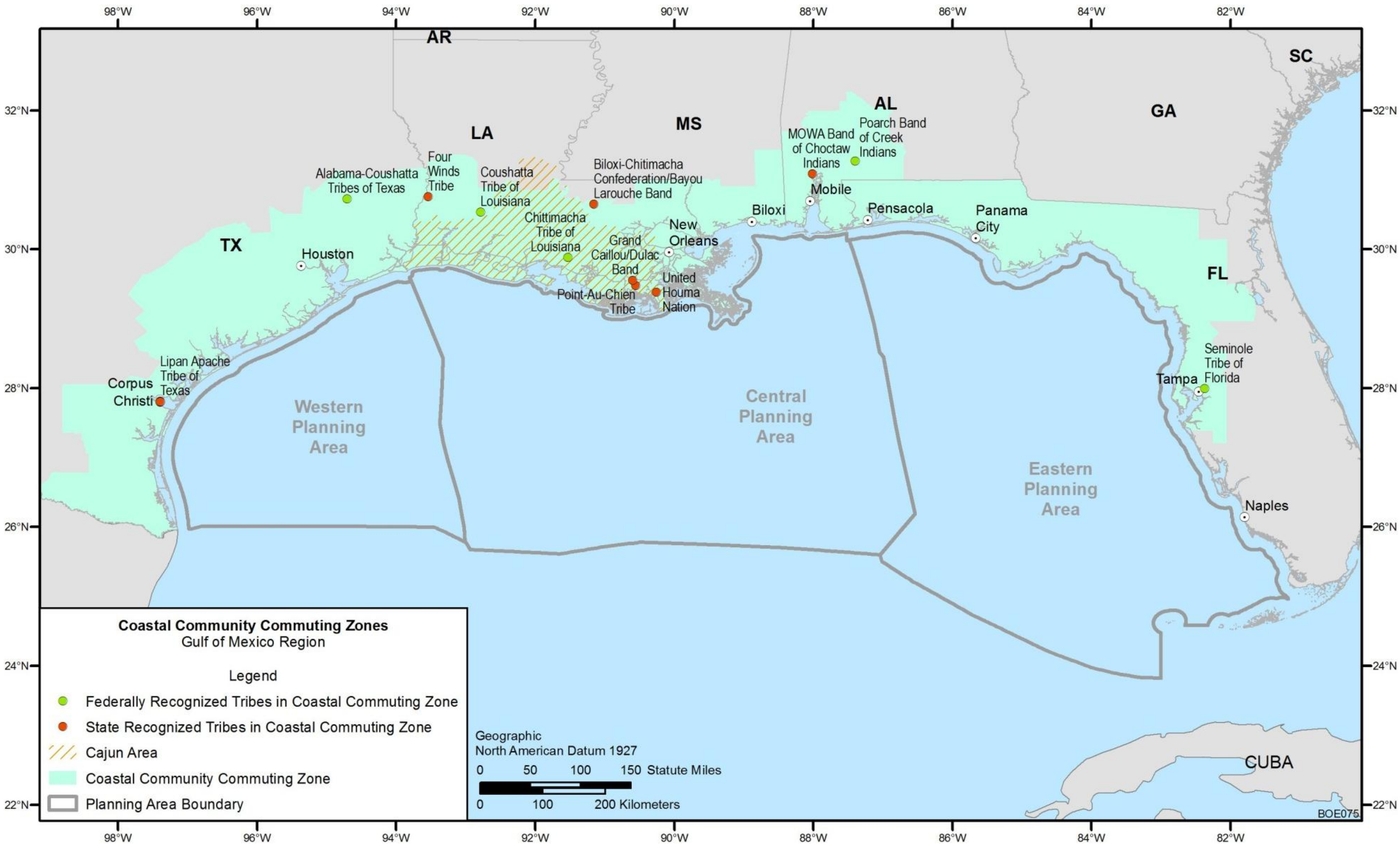

FIGURE 3.14.1-1 GOM Coastal Community Commuting Zone

TABLE 3.14.1-1 Federally Recognized Tribes in the Coastal Community Commuting Zone

State	County/Parish	Tribe
Alabama	Escambia	Poarch Band of Creek Indians
Florida	Escambia	Poarch Band of Creek Indians
Florida	Hillsborough	Seminole Tribe of Florida
Louisiana	Allen	Coushatta Tribe of Louisiana
Louisiana	St. Mary	Chittimacha Tribe of Louisiana
Texas	Polk	Alabama-Coushatta Tribes of Texas

Source: NPS 2010.

TABLE 3.14.1-2 State-Recognized Tribes in the Coastal Community Commuting Zone

State	County/Parish	Tribe
Alabama	Mobile	MOWA Band of Choctaw Indians
Louisiana	East Baton Rouge	Biloxi-Chitimacha Confederation/ Bayou Larouche Band
Louisiana	Vernon	Four Winds Tribe
Louisiana	Terrebonne	Point-Au-Chien Tribe
Louisiana	Lafourche	United Houma Nation
Louisiana	Terrebonne	Grand Caillou/Dulac Band
Texas	Nueces	Lipan Apache Tribe of Texas

Sources: AIAC 2011; FGCIA 2011; LATT 2009; LGOIA 2011.

Bankston 2002). While the oil and gas industry brought an increased exposure of the Cajun communities to a wider cultural mix and resulted in the adoption of some characteristics of broader American culture, the exposure to outsiders also reinforced behaviors held to be characteristically Cajun, including festivals and the preparation of certain foods such as crawfish (Esman 1982).

3.14.1.2 Subsistence and Renewable Resource Harvesting

The coastal estuaries along the GOM have long provided a wealth of wild resources suitable for harvesting. While the bulk of the harvest currently comes in the form of commercial shrimping, fishing, and oystering, traditional subsistence harvesting including fishing and hunting continues among some ethnic groups and low-income minorities (Hemmerling and Colton 2004). In the words of Tim Melancon, a Cajun shrimper, “We’re the last of the Mohicans. We still live off the land. Everything we need is right here” (Tidwell 2003).

Although most Cajuns are now urban dwellers with blue collar jobs, the cultural ideal of harvesting the bounty of the bayous remains and is practiced recreationally (Henry and Bankston 2002). Native American groups such as the State-recognized United Houma Nation and the federally recognized Chittimacha Tribe in southern Louisiana depend on fishing, hunting, and gathering for at least part of their domestic subsistence (Brightman 2004; Campisi 2004). Despite being primarily commercial fishers, Vietnamese fishers normally retain up to 25% of their catch for family use and for barter (Alexander-Bloch 2010). These minority communities might have specific concerns related to their sociocultural welfare now and following disturbances to existing conditions, such as from a large hurricane or oil spill (Picou 2010; Yeoman 2010).

3.14.2 Alaska – Cook Inlet

3.14.2.1 Sociocultural Systems

The region surrounding the Cook Inlet Planning Area, referred to as south central Alaska, including both the southern portions of Cook Inlet and the Shelikof Strait, is quite diverse (Figure 3.14.2-1). It includes economically complex cities such as Anchorage and its suburbs, the largest urban community in the State; towns such as Kenai, Soldotna, and Nikiski that are centers of the oil and gas industry, on the Kenai Peninsula, as well as commercial fishing; smaller towns such as Port Lions that are dependent on commercial fishing; and small, predominantly Alaska Native communities. The northern Knik Arm of Cook Inlet extends into the Borough of Matanuska-Susitna (Mat-Su), which includes both urban communities tied to Anchorage and remote rural settlements. Subsistence harvesting plays some role in communities of all types.

Anchorage is the major service center for the area. It is located between the Knik and Turnagain Arms of upper Cook Inlet northeast of the Cook Inlet Planning Area. Oil and Gas activities in the Cook Inlet Planning Area would affect Anchorage to the extent that they affect the waters of the upper inlet and the oil and gas companies located in the Anchorage area. It is the center of the local road network and serves as a hub for scheduled and charter air traffic. Although majority Caucasian, it is home to significant Alaska Native, Asian, Black, and Hispanic populations. It is the center of commerce for the State, serving as the headquarters for the oil and gas industry, finance and real estate, communications, government offices, and military facilities, as well as much of the tourist industry (DCRA 2011). In spite of its urban character, the Anchorage community partakes in Alaskan values of independence and accessibility to the wild and remote. The ADFG estimates that 34 Anchorage households currently participate in subsistence harvesting (ADFG 2011e).

Lying north of Anchorage, the Mat-Su Borough, although including the northern reach of Knik Arm, is farther from the Cook Inlet Planning Area. Activities in the planning area would affect Mat-Su communities in much the same way as they would the Anchorage area. Palmer and Wasilla are major Mat-Su communities. Connected to Anchorage by the road network, they serve partly as bedroom communities for Anchorage, but also are home to a variety of retail,

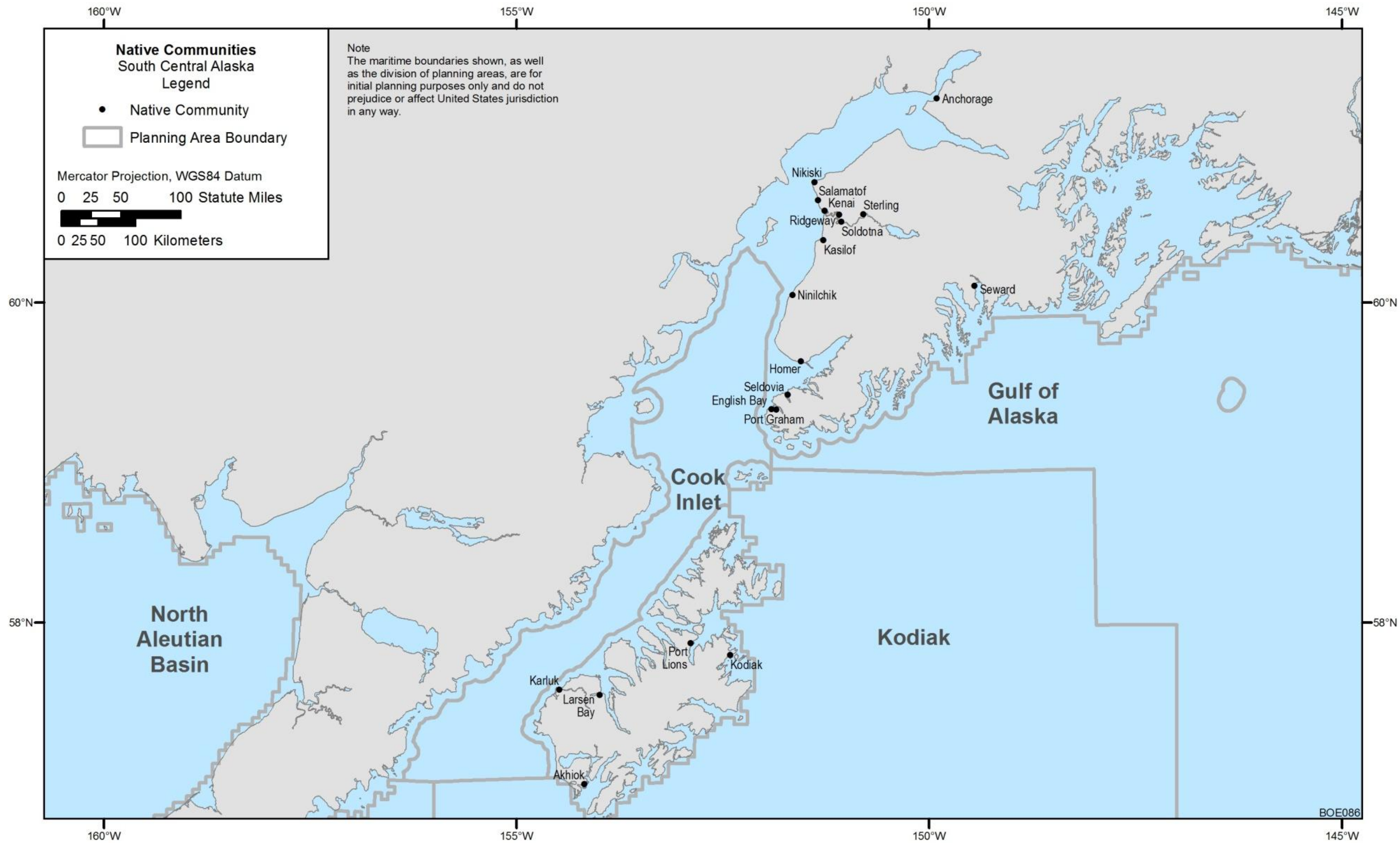

FIGURE 3.14.2-1 Native Communities around Cook Inlet

service, and light manufacturing enterprises. Seventy-seven Palmer residents have commercial fishing permits and could be affected by oil and gas activities in Cook Inlet (DCRA 2011). The ADFG has tracked subsistence use in four Mat-Su communities. Subsistence harvest includes marine resources (ADFG 2011e), indicating that subsistence users are harvesting in areas beyond the upper inlet, very likely within the planning area.

The Kenai Peninsula forms the southeastern coast of Cook Inlet and has direct access to the Cook Inlet Planning Area from its southern end. The Kenai-Soldota area (Kenai, Soldotna, Nikiski, Sterling, Ridgeway, and Kasilof) serves as a diversified center for the central Kenai Peninsula. Homer serves as a smaller-scale hub for the southern part of the peninsula. All communities on the peninsula except those lying south of Katchemak Bay are connected to Anchorage by a road network. Most communities are of mixed ethnicity or predominantly non-Native. Small communities that are not connected to the road network include Tyonek, Nanwalek, Port Graham, and Seldovia. These four communities share many of the same characteristics as communities in the less economically developed areas of the State. All but Seldovia are predominantly Alaska Native with limited commercial economic activities primarily related to fishing and fish processing. Tyonek is a Dena'ina village, while Nanwalek and Port Graham are Chugachmuit. In these communities, subsistence activities retain significant importance and reinforce their fundamental kin-based social organization.

The Cook Inlet Planning Area extends southwest beyond Cook Inlet proper and includes the heart of the Shelikof Strait. The Shelikof Strait lies between Kodiak Island and the Alaska Peninsula. The small communities along the northwestern coast of Kodiak Island, Ahiok, Karluk, Larsen Bay, and Port Lions are reachable only by sea and by air. Similar to the small isolated communities on the Kenai Peninsula, they have a high proportion of Alaska Native inhabitants and rely mostly on commercial fishing and subsistence harvesting (DCRA 2011). Given their reliance on marine resources, these communities have the potential to be directly affected by oil and gas development in the Cook Inlet Planning Area.

At the time of European contact, the area around Cook Inlet was inhabited by Dena'ina Athabascans. The southern end of the Kenai Peninsula was inhabited by the Chugachmuit, while Kodiak Island and the southwestern shores of the inlet were inhabited by Koniagmiut. The area covered by Cook Inlet Region, Inc. (CIRI), a regional Alaska Native corporation established under the ANCSA, closely follows traditional Dena'ina lands, but draws its membership from a cross section of Native cultures whose descendants now live in the Anchorage metropolitan area. Table 3.14.2-1 lists south central Alaska communities with Alaska Native populations (DCRA 2011).

3.14.2.2 Subsistence

Alaskans generally place a high value on being able to hunt, fish, and to live off the land, if desired. The Alaska Constitution guarantees equal access to fish, wildlife, and waters for all State residents. Traditionally, Alaska Natives hunted, fished, and lived off the land of necessity. They view subsistence hunting and gathering as a core value of their traditional cultures. For them, most subsistence activities are group activities that further core values of community,

TABLE 3.14.2-1 Alaska Natives in Communities around the Cook Inlet

Community	Population (2010)	Percent Native	Local Native Corporation	Federally Recognized Tribal Government	Incorporated?
Cook Inlet Region Inc.					
Anchorage	291,826	8	None	None	1920
Big Lake	529	23	None	None	No
Chickaloon	272	6	Chickaloon-Moose Creek Native Association	Chickaloon Native Village	
Eklutna	384	13	Eklutna, Inc.	Native Village of Eklutna	No
Fishhook	4,679	4	None	None	No
Glacier View	234	1	None	None	No
Houston	1,912	7	None	None	1966
Kenai	7,100	9	Kenai Natives Association, Inc.	Kenaitze Indian Tribe	1960
Knik Fairview	14,923	5	Knikatnu, Inc.	Knik Tribal Council	No
Knik River	744	4	None	None	No
Lake Louise	48	2	None	None	No
Ninilchik	883	5	Ninilchik Native Association, Inc.	Ninilchik Traditional Council	No
Palmer	5,937	9	Montana Creek Native Association		
Point Mackenzie	529	23	None	None	No
Salamatof	980	18	Salamatof Native Association, Inc.	Native Village of Salamatof	No
Seldovia	255	14	Seldovia Native Association, Inc.	Seldovia Village Tribe	1945
Trapper Creek	481	6	None	None	No
Tyonek	171	88	Tyonek Native Corp.	Native Village of Tyonek	No
Wasilla	7,831	5			1951
Chugach Alaska Corp.					
Nanwalek	254	80	English Bay Corporation	Native Village of Nanwalek	No
Port Graham	177	71	Port Graham Corp.	Native Village of Port Graham	No
Koniag, Inc.					
Akhiok	71	51	Ayakulik Inc.	Native Village of Ahiok	
Karluk	37	95	None	Native Village of Karluk	
Larsen Bay	87	71	None	Native Village of Larsen Bay	
Port Lions	194	59	Afognak Native Corp.	Native Village of Port Lion	

Source: DCRA 2011.

kinship, cooperation, and reciprocity. In Alaska, State and Federal definitions of subsistence and who is permitted to participate in the subsistence harvest differ. The ADFG defines subsistence fishing as “the taking of, fishing for, or possession of fish, shellfish or other fisheries resources by a resident of the State for subsistence uses [customary and traditional uses of fish]” (ADFG 2011f). Current Federal regulations define subsistence use as “the customary and traditional use by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools of transportation; for making and selling handicraft articles out of inedible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade” (FSMP 2010). The State definition makes subsistence harvesting available to all Alaska residents, while Federal land managers restrict the harvest to those whose primary residence is rural, and may restrict a particular harvest area to a specified community or group of communities. The entire State is defined as rural except for designated non-rural areas (FSMP 2011). Priority for subsistence harvesting in land management is expressed in the ANILCA, passed by Congress in 1980. Similar State legislation was struck down as violating the State Constitution. ANILCA now applies only to Federal lands. Both approaches to subsistence are represented in south central Alaska.

Subsistence resources on Federal lands and waters are managed by the Federal Subsistence Board (FSB). For some resources in certain areas, the FSB has determined that all rural Alaskans are qualified subsistence users. For other areas, the FSB has made more restrictive “customary and traditional” determinations of eligibility. For example, only the communities of Copper Landing, Hope, and Ninilchik may harvest salmon with dipnets in the Kenai River drainage. *Customary and traditional use* means “a long-established, consistent pattern of use, incorporating beliefs and customs transmitted from generation to generation. This use plays an important role in the economy of the community” (FSMP 2011).

Some marine resources are subject to Federal regulation. Subsistence hunting of marine mammals is governed by the MMPA, and is restricted to Alaska Natives who reside on the coast of the North Pacific Ocean or the Arctic Ocean. Halibut may be harvested by residents of rural communities through the Federal subsistence halibut program (ADFG 2011f).

While the State of Alaska makes regulated subsistence harvesting available to all residents of at least a year, it also designates some areas as nonsubsistence use areas. Alaska statutes define nonsubsistence use areas as “areas where dependence upon subsistence (customary and traditional uses of fish and wildlife) is not a principal characteristic of economy culture and way of life” (AS 16.05.258(c)). In south central Alaska, the Anchorage-Mat-Su-Kenai Nonsubsistence Use Area includes FSB-designated non-rural areas in Anchorage, the Mat-Su Borough, and on the Kenai Peninsula. The State does allow “personal use” fisheries within nonsubsistence use areas. Alaska defines “personal use” fishing as “the taking, fishing for, or possession of finfish, shellfish, or other fishery resources, by Alaska residents for personal use and not for sale or barter, with gill or dip net, seine, fish wheel, long line, or other means defined by the Board of Fisheries” (ADFG 2011f). Personal use harvest is for food rather than sport. It is illegal to buy, sell, trade or barter personal use finfish, shellfish, or aquatic plants.

A discussion of subsistence in and around the Cook Inlet Planning Area must take into account, both Native and non-Native populations, urban and rural communities, Federal and State jurisdiction; and the Anchorage-Mat-Su-Kenai Nonsubsistence Use Area, and personal use fisheries. The Anchorage-Mat-Su-Kenai Nonsubsistence Use Area includes all but the southern tip of the Kenai Peninsula, State waters within Cook Inlet, and Anchorage and its suburbs and extends northward into Mat-Su Borough as far as Chickaloon, Talkeetna, and Petersville. Although subsistence harvesting is excluded from this area, personal use fishing does provide opportunities for harvesting fish with gear other than rod and reel within nonsubsistence areas at designated locations and in designated seasons. These include a salmon fishery off the mouth of the Kenai River, a razor clam fishery on the beaches between Homer and Kenai, and a hooligan and herring fishery in Cook Inlet (ADFG 2011f). The urban Anchorage area is home to 42% of the State's population. Its residents hunt and fish under personal use, sport, and subsistence regulations in other parts of the area, especially the Kenai Peninsula.

These hunting and fishing options are available to Alaska residents living in Mat-Su as well. The small Caucasian community of Chase, located just outside the nonsubsistence area, relies almost entirely on subsistence harvesting and gardening, and Trappers Creek with a small Native population, relies substantially on subsistence harvesting as well (DCRA 2011) (see Table 3.14.2-1). The most recent subsistence harvest data for Mat-Su communities dates to the 1980s (Table 3.14.2-2). While the bulk of the harvested species reported are terrestrial species or anadromous fish, subsistence harvesters were taking marine finfish and shellfish as well, suggesting that the effects of gas and oil activities in the Cook Inlet Planning Area would not be confined to communities directly on the coast.

In the predominantly Alaska Native communities (Table 3.14.2-1) adjacent to the planning area — Port Graham, Nanwelek, Tyonek, Akhiok, Karluk, Larsen Bay, and Port Lions — subsistence resources are an important part of household economy in terms of variety, amount, and sharing (see Table 3.14.2-3). The communities connected to the road network are of mixed ethnicity or predominantly non-Native and display somewhat different patterns of subsistence resource use.

Many species, often migratory species, play an important role in the annual cycle of subsistence-resource harvests. Thus, specific effects on subsistence can be serious, depending on the season in which they occur. Seasonally specific effects on subsistence can be serious, even if the annual net quantity of available food does not decline. Subsistence use patterns vary considerably in and adjacent to the Cook Inlet Planning Area. Smaller, more traditional villages harvest salt and freshwater fishes and small sea mammals in summer and fall, hunt moose in the fall, and harvest invertebrates and some sea mammals all year. Residents in the more urban-based communities tend to fish in the summer and hunt in the fall.

Where Alaska Natives are located in urban areas, such as the Kenaitze Indian Tribe, located in Kenai, a yearly Educational Fishery Permit has been issued so that they can instruct the younger generation in traditional food harvesting and preparation skills. In 2008, a quota of 8,000 salmon was allotted to the Kenaitze Tribe during a season lasting from May 1 to November 30 (Kenaitze Indian Tribe 2011). In 2010, due to low escapement numbers in the

TABLE 3.14.2-2 Reported Subsistence Use at Mat-Su Borough Communities

Resource	Scientific Name	Chase 1986	Chickaloon 1982	Lake Louise 1987	Trapper Creek 1985
Marine Mammals		–	–	–	–
Terrestrial Mammals					
Deer	Species not reported	X	–	X	–
Bison	*Bison bison*	–	X		X
Dall Sheep	*Ovis dalli*	X	–	–	–
Moose	*Alces alces*	X	X	X	X
Brown Bear	*Ursus arctos*	X	–	X	–
Black bear	*Ursus americanus*	X	X	X	X
Fox	Species not reported	X	X	X	X
Wolf	*Canis lupus*	X	–	X	–
Coyote	*Canis latrans*	X	X	–	–
Wolverine	*Gulo gulo*	X	–	–	–
Porcupine	*Erethizon dorsatum*	X	X	–	X
Beaver	*Castor Canadensis*	X	X	–	X
Marten	*Martes* spp.	X	X	X	X
Mink	Species not reported	X	–	X	X
Weasel	Species not reported	X	–	X	–
Hare	Species not reported	X	X	–	X
Land otter	*Lutra canadensis*	X	–	–	–
Muskrat	*Ondatra zibethicus*	–	X	–	–
Fish					
Salmon	Species not reported	X	X	X	X
Chum	*Oncorhynchus keta*	X	–	–	X
Pink (humpback)	*O. gorbuscha*	X	X	–	X
Silver (coho)	*O. kisutch*	X	X	X	X
Chinook	*O. tshawytscha*	X	X	X	X
Sockeye	*O. nerka*	X	X	X	X
Herring	*Clupea* spp.	X	–	–	–
Halibut	*Hippoglosus* spp.	X	–	X	X
Dolly varden	*Salverlinus mallma miyabei*	X	X	–	–
Char	Species not reported	X	–	X	–
Rock fish	Species not reported	–	–	X	–
Trout	Species not reported	X	X	–	X
Lake trout	*Salvelinus namaycush*	X	X	X	–
Smelt	Species not reported	X	X	–	–
Pacific cod	*Gadus macrocephalus*	–	–	–	X
Burbot	*Lota lota*	X	X	X	–
Pike	Species not reported	–	–	X	–
Grayling	*Thymallus arcticus*	X	X	X	X
Greenling	Species not reported	–	X	–	–
White fish	*Coregonus* spp.	X	–	X	X
Eulachon	*Thaleichthys pacificus*	X	X	–	–

TABLE 3.14.2-2 (Cont.)

Resource	Scientific Name	Chase 1986	Chickaloon 1982	Lake Louise 1987	Trapper Creek 1985
Marine Invertebrates					
Mussels	Species not reported	–	–	–	X
Clams	Species not reported	X	–	–	X
Crab	Species not reported	X	–	–	–
Shrimp	Species not reported	X	–	–	–
Birds		X	X	X	X
Ducks	Species not reported	X	X	X	X
Mallard	*Anas platyrhynchos*	–	X	–	–
Geese	Species not reported	X	–	–	–
Ptarmigan	*Lagopus* spp.	X	X	X	X
Grouse	Species not reported	X	X	X	X
Other Resources					
Berries	Species not reported	X	X	X	X
Greens/roots/mushrooms	Species not reported	X	X	X	X
Wood	Species not reported	X	–	X	–

Source: ADFG 2011e.

Ninilchik River, the Ninilchik Village Tribe was allotted 100 king salmon and 200 coho salmon during an educational fishery season lasting from May 1 through May 20 (NTC 2010).

Residents of Seldovia, Port Graham, and Nanwalek are the primary subsistence harvesters of the lower Kenai Peninsula, and, since the *Exxon Valdez* oil spill fouled local traditional clamming areas, residents of Nanwalek and Port Graham have used the area around Ninilchik for the harvest of clams. Subsistence harvesting of fish, wildlife, and vegetation also occurs at the head and along the southern shore of Kachemak Bay. Area residents harvest seals, sea lions, and sea otters around Yukon Island and Tutka Bay. Primary waterfowl harvest areas are in the vicinity of Seldovia, Tutka, and China Poot Bays and McKeon and Fox River flats. Seabirds and their eggs also are harvested. Moose, black bear, and mountain goats are hunted along local shorelines. Port Graham and Nanwalek residents harvest salmon in Nanwalek and Koyuktolik (“Dogfish”) Bays. Seldovians gather berries in larger quantities than any of the other Kenai Peninsula subsistence communities (ADNR 1999).

Resources preferred by Nanwalek and Port Graham residents include clams, chitons, bear, and especially salmon. These provide large quantities of food during a short period of the year that can be preserved for use throughout the remainder of the year. A combination of commercial, subsistence, personal use, and rod-and-reel fisheries provide salmon for domestic use. Residents of Nanwalek and Port Graham participate in permitted general subsistence and

TABLE 3.14.2-3 Reported Subsistence Use at Selected Alaska Native Villages Adjacent to the Cook Inlet Planning Area

Resource	Scientific Name	Nanwalek 2003	Port Graham 2003	Tyonek 2006	Akhiok 2003	Larsen Bay 2003	Poort Lions 2003
Marine Mammals							
Harbor seal	*Phoca vitulina*	X[a]	X	X	X	X	X
Steller sea lion	*Eumetopias jubatus*	X	X	X	X	—	—
Beluga whale	*Delphinapterus leucas*	—[a]	—	X	—	—	—
Bowhead whale	*Balaena mysticetus*	—	—	X	—	—	—
Sea otter	*Enhydra lutris*	X	X	—	—	—	X
Terrestrial Mammals							
Deer	Species not reported	—	X	X	X	X	X
Moose	*Alces alces*	—	X	X	—	—	X
Elk	*Cervus canadensis*	—	—	—	—	—	X
Black bear	*Ursus americanus*	X	X	X	—	—	—
Fox	Species not reported	—	—	X	—	—	X
Porcupine	*Erethizon dorsatum*	X	X	X	—	—	—
Beaver	*Castor Canadensis*	—	—	X	—	—	X
Coyote	*Canis latrans*	—	—	X	—	—	—
Snowshoe hare	*Lepus americanus*	—	—	—	—	X	X
Fish							
Salmon	Species not reported	X	X	X	X	X	X
Chum	*Oncorhynchus keta*	X	X	X	X	X	X
Pink (humpback)	*O. gorbuscha*	X	X	X	X	X	X
Silver (coho)	*O. kisutch*	X	X	X	X	X	X
Chinook	*O. tshawytscha*	X	X	X	—	—	—
Sockeye	*O. nerka*	X	X	X	X	X	X
Steelhead	*O. mykiss*	—	—	—	—	X	X
Herring	*Clupea* spp.	—	X	X	—	X	X
Halibut	*Hippoglosus* spp.	X	X	X	X	X	X
Dolly varden	*Salverlinus mallma miyabei*	X	X	X	X	X	X
Char	Species not reported	X	X	X	X	X	X
Rock fish	Species not reported	X	X	—	X	X	X
Sculpin	Species not reported	X	—	—	—	—	—
Trout	Species not reported	X	—	X	—	X	X
Smelt	Species not reported	X	X	X	—	—	—
Pacific cod	*Gadus macrocephalus*	X	X	—	X	X	X
Tomcod	*Eleginus gracilis*	X	X	X	—	—	—
Flounder	*Liopsetta glacialis*	X	X	—	—	—	X
Eel	Species not reported	X	X	—	—	—	—
Walleye Pollock	*Theragra chalcogramma*	—	—	—	—	—	X
Greenling	Species not reported	—	—	—	—	—	X
Shark	Species not reported	—	—	—	—	—	X
Sole	*Hippoglossoides elassodon*	—	—	—	—	—	X

TABLE 3.14.2-3 (Cont.)

Resource	Scientific Name	Nanwalek 2003	Port Graham 2003	Tyonek 2006	Akhiok 2003	Larsen Bay 2003	Poort Lions 2003
Marine Invertebrates							
Chitons	Species not reported	X	X	—	X	—	—
Limpets	Species not reported	X	—	—	—	—	—
Mussels	Species not reported	X	X	—	—	—	X
Clams	Species not reported	X	X	X	X	X	X
Oysters	Species not reported	—	X	—	—	—	—
Snails	Species not reported	X	X	—	—	X	—
Crab	Species not reported	X	—	—	X	X	X
Shrimp	Species not reported	X	—	—	—	—	—
Cockles	Species not reported	—	—	—	X	—	—
Sea urchins	Species not reported	—	—	—	X	—	X
Octopus	Species not reported	X	X	—	—	—	—
Birds							
Ducks	Species not reported	X	X	X	X	X	X
Mallard	*Anas platyrhynchos*	X	X	X	X	X	X
Pintail	*Anas acuta*	—	—	X	—	—	—
Canvasback	*Aythya valisineria*	—	—	X	—	—	—
Eider	*Somerteria* spp.	—	—	—	—	—	X
Bufflehead	*Bucephala albeola*	—	—	—	—	—	X
Gadwall	*Anas strepera*	—	—	—	—	—	X
Harlequin	*Histrionicus histrionicus*	—	—	—	—	—	X
Green-winged teal	*Anas carolinensis*	—	—	X	X	—	X
Scoter	Species not reported	X	X	—	—	—	X
Merganser	*Mergus merganser*	—	X	—	—	—	X
Goldeneye	*Bucephala* spp.	—	X	—	X	X	X
Snow goose	*Chen caerulescens*	—	—	X	—	—	—
Canada goose	*Branta canadensis*	—	—	X	—	—	X
Emperor goose	*Chen canagica*	—	—	—	X	—	—
Sandhill crane	*Grus canadensis*	—	—	X	—	—	—
Ptarmigan	*Lagopus* spp.	—	—	X	X	—	X
Grouse	Species not reported	X	X	X	—	—	—
Gulls	Species not reported	X	—	—	—	—	—
Other Resources							
Kelp	Species not reported	X	X	—	—	—	X
Berries	Species not reported	X	X	X	X	X	X
Bird eggs	Species not reported	X	X	X	X	X	X
Gull eggs	Species not reported	X	X	X	X	X	X
Greens/roots/mushrooms	Species not reported	X	X	X	X	X	X
Wood	Species not reported	X	X	X	X	X	X

[a] X = Reported; — = Not reported.

Source: ADFG 2011e.

personal-use fisheries that have existed in upper Cook Inlet since 1991 and are open to Natives and non-Natives. Dipnet fisheries take place on the Kenai and Kasilof Rivers and on Fish Creek. A set gillnet fishery takes place on the Kasilof River beginning June 21. In addition, a general Kachemak Bay subsistence and personal-use salmon fishery has taken place since before statehood. This fishery uses Fox River drainage salmon runs and hatchery stocks returning to the fishing lagoon on Homer Spit and to Fox Creek (ADNR 1999).

Other resources such as trout, cod, halibut, chitons, snails, whelks, and crabs are consumed fresh in season. Harbor seals and sea lions are highly valued marine mammals, are harvested by local Alaska Native residents year-round, and are extensively shared by the Alaska Natives in any community. A variety of plants also are harvested in Kachemak Bay and Cook Inlet. Bull kelp, rockweed, and brown seaweeds are collected from intertidal areas, and shoreline areas provide seaside plantain, rye grass, beach pea, wild parsley, and cow parsnip. Seldovia, Kasitsna, and Jakolof Bays are important areas for the harvest of marine invertebrates.

The Native villages on Kodiak Island rely on a varying mix of commercial fishing, fish processing, tourism, and subsistence harvesting. While the extent to which they rely on subsistence varies, all of these villages rely on subsistence harvesting to a greater or lesser degree. Salmon and halibut are subsistence mainstays, as are seals and migrating birds along with invertebrates such as clams and crabs (Table 3.14.2-3) (DCRA 2011).

Often overlooked, gardening has been part of village subsistence life since Russian times. Potatoes, cabbage, and turnips were brought to the Kenai Peninsula by Russian settlers who planted gardens due to the need for fresh vegetables (Fall 1981). A variety of local wild berries are picked, particularly low- and high-bush cranberries, rosehips, blueberries, moss berries, and wild raspberries. Locally harvested subsistence foods are distributed widely among community households.

Tyonek, on the west side of Cook Inlet, has a subsistence harvest area that extends from the Susitna River south to Tuxedni Bay; harvests concentrate in areas west and south of Tyonek. Moose and salmon are the most important subsistence resources, although important components of the harvest include non-salmon fishes such as smelt, waterfowl, and clams (ADNR 1999). In the past, the subsistence use of beluga in Cook Inlet was traditionally important to the village of Tyonek. Declines in the beluga population have led Cook Inlet beluga stock to be classified as depleted under the MMPA and endangered under the ESA (see Section 3.8.1.2.1) In 1999 and 2000, Federal laws established a moratorium on beluga whale harvests except for subsistence hunts under cooperative agreements between the NMFS and affected Alaska Native organizations. Co-management agreements between NMFS and the Cook Inlet Marine Mammal Council representing Native subsistence hunters were signed for 2000–2003 and 2005–2006. Two belugas were harvested from Cook Inlet as recently as 2005. Currently, harvest limits are determined in 5-yr increments based on the average beluga population over the preceding 5 yr and the population growth rate over the previous 10 yr. When that average falls below 350, no harvest is allowed. Since the 2003–2007 average abundance was below 350, there is no allowable beluga harvest for the years 2008–2012 (Allen and Angliss 2011). In April of 2011, the NMFS designated upper Cook Inlet, Katchemak Bay, and the eastern coastal waters of lower

Cook Inlet as critical habitat for beluga whales. The taking of belugas in these waters is prohibited (76 FR 69:20180–20194).

3.14.3 Alaska – Arctic

3.14.3.1 Sociocultural Systems

Since the planning areas under consideration here are for the most part located adjacent to sparsely populated rural areas that are largely inhabited by indigenous Iñupiat, this section focuses on Alaska Native sociocultural systems, although non-Native populations are considered as well. Unlike many of the indigenous populations in the lower 48 States, Alaska Natives continue to occupy and use their traditional lands. They maintain many traditions with respect to social organization and cultural values. Among the most prized values retained are those placed on social cohesion and group activities expressed in subsistence harvesting of wildlife and plant resources. Alaska Natives have been able to maintain these values partly because of the interaction between ecological possibilities, history of contact with non-Natives, and a commitment to retaining their culture and identity. The sociocultural systems of modern Alaska Natives have been modified to some extent from those existing prior to Euro-American contact; however, much of the earlier systems survive, resulting in modern sociocultural systems that to various degrees blend traditional and Euro-American characteristics.

Native populations in Alaska are involved in a complex network of institutions, unique among Native populations in the United States that have allowed them to retain or regain control over much of their traditional homelands and modify western institutions of government and business to further traditional values. These include municipal governments, tribal councils, and regional and local ANSCA Native village and regional corporations, as well as non-governmental organizations (NGOs) such as the Alaska Federation of Natives (AFN) and the Alaska Eskimo Whaling Commission (AEWC). Under the terms of Section 4 of the Alaska Statehood Act (P.L. 85-508), the State of Alaska disclaimed all right and title to lands “title to which may be held by any Indians, Eskimos, or Aleuts (hereinafter called Natives) or is held by the United States in trust for said Natives.” However, Section 6 allowed the State to select just over 42 million ha (104 million ac) of public or Federal lands that were “vacant, unappropriated, and unreserved at the time of selection.” In many cases, lands selected by the State as vacant, unappropriated, and unreserved were lands that Alaska Natives considered to be theirs. In order to settle the resulting disputes, Congress passed ANCSA in 1971. Under ANCSA, Alaska Natives selected 18 million ha (44 million ac) of their traditional lands in fee title. In exchange for extinguishing claims to the remainder of the State, they received just under a billion dollars over a 10-year period. Under ANCSA, titles to the lands were given to 12 regional for-profit corporations and more than 200 village corporations that could be organized on either a not-for-profit or for-profit basis. Corporation shares were divided among Alaska Natives. In most cases, village corporations hold title to the surface estate while the regional corporations hold title to the subsurface estate. Despite initial concerns that Native cultural values would be enveloped by American corporate culture and that they could eventually lose control of their corporations and corporation lands, Alaska Natives have modified corporate culture to support traditional cultural values including sharing and subsistence (ASRC 2012). To make it more likely that Natives will maintain control of their corporations in the future, ANSCA was modified in 1987 to allow corporations to allocate shares to the younger generation not covered under the original Act and to restrict share ownership to Alaska Natives.

Given these multiple layers of jurisdiction and control, a Native community might be governed by a local municipal government, a wider borough government, and a local and regional tribal council. The land surface might be owned and administered by a village corporation while subsurface resources would be under the control of a regional corporation. The multiple concerned institutions do not always see eye to eye, and there is some tension between successful and less profitable corporations (Zellen 2008).

This section discusses the regional and community systems found on Alaska's North Slope and Northwest Arctic Borough (Figure 3.14.3-1) that could be affected by future oil and gas activities on the Arctic OCS. The oil and gas development under consideration in this EIS would take place offshore of North Slope Borough communities lying along the shores of the Beaufort and Chukchi Seas. These communities would be subject to direct effects from the widest array of development activities. These include the predominantly Alaska Native communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, and Point Hope, as well as the unincorporated community of Deadhorse that serves primarily to house as many as 5,000 transient workers in the nearby Prudhoe Bay oil fields. However, coastal Northwest Arctic Borough communities (Kivalina, Kotzebue, Buckland, and Deering) that are also on the shores of the Chukchi Sea could also be affected. The migrating whales and other sea mammals that are hunted by North Slope Borough communities are also hunted by Northwest Arctic Borough whaling communities. Any adverse effects on marine mammal populations migrating along the northern coast would also be felt by Northwest Arctic Borough communities along the coast as well as the inland villages that trade with them. Migrating whales continue south to the Bering Sea, and similar effects would also be felt in the Alaska Native whaling communities of Wales, Diomede, Savoonga, and Gambell, which lie along their migratory path, and by traditional whaling communities in Russia.

3.14.3.1.1 North Slope. The Chukchi Sea and Beaufort Sea Planning Areas lie off the northern coast of the North Slope Borough. At the 2010 Census, the population of the North Slope Borough was 9,430, almost 54% of which were Alaska Natives (USCB 2011c). The Alaska Natives living in communities lying along the shore of the Chukchi and Beaufort Sea Planning Areas are primarily Iñupiaq Eskimo whose traditional culture is based on cooperation, kinship ties, and subsistence hunting and gathering. In particular, traditional coastal North Slope cultures are specially adapted to whaling (Spencer 1984).

Chukchi Sea communities include Barrow, Wainwright, Point Hope, and Point Lay along the coast, while Atqasuk lies somewhat inland (Figure 3.14.3-1, Table 3.14.3-1). Barrow is the largest permanent community on the North Slope and serves as the administrative and commercial hub of the region. It is a traditional Iñupiaq settlement with 61% of the population being Alaska Natives. The North Slope Borough is the city's largest employer, but there are also numerous businesses providing support services to oil field operations. Subsistence whaling,

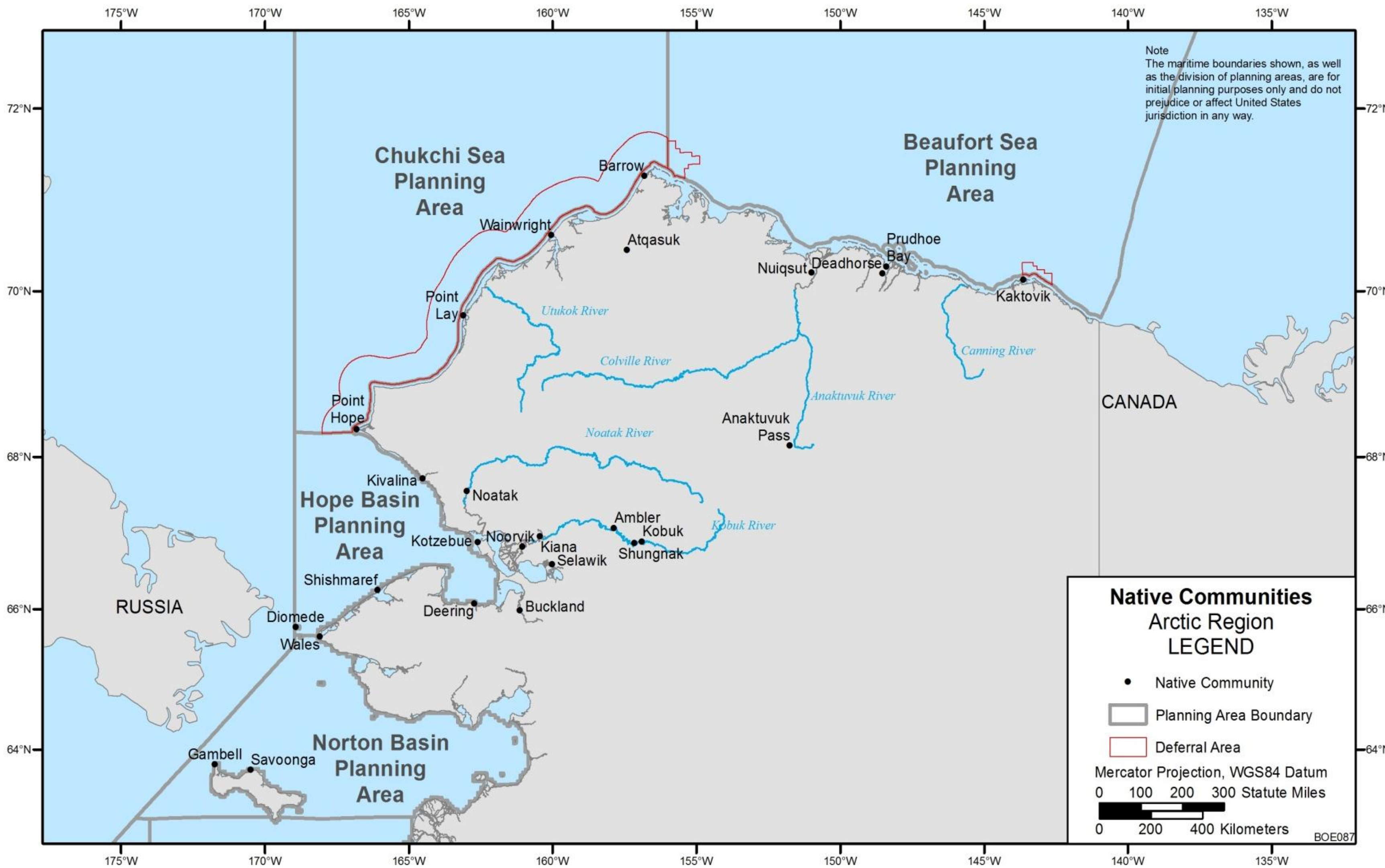

FIGURE 3.14.3-1 Native Communities around the Arctic Region

TABLE 3.14.3-1 North Slope Alaska Native Communities

Community	Population (2010)	Percent Alaska Native	Native Corporation	Federally Recognized Tribal Government	State Incorporated Municipality?
Anaktuvak Pass	325	83	Nunamiut Corp	Native Village of Anaktuvak Pass	Yes 1959
Atqasuk	233	92	Atqasuk Village Corp.	Native Village of Atqasuk	Yes 1982
Barrow	4,212	61	Ukpeagvik Iñupiat Corp.	Native Village of Barrow	Yes 1959
Kaktovik	239	89	Kaktovik Iñupiat Corp.	Native Village of Kaktovik	Yes 1971
Nuiqsut	402	87	Kuupik Village Corp.	Native Village of Nuiqsut	Yes 1975
Point Hope	674	90	Tikigaq (Tigara) Corp.	Native Village of Point Hope	Yes 1966
Point Lay	189	88	Cully Corp.	Native Village of Point Lay	No
Wainwright	556	90	Olgoonik Corp.	Native Village of Wainwright	Yes 1962

Source: ASRC 2012; DCRA 2011; North Slope Borough 2011; BIA 2010.

hunting, and fishing are important to the economy, and many residents with full- or part-time employment continue to hunt and fish for food (DCRA 2011; City of Barrow 2012). Wainwright is located on the coast 137 km (85 mi) southwest of Barrow. Alaska Natives make up 90% of its population, which is highly dependent on subsistence hunting, especially whaling. Most full-time employment is through the North Slope Borough. Traditional practices are preserved including the *nalukataq* festival that celebrates a successful spring whale hunt (DCRA 2011; ASRC 2012). Point Lay, located about 153 km (95 mi) farther down the coast, is another traditional Iñupiaq village heavily dependent on subsistence harvesting. Just under 90% of its population are Alaska Natives. One of the more recently established settlements in the North Slope Borough, it is unincorporated. Situated near the Kasugaluk Lagoon, it is a prime location for hunting beluga whales, but also participates in the bowhead hunt. Most year-round employment opportunities are through the borough government (DCRA 2011; ASRC 2012). Located on the Point Hope (*Tikweraq*) Peninsula, about 193 km (120 mi) to the southwest of Point Lay, Point Hope occupies one of the longest continuously occupied Iñupiaq areas in Alaska. The peninsula offers good access to marine mammals, and typical ice conditions allow easy boat launchings into open leads early in the spring whaling season. Most full-time employment is with North Slope Borough and city governments. Apart from subsistence hunting, residents supplement their income by the production of traditional craft items. The community has retained a strong traditional culture and is the site of the *oagrugvik* feast to celebrate a successful whale hunt (DRCA 2011; ASRC 2012). Atqasuk is located on the Meade River about 97 km (60 mi) south of Barrow. Reestablished in the 1970s, Atqasuk's population in 2010 was over 90% Alaska Native. Located well inland, it is still connected to the Beaufort Sea by the Meade River, and its inhabitants participate in both inland and marine subsistence activities (DCRA 2011; ASRC 2012). Subsistence harvesters from Barrow range as far as Atqasuk and beyond (SRBA 2010), and the two communities interact for subsistence purposes.

East of Barrow, the communities of Nuiqsut and Kaktovik are also subsistence-based. Nuiqsut is located on the western bank of the Colville River about 27 km (17 mi) from the Beaufort Sea and 219 km (136 mi) southeast of Barrow. It is only 13 km (8 mi) from the Alpine oil field, one of the major oil producing fields on the North Slope. About 87% of its 2010 population were Alaska Natives. With access to the Coleville delta, a rich source of subsistence resources, it is a traditional Iñupiaq village reliant on a variety of both marine and terrestrial resources. Even though located inland, bowhead whales are considered a vital resource for the community, and residents participate in the bowhead camp at Cross Island (SRBA 2010). Unemployment is high, with the school, borough services, a store, and the local Native corporation providing the most year-round employment (DCRA 2011; ASRC 2012). Kaktovik lies on the northern shore of Barter Island, the traditional bartering place between the Iñupiat and Inuit of Canada. The community is isolated, and Alaska Natives comprise about 89% of its population. Closer to the mountains than most coastal communities, the village harvests a wide variety of wild marine and terrestrial species. Other employment is mainly with the school, city, or the borough (DCRA 2011; ASRC 2012). Anaktuvak Pass is an inland Nunamiut community located in the central Brooks Range about 400 km (250 mi) southeast of Barrow. Hunting and trapping are important subsistence activities there. While not on the coast and directly affected by oil and gas development on the OCS, the community receives marine mammal subsistence foods from coastal communities through trade, bartering, and good will (Burris 2011).

Traditionally, the Iñupiat occupied small, independent, kin-based communities or camps dispersed across the North Slope and northwest Alaska. Communities were situated to take seasonal advantage of subsistence resources. Not all Iñupiaq communities practiced whaling themselves, but most were tied to whaling through ties of kinship and trade. For the most part, Iñupiat subsistence activities and whaling in particular were and continue to be group activities requiring cooperative efforts (SRBA 2010). Whaling crews, comprised of those pursuing whales on the water and their support teams on shore or ice, bound the society together (Spencer 1984; Burch 2006).

The arrival of Yankee commercial whalers in the mid- to late nineteenth century (Bockstoce 1995) prompted Iñupiaq settlement patterns to begin to change. The desire for Western trade goods drew an increasing number of Alaska Natives to the coast, where permanent communities remain today. In spite of significant population loss resulting from exposure to European diseases, the Iñupiat were slowly drawn into the world economy (Chance 1984; Spencer 1984). Even after Alaska was organized as a U.S. territory, Alaska Natives continued to outnumber immigrants from the United States until the military buildup during World War II. Communities on the Arctic coast remained relatively isolated from Western culture. Western influence increased when many Alaska Natives served in the Alaskan Territorial Guard and as a result of the military buildup on the North Slope during the Cold War, the construction of the Distant Early Warning (DEW) Line and the White Alice communication network, and the establishment of the Naval Arctic Research Laboratory (NARL) at Barrow in 1947. This military presence on the North Slope increased the exposure of the Iñupiat to industrialized Euro-American culture. Exposure to industrialization was significantly increased by the discovery of the Prudhoe Bay oil fields in 1967 and the construction of the TAPS along with the construction of the Dalton Highway connecting the North Slope to the south. The increasing presence of modern American culture has stressed traditional Native culture, yet the Iñupiat have managed to remain in and retain control over much of their traditional homeland. They have successfully incorporated modern technology into their subsistence way of life. Rifles and whale bombs have replaced spears and harpoons, aluminum skiffs are employed along with seal-skin boats (*umiak*) in the whale hunt, whaling crews use electronic global positioning and communication devices in the hunt, and snow machines and all-terrain vehicles (ATVs) have replaced dog teams and sleds (Roderick 2010; SRBA 2010). With increasing local control of land and resources has come a resurgence of traditional culture, as local and regional corporations and governments have supported the preservation of traditional languages and culture, and teaching of traditional values to the rising generation (Zellen 2008).

Local control has been increased through adaptation of Western business and governmental institutions to local values and needs. The municipal government of the North Slope Borough, established in 1972, is dominated by Alaska Natives. With ample resources from the taxation of the developing energy industry in the region, the North Slope Borough has been able to make marked improvements in municipal services and education. The Arctic Slope Regional Corporation (ASRC) is the regional corporation covering the Arctic coast. It is one of the more profitable regional corporations. It receives and distributes royalties from the development of mineral resources on Native lands. Half of the Alpine Oil Field lies on ASRC lands. ASRC has extended membership to Iñupiat born after 1971 and encourages the preservation and transmission of traditional Iñupiaq values including the maintenance of subsistence resources (ASRC 2012). As shown in Table 3.14.3-1, each Iñupiaq village is subject to multiple jurisdictions. Village corporations own the surface lands and further Iñupiat business interests. Local and regional municipal governments provide social services, public safety, education, and utilities. Tribal government councils, both village councils and the regional Iñupiat Community of Arctic Slope, are recognized by the Federal Government and have jurisdiction in the domestic affairs of tribal members and serve to transmit traditional culture to the next generation (Roderick 2010; Zellen 2008). The corporations tend to support tribal values, traditional culture, and subsistence activities. Through the North Slope Borough, Alaska Natives exert some measure of control over their traditional homeland beyond the lands retained by the Native corporations (Zellen 2008).

Based on past experience, many Alaska Natives approach their relationship with the Federal Government with some degree of mistrust. For much of the last century, the government either neglected or sought to acculturate Alaska Natives. Even today, Alaska Natives express skepticism that Native input at public hearings will have much, if any, effect on project decisions and the overall direction of the leasing program. In the past, Alaska Natives have expressed fear of losing or diluting their traditional culture as industrial development of oil fields results in an influx of outsiders (MMS 2007b).

3.14.3.1.2 Northwest Arctic Borough. The Northwest Arctic Borough lies south of the western portion of the North Slope Borough. Its 2010 population was 7,523, 81% of which were Alaska Natives (USCB 2011c). The Northwest Arctic Borough includes 11 communities, all of which are predominantly Alaska Native (Table 3.14.3-2). Seven of these are on the coast or are regularly involved in subsistence harvesting of marine resources.

Kotzebue is the administrative and communications hub of the Northwest Arctic Borough. As is the case with the North Slope Borough, Native Alaskans strongly influence local municipal government; however, unlike the North Slope Borough, most villages have no Native village corporations. These small communities found it difficult to support village corporations. All local corporations except the Kikiktagruk Iñupiat Corporation in Kotzebue merged with the NANA Regional Corporation in 1976 (Burch 1984a).

The traditional lifeway of the Alaska Natives living along and upstream from the Bering Sea and Kotzebue Sound was similar to that found on the North Slope. Mobile kin-based groups dispersed across the landscape taking seasonal advantage of a variety of wild food sources. Kin groups came together for a regional summer fair at Sheshalik, or combined in smaller groups in messenger feasts (Burch 1984b). Even after first European contact in 1816, they maintained their traditional lifestyle until mid-century. The latter half of the nineteenth century was a time of stress. Increased contacts with American and European traders lead to the introduction of disease, alcohol and firearms. This combined with a rapid decline in the caribou herd led to out-migration and depopulation of much of the Northwest Arctic Borough in the 1880s. A period of consolidation began in 1897 followed by a gold rush along the Noatak and Kobuk Rivers and Seward Peninsula. Newly established missions and schools and domesticated reindeer introduced in the first decades of the twentieth century became the foci for the Natives who continued for the most part to live in dispersed camps hunting and herding reindeer. The decline of the reindeer herds and the collapse of the fur market during the 1930s resulted in sedentarization in mission-school villages that have mostly persisted to the present day. An increase in caribou population and the arrival of a moose population in the 1940s and ‘50s, in combination with the maintenance of marine resources, allowed a subsistence lifeway to continue. By the 1960s, each community had a school, a store, a National Guard armory, and an all-weather airstrip and Natives lived on a combination of the subsistence harvest, welfare, and wage labor (Burch 1984a). The Northwest Alaska Native Association (NANA) was formed in 1966, as a not-for-profit organization to help northwest Iñupiat settle land claims issues. The association developed into an advocate for Alaska Native rights and continues today as the Maniilaq Association (Maniilaq Association 2003). After the passage of ANCSA in 1971, a separate for-profit corporation, NANA Regional Corporation, was formed in 1972 and Natives in the area began to have increased control of the development of the area (NANA 2010). NANA worked to develop resources, such as the Red Dog Mine. The Northwest Arctic Borough was established in 1986. Currently, the economy of the Northwest Arctic Borough relies on a combination, of subsistence harvesting, employment in the government sector, mining, other commercial ventures, and commercial fishing. Each of the villages along the coast has at least one inhabitant with a commercial fishing permit, while Kotzebue is home to 115 permitees (DCRA 2011). The borough’s inland communities, Ambler, Kiana, Kobuk, Noatak, Noorvik, Selawik, and Shungnak (Figure 3.14.3-1), lie mostly on rivers or estuaries and are tied to the coast through their reliance on anadromous fish resources, exchange relationships with coastal communities, and in some cases participation in the marine subsistence harvest.

TABLE 3.14.3-2 Northwest Arctic Borough Alaska Native Communities

Community	Population (2010)	Percent Alaska Native	Native Corporation	Federally Recognized Tribal Government	State Incorporated Municipality?
Ambler	276	85	Merged with NANA	Native Village of Ambler	Yes 1971
Buckland	416	95	Merged with NANA	Native Village of Buckland	Yes 1966
Deering	122	87	Merged with NANA	Native Village of Deering	Yes 1970
Kiana	361	90	Merged with NANA	Native Village of Kiana	Yes 1964
Kivalina	374	96	Merged with NANA	Native Village of Kivalina	Yes 1969
Kobuk	148	90	Merged with NANA	Native Village of Kobuk	Yes, 1973
Kotzebue	3,201	74	Kikiktagruk Iñupiat Corporation	Native Village of Kotzebue	Yes 1958
Noatak	514	95	Merged with NANA	Native Village of Noatak	No
Noorvik	668	88	Merged with NANA	Noorvik Native Community	Yes 1964
Selawik	868	85	Merged with NANA	Native Village of Selawik	Yes, 1974
Shungnak	261	94	Merged with NANA	Native village of Shungnak	Yes 1967

Source: DCRA 2011; Burch 1984a.

For all of the Northwest Arctic Borough communities, subsistence activities are the most significant food source and subsistence practices are essential to their economies, culture, and social structure. Subsistence practices are an integral part of the Kotzebue lifeway; however, Kotzebue is also the service and transportation hub of the Northwest Arctic Borough, and more opportunity for employment in the government sector, the NANA Regional Corporation, and the Maniilaq Association is available. Commercial fishing also plays an important economic role. The other smaller communities within the Northwest Arctic Borough, located around the Kotzebue Sound, are Kivalina, Deering, and Buckland. Within these communities, marine resources form a large part of the subsistence harvest. Kivalina and Kiana are the only communities within the Northwest Arctic Borough who hunt the bowhead whale. Kivalina residents also harvest bearded seals, beluga whales, and walrus. Deering and Buckland marine mammal subsistence harvests include beluga whales and seals. These communities also rely on saltwater fish, waterfowl, moose, and small mammals (DCRA 2011).

More than 75% of the population in each of the Kotzebue Sound communities are Alaska Natives (Table 3.14.3-2). Kivalina, Deering, and Buckland rely heavily on subsistence activities for their livelihood. Available year-round sources of income include jobs in the public sector (schools, city), health clinics, local stores, handicrafts, the Red Dog Mine, the Maniilaq

Association, the NANA Regional Corporation, tribal council, and the airlines. Kotzebue Sound is part of the Hope Basin Planning Area, and although oil and gas exploration is not included in the Hope Basin Planning Area in this five-year plan, the marine resources these communities rely on migrate through the Chukchi and Beaufort Seas seasonally, exposing them to the effects of oil and gas development there. Thus, these communities have the potential to be affected by oil and gas development in the neighboring Chukchi Sea Planning Area (see 4.4.13.3). .

The communities of Noatak, Noorvik, and Kiana are located east of Kotzebue Sound along rivers that flow into Hotham Inlet or Kotzebue Sound. These communities rely on the harvest of wild anadromous and freshwater fish species, waterfowl, moose, caribou, small mammals, and berries for subsistence (DCRA 2011). More than 85% of the population in each of these communities are Alaska Natives. Other year-round jobs include working for the school districts, local stores, and health care. Residents of Noorvik and Noatak find seasonal summer work either in Kotzebue, with the Bureau of Land Management (BLM), firefighting, or with the Red Dog Mine. Noatak residents also travel to fish camps during the summer (DCRA 2011).

The four inland Northwest Arctic Borough communities are Selawik, Shungnak, Ambler, and Kobuk. More than 85% of the population in each of these communities are Alaska Natives. These communities rely mainly on subsistence resources from the streams, lakes, mountains, and forests. Freshwater fish, caribou, moose, bear, and waterfowl are important parts of their subsistence harvests. Year-round employment opportunities include working for the school districts, tribal governments, city governments, local stores, health care institutions, and the production of handicrafts. Seasonal work includes employment with the BLM, mining, and construction (DCRA 2011).

3.14.3.1.3 Bering Strait Communities. Farther south are four more subsistence-dependent communities that participate in the whale hunt: Wales, Diomede, Gambell, and Savoonga (Table 3.14.3-3). These communities are located on or near the Bering Strait through which migrating whales must pass to reach their wintering locations in the Bering Sea and their summering locations in the Canadian Beaufort Sea. Located on the tip of the Seward Peninsula, Wales has a strong traditional Kinugmuit whaling culture, still preserved in songs, dances, and customs (DCRA 2011; Kawerak 2009; Braund and Langdon 2011). Located on Little Diomede Island in the Bering Strait, the Ingalikmiut village of Diomede is believed to have been the site of a spring whaling camp for the last 3,000 years. Diomede is almost entirely dependent on subsistence hunting, in marine waters and on the mainland, but is also a center of trade in walrus ivory (DCRA 2011; Kawerak 2009; Braund and Langdon 2011). Gambell and Savoonga are Yup'ik villages located on St. Lawrence Island in the northern Bering Sea, where whales that migrate through the Chukchi and Beaufort Seas over winter. When ANCSA was passed in 1971, Gambell and Savoonga decided not to participate and instead opted for title to the 0.460 million ha (1.136 million ac) of land in the former St. Lawrence Island Reserve. The island is jointly owned by Savoonga and Gambell. These communities are subsistence based with over 80% of their diet coming from subsistence resources. Commercial fishing, seafood processing, tourism, and handicrafts also contribute to the economies, and Savoonga considers itself the Walrus Capitol of the World. They are the southernmost subsistence bowhead whaling

TABLE 3.14.3-3 Bering Strait Whaling Communities

Community	Population (2010)	Percent Alaska Native	Native Corporation	Federally Recognized Tribal Government	State Incorporated Municipality?
Diomede	107	92	Diomede Native Corporation	Native Village of Diomede	Yes 1970
Gambell	677	96	Sivuqaq, Incorporated	Native Village of Gambell	Yes 1963
Savoonga	704	95	Kukulget, Incorporated	Native Village of Savoonga	Yes 1969
Wales	154	85	Wales Native Corporation	Native Village of Wales	Yes 1964

Source: DCRA 2011.

communities in Alaska, taking bowhead, grey whales, and beluga (DRCA 2011; Downs and Calloway 2008).

3.14.3.1.4 The Russian Chukchi Coast. Oil and gas activities on the OCS could also affect communities to the east of the Chukchi and Bering Seas located in Russia. The indigenous Chukotan peoples on the eastern shore of the Chukchi Sea are citizens of the Chukotsky Autonomous Okrug. Important coastal lagoons and near-shore subsistence harvest areas for beluga, gray, and bowhead whales; as well as other marine mammals and seabirds could be affected by a large oil spill. The concept of subsistence harvesting as known in Alaska does not exist on the Russian side of the sea, however local native leaders and activists are in support of indigenous concerns and initiatives. The North Slope Borough has cooperated with the Eskimo Society of Chukotka to aid in reestablishing whaling traditions and to help facilitate the gray whale harvest (MMS 2008b).

On the Russian side, the Arctic tundra region starting at East Cape and extending 200 mi west includes the coastal indigenous communities of Naukan (population 350); Uelen (population 678); Inchoun (population 362); Chegitun (a seasonal subsistence camp); Enurmino (population 304); Neshkan (population 628); Alyatki (a seasonal subsistence camp); Nutpel’men (population 155); and Vankarem (population 186). The former seasonal hunting and fishing sites of Naukan, Chegitun, and Alyatki may have been reoccupied. Uelen, Inchoun, Enurmino, Neshkan, Nutpel’men, and Vankarem are permanent indigenous settlements where subsistence hunting and fishing occur year-round. Both Naukan and Uelen are important areas for hunting polar bears. The area west of Inchoun, including the communities of Enurmino and Neshkan, was particularly hard hit by socioeconomic disintegration during the collapse of the Soviet Union in the 1990s (MMS 2008b)

Historically, there were a number of indigenous settlements in the region from Vankarem west and north to Cape Billings. In general, there has been a trend toward repopulating settlements (and reoccupying seasonal hunting and fishing camps) abandoned earlier due to forced relocation by the Soviet government into larger urban and centralized communities. Repopulation also has occurred to exploit natural food sources, as subsidies from Moscow to support employment and infrastructure have disappeared. The coastal settlements westward from Vankarem are Rigol (population unknown); Mys Shmidta (Cape Shmidt; population 717); Rypkarpyy (population 915); Polyarnyy (population unknown); Pil'gyn (population unknown); Leningradskii (population 835); Billings (Cape Billings; population 272); and Ushakovskoe (population 8) on Wrangel Island. Of all these named settlements, only Ushakovskoe is known to still have functioning subsistence-harvest practices. Many names that still appear on maps of the region are historical villages that no longer exist and, in some cases, they may be small family camps where a few Native inhabitants live on a seasonal basis (MMS 2008b).

3.14.3.2 Subsistence

The majority of permanent residents of the Arctic and Bering Sea coasts are Alaska Natives. For them, many subsistence activities are group activities that further core values of community, kinship, cooperation, and reciprocity. Current regulations define subsistence use as "the customary and traditional use by rural Alaska residents of wild renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools of transportation; for making and selling handicraft articles out of inedible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade" (FSMP 2010). Section 109 of the MMPA applies the same definition explicitly to the subsistence harvesting of marine mammals.

Priority for subsistence harvesting in land management is expressed in ANILCA, passed by Congress in 1980. Similar State legislation was struck down as violating the Alaska constitution, which guarantees equal access to fish, wildlife, and waters for all State residents. ANILCA applies only to Federal lands (excluding the OCS).

Subsistence resources on Federal lands and navigable waters along the coast are managed by the Federal Subsistence Board (FSB). The FSB has determined that all communities on Alaska's North Slope and Kotzebue Sound are, with the exception of the Prudhoe Bay area, qualified subsistence users. Alaska Native communities would also qualify under the more restrictive customary and traditional use determination of eligibility. *Customary and traditional use* means "a long established, consistent pattern of use, incorporating beliefs and customs transmitted from generation to generation" (FSMP 2010).

While a subsistence lifestyle is a rural preference and not confined to Alaska Natives in rural communities, subsistence is inextricably intertwined with Alaska Native culture and is key to cultural identity. The harvest and consumption of wild resources are only the most visible aspects of a complex set of behaviors and values that extend far beyond the food quest. Kinship, sharing, and subsistence resource use behaviors (such as preparation, harvest, processing, consumption, and celebration) are inseparable. Beyond dietary benefits, subsistence resources provide materials for personal and family use, and the sharing of resources helps maintain traditional family organization.

Subsistence is a central focus of North Slope and Northwest Arctic Borough personal and group cultural identity (MMS 2007b, 2008b). Subsistence activities provide cultural identity, social integration and solidarity, and diet that Alaska Natives view as more healthy (BOEMRE 2011c–f). Many of the most important subsistence resources are found in or near the sea and are thus potentially subject to the effects of oil and gas exploration, production, and any spills on the continental shelf. The cultural value placed on subsistence harvesting and whaling in particular is found throughout the North Slope and in northwestern Alaska. For example, the CEO of the ASRC describes himself as a part-time subsistence hunter (ASRC 2012). Subsistence has been described as the "organizing concept for the North Slope Borough." The North Slope Borough has been described as "the most organized, strongest, and best-funded subsistence economy in Alaska" (MMS 2007b). Within the North Slope Borough and Northwest Arctic Borough, both subsistence activities and wage economic opportunities are highly developed and highly interdependent. Since money is needed to purchase resources, such as rifles, ammunition, fuel, snow machines, ATVs, boats, and motors, to most effectively harvest resources, Native communities most active in subsistence activities tend to also be very involved in the wage economy (MMS 2007b).

In general, subsistence foods consist of a wide range of fish and game products that have substantial nutritional benefits. They tend to be rich in nutrients and low in fats. In addition to health benefits, there are social and cultural benefits to subsistence food harvesting and sharing (MMS 2007b). Marine mammals are culturally most important even in villages where caribou or fish supply more meat. Bowhead whale meat is most preferred, and seal oil is a necessary adjunct to meals based on the sea harvest (MMS 2008b). Subsistence species supply more than meat. Skins and furs go into the production of clothing and *umiat*. Bone, baleen, and ivory provide raw materials for handicrafts.

The subsistence harvest plays an important role in all Native communities of the North Slope and northwest Alaska. However, each community has its unique harvest pattern and preferences. Table 3.14.3-4 provides information on the subsistence harvest by hunters and fishers from the villages of Barrow, Nuiqsut, and Kaktovik (SRBA 2010). Table 3.14.3-5 provides a fuller listing of species reported as harvested by communities along the Beaufort and Chukchi Seas. Table 3.14.3-6 provides a listing of species reported harvested by Northwest Arctic Borough communities Subsistence harvesting follows a seasonal pattern constrained by changes in climate and by the migration patterns of whales, fishes, birds, and terrestrial mammals such as caribou. A recent study of subsistence harvesting patterns in Beaufort Sea communities suggests that subsistence marine harvesting can occur anywhere along the coast, but tends to be concentrated in areas directly offshore from the villages and regularly used whaling camps, such as Cross Island where the village of Nuiqsut stages its fall bowhead hunt (SRBA 2010). Most seaward harvesting occurs within 40 km (25 mi) of shore but may extend to as much as three times that distance depending on the conditions of ice and sea. Preference is given to locations where returning harvesters do not have to fight against the currents to bring their harvest home (SRBA 2010).

The bowhead whale hunt is the most iconic of the Iñupiaq subsistence harvesting activities. The whaling crew consists of a captain, a harpooner, and other hunters (Spencer 1984). Whaling captains are influential figures both economically and socially in

TABLE 3.14.3-4 Important Subsistence Species Harvested from Kaktovik, Nuiqsut, and Barrow[a]

Marine Mammals	
Bowhead whale	Taken in spring and fall migrations; mostly within 32–40 km (20–25 mi) of the coast, but as far as 80 km (50 mi). Primarily for food.
Bearded seal	Taken in summer on ice mostly within 40 km (25 mi) of the coast, but as far out as 80 km (50 mi). Skins used for *umiak* construction by Barrow whalers. Seal oil is an important part of the diet.
Ringed seal	Taken year-round. Formerly used to feed sled dogs.
Walrus	As opportunity arises. Mostly in summer and fall on ice within 40 km (25 mi), as far out as 120 km (75 mi).
Terrestrial Mammals	
Caribou	A major meat source taken year-round, but primarily in summer, mostly inland but in summer hunted by boat along the coast.
Wolves and wolverines	Inland during winter.
Fish	
Broad white fish	Mostly summer and fall; major fish source along coast and in rivers.
Arctic cisco	Mostly summer and fall; along coast and in rivers.
Arctic char/Dolly varden	Mostly late summer/early fall along coast and in rivers.
Waterfowl	
Geese	In spring and fall, mostly inland but as far as 80 km (50 mi) offshore.
Eider	On ice in spring and fall mostly within 40 km (25 mi) of shore, but as far as 64 km (40 mi).

[a] The species listed here were the objects of mapped subsistence harvesting from three villages near the Beaufort Seas. It is not a complete inventory of species harvested from those villages.

Source: SRBA 2010.

Iñupiat communities, and crew members may be drawn from both coastal and inland communities. Bowhead whales are harvested during both the spring and fall in Barrow and Wainwright, and during the spring migration in Point Hope and Point Lay. Nuiqsut and Kaktovik only harvest bowhead whale in the fall. Most Western Arctic Stock bowheads migrate annually from wintering areas in the northern Bering Sea on the Bering Shelf north of Navarin Canyon through the Chukchi Sea, where most calving occurs, in the spring to summer in the Beaufort Sea and Amundsen Gulf in Canada’s Northwest Territories (Quakenbush et al. 2010a) (see Section 3.8.1.3.1). Their distribution is governed primarily by prey and ice densities. Some animals remain in the eastern Chukchi and western Beaufort Seas during the summer. In September to mid-October, bowheads head west out of the Beaufort Sea into the Chukchi Sea. They often rest and feed in Camden Bay (Galginaitis 2010; Quakenbush and Huntington 2010). Their migratory path is less confined than in the spring. Some head for Wrangel Island while others migrating later follow the coast of Alaska southward (MMS 2008b; NMFS 2011j). Their migration patterns thus take them past whaling villages on islands in the Bering Sea, along the coast of the Northwest Arctic Borough, and along the shore of the North Slope Borough. Traditionally, whaling crews have headed out from some villages during both the spring and fall

TABLE 3.14.3-5 Reported Subsistence Use at Arctic Coast Alaska Native Villages[a]

			Native Villages						
Resource	Iñupiaq Name	Scientific Name	Point Lay	Point Hope	Wainwright	Barrow	Atqasuk	Nuisqut	Kaktovik
Marine Mammals									
Bearded seal	Ugruk	*Erignathus barbatus*	X[b]	X	X	X	X	X	X
Ringed seal	Natchiq	*Phoca hispida*	X	X	X	X	X	X	X
Spotted seal	Qasigiaq	*Phoca largha*	X	—[b]	X	X	X	X	X
Ribbon seal	Qaigulik	*Phoca fasciata*	X	—	X	X	X	—	—
Beluga whale	Quilalugaq	*Delphinapterus leucas*	X	X	X	X	X	—	X
Bowhead whale	Agviq	*Balaena mysticetus*	X	X	X	X	X	X	X
Polar bear	Nanuq	*Ursus maritimus*	X	X	X	X	X	X	X
Walrus	Aiviq	*Odobenus rosmarus*	X	X	X	X	X	—	X
Terrestrial Mammals									
Caribou	Tuttu	*Rangifer tarandus*	X	X	X	X	X	X	X
Moose	Tuttuvak	*Alces alces*	—	X	X	X	X	X	—
Brown bear	Aklaq	*Ursus arctos*	X	—	X	X	X	X	—
Dall sheep	Imnaiq	*Ovis dalli*	—	X	X	X	X	X	X
Muskox	Uminmaq	*Ovibus moschatus*	—	—	X	—	X	X	X
Arctic fox (blue)	Tigiganniaq	*Alopex lagopus*	X	—	X	X	X	X	X
Red fox	Kayuqtuq	*Vulpes fulva*	X	—	X	X	X	X	—
Porcupine	Qinagluk	*Erethizon dorsatum*	—	—	X	X	—	—	—
Ground squirrel	Siksrik	*Spermophilus parryii*	X	—	X	X	X	X	X
Wolverine	Qavvik	*Gulo gulo*	X	—	X	X	X	X	X
Weasel	Itigiaq	*Mustela erminea*	—	—	X	—	X	X	—
Wolf	Amaguk	*Canis lupus*	X	—	X	X	X	X	X
Marmot	Siksrikpak	*Marmota broweri*	X	—	X	—	X	X	X
Fish									
Salmon	Species not reported	Species not reported	X	X	X	X	X	X	—
Chum	Iqalugruaq	*Oncorhynchus keta*	X	X	X	X	X	X	—
Pink (humpback)	Amaqtuuq	*O. gorbuscha*	—	X	X	X	X	X	—
Silver (coho)	Iqalugruaq	*O. kisutch*	—	X	—	—	—	—	—
Whitefish	Aanaakliq	*Coregonus* spp.	—	X	X	X	X	—	—
Round whitefish	Aanaakliq	*Prosopium cylindraceum*	—	—	X	X	—	—	—
Broad whitefish	Aanaakliq	*Coregonus nasus*	—	—	X	X	X	X	X
Humpback whitefish	Pikuktuuq	*C. clupeaformis*	—	—	X	X	X	X	—
Least cisco	Iqalusaaq	*C. sardinella*	—	—	X	X	X	X	X
Bering and Arctic cisco	Qaaktaq	*C. autumnalis*	X	—	X	X	X	X	X

TABLE 3.14.3-5 (Cont.)

Resource	Iñupiaq Name	Scientific Name	Native Villages: Point Lay	Point Hope	Wainwright	Barrow	Atqasuk	Nuisqut	Kaktovik
Other Freshwater Fish									
Arctic grayling	Sulukpaugaq	*Thymallus arcticus*	X	X	X	X	X	X	X
Arctic char	Iqalukpik	*Salvelinus alpinus*	X	X	X	X	X	X	X
Burbot (ling cod)	Tittaaliq	*Lota lota*	—	—	X	X	X	X	—
Lake trout	Iqaluaqpak	*Salvelinus namaycush*	—	—	X	X	X	X	—
Northern pike	Siulik	*Esoxlucius*	—	—	X	X	—	—	—
Other coastal fish									
Rainbow smelt	Ilhuagniq	*Osmerus morda*	X	—	X	X	—	X	—
Arctic cod	Iqalugaq	*Boreogadus saida*	—	—	X	X	X	X	X
Tomcod	Uugaq	*Eleginus gracilis*	X	X	X	X	X	—	X
Flounder	Nataagnaq	*Liopsetta glacialis*	—	X	—	—	—	—	X
Birds									
Snowy owl	Ukpik	*Nyctea scandiaca*	—	X	X	—	—	X	—
Red-throated loon	Qaqsraupiagruk	*Gavia stellata*	*X*	—	X	X	—	—	—
Tundra swan	Qugruk	*Cygnus columbianus*	—	—	X	—	X	X	X
Eider	Species not reported	Species not reported	—	X	—	—	—	—	X
Common eider	Amauligruaq	*Somateria mollissima*	X	—	X	X	X	X	—
King eider	Qinalik	*Somateria spectabilis*	X	—	X	X	X	X	—
Spectacled eider	Tuutalluk	*Somateria fischeri*	X	—	X	X	—	—	—
Steller's eider	Igniqauqtuq	*Polysticta stelleri*	X	—	X	X	—	—	—
Other ducks	Qaugak	Species not reported	—	X	X	X	X	—	—
Pintail	Kurugaq	*Anas acuta*	X	—	X	—	X	—	X
Long-tailed duck	Aaqhaaliq	*Clangula hyemalis*	*X*	—	X	X	X	—	X
Surf scoter	Aviluktuk	*Melanitta perspicillata*	—	—	X	X	—	—	—
Geese	Species not reported	Species not reported	—	X	—	—	—	—	X
Brant	Niglingaq	*Branta bernicla* n.	X	X	X	X	X	X	X
White-fronted goose	Niglivialuk	*Anser albifrons*	X	—	X	X	X	X	X
Snow goose	Kanuq	*Chen caerulescens*	X	—	X	X	X	X	X
Canada goose	Iqsragutilik	*Branta canadensis*	X	—	X	X	X	X	X
Ptarmigan	Aqargiq	*Lagopus* spp.	—	—	X	X	X	X	X
Willow ptarmigan	Nasaullik	*L. lagopus*	X	—	X	X	—	—	—
Other Resources									
Berries	Species not reported	Species not reported	X	X	X	X	X	X	
Cranberry	Kimminnaq	*V. vitisidaea*	—	—	X	X	—	—	—
Salmonberry	Aqpik	*Rubus spectabilis*	—	—	X	X	—	—	—
Bird eggs	Mannik	Species not reported	X	X	X	X	X	—	—
Gull eggs	Species not reported	Species not reported	—	—	X	—	X	—	—
Goose eggs	Species not reported	Species not reported	—	—	X	—	X	—	—
Eider eggs	Species not reported	Species not reported	—	—	X	X	X	—	—
Greens/roots	Species not reported	Species not reported	—	—	X	X	X	X	—

TABLE 3.14.3-5 (Cont.)

			Native Villages						
Resource	Iñupiaq Name	Scientific Name	Point Lay	Point Hope	Wainwright	Barrow	Atqasuk	Nuisqut	Kaktovik
Wild rhubarb	Qunulliq	*Oxyric digyna*	—	—	X	X	—	—	—
Wild chives	Quagaq	*Allium schoenoprasum*	—	—	X	X	—	—	—
Clams	Imaniq	Species not reported	X	—	X	X	—	—	—
Crab	Puyyugiaq	Species not reported	X	X	X	—	X	X	—

[a] This table is based on a variety of surveys conducted at different times between 1987 and 2006. The underlying data were not uniformly collected. The range of resources used in some communities, particularly Point Hope, may be underreported.

[b] X = Reported; — = Not reported.

Sources: ADFG 2011e; MMS 2008b.

migrations while other villages have confined themselves to a single migration; however, the AEWC reports that whaling patterns along the Chukchi Sea coast are changing rapidly and more villages are whaling during both migrations (Aiken 2012). In the North Slope Borough, Barrow, Wainwright, Point Hope, and Point Lay crews hunt in both the spring and fall, while crews from Nuiqsut and Kaktovik whale only in the fall (Galginaitis 2010).

In the Northwest Arctic Borough, Kivalina and Kiana take occasional bowheads in the spring if they follow nearshore leads, areas of open water resulting from the breaking up of ice flows, but more frequently hunt belugas, as do Noatak, Buckland, Deering, and Wales (MMS 2008b; ADFG 2011e). Farther south, the Bering Strait villages of Wales and Diomede also pursue bowheads, as do the villages of Savoonga and Gambell on Saint Lawrence Island in the Bering Sea. Proximity to the Russian territorial waters limits Diomede’s ability to pursue and land bowheads. Changes in the ice in recent years has led the St. Lawrence villages to change from a spring to a winter bowhead hunt (AEWC 2011). The St. Lawrence villages also hunt gray whales (Braund and Langdon 2011; Downs and Calloway 2008; DRCA 2011; Kawerak 2009; Noongwook et al. 2007).

The smaller beluga whales also migrate past Northwest Arctic Borough and North Slope Borough villages. Belugas spend the winter in the Bering Sea. In the spring, belugas migrate to coastal estuaries, bays, and rivers. The eastern Chukchi Sea stock gather in the nearshore waters of Kotzebue Sound and Kasegaluk Lagoon, near Point Lay, and Omalik Lagoon in June and July. Between July and September, females tend to remain near the Beaufort and Chukchi Seas shelf break, while the males head for deeper water. In September and October, they migrate west, returning to the Bering Sea (NMFS 2011j) providing additional opportunities for whalers. Point Lay has traditionally hunted only beluga whales in the spring, but now hunts bowheads in the spring. In the spring, when whales are migrating toward the pole, Barrow and Point Hope

TABLE 3.14.3-6 Reported Subsistence Harvest by Coastal Northwest Arctic Borough Communities[a]

		Native Villages[b]										
Resource	Scientific Name	Kivalina	Noatak	Kiana	Selawik	Kotzebue	Noorvik	Buckland	Kobuk	Deering	Ambler	Shungnak
Marine Mammals							X					
Seal	Species not reported	X	X	X	—	X	—	X	—	X	—	—
Bearded seal	*Erignathus barbattus*	X	X	X	—	X	—	—	—	X	—	—
Ringed seal	*Phoca hispida*	X	X	X	—	X	—	—	—	X	—	—
Spotted seal	*Phoca largha*	X	X	X	—	X	—	—	—	X	—	—
Ribbon seal	*Phoca Fasciata*	X	—	—	—	X	—	—	—	X	—	—
Beluga whale	*Delphinapterus leucas*	X	X	X	—	X	—	X	—	X	—	—
Bowhead whale	*Balaena mysticetus*	X	—	X	—	—	—	—	—	—	—	—
Polar bear	*Ursus maritimus*	X	—	X	—	X	—	—	—	X	—	—
Walrus	*Odobenus rosmarus*	X	X	X	—	X	—	—	—	X	—	—
Terrestrial Mammals												
Caribou	*Rangifer tarandus*	X	X	X	X	X	X	—	X	X	X	X
Moose	*Alces alces*	X	X	X	X	X	X	—	X	X	X	X
Brown bear	*Ursus arctos*	X	X	X	X	X	X	—	X	X	X	X
Black bear	*Ursus americanus*	—	X	X	X	X	X	—	X	—	X	X
Muskox	*Ovibus moschatus*	X	X	X	—	—	—	—	—	—	—	—
Dall sheep	*Ovis dalli*	X	X	X	X	X	—	—	X	—	X	X
Arctic Fox (blue)	*Alopex lagopus*	X	X	X	X	—	—	—	X	X	X	X
Red fox	*Vulpes fulva*	X	X	X	X	X	—	—	X	X	X	X
Porcupine	*Erethizon dorsatum*	X	—	X	—	X	—	—	—	X	—	—
Ground squirrel	*Spermophilus parryii*	X	—	—	X	X	—	—	X	X	X	X
Wolverine	*Gulo gulo*	X	X	X	X	X	X	—	—	X	X	—
Wolf	*Canis lupus*	X	X	X	X	X	X	—	—	X	—	—
Beaver	*Castor canadensis*	X	X	X	X	X	—	—	X	X	X	X
Land otter	*Lutra Canadensis*	X	X	X	—	X	—	—	—	X	—	—
Marten	*Martes sp.*	—	X	X	X	X	—	—	X	—	X	X
Muskrat	*Ondatra zibethicus*	—	X	X	X	X	—	—	X	X	X	X
Fish												
Salmon	Species not reported	X	X	X	X	X	—	X	X	X	X	X
Chum	*Oncorhynchus keta*	—	X	X	X	X	—	—	X	X	X	X
Pink (humpback)	*O. gorbuscha*	X	X	X	—	X	—	—	—	X	—	—
Silver (coho)	*O. kisutch*	X	X	X	—	X	—	—	—	X	—	—
Chinook	*O. tshawytscha*	X	X	X	X	X	—	—	—	X	—	—
Sockeye	*O. nerka*	—	X	X	—	X	—	—	—	X	—	—
Whitefish	*Coregonus sp.*	X	X	—	X	X	—	—	X	—	X	X
Broad whitefish	*Coregonus nasus*	—	—	—	X	X	X	—	X	—	X	X
Humpback whitefish	*C. clupeaformis*	—	—	—	X	X	—	—	X	—	X	X
Least cisco	*C. sardinella*	—	X	X	X	X	—	X	X	—	—	X
Bering and Arctic cisco	*C. sutumnalis*	X	—	—	—	X	—	X	—	X	—	—

TABLE 3.14.3-6 (Cont.)

Resource	Scientific Name	Native Villages[b] Kivalina	Noatak	Kiana	Selawik	Kotzebue	Noorvik	Buckland	Kobuk	Deering	Ambler	Shungnak
Other Freshwater Fish												
Arctic grayling	*Thymallus arcticus*	X	X	X	—	X	—	—	X	X	X	X
Arctic char	*Salvelinus alpinus*	X	X	X	—	X	—	—	—	—	—	—
Burbot (ling cod)	*Lota lota*	X	X	X	—	X	—	—	—	—	—	—
Dolly Varden Trout	*Salvelinus malma malma*	X	X	X	X	X	—	X	X	X	X	X
Lake Trout	*Salvelinus namaycush*	—	X	X	X	—	—	—	—	—	X	—
Northern Pike	*Esoxlucius*	—	X	X	X	X	—	—	X	—	X	X
Sheefish	*Stenodus leucicthyes*	X	X	X	X	X	—	—	—	—	X	X
Sucker	Species not reported	—	—	—	X	—	—	X	X	—	X	X
Mudshark/Spiny Dogfish	*Squalus acanthias*	—	—	—	X	—	—	X	X	—	X	X
Other Coastal Fish												
Rainbow smelt	*Osmerus morda*	X	—	X	—	X	X	X	—	X	—	—
Arctic cod	*Boreogadus saida*	X	—	—	—	X	—	X	—	X	—	—
Tomcod (Saffron cod)	*Eleginus gracilis*	X	—	—	—	X	—	X	—	X	—	—
Herring	*Clupea sp.*	—	—	—	—	X	—	—	—	X	—	—
Halibut	*Hippoglosus sp.*	—	—	X	—	X	—	—	—	—	—	—
Flounder	*Liopsetta glacialis*	—	—	—	—	X	—	X	—	X	—	—
Birds												
Snowy owl	*Nyctea scandiaca*	X	X	—	X	—	X	X	X	X	X	X
Ptarmigan	*Lagopus sp.*	X	X	X	X	X	X	X	X	X	X	X
Grouse	Species not reported	X	X	X	X	X	X	X	X	X	X	X
Murres	Multiple species	X	—	—	X	—	X	X	X	X	X	X
Waterfowl	Species not reported	X	X	X	X	X	X	X	X	X	X	X
Loon	Multiple Species	—	—	—	X	—	X	X	X	X	X	X
Red-throated loon	*Gavia stellata*	—	—	—	X	X	X	X	X	X	X	X
Gull	Multiple species	—	—	—	X	—	X	X	X	X	X	X
Tundra swan	*Cygnus columbianus*	X	X	X	X	X	X	X	X	—	X	X
Eider	Species not reported	X	—	—	X	X	X	X	X	X	X	X
Common eider	*Somateria mollissima*	X	—	—	X	—	—	X	X	X	X	X
King eider	*Somateria spectabilis*	X	—	—	X	—	X	X	X	X	X	X
Spectacled eider	*Somateria fischeri*	—	—	—	X	—	X	X	X	X	X	X
Pintail	*Anas acuta*	X	X	—	X	X	X	X	X	X	X	X
Long-tailed duck	*Clangula hyemalis*	—	X	—	X	—	X	X	X	X	X	X
Scoters	Multiple species	—	X	—	X	—	X	X	X	X	X	X
Bufflehead	Bucephala albeola	—	—	—	X	—	X	X	X	X	X	X
Canvasback	*Aythya valisineria*	—	—	—	X	—	X	X	X	X	X	X
Harlequin	*Histrionicus histrionicus*	—	—	—	X	—	X	X	X	X	X	X
Mallard	*Anas platyrhynchos*	X	X	—	X	X	X	X	X	X	X	X
Merganser	Multiple species	—	X	—	X	—	X	X	X	X	X	X
Scaup	Multiple species	—	—	—	X	—	X	X	X	X	X	X
Teal	Multiple species	—	—	—	X	—	X	X	X	X	X	X

TABLE 3.14.3-6 (Cont.)

		Native Villages[b]										
Resource	Scientific Name	Kivalina	Noatak	Kiana	Selawik	Kotzebue	Noorvik	Buckland	Kobuk	Deering	Ambler	Shungnak
Wigeon	Multiple species	—	X	—	X	—	X	X	X	X	X	X
Other ducks	Species not reported	X	X	X	X	X	X	X	X	X	X	X
Geese	Species not reported	X	X	X	X	X	X	X	X	X	X	X
Brant	*Branta bernicla n.*	X	X	X	X	X	X	X	X	X	X	X
White-fronted goose	*Answer albifrons*	X	X	X	X	X	X	X	X	X	X	X
Snow goose	*Chencaerulescens*	X	X	X	X	X	—	X	X	X	X	X
Canada goose	*Branta Canadensis*	X	X	X	X	X	X	X	X	X	X	X
Sandhill crane	*Grus canadensis*	—	—	—	X	—	X	X	X	X	X	X
Snipe	Multiple Species	—	—	—	X	—	—	X	—	X	X	X
Plover	Multiple Species	—	—	—	X	—	X	X	X	X	X	X
Auk	Multiple Species	—	—	—	X	—	X	X	X	X	X	X
Bird eggs	Species not reported	X	X	X	X	X	X	X	X	X	X	X
Gull eggs	Species not reported	X	X	—	X	X	X	X	X	X	X	X
Goose eggs	Species not reported	X	X	X	X	—	X	X	X	X	—	X
Duck eggs	Species not reported	X	X	X	X	—	X	X	X	X	X	X
Eider eggs	Species not reported	X	—	—	X	—	X	X	X	X	X	X
Other Resources												
Berries	Species not reported	X	X	X	X	X	—	—	—	—	X	X
Cranberry	*V. vitisidaea*	X	X	X	—	—	—	—	—	—	—	—
Salmonberry	*Rubus spectabilis*	X	X	X	—	—	—	—	—	—	—	—
Blueberry	*Vsccimium sp.*	X	X	X	X	—	—	—	X	—	X	X
Blackberry	*Rubus sp.*	X	X	—	—	—	—	—	—	—	—	—
Crowberry	*Empetrum sp.*	—	—	X	—	—	—	—	—	—	—	—
Greens/roots	Species not reported	X	X	X	X	X	—	—	X	—	X	X
Wild rhubarb	*Oxyric digyna*	X	X	X	X	—	—	—	X	—	X	X
Wild celery	*Vallisneria Americana*	X	X	—	X	—	—	—	X	—	X	X
Eskimo potato	Species not reported	X	X	X	—	—	—	—	—	—	—	—
Stinkweed	Species not reported	X	X	X	—	—	—	—	—	—	—	—
Sourdock	*Rumex crispus*	X	X	X	—	—	—	—	—	—	—	—
Willow leaves	Species not reported	X	X	X	X	—	—	—	X	—	X	X
Clams	Species not reported	—	—	X	—	X	—	—	—	—	—	—
Crab	Species not reported	X	X	X	—	X	—	—	—	—	—	—
Shrimp	Species not reported	—	—	—	—	X	—	—	—	—	—	—

[a] This table is based primarily on data from the Alaska Department of Fish and Game. Subsistence harvest data are not uniformly reported. Data for Noorvik, Buckland, Deering, Amble, Kobuk, Selawikand, and Shungnak are mostly confined to migrating bird species. The date next to the community name is the date of the subsistence harvest data designated as “most representative” on the ADFG subsistence website.

[b] X = Reported; — = Not reported.

Sources: ADFG 2011e; ASRC 2012; MMS 2008b.

crews bring light seal skin *umiat* to leads in the ice. Aluminum and fiberglass skiffs are used in open water for the fall harvest, which targets younger, smaller whales (MMS 2008b). In addition to boat crews, there are camp crews on ice or shore that provide food and other support to the whalers. Some crews may hunt ringed seals to provide camp food. Crews help one another in hauling and butchering their take. Whale meat and blubber are distributed according to cultural norms relating to the roles played in the hunt and support, kin and other social ties, and the values placed on generosity and the social responsibility to provide for widows and others unable to hunt. With the *Nalukataq* festival, an important Iñupiaq ceremony, the community the marks the end of the whale hunt (SRBA 2010).

In recent public meetings, Alaska Natives in the Arctic have voiced concerns regarding past and potential effects of oil and gas exploration on subsistence resources and are concerned that traditional knowledge of subsistence resources is not regularly taken into account. They express concerns that noise, particularly from seismic testing, disturbs whales and other sea mammals, causing them to avoid the noise source and stay farther out to sea, making the whale hunt in small craft more difficult and more dangerous, and exposing the whalers to rougher seas, more shifting ice, shipping traffic, and stronger offshore currents (see also Quakenbush and Huntington 2010a). They are concerned that any oil spill, even if rare, could result in harm to subsistence species and could cause others to avoid the area. They also feel that existing pipelines on land have altered caribou migration patterns (BOEMRE 2011c–f).

Alaska Natives have also voiced concerns over increased shipping facilitated by the opening of the Northwest Passage, since shipping noise may interfere with marine subsistence hunts. They are currently adapting to later ice formation in the fall and earlier ice retreat in the spring. The lengthening of the ice-free season allows for more shipping to support the oil and gas industry, community resupply, or tourism. With increased traffic, there is a tendency to stretch the ice-free season even longer by the use of ice breakers. It follows that shipping plays a role and has an impact on the formation of sea ice not only on its own, but also through combining with other drivers of change (e.g., climate change) (Arctic Council 2009). Annual sea ice formation is critical for Alaska Natives as well as marine fish and mammals. Alaska Natives are very concerned by the loss of multiyear ice, which forms a sturdy platform of sufficient depth to allow for camping, butchering whales, and hunting along sea ice routes that remain passable for hunters as well as for the migratory game they pursue (Arctic Council 2009).

3.15 ENVIRONMENTAL JUSTICE

Executive Order 12898, ‘‘Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations’’ (59 FR 7629), formally requires Federal agencies to incorporate environmental justice as part of their missions. Environmental justice is defined by the Executive Order as “the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, State, local, and tribal programs and policies." Specifically, it directs them to address, as appropriate, any disproportionately high and adverse human health or environmental effects of their actions, programs, or policies on minority and low-income populations.

The analysis of the impacts of offshore oil and gas development projects on environmental justice issues follows guidelines described in the Council on Environmental Quality's (CEQ's) *Environmental Justice Guidance under the National Environmental Policy Act* (CEQ 1997). The analysis method has three parts: (1) a description of the geographic distribution of low-income and minority populations in the affected area is undertaken; (2) an assessment is conducted to determine whether oil and gas activities would produce impacts that are high and adverse; and (3) if impacts are high and adverse, a determination is made as to whether these impacts would disproportionately affect minority and low-income populations.

Construction and operation of offshore oil and gas development projects could affect environmental justice if any adverse health and environmental impacts resulting from either phase of development are significantly high and if these impacts disproportionately affect minority and low-income populations. If the analysis determines that health and environmental impacts are not significant, there can be no disproportionate impacts on minority and low-income populations. In the event impacts are significant, disproportionality would be determined by comparing the proximity of any high and adverse impacts with the location of low-income and minority populations.

A description of the geographic distribution of minority and low-income groups in the affected area was based on demographic data from the 2000 Census (USCB 2011g,h). The following definitions were used to define minority and low-income population groups:

- **Minority.** Persons are included in the minority category if they identify themselves as belonging to any of the following racial groups: (1) Hispanic, (2) Black (not of Hispanic origin) or African American, (3) American Indian or Alaska Native, (4) Asian, or (5) Native Hawaiian or Other Pacific Islander.

  Beginning with the 2000 Census, where appropriate, the census form allows individuals to designate multiple population group categories to reflect their ethnic or racial origins. In addition, persons who classify themselves as being of multiple racial origin may choose up to six racial groups as the basis of their racial origins. The term minority includes all persons, including those classifying themselves in multiple racial categories, except those who classify themselves as not of Hispanic origin and as White or "Other Race" (USCB 2009a).

- **Low-Income.** Individuals who fall below the poverty line. The poverty line takes into account family size and age of individuals in the family. In 1999, for example, the poverty line for a family of five with three children below the age of 18 was $19,882. For any given family below the poverty line, all family members are considered as being below the poverty line for the purposes of analysis (USCB 2009b).

The CEQ guidance proposed that minority and low-income populations be identified where either (1) the minority or low-income population of the affected area exceeds 50% or (2) the minority or low-income population percentage of the affected area is greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

This PEIS applies both criteria in using the U.S. Census Bureau data, wherein consideration is given to the minority and population that is both greater than 50% and 20 percentage points higher than in the State as a whole (the reference geographic unit).

3.15.1 Gulf of Mexico

The analysis of environmental justice issues associated with the development of offshore oil and gas development facilities considered impacts within the 129 counties that constitute the 23 Labor Market Areas (LMAs) located along the GOM coast, defined on the basis of inter-county commuting patterns using a method suggested by Tolbert and Sizer (1996). Analysis at the county level for each LMA allows the inclusion of impacts that would potentially occur at the various facilities and infrastructure directly and indirectly associated with the construction and operation of offshore oil and gas developments.

The data in Table 3.15.1-1 show the minority and low-income composition of the total population located within the LMA counties along the GOM coast based on 2000 Census data and CEQ guidelines. Individuals identifying themselves as Hispanic or Latino are included in the table as a separate entry. However, because Hispanics can be of any race, this number also includes individuals identifying themselves as being part of one or more of the population groups listed in the table.

A large number of minority and low-income individuals are located in the LMA counties along the GOM coast. Within the combined LMA counties in each State along the GOM coast, the percentage of the total population classified as minority varies between 23.6% in Mississippi and 55.8% in Texas. The number of minority individuals in the LMAs combined exceeds 50% of the total population in Texas, but the number of minority individuals does not exceed the State average by 20 percentage points or more in any of the combined LMA counties in each State; thus, there is a minority population only in the LMA counties in Texas, based on 2000 Census data and CEQ guidelines. The number of low-income individuals in the combined LMA counties in each State does not exceed the State average by 20 percentage points or more and does not exceed 50% of the total population in any of the LMA counties; thus, there are no low-income populations in any of the combined LMA counties in any of the five States.

In the Alabama portion of the GOM coast, more than 50% of the population is classified as minority in Wilcox County, northeast of Mobile, where the low-income population is more than 20 percentage points higher than the State average. In Florida, more than 50% of the population is classified as minority in Gadsden County, west of Tallahassee, and in Miami-Dade County. In Louisiana, Iberville Parish, to the southwest of Baton Rouge; St. Helena Parish, to

TABLE 3.15.1-1 Gulf Coastal Region Minority and Low-Income Populations, 2000

Population Segment	Alabama	Florida	Louisiana	Mississippi	Texas	Total
Total Population	599,405	8,955,931	3,382,809	458,674	6,939,834	20,336,653
White, Non-Hispanic	401,434	5,297,536	2,116,976	350,300	3,068,665	11,234,911
Hispanic or Latino	7,790	2,002,650	91,720	9,761	2,584,430	4,696,351
Non-Hispanic or Latino minorities	190,181	1,655,745	1,174,113	98,613	1,286,739	4,405,391
One Race	184,863	1,520,754	1,143,483	93,437	1,215,951	4,158,488
Black or African American	173,361	1,341,280	1,073,021	83,554	942,898	3,614,114
American Indian or Alaskan Native	4,751	23,724	17,988	1,778	16,203	64,444
Asian	6,193	135,194	47,637	7,470	247,451	443,945
Native Hawaiian or Other Pacific Islander	124	3,574	793	234	2,254	6,979
Some Other Race	434	16,982	4,044	401	7,145	29,006
Two or More Races	5,318	134,991	30,630	5,176	70,788	246,903
Total Minority	197,971	3,658,395	1,265,833	108,374	3,871,169	9,101,742
Percent Minority	33.0%	40.8%	37.4%	23.6%	55.8%	44.8%
Low-Income	101,236	1,200,105	611,737	65,629	1,194,653	3,173,360
Percent Low-Income	16.9%	13.4%	18.1%	14.3%	17.2%	15.6%

Sources: USCB 2011g, h.

the northeast of Baton Rouge; and West Feliciana Parish, to the north of Baton Rouge, have populations in which more than 50% is classified as minority. The case is similar in Orleans Parish, in central New Orleans, and St. James Parish, to the west of New Orleans.

In Texas, more than 50% of the population in Brooks County, southwest of Corpus Christi, is classified as minority, where the low-income population is more than 20 percentage points higher than the State average. Elsewhere in the Corpus Christi area, in Duval County, Jim Wells County, Kenedy County, Kleburg County, Nueces County, and Refugio County, more than 50% of the population is classified as minority. In the Brownsville area, Harris and Starr Counties have more than 50% of the population classified as minority, and have a low-income population that is more than 20 percentage points higher than the State average. The low-income population in Starr County also exceeds 50% of the total population. In Cameron and Willacy Counties, more than 50% of the population is classified as minority. In the Houston area, in Fort Bend County, Harris County, and Waller County, more than 50% of the population is classified as minority.

There are 81 counties and parishes in the GOM coast region that contain oil-related infrastructure, including platform fabrication yards, port facilities, shipyards, shipbuilding yards, support facilities, transport facilities, waste management facilities, pipelines, pipe coating yards, natural gas processing facilities, natural gas storage facilities, refineries, and petrochemical facilities (MMS 2006b). Thirty-nine counties contain more than five facilities. Ten counties (or parishes in Louisiana) have a high concentration of oil-related infrastructure (50 or more facilities). Of these 10 counties, 5 have higher minority percentages than their respective State average. These counties include Mobile, Alabama; St. Mary, Louisiana; and Galveston, Harris, and Jefferson, Texas. Two of the 10 high infrastructure concentration counties also have higher poverty rates than their respective State rate. St. Mary Parish, Louisiana, and Jefferson, Texas, have higher poverty rates than the average poverty rate in their States. Fifteen counties (or parishes in Louisiana) are considered to have a medium concentration of oil-related infrastructure (15–49 facilities). Five of these counties have a higher poverty rate than the mean rate in their States: Iberia, Orleans, and Vermillion, Louisiana; and Nueces and San Patricio, Texas. Eight of the 15 medium concentration counties also have higher minority populations than their State average. These counties include Hillsborough, Florida; East Baton Rouge, Iberia, Orleans, and St. James, Louisiana; and Calhoun, Nueces, and San Patricio, Texas.

3.15.1.1 Oil Spills and Human Health Effects

The potential health effects of oil spills include effects related to worker safety, toxicological effects in workers and community members, and mental health effects emanating from social and economic disruption (Goldstein et al. 2011). Toxicological effects include chemical effects such as respiratory and dermal irritation, headaches, eye irritation, nausea, and dizziness. The short-term and long-term natures of these impacts are dependent on the contaminants involved and the characteristics of the exposed populations.

Crude oil contains many different hydrocarbons, and the relative amounts of trace metal and sulfur content can vary significantly (Goldstein et al. 2011). Some crude oil components can cause respiratory, hepatic, renal, endocrine, neurologic, hematologic effects at high doses after a threshold concentration has been exceeded. Mutagenic effects, on the other hand, can result from a single molecular DNA alternation (Goldstein et al. 2011). Carcinogens in crude oil include benzene, which is present at a concentration of between 1 and 6%, and PAHs, which are present at lower, variable concentrations. Benzene and PAHs are also present from the offshore controlled burning of crude oil (Goldstein et al. 2011). Benzene is a known hematotoxicant and hematocarcinogen (Goldstein and Witz 2009). Benzene affects the circulating blood cells in workers exposed to concentrations below current occupational health standards (Lan et al. 2004), and has reproductive and developmental effects (Xing et al. 2010). Benzene is only a risk close to an oil source; it appears to evaporate, with other VOCs, before reaching shore, meaning that community exposures are relatively minimal (Morita et al. 1999). PAHs are more persistent, and can cause skin and lung cancer, in addition to reproductive and neurological effects (Department of Health and Human Services 2010). All organic components of crude oil may contribute to acute short-term effects, but are unlikely to be present in sufficient concentrations to cause long-term health effects (Goldstein et al. 2011). During summer months VOCs are converted to ozone, which can cause respiratory irritation, including asthma (Eggleston 2007; Leikauf 2002).

Surfactants used as dispersants during the DWH event contained petroleum distillate, propylene glycol, and sulfonic acid salt, which contained dioctyl sodium sulfosuccinate, or stool softener (Goldstein et al. 2011). Another surfactant used was 2-butoxyethnol, known to cause hepatic angiosarcoma and hemolytic anemia in rodents (Gualtieri et al. 2003). Exposure to trace quantities of metals such as arsenic, chromium, lead, and nickel could be a toxicological concern, and statistical evidence of association with endocrine and genotoxic effects after spills has been established (Perez-Cadahia et al. 2008). Water monitoring by the USEPA did not find positive evidence of benzene or PAHs in water samples, and air monitoring did not find evidence of VOCs except for trace levels of naphthalene (USEPA 2011f).

Approximately 52,000 workers responded to the DWH event (NIOSH 2011), and a number of symptoms were reported in evaluations undertaken by NIOSH, including chemically induced upper respiratory illnesses, throat and eye irritation, headaches, dizziness, nausea, and vomiting (Goldstein et al. 2011). Longer-term health effects in workers include pulmonary abnormalities (Meo et al. 2009), bronchial hyperresponsiveness, acute and persistent genotoxic effects, and endocrine effects (Aguilera et al. 2010).

The DWH event affected many communities that had health disparities compared to others in the United States, and that were also still suffering from the impacts of Hurricane Katrina (Goldstein et al. 2011). Louisiana, for example, is currently ranked among the most severely affected States in the nation in terms of rates of infant death, death from cancer, premature death, death from cardiovascular disease, children in poverty, and violent crime (United Health Foundation 2009). Children are particularly at risk for effects of environmental exposure; they breathe more air per unit of body mass, detoxify chemicals less effectively, and may suffer from accidental exposure more readily than adults (Goldstein et al. 2011). No evidence has been found regarding the risk of asthma or impaired respiratory function in children (Crum 1993), although indoor exposure may pose additional risk for children with asthma (Barbeau et al. 2010). The effects of crude oil components, such as higher-weight molecular compounds, are unknown (Xu et al. 2005).

Although symptoms of deterioration in mental health following an oil spill are reflected in increases in calls to mental health and violence hotlines (Yun et al. 2010), assessments of factors leading to deterioration in mental health, lack of adequate baseline data, study design, and delay in study initiation have limited the validity of studies on mental health impacts (Savitz et al. 2008). In addition, in the case of the DWH event, many communities were still recovering from Hurricane Katrina, complicating the response by community members to the DWH event (Goldstein et al. 2011). After Katrina, the severity and frequency of mental health symptoms seems to have increased, but there has also been a decline in the use of mental health services and the use of prescribed medication (Kessler et al. 2008). The Centers for Disease Control reported that 50% of adults in New Orleans had psychological stress, while post-traumatic stress disorder was prevalent among first responders, leading to alcohol and domestic abuse (Goldstein et al. 2011). Another survey found that in 2005–2006, 48% of returning students in the main parishes affected by Katrina had mental health symptoms, a rate that had only dropped to 30% by 2009–2010, indicating that repeated trauma increases vulnerability to deterioration in mental health (Kronenberg et al. 2010).

Minority communities may have specific concerns related to their psychosocial welfare. Working-age Vietnamese residents in New Orleans had numerous unresolved problems in the aftermath of Katrina, and then 1 yr later, including inadequate access to healthcare (Vu et al. 2009). Suspension of free health services led to the reemergence of disparities between racial and ethnic groups (Do et al. 2009). Symptoms of post-traumatic stress disorder were found in this population group, especially among members with a low degree of acculturation and high exposure to floods, together with long stays in emigration transit camps (Norris et al. 2009). As was the case for small, isolated Alaskan native communities with the *Exxon Valdez* spill (Goldstein et al. 2011), it is likely that the DWH event could lead to higher levels of depression, generalized anxiety disorder, post-traumatic stress disorder, violence, and other psychological problems among minority communities.

3.15.2 Alaska – Cook Inlet

The analysis of environmental justice issues associated with the development of offshore oil and gas development facilities considered impacts for the south central Alaska region, which includes Anchorage Municipality, Kenai Peninsula Borough, Kodiak Island Borough, and Matanuska-Susitna Borough.

The data in Table 3.15.2-1 show the minority and low-income composition of the total population located within the south Alaska region based on 2000 Census data and CEQ guidelines. Individuals identifying themselves as Hispanic or Latino are included in the table as a separate entry. However, because Hispanics can be of any race, this number also includes individuals identifying themselves as being part of one or more of the population groups listed in the table.

A large number of minority and low-income individuals are located in the south central Alaska region. However, the number of minority individuals in each of the boroughs does not exceed 50% of the total population, and the number of minority individuals does not exceed the State average by 20 percentage points or more in any of the boroughs; thus, there is no minority population in the south central Alaska region, based on 2000 Census data and CEQ guidelines. The number of low-income individuals in the three boroughs does not exceed the State average by 20 percentage points or more and does not exceed 50% of the total population; thus, there are no low-income populations in any of the boroughs.

3.15.2.1 Consumption of Fish and Game

Subsistence is “an activity performed in support of the basic beliefs and nutritional need of the residents of the borough and includes hunting, whaling, fishing, trapping, camping, food gathering, and other traditional and cultural activities” (ADNR 1997). Subsistence fishing is for direct personal or family consumption. Many thousands of Alaskans participate in subsistence fishing and processing, and it is an important element of Alaska’s social and cultural heritage. For a more complete discussion of subsistence and its cultural and nutritional importance, see Section 3.5.5.6. In rural Alaska, subsistence fisheries harvest produces about 230 lb per person per year (MMS 2006b). Although important as a source of food, subsistence fisheries are only about 2% of the fisheries harvest. Commercial fisheries account for about 97% of the wild harvest, and sport fisheries the remaining 1% (MMS 2006b).

TABLE 3.15.2-1 South Central Alaska Region Minority and Low-Income Populations, 2000

Population Segment	Anchorage Municipality	Kenai Peninsula	Kodiak Island	Matanuska-Susitna	South Central Alaska Region Total
Total population	260,283	49,691	13,913	59,322	383,209
White, Non-Hispanic	181,982	42,263	8,001	51,175	283,421
Hispanic or Latino	14,799	1,087	848	1,485	18,219
Non-Hispanic or Latino Minorities	63,502	6,341	5,064	6,662	81,569
One Race	50,119	4,549	4,439	4,195	63,302
Black or African American	14,667	220	129	398	15,414
American Indian or Alaskan Native	18,326	3,644	1,997	3,168	27,135
Asian	14,208	471	2,193	401	17,273
Native Hawaiian or Other Pacific Islander	2,335	85	105	66	2,591
Some Other Race	583	129	15	162	889
Two or More Races	13,383	1,792	625	2,467	18,267
Total Minority	78,301	7,428	5,912	8,147	99,788
Percent Minority	30.1	14.9	42.5	13.7	26.0
Low-Income	18,682	4,861	901	6,419	30,863
Percent Low-Income	7.3	10.0	6.6	11.0	8.2

Sources: USCB 2011g, h.

Subsistence fishing and hunting are an important part of the economies of rural Alaskan communities, providing sources of food, clothing, and employment. While the harvest of animals, birds, shellfish, and plants only represents 2% of the fish and game harvested annually (MMS 2006b), the subsistence harvest contains about 35% of the caloric requirements of the rural population. In some areas of Alaska, notably the interior and western areas, subsistence products provide up to 50% of the daily requirement (MMS 2006b; Bersamin et al. 2007). Approximately 2% of the daily requirement of the urban population is met through subsistence activities.

Although it is difficult to establish the economic importance of subsistence harvests because the consumption and exchange of subsistence products do not occur in the marketplace, estimates of their importance have been made based on the dollar value of replacing subsistence products in the market. Using a replacement value of $3/lb, the replacement value of subsistence harvests in rural Alaska is estimated to be $131 million annually; at $5/lb, the replacement value of these products would be $219 million. In Alaska as a whole, the replacement value of subsistence products is estimated to be between $160 million and $267 million (MMS 2006b).

3.15.2.2 Oil Spills and Subsistence

Subsistence activities of Native communities could be affected by accidental oil spills, with the potential health effects of oil spill contamination of subsistence foods being the main concern (MMS 2009). After the 1989 *Exxon Valdez* spill, testing of subsistence foods for hydrocarbon contamination between 1989 and 1994 revealed very low concentrations of petroleum hydrocarbons in most subsistence foods, and the U.S. Food and Drug Administration concluded that eating food with such low levels of hydrocarbons posed no significant risk to human health (Hom et al. 1999). Human health risks can be reduced through timely warnings about spills, forecasts about which areas may be affected, and even evacuations of people and avoidance of marine and terrestrial foods that may be affected. Avoidance of shellfish, which accumulates hydrocarbons, would be recommended, and Federal and State agencies with health care responsibilities would have to sample the food sources and test for possible contamination.

Whether subsistence users will use potentially tainted foods would depend on the cultural "confidence" in the purity of these foods. Based on surveys and findings in studies of the *Exxon Valdez* spill, Natives in affected communities largely avoided subsistence foods as long as the oil remained in the environment. Perceptions of food tainting and avoiding use lingered in Native communities after the *Exxon Valdez* spill, even when the testing agency maintained that consumption posed no risk to human health (MMS 2006b).

The assessment and communication of the contamination risks of consuming subsistence resources following an oil spill is a continuing challenge to health and natural resource managers. After the *Exxon Valdez* spill, analytical testing and rigorous reporting procedures failed to convince many subsistence consumers because test results were often inconsistent with Native perceptions about environmental health. According to MMS (2006b), a discussion of subsistence food issues must be cross-disciplinary, reflecting a spectrum of disciplines from toxicology, to marine biology, to cultural anthropology, to cross-cultural communication, to ultimately understanding disparate cultural definitions of risk perception itself. Any effective discussion of subsistence resource contamination must understand the conflicting scientific paradigms of Western science and traditional knowledge in addition to the vocabulary of the social sciences in reference to observations throughout the collection, evaluation, and reporting processes. True restoration of environmental damage "must include the re-establishment of a social equilibrium between the biophysical environment and the human community" (Picou and Gill 1996; Field et al. 1999; Nighswander and Peacock 1999; Fall et al. 1999). Since 1995, subsistence restoration resulting from the Exxon Valdez oil spill has improved by taking a more comprehensive approach by partnering with local communities and by linking scientific methodologies with traditional knowledge (Fall et al. 1999; Fall and Utermohle 1999).

3.15.3 Alaska – Arctic

The analysis of environmental justice issues associated with the development of offshore oil and gas development facilities considered impacts for the Arctic region, which consists of the North Slope Borough and the Northwest Arctic Borough.

The data in Table 3.15.3-1 show the minority and low-income composition of the total population located within the Arctic region, based on 2000 Census data and CEQ guidelines. Individuals identifying themselves as Hispanic or Latino are included in the table as a separate entry. However, because Hispanics can be of any race, this number also includes individuals identifying themselves as being part of one or more of the population groups listed in the table.

A large number of minority and low-income individuals are located in the Arctic region. The number of minority individuals in the region exceeds 50% of the total population, and the number of minority individuals exceeds the State average by 20 percentage points; thus, there is a minority population in the Arctic region, based on 2000 Census data and CEQ guidelines. The number of low-income individuals in the region does not exceed the State average by 20 percentage points or more and does not exceed 50% of the total population; thus, there are no low-income populations in the region.

3.15.3.1 Health Status of Alaska Native Communities

The potential health effects of oil spills, including effects related to worker safety, toxicological effects in workers and community members, and mental health effects emanating from social and economic disruption, can disproportionately impact Alaska Native and other minority population groups and low-income communities (see Section 3.15.1.1). In addition to the impacts of oil spills, there are more general concerns regarding the possible health effects of oil and gas exploration and development on minority and low-income populations. Based on analysis undertaken for MMS, this section summarizes the current health status of the North Slope Iñupiat, the changes that have taken place over the past 50 yr, and the important determinants of public health in the North Slope communities, based on a series of meetings between the North Slope Borough and BOEM on this issue (MMS 2006b). Although specifically related to health issues in the North Slope Borough, many of the health issues identified in this section are also relevant to Alaskan Native populations in south central Alaska. "Health" is defined as "a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity" (MMS 2006b). The disease and mortality figures discussed are age-adjusted unless otherwise specified.

Alaska Native health has undergone profound changes over the last 50 yr, and the changes in health status among the Iñupiat residents of the North Slope mirrors Statewide trends in Alaska Native health status in many respects. Since 1950, infant mortality, overall mortality, and life expectancy have improved significantly, as has been the case in American Indian tribes throughout the United States. However, over the same time period, cancer, chronic diseases (such as diabetes, hypertension, and asthma), and social pathology have increased (MMS 2006b).

Much of the overall improvement in mortality figures is attributable to decreased rates of infectious diseases such as tuberculosis. In 1950, tuberculosis was the leading cause of death, causing over 45% of deaths; by 2000, the proportion of deaths caused by infection had fallen to 1.3%; life expectancy at birth had increased from 46.6 to 69 yr, and infant mortality had decreased from 90/100,000 to 9.5/100,000. The most rapid improvement in general health indicators occurred in the 1950s and 1960s. However, since 1979, health status has continued to

TABLE 3.15.3-1 Arctic Region Minority and Low-Income Populations, 2000

Population Segment	North Slope Borough	Northwest Arctic Borough	Arctic Region Total
Total Population	7,385	7,208	14,593
White, Non-Hispanic	1,228	878	2,106
Hispanic or Latino	175	57	232
Non-Hispanic or Latino Minorities	5,982	6,273	12,255
One Race	5,530	6,101	11,540
Black or African American	51	15	66
American Indian or Alaskan Native	4,982	5,919	10,901
Asian	435	64	499
Native Hawaiian or Other Pacific Islander	59	4	63
Some Other Race	3	8	11
Two or More Races	452	263	715
Total Minority	6,157	6,330	12,487
Percent Minority	83.4	87.8	85.6
Low-Income	663	1,243	1,906
Percent Low-Income	9.1	17.4	13.2

Sources: USCB 2011g, h.

improve based on general indicators, with a decline of roughly 20% in all-cause mortality (MMS 2006b).

Health improvements have been facilitated by a combination of region-wide increases in general socioeconomic status (a powerful determinant of health); improved housing, sanitation, and health care; and specific infection-control efforts. Since 1979, much of the continued improvement in mortality figures can be accounted for by decreasing fatality from injuries. Mortality from unintentional injury, the second leading cause of death in Alaska Natives, accounts for much of the more recent improvement, with a decline of roughly 40% between 1979 and 1998. Much of this change can be attributed to local health departments' injury prevention programs and the efficacy of local alcohol control and local prohibition ordinances (MMS 2006b).

Despite these improvements in overall mortality figures, significant health disparities remain, and cancer, social pathology, and chronic diseases are rapidly increasing. Health disparities between Alaska Natives and American Indians and the general U.S. population constitute one of the top priorities in current public health efforts. Life expectancy at birth for Alaska Natives remains significantly lower than for the general population (69 compared with 76 yr). Since 1979, Alaska Native mortality rates remain roughly 30% higher than the

U.S. population, and on the North Slope, overall mortality rates are 1.5 times higher than the U.S. population. Rates of assault, domestic violence, and unintentional and intentional (homicide and suicide) injury and death on the North Slope remain far higher than in the general U.S. population, despite the improvements noted above in unintentional injuries (MMS 2006b).

To understand the changes in Iñupiat health status and the reasons behind the current health disparities in general health indicators, it is useful to examine the prevalent health issues among the North Slope Iñupiat communities individually.

3.15.3.1.1 Cancer. Cancer has increased roughly 50% since 1969, and is now the leading cause of death on the North Slope. Three cancers — breast, colon, and lung — account for much of the overall increase. North Slope Alaska Natives have the highest incidence of cancer in Alaska, at 579/100,000. Cancer mortality rates for all Alaska Natives, including North Slope residents, at 303/100,000, are significantly higher than the U.S. rate of 163/100,000, a disparity of great concern to health care providers in the State (MMS 2006b).

A substantial percentage of the increase in cancer incidence, particularly for lung cancer, is attributable to smoking. There may be other, much less significant environmental factors at work as well, such as environmental contamination due to increases in industrialization, the use of locally generated electricity and of vehicles, and the adoption of highly insulated housing. Cancer mortality rates due to these factors are less well understood. The possible contribution of environmental factors such as contaminants in subsistence resources is of great concern to local residents, but does not likely constitute the sole or perhaps the most likely explanation. Current public health efforts focus on smoking cessation efforts, early detection, surveillance of carcinogens in subsistence foods, and curtailing exposure to known carcinogenic compounds as much as possible while discouraging their continued use (MMS 2006b).

3.15.3.1.2 Psychological and Social Problems. Alcohol and drug problems, accidental and intentional injury (a high percentage of which are associated with alcohol use), depression, anxiety, and assault and domestic violence are now highly prevalent in the North Slope Borough (as they are in many rural Alaska Native villages) and cause a disproportionate burden of suffering and mortality for these communities. Suicide rates among Alaska Natives have increased dramatically since 1960 (MMS 2006b). The prevalence of suicide on the North Slope in recent years has been estimated at roughly 45/100,000, more than four times the rate in the general U.S. population. Still more strikingly, the age distribution of suicide has shifted to become a phenomenon of youth; before 1960, it was exceedingly rare and generally occurred primarily among elderly individuals. The rate of suicide among young Iñupiat men in the Alaskan Arctic has been documented as high as 185/100,000, nearly 16 times the national rate (MMS 2006b).

Domestic violence and child abuse are also now generally acknowledged as epidemic problems in rural Alaska and, internationally, in other Arctic indigenous communities as well. Unprocessed arrest data from the U.S. Department of Health and Social Services in 2000–2003, for example, show rates of rape and assault 8–15 times the national rate (MMS 2006b).

Homicide rates have dropped more than 50% since 1979, but remain markedly higher than the U.S. population. Alcohol and substance abuse are thought to contribute substantially to the rates of these problems (MMS 2006b).

Research in circumpolar Inuit societies suggests that social pathology and related health problems, which are common across the Arctic, relate directly to the rapid sociocultural changes that have occurred over the same time period (MMS 2006b). In the North Slope Borough, suicide rates increased dramatically in the 1960s and 1970s, and since 1979 have remained relatively constant but dramatically higher than the overall U.S. rates.

3.15.3.1.3 Injury Rates. Injury — including unintentional (or accidental) injury, suicide, assault, and homicide — is the second leading cause of death on the North Slope. Accidental injury rates have declined 43% since 1979, but mortality from accidental injury remains 3.5 times more common for Alaska Natives than U.S. whites (MMS 2006b). Injury is the second leading reason for hospitalization, after childbirth. Figures from the Alaska Trauma Registry indicated that the hospitalization rate for injuries in the North Slope Borough was the highest in the State, at 141/10,000 residents, and over twice the State average. Alcohol has been estimated to be involved in up to 40% of injuries and traumatic deaths in Alaska Natives (MMS 2006b).

Unintentional injury rates are high in the North Slope, not only because of the challenges of life in Arctic Alaska, but also because of factors such as high rates of alcohol and substance abuse and risk-taking behavior in youth (MMS 2006b). Many public health officials in Alaska have speculated that many "accidental" injuries in younger people may actually reflect abnormal risk-taking or latent suicidal behaviors.

3.15.3.1.4 Diabetes and Metabolic Diseases. Diabetes, obesity, and related metabolic disorders were previously rare or nonexistent in the Iñupiat. Diabetes rates in the North Slope Borough are low compared with other Alaska Native groups — and extremely low compared with all American Indians — but have begun to climb quite rapidly (MMS 2006b). The prevalence of diabetes in the North Slope is estimated at only 2.4% compared with the U.S. rate of roughly 7%. However, between 1990 and 2001, the rate of diabetes climbed roughly 110%, nearly three times the rate of increase in the general U.S. population (MMS 2006b). Subsistence diets and the associated active lifestyle are known to be the main protective factors against diabetes. The increase in diabetes is felt to reflect increased use of store-bought food, and a more sedentary lifestyle, potentially against the backdrop of a baseline genetic susceptibility (MMS 2006b).

3.15.3.1.5 Cardiovascular Disease. Cardiovascular disease rates, the second leading cause of death in Alaska, are significantly lower in Alaska Natives than in U.S. non-Natives. In the North Slope Borough, recent mortality figures show death rates roughly 10% less than the U.S. population (MMS 2006b). However, as discussed above, many of the risk factors are increasing, and smoking rates are already extremely high (MMs 2006b). As in the case of diabetes, many public health researchers have explained the lower mortality from cardiovascular disease as stemming primarily from subsistence diets and the associated active lifestyle.

3.15.3.1.6 Chronic Pulmonary Disease. Chronic pulmonary disease mortality rates in Alaska Natives have climbed 192% since 1979. North Slope Borough residents have the highest mortality in the State from chronic lung diseases, at nearly three times the mortality rate for the United States (130/100,000 compared with 45/100,000) (MMS 2006b). As in the case of cancer, the primary reason for the disparate rates of increase and mortality in pulmonary disease is ascribed to the high smoking rates in the North Slope Borough. However, there may be environmental reasons for the rates of increase as well, such as air pollution generated by industrialization and changes in local energy use (see discussion on cancer above). Because there are no available data on local fine particulate concentrations, no data on hazardous air pollutants, and little data on intra-regional variation in other USEPA criteria pollutants, it is difficult to determine the possible contribution of these environmental factors.

In the United States in recent years, the field of public health has focused on efforts to explain and address health disparities between ethnic groups and social classes (MMS 2006b). That health disparities tend to accrue predominantly in minority and low-income populations is an indication of the vulnerability of these groups to outside societal-level influences on health status. An impressive body of data has demonstrated a direct association between measurable societal factors, which have been collectively termed the “social determinants of health” — including income inequity within a society, the “social gradient” (or disparities of social class), stress, social exclusion, decreasing social capital (the social support networks that provide for needs within a group or community), unemployment, cultural integrity, and environmental quality — and the incidence, prevalence, and mortality rates of many specific diseases. These disparities persist and can be dramatic, even after controlling for standard risk factors such as smoking rates, cholesterol and blood pressure levels, and overall poverty (MMS 2006b).

The determinants of health status in North Slope Iñupiat communities are complex and reflect a wide array of considerations, including genetic susceptibility, behavioral change, environmental factors, diet, and sociocultural inputs (MMS 2006b). Identifying the potential influences, or “determinants,” of health status is an essential step for public health programs seeking to address health disparities. State, regional, and village-specific influences on health and health behavior can be directly or indirectly associated with past oil and gas development on the North Slope. For example, modernization and socioeconomic change are common to all of rural Alaska, and are one of the dominant influences on the evolution of health status. As noted above, North Slope petroleum development provided the economic tax base that funded many of the programs and activities that define these changes in rural Alaska. The associations between these influences and oil and gas development can be very complex and indeterminate (MMS 2006b). For example, regional differences exist between the North Slope Borough and other rural regions, such as the Northwest Arctic Borough, in terms of family income and employment status, largely related to oil and gas taxation and employment opportunities that came into being not because of the oil development alone, but because of the establishment and policymaking of the North Slope Borough. Similarly, residents of the North Slope village of Nuiqsut have experienced socioeconomic changes related not only to the State and regional-level influences discussed above, but also from local social and economic influences of the petroleum industry from the Alpine oilfield such as profits of the Kuukpik Corporation, shifts in income distribution, oilfield-related employment, the increased presence of oil workers in the village, a new road connection to the Alaska road system, and changes in hunting patterns and the availability of game due to oil-related infrastructure (MMS 2006b).

Public testimony on prior NEPA-based onshore and offshore actions in the region has indicated a persistent concern that regional industrialization may be at the root of some of the human health disparities described above. For example, testifying in 2001 on MMS' Liberty draft EIS, Rosemary Ahtuangaruak, a former health aide who received advanced training as a physician's assistant, stated:

"Increased incidents of community social ills associated with rapid technological and social change cause problems with truancy, vandalism, burglary, child abuse, domestic violence, alcohol and drug abuse, suicide, and primarily the loss of self-esteem. This has materialized during transient employment cycles. The influx of construction workers brings their own problems to a village impacted by oil development activities already. Historically, from past experience, we know that the incidents of alcohol and drug use increase dramatically" (MMS 2006b).

Similarly, former North Slope Borough Mayor George Ahmaogak noted: "The benefits of oil development are clear — I don't deny that for a moment. The negative impacts are more subtle. They're also more widespread and more costly than most people realize. We know the human impacts of development are significant and long-term. So far, we've been left to deal with them on our own. They show up in our health statistics, alcohol treatment programs, emergency service needs, police responses — you name it" (MMS 2006b).

The health status of the North Slope Iñupiat people has improved significantly since the 1950s; however, significant new pathologies, most importantly cancer, cardiovascular and metabolic problems, and social pathology, have emerged during this period. The reasons for the improvements, the continuing disparities, and the new problems are very complex and originate in many different sources. However, while there is little definitive data linking degradation of environmental quality and local health impacts, and no data indicating specific health impacts of a particular oil and gas development project, a consideration of regional health data does allow for the recognition of risks associated with projects, and for the development of mitigation strategies. In general, the field of health impact assessment responds to concerns of environmental health impacts through efforts to control exposure to environmental contaminants rather than through attempts to identify specific increases in disease rates with specific exposures (MMS 2006b).

3.16 ARCHAEOLOGICAL AND HISTORIC RESOURCES

As defined in the Advisory Council on Historic Preservation (ACHP) regulations at 36 CFR 800.16, "historic property" means any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the *National Register of Historic*

Places (NRHP). The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the NRHP criteria. As used in this analysis, the more general term "cultural resources" also includes those historic resources not yet determined eligible for the NRHP.

Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA; 16 USC 470(f)) requires that Federal agencies such as BOEM take into account the effect of an undertaking under their jurisdiction on significant cultural resources. A cultural resource is considered significant when it meets the eligibility criteria for listing on the NRHP (36 CFR 60.4). The Section 106 process requires the identification of cultural resources within the area of potential effect of a Federal project, consideration of a project's impact on cultural resources, and the mitigation of adverse effects on significant cultural resources. The process also requires consultation with State Historic Preservation Officers (SHPOs), the ACHP, Native American tribes, and interested parties. In the case of oil, gas, and sulfur leases, BOEM has established regulations (e.g., 30 CFR 250.194) and issues guidance to lessees (e.g., Notice to Lessees [NTL] No. 2005-G07 and G10, NTL No. 2006-G07, NTL No. 2005-A03, NTL No. 2006-PO3) to ensure compliance with Section 106 of the NHPA and its implementing regulations in 36 CFR Part 800. The NTLs provide guidance on the regulations regarding archaeological discoveries and the conduct of archaeological surveys and identify specific OCS lease blocks with a high potential for containing cultural resources on the basis of previous studies.

3.16.1 Gulf of Mexico

3.16.1.1 Offshore Prehistoric Resources

The GOM region consists of approximately 2,600 km (1,600 mi) of coastline. Onshore cultural resources are highly varied in coastal areas. Prehistoric cultural resources range from small, temporary use sites to substantial permanent settlements ranging in age from the earliest known human occupation of the area, approximately 12,000 yr ago, through the post-contact period (e.g., the last several hundred years). It is estimated that the current water levels of the GOM were reached approximately 3,000 yr ago (Stright et al. 1999). Therefore, sites predating this period could be located under water.

Approximately 19,000 yr ago, during the late Wisconsinan glacial advance, much of the OCS constituted dry land, as the sea level was approximately 120 m (390 ft) lower than present levels. During the earliest period of uncontested human prehistoric populations in the GOM coast region (approximately 12,000 yr ago), the sea level would have been approximately 45 to 60 m (150 to 200 ft) lower than present (CEI 1982). The submerged area between the paleoshoreline (vicinity of the 45- to 60-m [150- to 200-ft] bathymetric contour) to the present-day shoreline would, therefore, have the potential to contain prehistoric sites. Studies conducted in the 1980s and 1990s confirmed that inundated former terrestrial archaeological sites do exist in the GOM (Dunbar et al. 1989; Anuskiewicz and Dunbar 1993). A growing body of information suggests that North America may have been populated much earlier than 12,000 yr ago (e.g., Waters et al. 2011). If an earlier date can be established for the settling of North America, the depth and extent of areas with the potential for inundated terrestrial sites could expand.

3.16.1.2 Offshore Historic Resources

From the historic period (1492 to present), offshore cultural resources primarily consist of numerous shipwrecks dating from as early as the sixteenth century. However, other historic structures can also be found offshore, such as the Ship Shoal Lighthouse. Literature searches can be completed for reported ship losses and known shipwrecks, but they offer only a partial understanding of the resources that may be present. It can be assumed that some percentage of the reporting is inaccurate, some locations were imprecisely recorded, some of the ships were badly broken up and widely dispersed during drift, and additional ship losses may not have been documented (e.g., the losses of small coastal fishing boats were largely unreported, and the regular reporting of other larger watercraft did not occur until the nineteenth century). Often there is only a record that a ship was lost in the GOM region.

The preservation potential of shipwrecks varies throughout the GOM. The preservation of shipwrecks is dependent on several factors including the level of sedimentation at a wreck site, the depth the wreck, the strength and extent of water current activity near a site, and the temperature of the water. Shipwrecks in areas with high sediment loads are expected to be better preserved. The sediment protects the sites from the effects of severe storms and wood-eating shipworms. The coasts of Texas, Louisiana, Mississippi, and Alabama are likely to have sufficient sediment load to preserve shipwrecks. However, as a result of differences in sedimentation rates, it is anticipated that preservation would be slightly better off the Mississippi/Alabama coast than off the Louisiana coast due to the greater amount of sediment being discharged and deposited from the Mississippi River (CEI 1977).

Deepwater shipwrecks are expected to have a moderate to high preservation potential. Studies conducted in 2004 and 2008 for BOEM suggest that the high level of preservation in deep water is partially attributable to these areas being low-energy environments (Church et al. 2004; Ford et al. 2008). In addition, the water is colder at deepwater sites; this slows the oxidation process. Finally, the cause of a shipwreck could also affect its preservation potential. Shipwrecks nearer to the shoreline have a greater potential to be broken up and scattered by subsequent storms.

Several studies have been conducted for BOEM to model areas in the GOM where shipwrecks have the highest potential to exist. The first study, conducted in 1977, concluded that two-thirds of all shipwrecks in the northern GOM are located within 1.5 km (0.9 mi) of the shore (CEI 1977). A second study in 1989 (Garrison et al. 1989) concluded that the highest frequency of shipwrecks occurred in areas of the highest volume of marine traffic (e.g., approaches to seaports and mouths of navigable rivers and straits). This study also reported an increased frequency in shipwrecks in the open sea of the eastern GOM that was double that reported for the western or central GOM, attributed to changes in sailing routes in the late nineteenth and early twentieth centuries. In addition, the study looked at distribution patterns of shipwrecks relative to ocean currents, storm tracks, natural navigational hazards, and economic histories of ports. The final study, conducted in 2003 (Pearson et al. 2003), incorporated new data that had been compiled over 15 yr of high-resolution shallow hazard surveys for oil and gas development and sonar surveys. To date, shipwrecks have been discovered in water depths of over 2,700 m (~9,000 ft).

Many of the deepwater wrecks, or at least their locations, were not previously known; several of the deepwater shipwrecks date to the World War II era (Church et al. 2009). Six World War II–era vessels, for instance, were found during modern oil and gas surveys in water depths ranging from 87 to 1,964 m (285 to 6,444 ft). These wrecks included the *Virginia*, the *Halo*, the *Gulfpenn*, the *Robert E. Lee*, the *Alcoa Puritan*, and the *U-166*. Each shipwreck was identified during BOEM-required surveys; each was investigated to determine its individual site boundaries, its eligibility for the NRHP, and its state of preservation and stability (Church et al. 2009).

As a result of the findings in these studies, BOEM updated its guidelines to include lease blocks in deepwater areas within the approach to the Mississippi River as high-potential areas requiring archaeological survey. For instance, BOEM updated or created new NTLs that provided clarification on when archaeological surveys are needed for activities on the OCS. Among these notices was NTL No. 2006-G07, which provided new additions and modifications to the list of OCS blocks that required archaeological resource surveys and reports for submittal to BOEM, as well as the required survey line spacing for each block.

Another NTL (NTL 2011-Joint-G01) issued in 2011 provided additions and modifications in survey line spacing, as well as identifying new OCS blocks that require archaeological resource surveys. The 2011 NTL superseded NTL 2008-G20. The 2011 NTL did not rescind NTL No. 2005-G07, which provided specific guidance on how to satisfy the BOEM requirements concerning archaeological surveys in the GOM (BOEM 2011).

3.16.1.3 Onshore Archaeological and Historic Resources

Geographic features associated with onshore prehistoric archaeological sites in coastal areas in the western and central GOM include river channels and associated floodplains, terraces, levees and point bars, barrier islands, back barrier embayments, and salt domes. In the eastern GOM, off the coast of Florida, additional features include chert outcrops, solution caverns, and sinkholes. These same types of features are present on the OCS, are submerged and often buried by estuarine and marine sediments, and have the same potential for being associated with prehistoric site locations in this region. BOEM requires high-resolution remote sensing surveys prior to any bottom-disturbing activities associated with oil, gas, and sulfur leasing.

Historic resources located in coastal regions can include historic residences and communities, lighthouses, historic forts (e.g., Fort Livingston at Grande Terre Island, Louisiana), and piers and docks. Onshore historic resources also can include shipwrecks that have been buried on beaches.

3.16.1.4 Climate Change

The effects of climate change have the potential to alter archaeological and historic sites. Climate change is expected to result in increased sea temperatures, rising sea levels, and increased ocean acidity (Howard et al. undated). Most archaeological and historic resources have stabilized to the current environmental setting. Coastal archaeological sites and historic structures are at greater risk due to flooding, coastal erosion, and subsidence, which all have been identified as potential impacts of climate change (Cassar 2005). Some archaeological sites that are found on the OCS have already experienced the effects of climate change, as they were inundated when the last ice age ended. The primary effect from climate change for the BOEM archaeological and historic program could be an alteration of the lease blocks resulting from sea level change, requiring archaeological investigations.

3.16.2 Alaska – Cook Inlet

3.16.2.1 Offshore Prehistoric Resources

Minimal research has been conducted in the Cook Inlet Planning Area concerning the potential for submerged landforms that could contain archaeological material. During the time that Alaska was first populated (c. 13,000 yr ago), sea levels were significantly lower than today (Dixon et al. 1986). Much of the shoreline, where the first peoples would have lived, is now inundated in water up to 60 m (197 ft) in depth. Most of the research concerning identification of these old shorelines has occurred in the Beaufort and Chukchi Seas (see Section 3.6.5.8.1). However, an archaeological baseline study completed by Dixon et al. (1986) compiled available geologic, bathymetric, geophysical, climatic, and archaeological data in an effort to outline those areas of the Alaska OCS that may have the highest potential for preserved prehistoric archaeological sites. The primary indicators used to evaluate offshore prehistoric site potential were coastal geomorphic features onshore, relict geomorphic features offshore, and ecological data. It was proposed in the baseline study that these lines of evidence, taken together, indicate areas where subsistence resources used by prehistoric human populations would have been concentrated for sustained periods of time. However, actual geophysical data would be required to reconstruct the offshore paleogeography and determine specific areas where prehistoric archaeological sites might occur. The results of the baseline study suggest that the area around the Aleutian Islands has potential for preserved prehistoric sites. While the information contained in the Dixon et al. (1986) report is useful for understanding Alaskan prehistory, the Alaska SHPO requires that baseline reports be updated regularly (McMahan 2011).

Portions of Cook Inlet are subject to high-energy tidal movements. The seafloor of lower Cook Inlet contains seafloor characteristics such as lag gravels, sand ribbons, and sand wave fields (MMS 2003a). These features are only formed in areas of high energy. High-energy water movement may have removed the potential for archaeological resources to be present. Additional research is needed to determine the extent of the disturbance.

3.16.2.2 Offshore Historic Resources

A total of 108 shipwrecks were lost in Cook Inlet between 1799 and 1954 (Tornfelt and Burwell 1992). With some exceptions, the sites of most of these shipwrecks are within State waters. However, the best-preserved shipwrecks are likely to be found on the OCS, because wave action and ice are less likely to contribute to the breakup of ships in deeper waters. No shipwreck studies have been done in Cook Inlet since 1992.[15]

3.16.2.3 Onshore Archaeological and Historic Resources

Records for known onshore archaeological and historic resources around Cook Inlet are maintained by the Alaska Office of History and Archaeology (Alaska OHA). Along the shoreline surrounding Cook Inlet, the predominant types of prehistoric resources are house pits containing the household and subsistence artifacts (stone lamps, sinkers, arrowheads, etc.) of prehistoric people. Historic sites found onshore consist of early Russian houses, churches, roadway inns, fish camps, and mining camps.

3.16.2.4 Climate Change

The effects of climate change have the potential to alter archaeological and historic sites. Climate change is expected to result in increased sea temperatures, rising sea levels, and increased ocean acidity (Howard et al. undated). Most archaeological and historic resources have stabilized to the current environmental setting. Coastal archaeological sites and historic structures are at greater risk due to flooding, coastal erosion, and subsidence, which all have been identified as potential impacts of climate change (Cassar 2005). Some archaeological sites that are found on the OCS have already experienced the effects of climate change, as they were inundated when the last ice age ended. The primary effect from climate change for the BOEM archaeological and historic program could be an alteration of the lease blocks resulting from sea level change, requiring archaeological investigations.

3.16.3 Alaska – Arctic

3.16.3.1 Offshore Prehistoric Resources

At the height of the late Wisconsinan glacial advance (approximately 19,000 yr ago), the global (eustatic) sea level was approximately 120 m (394 ft) lower than present. During this time, large expanses of what is now the OCS were exposed as dry land. Where the actual shorelines were located varied depending on the location and the amount of ice that was present.

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[15] The *Torrent* shipwreck was found by a private dive team in 2007 off the coast of Cook Inlet. The team has since launched an exploration and Web site to attract funding to continue their studies (Lee 2007; Lloyd 2008).

The lower sea levels created land bridges between the Asian continent and the North American continent. It is commonly thought that it was over these land bridges that the first people came to North America roughly 13,000 yr ago (Darigo et al. 2007). It is also commonly held that the first inhabitants of North America would have settled along the coasts. Therefore, if the relic coastlines or landforms (which are now completely inundated) can be found and identified, it is possible that archaeological evidence for the populating of North America could be found.

Studies using data collected during various explorations in the Beaufort Sea attempted to clarify if landforms dating to the early Holocene Period (between 13,000 and 11,000 yr ago) could be found and whether there was any potential for intact archaeological material to remain in these areas (Darigo et al. 2007). The studies found that the shoreline at 13,000 yr ago was approximately 60 m (197 ft) below sea level and that landforms do appear to exist from that time period. Similarly, in 1992, studies conducted in the Chukchi Sea also seem to indicate that landforms from the early Holocene may remain (Elias et al. 1992). However, major disturbances have occurred to these landforms. Ice gouging resulting from large pieces of ice dragging along the bottom of the ocean may have altered the landform sediments and removed all archaeological evidence of the first peoples. The full extent of the disturbance is not known. Some areas near barrier islands or areas that are protected by shorefast ice show less evidence of ice gouging (Darigo et al. 2007). The amount of disturbance also varies between the Beaufort and Chukchi Seas. Because more investigations have occurred in the Beaufort Sea, there is a better understanding of the situation in that area. Ultimately, sonar and seismic surveys are needed to determine the condition of the sediments and underlying strata.

3.16.3.2 Offshore Historic Resources

Numerous shipwrecks have been documented in the Beaufort and Chukchi Seas. Most of the shipwrecks off of Alaska's north coast were associated with commercial whaling, which occurred between 1849 and 1921 (Bockstoce and Burns 1993). Archival research has identified numerous reports of shipwrecks (Bockstoce 1977; Tornfelt and Burwell 1992; Rozell 2000). BOEM maintains an Alaska Shipwreck Database which includes information on all known shipwrecks. As a result of the studies conducted on shipwrecks, BOEM has identified some areas in the Chukchi and Beaufort Seas as having high probability for containing wrecks. Most of the wrecks off northern Alaska are likely in State waters and are not under the direct jurisdiction of BOEM. High resolution geophysical surveys are needed to determine shipwreck locations. The following contains some information on the types and locations of shipwrecks in the Beaufort and Chukchi Seas.

Based on archival research cited above, between 1849 and 1921, 34 shipwrecks occurred within a few miles of Barrow; another 13 wrecks occurred to the west and east of Barrow in the waters of the Chukchi and Beaufort Seas. No surveys of these shipwrecks have been made; therefore, no exact locations are known. These wrecks would be important finds, providing information on past cultural norms and practices, particularly with regard to the whaling industry (Tornfelt and Burwell 1992).

At Point Belcher near Wainwright, 30 ships were frozen in the ice in September 1871; 13 others were lost in other incidents off Icy Cape and Point Franklin. Another 7 wrecks occurred off Cape Lisburne and Point Hope. From 1865 to 1876, 76 whaling vessels — an average of more than 6 per year — were lost because of ice and also because of raids by the *Shenandoah*, which burned 21 whaling ships near the Bering Strait during the Civil War (Bockstoce 1977). The possibility exists that some of these shipwrecks have not been completely destroyed by ice and storms. The probabilities for preservation are particularly high around Point Franklin, Point Belcher, and Point Hope (Tornfelt and Burwell 1992).

A remote sensing survey in the Beaufort Sea recorded a large side-scan sonar target. The size and shape of this object and historical accounts suggest that it may be the crash site of the Sigismund Levanevsky, a Russian airplane that was lost during a transpolar flight in 1939 (Rozell 2000). Subsequent attempts at relocating the object and confirming its identity were unsuccessful.

3.16.3.3 Onshore Archaeological and Historic Resources

Archaeological and historic resources are found along the Chukchi and Beaufort Sea coasts. Onshore archaeological resources near the Chukchi Sea coast receive less damage from the eroding shoreline than those on the Beaufort Sea coast, which is subjected to more slumping because of water action and permafrost (Lewbel 1984). Therefore, known onshore archaeological resources exist in greater numbers in the coastal areas adjacent to the Chukchi Sea; additional unknown resources are also more likely to exist. Known historic and archaeological resources are cataloged in the Alaska Heritage Resources Files maintained by the Alaska OHA. The types of onshore archaeological and historic resources known to exist include prehistoric and historic villages, graves, whaling camps, fishing/hunting camps, and whaling ship remains (Tornfelt and Burwell 1992). In addition, Cold War era historic sites including former Distant Early Warning line outposts, radar stations associated with the Aircraft Control and Warning System, missile sites, and others can be found along the Chukchi and Beaufort Sea coasts (Whorton and Hoffecker 1999).

Significant resources found along the Chukchi and Beaufort Seas include the Ipiutak Site National Historic Landmark at Point Hope, the Cape Krusenstern National Monument, the Bering Land Bridge National Preserve, and the Birnirk Site National Historic Landmark at Barrow. These areas are known to contain significant archaeological resources, occasionally in large numbers.

3.16.3.4 Climate Change

The effects of climate change have the potential to alter archaeological and historic sites. Climate change is expected to result in increased sea temperatures, rising sea levels, and increased ocean acidity (Howard et al. undated). Most archaeological and historic resources have stabilized to the current environmental setting. Coastal archaeological sites and historic structures are at greater risk due to flooding, coastal erosion, and subsidence, all of which have been identified as potential impacts of climate change (Cassar 2005). Some archaeological sites that are found on the OCS have already experienced the effects of climate change, as they were inundated when the last ice age ended. The primary effect from climate change for the BOEM archaeological and historic program could be an alteration of the lease blocks resulting from sea level change, requiring archaeological investigations.

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4 ENVIRONMENTAL CONSEQUENCES

4.1 ENVIRONMENTAL CONSEQUENCES ASSOCIATED WITH OCS OIL AND GAS ACTIVITIES

This programmatic environmental impact statement (PEIS) evaluates 8 alternatives, including no action (see Chapter 2). All of the action alternatives identify Outer Continental Shelf (OCS) Planning Areas in the Gulf of Mexico (GOM), Cook Inlet, and the Arctic where lease sales may occur under the 2012-2017 OCS Oil and Gas Leasing Program (the Program). Chapter 3 of this PEIS describes the nature and condition of natural and socioeconomic resources that have a potential to be affected by oil and gas (O&G) activities within those OCS Planning Areas under the Program. In general, O&G development follows a four-phase process, beginning with (1) exploration to locate viable deposits, (2) development of the production well and support infrastructure, (3) operation (oil or gas production), and (4) decommissioning of the well once it is no longer productive or profitable. Seismic exploration, geological, and hazard surveys are generally the first industry activities to occur during a new Program. Exploration drilling, development drilling, and platform installation typically begin several years after the first lease sale. Based on historical data, peak exploration drilling is expected to occur 5 to 10 years after the Program is approved, although a decreasing number of exploration wells will be spudded over the entire 40- to 50-year window of the Program. The peak in development drilling and platform construction operations generally lags the peak in exploration drilling, but also peaks within the first 10 years. Peak production associated with lease sales held under the new Program is expected to occur about 20 years after the Program's approval. The OCS activities potentially authorized under the new 5-year program will be occurring in context of comparable exploration and development operations pursued under previous 5-year programs, lease sales, and plan approvals. One lease sale only contributes to a relatively small percentage of OCS activity in the GOM at any given time (MMS 2007a). In 2009–2011, production was occurring as a result of 95–98 different lease sales, and exploration and development wells were spudded as a result of approximately 54–60 different lease sales.

Since lease- and project-specific details are not known at this time, the analyses in this PEIS take a programmatic approach and evaluate resources on a larger, more regional scale rather than at a lease-block scale (the scale at which project-specific impacts could occur). The evaluation of environmental consequences presented in this PEIS focuses on those resources most likely to be affected during future O&G development under each of the alternatives considered in this PEIS. Some information is currently unavailable or incomplete, such as a complete understanding of affected environment baseline changes in the GOM from the Deepwater Horizon (DWH) event, or the dynamic influence of climate change in the Arctic. However, this information is not essential in order to make a reasoned choice among alternatives at this programmatic stage (see Section 1.4.2, Incomplete and Unavailable Information). Exploration and development scenarios have been prepared that identify potential levels of O&G development that may occur as a result of lease sales in the GOM, the Cook Inlet, and the Chukchi and Beaufort Sea Planning Areas under the Program. These scenarios are presented for each alternative later in this chapter and are used for the programmatic impact analyses of this

PEIS. More detailed, location-specific impact analyses would be conducted in subsequent lease sale-specific National Environmental Policy Act (NEPA) analyses.

The programmatic evaluation of environmental or socioeconomic impacts presented in this PEIS provides useful information for considering the effects of O&G development on the resources of the OCS (and associated coastal environments) under each alternative. The programmatic analyses identify the types of activities that typically occur during exploration, development, production, and decommissioning; the resources that could be affected by those activities; and the nature and relative magnitude of effects those resources could incur.

4.1.1 Routine Operations and Common Impact-Producing Factors

Impacts from OCS O&G development originate from the specific activities that occur following OCS leasing, and both activities and impacts will vary by the phase of O&G development. In general, the major activity types under a given lease include exploration drilling, development drilling, and production of wells (see Table 4.4.1-1). The onset and timing of different activity types that may result from a lease sale in the Program will vary within and between planning areas over the 40- to 50-year life of the Program. For example, relatively more exploration drilling is expected to occur in the first 5–10 years of the Program, which will then be followed by relatively more development drilling and production later in the Program (see Section 4.4.1). Each phase will have a set of impact-producing factors (some unique to a particular phase) that represent O&G development activities that produce physical or environmental conditions that may affect one or more natural, cultural, or socioeconomic resources, and these may vary within each phase depending on the specific activity. For example, an impact-producing factor associated with exploration is noise, which will differ in its nature, magnitude, and duration depending on how it is generated. Noise generated by seismic survey equipment will differ in magnitude, frequency, and duration from noise generated during exploration well drilling or by ship traffic. The resources that could be affected by noise and the nature and magnitude of potential effects will also vary, depending on the source and characteristics of the noise (duration, frequency, magnitude) that is generated.

The nature, magnitude, and duration of each impact-producing factor (and any subsequent environmental effects) will also vary among the four phases of O&G development. For example, noise generated by seismic survey equipment will be relatively short term in duration but very high in magnitude, and will cease once the survey portion of the exploration phase is completed. Similarly, noise from the explosive removal of a platform during the decommissioning phase would be of very short-term duration (effectively a one-time event). In contrast, noise from ship and helicopter traffic that supports production platforms could be generated for 20 years or more, depending on the production lifespan of the platform. Table 4.1.1-1 presents the major categories of impact-producing factors associated with O&G development on the OCS. It is important to note that many impact-producing factors can be associated with multiple O&G development phases, and can be subject to mitigation measures to help reduce impacts.

TABLE 4.1.1-1 Impact-Producing Factors Associated with OCS O&G Development Phases

	O&G Development Phase				
	Exploration				
Impact-Producing Factor	Seismic Survey	Exploration Well	Development	Operation	Decommissioning
Noise	X	X	X	X	X
Seismic noise	X	X			
Ship noise	X	X	X	X	X
Aircraft noise	X	X	X	X	X
Drilling noise		X	X		
Trenching noise			X		
Production noise				X	
Offshore construction			X		
Onshore construction			X		
Platform removal					X
Traffic	X	X	X	X	X
Aircraft traffic		X	X	X	X
Ship traffic	X	X	X	X	X
Drilling Mud/Debris		*X*	*X*		
Bottom/Land Disturbance		X	X		
Drilling		X	X		
Pipeline trenching			X		
Onshore construction			X		
Air Emissions		X	X	X	X
Offshore		X	X	X	X
Onshore			X	X	X
Explosives					X
Platform removal					X
Lighting		X	X	X	
Offshore facilities		X	X	X	
Onshore facilities			X	X	
Visible Infrastructure		X	X	X	
Offshore		X	X	X	
Onshore			X	X	
Space Use Conflicts	X	X	X	X	
Offshore facilities	X	X	X	X	
Onshore facilities			X	X	
Accidental Spills		X	X	X	X

The following discussions summarize the general types of activities that may be expected during each of the four O&G development phases and identify likely impact-producing factors for each phase. These impact-producing factors, the resources that each may affect, and the nature, magnitude, and duration of possible effects are discussed in more detail in the resource-specific impact sections presented later in this chapter.

4.1.1.1 Exploration

During exploration, typical activities include the conduct of geophysical seismic surveys and possibly the drilling of exploration wells. During seismic surveys, one or more airguns (or other sound sources) are towed behind a ship at depths of 5–10 m (16–33 ft) and produce acoustic energy pulses that are directed towards the seafloor. The acoustic signals then reflect off subsurface sedimentary boundaries and are recorded by hydrophones, which are typically also towed behind the survey ship. Following analysis of the acoustic data, one or more exploratory wells may be drilled to confirm the presence and determine the viability of the potential hydrocarbon reservoirs identified by the survey. Drilling of an exploration well typically involves the use of a mobile offshore drilling unit (MODU) (such as a jackup rig, a semisubmersible rig, or drillship) and the placement of infrastructure (such as a drilling template and a blowout preventer) on the seafloor to aid in the drilling. Both the seismic surveys and exploration well drilling involve the use of ships, whether to tow airguns and hydrophones or to bring drilling equipment and other support materials to the well location.

Impact-producing factors associated with exploration include noise, ship traffic, drilling mud and debris, seafloor disturbance, air emissions, lighting, visible infrastructure, and space use conflicts (Table 4.1.1-1). Noise will be generated by operating airgun arrays, vessel traffic, drilling, and support aircraft traffic. Resources of primary concern from noise impacts are marine mammals, sea turtles, and fish.

Ship traffic during the seismic surveys or in support of exploration well development has the potential for collisions with marine mammals and sea turtles, while the presence of ship and support aircraft traffic could affect normal behaviors of nearby biota (especially marine mammals). The disposal of drilling mud and debris during exploration well development will also affect local water quality and possibly biota.

Exploration well drilling will involve seafloor disturbance, primarily through the placement of drilling support infrastructure. This disturbance may affect overlying water quality as well as benthic biota and archeological resources (if present). Air emissions from the MODUs may affect local air quality, while MODU lighting may affect birds and sea turtles. Depending on location, MODUs may also present a visual impact. The conduct of seismic surveys and exploration well development could conflict with other uses of the marine environment at that location.

4.1.1.2 Development

Once exploration has confirmed the presence of a commercially viable reservoir, the next phase of O&G development is the construction of the production platform and drilling of production wells. Temporarily abandoned exploration wells may also be completed for production. Production wells are drilled using MODUs, and the type of production platform installed will depend on the water depth of the site and, to a lesser extent, on the expected facility lifecycle, the type and quantity of hydrocarbon product (e.g., oil or gas) expected, and the number of wells to be drilled. The number of wells per production platform depends on the type of production facility, the size of the hydrocarbon reservoir, and the drilling/production strategy for the drilling program. Production platforms may be fixed, floating, or subsea (only in deep water). Fixed platforms rigidly attached to the seafloor are typical in water depths up to 400 m (1,312 ft), while floating or subsea platforms are typically in waters deeper than 400 m (1,312 ft). Floating platforms are attached to the seafloor using line-mooring systems and anchors. Development will also include installation of seafloor pipelines for conveying product to existing pipeline infrastructure or to new onshore production facilities. In shallower waters (<60 m [<200 ft]), pipelines are typically buried to a depth of at least 0.91 m (3 ft) below the mudline. Pipelines may also be buried (trenched) in deeper waters, depending on conditions along the subsea pipeline corridor.

Impact-producing factors of development include noise, ship and helicopter traffic, drilling mud and debris, seafloor and land disturbance, air emissions, lighting, and visible infrastructure. During the development phase, noise will be generated during drilling, by ship and helicopter traffic, pipeline trenching, and onshore construction. Resources that could be affected by development-related noise include marine mammals, sea turtles, marine and coastal birds, and fish. Marine mammals and sea turtles could be affected by collisions with ship traffic supporting platform construction and drilling, while the presence of ship and helicopter traffic could disturb normal behaviors of marine mammals and birds.

The disposal of drilling muds and fluids may affect local water quality and aquatic biota. Some amount of seafloor disturbance will occur as a result of drilling, platform mooring, and pipeline trenching, which would result in some loss of habitat and biota as well as reductions in overlying water quality. Seafloor disturbance could also affect archeological resources if present in the project area. Air emissions from platforms where drilling is occurring as well as at onshore construction sites could affect local air quality. The lighting of offshore platforms could affect birds, while lighting at onshore facilities could affect sea turtles. Visual impacts may be incurred for some developments, depending on the location and nature (size) of the offshore platform or onsite facilities. Development of production wells and platforms as well as of new pipelines and onshore processing facilities could result in some space use conflicts in the project area.

4.1.1.3 Operation

Following completion of the production wells and platform, the facilities are operated to extract the hydrocarbon resource and transport it to onshore processing facilities. In recent years, offshore processing facilities, including floating production, storage, and offloading (FPSO) and liquefied natural gas (LNG) processing facilities, have also played a role in storage and processing. During the operation phase, activities center on maintenance of the production wells (workover operations) and platforms. Impact-producing factors associated with normal operations include noise, ship and helicopter traffic, air emissions, lighting, and visible infrastructure (Table 4.1.1-1).

During normal operations, noise will be generated by maintenance activities and by ship and helicopter traffic and may affect marine mammals and fish. Collisions with support ships could affect marine mammals and sea turtles, while ship and helicopter traffic could disturb normal behaviors of nearby biota. As noted for the development phase, lighting of onshore facilities could affect sea turtles, while lighting of offshore platforms could affect birds. Any visual impacts identified for the development phase could continue for the duration of the operation phase. Similarly, some of the space use conflicts incurred during the development phase would continue through production.

4.1.1.4 Decommissioning

Following lease termination or relinquishment, all facilities and seafloor obstructions are required to be removed. Facilities and obstructions may include, but are not limited to, platforms, production and pipeline risers, umbilicals, anchors, mooring lines, wellheads, well protection devices, subsea trees, and manifolds. All bottom-founded infrastructure is severed at least 5 m (15 ft) below the mudline. Production infrastructure could be removed using explosive or nonexplosive methods. After a facility is removed, the site is required to be cleared of all seafloor obstructions created by lease-holding and pipeline right-of-way operations.

After a pipeline is purged of its content, it may be decommissioned in place or physically recovered. Pipelines that are out of service for less than one year must be isolated at each end, and when out of service for more than one year but less than five years must be flushed and filled with inhibited seawater. Pipelines out of service for five years or more may be decommissioned in place when the regional supervisor determines that the pipeline does not constitute a hazard (obstruction) to navigation and commercial fishing operations, unduly interfere with other uses of the OCS, or have adverse environmental effects.

Impact-producing factors associated with decommissioning include noise, ship and helicopter traffic, air emissions, and explosives. Noise would be generated during either explosive or nonexplosive structure removal, as well as by ship and helicopter traffic supporting removal activities, and could affect marine mammals, sea turtles, and fish. Ship traffic could result in collisions with marine mammals and sea turtles, while ship and helicopter traffic could disturb behaviors of biota in the vicinity of the platform undergoing decommissioning. Air emissions could affect local air quality. Pressure from explosive detonations could injure marine mammals, sea turtles, and fish. Some additional space use conflicts could arise with explosive platform removal.

4.1.2 Accidental Events and Spills

4.1.2.1 Expected Accidental Events and Spills

A variety of accidental events or spills may be expected to occur during OCS O&G exploration and development activities (Table 4.1.2-1). During normal operations, ship and platform activities generate a variety of solid waste materials, such as plastic containers, nylon rope and fasteners, and plastic bags. The accidental release of such solid waste materials could affect marine mammals, sea turtles, and birds. While sanitary and domestic wastes produced in ships and platforms are routinely processed through onsite waste treatment facilities, the accidental discharge of such releases could affect local water quality and biota.

Ships supporting platform activities may accidentally collide with MODUs or platforms, releasing diesel fuel, which could affect water quality and biota. Loss of well control results in the uncontrolled release of a reservoir fluid that may result in the release of gas, condensate or crude oil, drilling fluids, sand, or water. Historically, most losses of well control have occurred during development drilling operations, but loss of well control can happen during exploratory drilling, production, well completions, or workover operations (Holand 2006; Izon et al. 2007). Oil and condensate spills may also occur directly from platforms, drilling ships, and support vessels or from ruptured pipelines following hurricane, trawl, or anchor damage. Releases associated with loss of well control have the potential to be the greatest in size and duration, as witnessed with the DWH event; these may affect water quality, biota, and space use.

While oil spills are unplanned accidental events, some spills may be reasonably expected to occur during the 2012-2017 OCS Leasing Program and associated O&G development phases, given historical spill rate frequencies and projected OCS activity levels. Depending on the phase of O&G development and the location, magnitude, and duration of a spill, natural resources that may be affected include marine mammals, marine and coastal birds, sea turtles, fish, benthic and pelagic invertebrates, water quality, marine and coastal habitats, and areas of special concern (such as marine parks and protected areas). In addition, spills may also affect a variety of socioeconomic conditions such as local employment, commercial and recreational fisheries, tourism, sociocultural systems, and subsistence. Spill scenarios for small and large platform and pipeline spills in the GOM, Cook Inlet, and Arctic planning areas have been developed for use in this PEIS. The scenarios and underlying assumptions regarding expected accidental spills are presented in detail in Section 4.4.2.1.

4.1.2.2 An Unexpected Accidental Spill — Catastrophic Discharge Event

In contrast to accidental spills that may be reasonably expected to occur during the Program, there is a low potential for a catastrophic accidental spill to occur. A scenario for a low probability, catastrophic discharge event (CDE) is presented for each program area in Section 4.3.3. Although unexpected, if such a spill were to occur, its effects could be catastrophic and adverse impacts be reasonably foreseeable to be incurred by affected resources.

TABLE 4.1.2-1 Expected Accidental Events and Spills That May Be Associated with OCS O&G Development Phases

	O&G Development Phase				
	Exploration				
Accidental Event or Spill	Seismic Survey	Exploration Well	Development	Operation	Decommissioning
Solid waste release	X	X	X	X	X
Sanitary waste release	X	X	X	X	X
Vessel collisions	X	X	X	X	X
Loss of well control		X	X	X	
Oil spills (non-CDE)		X	X	X	X

4.1.3 Assessment Approach

4.1.3.1 Routine Operations and Expected Accidental Events and Spills

The environmental consequences discussed in subsequent sections of Chapter 4 address the potential impacts that could be incurred as a result of routine operations and expected accidental events and spills under any of the seven action alternatives (Alternatives 1–7). Because Alternative 1, the Proposed Action, encompasses the six OCS Planning Areas considered for inclusion in the Program, OCS oil and gas activities that could occur following leasing under Alternative 1 may be expected to have the potential to cause impacts over the greatest geographic area. Any such potential impacts could also occur under the other action alternatives (Alternatives 2–7), as each represents a subset of the planning areas included in the proposed action. Thus, the analyses presented in Chapter 4, while focused on the proposed action, are fully applicable to each of the other action alternatives.

It is not possible to identify specific impacts from future OCS O&G development activities without development-specific location and design details. There are, however, general impacts that are typical of offshore O&G development, regardless of where development occurs. For example, the placement of a seafloor pipeline crossing shallow waters to a landfall will require trenching, which will disturb the seafloor and affect the overlying water quality, regardless of whether that pipeline is located in Cook Inlet or in the Western GOM Planning Area. The potential effects of pipeline placement will, however, differ between shallow and deep waters and by the nature of the seafloor communities present along the actual pipeline route.

As previously discussed, lease- and project-specific details are not known at this time. Thus, the analyses in this PEIS take a programmatic approach and evaluate resources on a larger, more regional scale rather than at a lease-block scale (the scale at which project-specific impacts could occur). Thus, the evaluation of environmental consequences presented in this PEIS has focused on those resources most likely to be affected during future O&G development on the OCS under the alternatives presented in Chapter 2.

For each resource, the impact-producing factors identified in Tables 4.1.1-1 and 4.1.2-1 were further examined and refined to identify aspects of those factors specific to the resource under evaluation. The analyses also identified, as applicable, important components of each resource to further refine the relationship between the impacting factors and the resource. For example, for sea turtles, the impact analyses identified four life stages (eggs, hatchlings, juveniles, and adults), four habitat types (nesting, foraging, overwintering, and nursery), and three important behaviors (courtship/nesting, foraging, migration) that could be affected by OCS O&G development activities. The impact analyses then focused on the impact-producing factors that could affect any of these life stages, habitats, or behaviors. Table 4.1.3-1 illustrates the refinement and linkage of impacting factors and important resource components.

TABLE 4.1.3-1 Relationships among Development Phase Impacting Factors and Habitats, Life Stage, and Behavior of Sea Turtles

	Sea Turtle Resource Component										
	Habitat Disturbance or Loss				Life Stage Affected				Behavior Affected		
Development Phase and Impacting Factor	Nesting	Foraging	Overwintering	Nursery	Eggs	Hatchlings	Juveniles	Adults	Foraging	Courtship/ Nesting	Migration
Vessel noise						X	X	X	X		
Aircraft noise											
Drilling noise							X	X			
Trenching noise							X	X	X		
Onshore construction noise								X		X	
Offshore air emissions											
Onshore air emissions											
Aircraft traffic											
Vessel traffic						X	X	X			
Hazardous materials					X	X	X	X			
Solid wastes					X	X	X	X			
Drilling mud/debris						X	X	X			
Bottom disturbance from drilling											
Bottom disturbance from pipeline trenching		X	X	X			X	X	X	X	
Offshore lighting											
Onshore construction	X				X	X		X		X	
Onshore lighting	X					X		X		X	
Explosive platform removal						X	X	X			

4.1.3.2 Unexpected Catastrophic Discharge Event

As previously discussed (Section 4.1.2.2), there is a low potential for a catastrophic accidental spill to occur. A CDE is discussed in detail in Sections 4.3.3 and 4.4.2. Although a CDE is not expected for the proposed action or for any of the alternatives, should such an event occur, it would be expected to affect a variety of resources. Effects which have catastrophic consequences, even if the probability of the occurrence of the catastrophic event is low, are reasonably foreseeable. The assessment approach employed to characterize CDE impacts is similar to that used for assessing impacts of expected accidents. Subsequent sections of Chapter 4 address the potential effects that could result if a CDE were to occur. The impacts would be similar in nature to those from expected accidental spills, differing only in the magnitude, extent, and duration of potential impacts. However, the occurrence of a CDE is unlikely and unexpected, given the projected level of activity of the proposed action.

4.1.4 Definition of Impact Levels

The conclusions for the resource analyses use a four-level classification scheme to characterize the impacts that could result from routine operations and expected accidental events and spills during OCS O&G development under the alternatives presented in this PEIS. Although CDE-level accidents are not expected to occur under any of the alternatives, the PEIS discusses the types of effects that could be incurred if such an unexpected accident were to occur. The CDE impact evaluations presented in the PEIS use the same classification scheme to characterize impacts as used to characterize impact levels of routine operations and expected accidental spills.

4.1.4.1 Impact Levels for Biological and Physical Resources

The following impact levels for biological and physical resources are used for the analysis of water quality, air quality, marine and terrestrial mammals, marine and coastal birds, fish resources, sea turtles, coastal and seafloor habitats, and areas of special concern (such as essential fish habitats [EFHs], marine sanctuaries, parks, refuges, and reserves). For most biota, these levels are based on population-level impacts rather than impacts on individuals. For species listed under the ESA, the impact levels consider impacts on individuals, when appropriate, as well as populations.

- Negligible: No measurable impacts.
- Minor:
  - Most impacts on the affected resource could be avoided with proper mitigation.
  - If impacts occur, the affected resource will recover completely without mitigation once the impacting stressor is eliminated.

- Moderate:
  - Impacts on the affected resource are unavoidable.
  - The viability of the affected resource is not threatened although some impacts may be irreversible, or
  - The affected resource would recover completely if proper mitigation is applied or proper remedial action is taken once the impacting stressor is eliminated.

- Major:
  - Impacts on the affected resource are unavoidable.
  - The viability of the affected resource may be threatened, and
  - The affected resource would not fully recover even if proper mitigation is applied or remedial action is implemented once the impacting stressor is eliminated.

4.1.4.2 Impact Levels for Socioeconomic Resources and Societal Issues

The following impact levels are used for the analysis of population, employment, and income; land use and infrastructure; commercial and recreational fisheries; tourism and recreation; sociocultural systems; environmental justice; and archeological and historic resources.

- Negligible: No measureable impacts.

- Minor:
  - Adverse impacts on the affected activity, community, resource could be avoided with proper mitigation.
  - Impacts would not disrupt the normal or routine functions of the affected activity or community.
  - Once the impacting stressor is eliminated, the affected activity or community will, without any mitigation, return to a condition with no measureable effects.

- Moderate:
  - Impacts to the affected activity, community, or resource are unavoidable.
  - Proper mitigation would reduce impacts substantially during the life of the project.
  - A portion of the affected resource would be damaged or destroyed.
  - The affected activity or community would have to adjust somewhat to account for disruptions due to impacts of the project, OR
  - Once the impacting stressor is eliminated, the affected activity or community will return to a condition with no measurable effects if proper remedial action is taken.

- Major:
  - Impacts on the affected activity, community, or resource are unavoidable.
  - Proper mitigation would reduce impacts somewhat during the life of the project.
  - For archeological resources, all of the affected resource would be permanently damaged or destroyed. For other socioeconomic and cultural resources, impacts could incur long-term effects.
  - The affected activity or community would experience unavoidable disruptions to a degree beyond what is normally acceptable, and
  - Once the impacting agent is eliminated, the affected activity or community may retain measurable effects for a significant period of time or indefinitely, even if remedial action is taken.

4.2 RELATIONSHIP OF THE PHYSICAL ENVIRONMENT TO OIL AND GAS OPERATIONS

4.2.1 Physiography, Bathymetry, and Geologic Hazards

4.2.1.1 Gulf of Mexico

4.2.1.1.1 Physiography and Bathymetry. The GOM is a small ocean basin measuring 900 km (660 mi) from north to south and 1,600 km (990 mi) from east to west with a mean water depth of about 1,615 m (5,300 ft) (Bryant et al. 1991; GulfBase 2011). The basin is almost completely surrounded by continental landmasses. Its shoreline runs 5,700 km (3,500 mi) from Cape Sable, Florida, to the tip of Mexico's Yucatan Peninsula, with another 380 km (240 mi) of shoreline on the northwest tip of Cuba (GulfBase 2011).

The continental shelf extends from the coastline to a water depth of about 200 m (660 ft). Width of the shelf varies, ranging from 10 km (6 mi) near the Mississippi Delta to about 280 km (175 mi) off the southern tip of Florida and the Yucatan Peninsula. Its topographic relief is relatively low. Extending from the edge of the shelf to the abyssal plain is the continental slope, a steep area with high topographic relief and diverse geomorphic features (canyons, troughs, and salt structures). The base of the slope occurs at a median depth of about 2,800 m (9,190 ft). The Sigsbee Deep, located within the Sigsbee Abyssal Plain in the southwestern part of the basin, is the deepest region of the GOM with a maximum depth ranging from 3,750 m (12,300 ft) to 4,330 m (14,200 ft). The GOM basin contains a volume of 2,434,000 km^3 (6.43×10^{17} gal) of water (Shideler 1985; GulfBase 2011).

Antoine (1972) has divided the GOM into physiographic provinces, the components of which correspond to the ecological regions delineated by the Commission for Environmental Cooperation (CEC) (Wilkinson et al. 2009). The physiographic regions presented below are organized from north to south. They are based on the CEC's nomenclature (Level II seafloor geomorphological regions[1]) and incorporate the physiographic descriptions of Antoine (1972), Bryant et al. (1991), Shideler (1985), Wilhelm and Ewing (1972), and GulfBase (2011).

Northern Gulf of Mexico Shelf and Slope. On its west side, the northern GOM shelf and slope extends from the Rio Grande (Texas) to Alabama and from 320 km (200 mi) inland of today's shoreline to the Sigsbee Escarpment. It encompasses the Texas-Louisiana Shelf and Slope and the Mississippi-Alabama Shelf (Figure 4.2.1-1). The major geologic feature in this province is the Mississippi Fan, which extends from the Mississippi River Delta to the central abyssal plain. The upper part of the fan (to a water depth of about 2,500 m or 8,200 ft) has a complex and rugged topography attributed to salt diapirism,[2] slumping, and current scour; the lower part of the fan by contrast is smooth, with a gently sloping surface that merges with the abyssal plain to the southeast and southwest. The Mississippi Canyon cuts the eastern side of the Texas-Louisiana Shelf to the southwest of the Mississippi River Delta. The submarine canyon is thought to have formed from large-scale slumping along the shelf edge. The area is characterized by thick sediments and widespread salt deposits.

To the east, the northern GOM shelf and slope extends from just east of the Mississippi River Delta near Biloxi, Mississippi, to the eastern side of Apalachee Bay (west Florida) and encompasses the West Florida Shelf and Terrace (Figure 4.2.1-1). The shelf in this region is characterized by soft terrigenous (land-derived) sediments. Sediments are thick west of DeSoto Canyon; Mississippi River-derived sediments cover the western edge of the carbonate platform of the West Florida Shelf. The Florida Escarpment, with slopes as high as 45° in places, separates the West Florida Shelf from the deeper GOM basin and also forms the southeastern side of DeSoto Canyon.

South Florida/Bahamian Shelf and Slope. This region is the submerged portion of the Florida Peninsula. The region extends along the West Florida coast from Apalachee Bay southward to the Straits of Florida and includes the Florida Keys and Dry Tortugas. Sediments become progressively more carbonate (ocean-derived) from north to south with thick accumulations in the Florida Basin. The basin may have been enclosed by a barrier reef system at one time. The Jordon Knoll, located within the Straits of Florida, is composed of remnants of the ancient reef system.

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1 The CEC's Level II seafloor geomorphological regions are determined by large-scale physiography (e.g., continental shelf, slope, and abyssal plain) and extend offshore to a depth of 370 km (200 mi). The designation of Level II regions is helpful to understanding marine ecosystems because it illustrates the importance of depth as a major determinant of benthic marine communities and shows how physiographic features can influence current flows and upwellings (Wilkinson et al. 2009). Other sections (e.g., Section 3.2 on Marine and Coastal Ecoregions) provide finer scale Level III region descriptions that take into account local variables such as water mass, regional landforms, and biological community types on the continental shelf.

2 Salt diapirism refers to a process by which natural salt (mainly halite but also including anhydrite and gypsum) in the subsurface deforms and flows in response to loading pressures from overlying sediments. Because of its low density, salt tends to flow upward from its source bed, forming intrusive bodies known as diapirs. Salt diapirs are common features of sedimentary basins like the GOM (Nelson 1991).

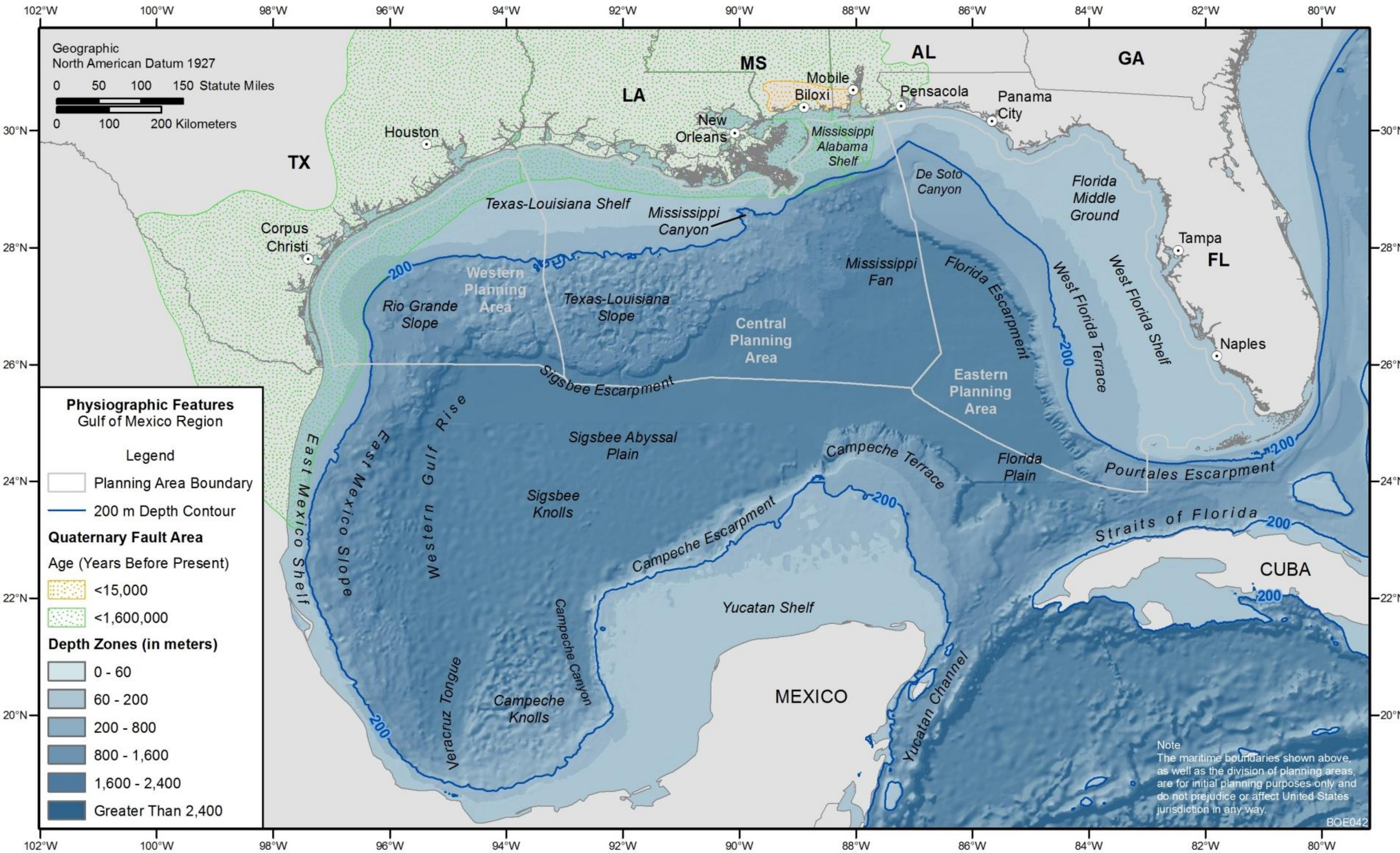

FIGURE 4.2.1-1 Physiographic Regions of the GOM (based on Bryant et al. 1991)

Gulf of Mexico Basin. The GOM Basin consists of the continental rise, the Sigsbee Abyssal Plain, and the Mississippi Cone. The continental rise is situated between the Sigsbee Escarpment and the Sigsbee Abyssal Plain (Figure 4.2.1-1). It is a large wedge of sediments originating from the unstable continental slope (deposited by gravity flows). The Sigsbee Abyssal Plain is the deep, flat portion of the GOM bottom just northwest of the Campeche Escarpment. It is 450 km (280 mi) long and 290 km (180 mi) wide and covers an area of more than 103,600 km^2 (40,000 mi^2). The plain is underlain by very thick sediments (up to 9 km, or 5.6 mi); the only major topographical features in this region are the small salt diapirs that form the Sigsbee Knolls. The Mississippi Cone lies between the Mississippi Canyon to the west and DeSoto Canyon to the east. It is the portion of the Mississippi River Delta that has accumulated at the base of the continental slope.

4.2.1.1.2 Geologic Hazards. Several types of geologic hazards are known to occur in the marine environment of the GOM region, most of which present a risk to offshore oil and gas activities because they contribute directly or indirectly to seafloor instability. As a result, seafloor instability is likely the principal engineering constraint to the emplacement of bottom-founded structures, including pipelines, drilling rigs, and production platforms.

Geologic hazards within the GOM are common on the northern continental slope (Figure 4.2.1-1) because of its high sedimentation and subsidence rates and the compensating movement of underlying salt. Geologic hazards are frequently concentrated in the areas along the edges of intraslope basins[3] where topography is high and complex. These intervening regions are created by shallow diapiric salt bodies and are steeply sloped and highly faulted. They are also areas of natural fluid and gas migration to the seafloor surface (Roberts et al. 2005). The potential geologic hazards in the GOM region are described below.

Irregular Topography. The regional topography of the continental slope is irregular, consisting predominantly of domes, ridges, and basins. On a more local scale, topographic features include slope failures, mounds, depressions, and scarps[4] (Roberts 2001b). Such features produce a wide range of potential hazards to drill rigs, bottom-laid and buried pipelines, and production platforms. The most topographically rugged province in the region is the Texas-Louisiana Slope, a 120,000-km^2 (46,300-mi^2) area of banks, knolls, basins, and domes where local slope gradients can exceed 20°. Topographic variability in this area is attributed to the movement of salt in the subsurface and the natural venting and seepage of petroleum and other fluids at the seafloor surface (Roberts et al. 2005; Bryant and Lui 2000; Kennicutt and Brooks 1990; Roberts et al. 1998).

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3 Intraslope basins are flat, featureless areas on the continental slope of the northwestern GOM where sediment depositional processes predominate.

4 Scarps (or escarpments) are steep bluff-like features formed by the downward displacement of sediments or rocks along a vertical fault plane.

Substrate types range from lithified (rock-like) hard bottoms[5] (bioherms, hardgrounds, carbonate banks, and outcrops) to extremely soft, fluid mud bottoms. Hard-bottom substrates are associated with topographic highs (most often created by salt diapirs) and present hazards to activities such as drilling, locating production platforms, and laying pipelines. The coral reefs of the Flower Garden Banks in the northwestern GOM are an example (Roberts et al. 2005; Roberts and Aharon 1994; Schmahl et al. 2011; see also Sections 3.7.2.1.2 and 3.9.1.2.1).

Bedforms and Bedform Migration. Bedforms are depositional features on the seabed that form by the movement of sediment caused by bottom currents. An extensive field of bedforms, ranging in size from small ripples and mudwaves to large furrows, is present at the base of the continental slope (along the Sigsbee Escarpment) in the GOM (Bean 2005; Bryant and Liu 2000). Large bedforms and their migration create potential navigation hazards and may undermine submarine pipelines. Numerous studies of these features relate their morphology and migration to water depth, availability of sediment, grain size, and current velocity (Whitmeyer and FitzGerald 2008).

Deep tow surveys conducted by Texas A&M University have found that the 30-m (98-ft) wide and 10-m (32-ft) deep furrows to the south of the Sigsbee Escarpment parallel the regional contours and extend for tens to hundreds of kilometers. These features indicate the long-term presence of high-velocity bottom currents along the base of the escarpment (Bryant and Liu 2000). Bean (2005) estimates current velocities in this region to be as high as 95 cm/s (37 in./s), significant enough to affect structures on the seafloor or in the water column. The bedforms have steep upstream-facing sides (where deposition takes place), suggesting they migrate in an upcurrent direction (Bean 2005).

Bottom Scour. Vigorous tidal circulation and storm waves have an important effect on the transport of sediments on the surface of the continental shelf. Episodic sediment movement caused by waves and ocean currents can undermine foundational structures and move unanchored bottom-laid pipelines (as reported by Thompson et al. 2005 and Coyne and Dollar 2005). Teague et al. (2006b) estimate that in 2004 Hurricane Ivan displaced as much as 100 million m^3 (3.5 billion ft^3) of sediment from a 35 by 15 km (22 by 9 mi) region in the storm's path, causing up to 36 cm (14 in.) of scour at moorings in areas over which the maximum wind stress occurred. Bottom scour occurs as a result of sediment resuspension by waves and current-driven transport of entrained sediments. Sediments entrained in bottom currents increase water density and mass, giving the strength to cause further scouring. In addition, wind-generated surface waves apply cyclic pressure to bottom sediments causing seabed motion (liquefaction).

5 Hard bottoms formed on diapiric high areas beyond the shelf edge during periods of lowered sea level in the late Pleistocene. During this time, the areas provided a substrate for the colonization of sedentary marine organisms. As sea level rose, the remains of the colonized organisms in these areas became fossilized, forming bioherms (e.g., fossilized coral reefs) and shallow banks (Roberts et al. 2005).

Fluid and Gas Expulsion. There are a wide range of natural fluid and gas[6] expulsion processes in seafloor sediments across the northern GOM continental slope. The geologic features related to these processes are variable and depend largely on the rate and duration of delivery as well as the composition of the fluid and gas expelled (Hardage 2011; Roberts 2001a). These include mud volcanoes, flows, and vents, resulting from rapid-flux or mud-prone processes; gas hydrate mounds and chemosynthetic communities, resulting from moderate-flux processes; and hard bottoms (carbonate mounds, hardgrounds, and nodular masses), resulting from slow-flux or mineral-prone processes (Roberts 2001a; Roberts et al. 2002). Below water depths of about 500 m (1,640 ft), moderate-flux processes dominate, promoting gas hydrate formation at or near the seafloor and creating conditions optimal for sustaining dense and diverse chemosynthetic communities. Rapid- and slow-flux processes may also occur on a more local scale at these depths (Roberts et al. 2002). Pockmarks — circular to oval depressions resulting from the removal of sediment near areas of rapid (and possibly explosive) gas expulsion — have been mapped along the northern continental shelf and slope. Some of these features are over 300 m (1,000 ft) in diameter (BOEMRE 2011l).

The main geologic hazard stemming from the processes of fluid and gas expulsion (seeps and eruptions) is seabed slope failure (submarine slumps and slides), especially on the continental slope and within active river deltas and submarine canyons. Fluid and gas releases lower sediment shear strengths and as a result can destabilize seabed structures such as cables, pipelines, and platforms.

Studies using high-resolution seismic and side-scan sonar have shown that the linear spatial distribution of seafloor features caused by fluid and gas expulsion can usually be correlated with faults intersecting the modern seafloor. Faults are important conduits for the upward natural migration of fluids and gases through the sedimentary column to the seafloor (Roberts 2001b). Neurater and Bryant (1990) report that it is the churning action of upwelling fluids and gases that causes a "slurry" of unconsolidated mud to form and migrate to the surface of the seafloor.

Along the Texas-Louisiana Shelf, shallow gas accumulations are most common in old channel systems. Shallow gas accumulations are also found in areas affected by salt uplift where numerous faults form pathways to near-surface sediments, creating small gas pockets that become sealed in thin clay layers (Foote and Martin 1981).

Natural Gas Hydrates. Gas hydrates are naturally occurring solids composed of hydrogen-bonded water lattices (also known as clathrates) that trap methane and other low-weight gas molecules (e.g., carbon dioxide, propane, and ethane). They form in deepwater ocean sediments within a surface-parallel layer referred to as the hydrate stability zone under conditions of high pressure and low temperature. In the GOM, gas hydrate deposits are found in

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6 Gases (predominantly methane) migrating from the seabed originate from both deep sources (termed thermogenic gases because they are heat-generated) and more shallow sources (termed biogenic or microbial gases because they are derived from the activity of microorganisms). Regardless of origin, high-pressure methane is highly mobile, flammable, and buoyant and poses a great hazard to drilling operations when encountered (Judd and Hovland 2007).

localized deepwater areas at or near the seafloor (intersecting the seafloor at a water depth of about 500 m, or 1,640 ft). They occur as a disseminated accumulation in the pore spaces of sedimentary units across vertical sections ranging in thickness from a few centimeters to several hundred meters. In more massive form, they occur in faults, fractures, and nodules and range in thickness from a few centimeters to several hundred meters. The size and shape of the hydrate stability zone are influenced by the presence of numerous salt features (Boatman and Peterson 2000; Roberts 2001b; MMS 2006a; Frye 2008).

Because they are pressure- and temperature-sensitive, gas hydrates (if present) can easily dissociate and rapidly release large amounts of gas during a drilling operation. Hydrate dissociation may trigger seafloor slumps and catastrophic landslides, which pose significant hazards for offshore oil and gas operations, including the loss of support for drilling and production platforms and pipelines, collapse of wellbore casings, and seafloor subsidence around wellbores where gas has leaked to the surface. As drilling operations in the GOM move into deeper waters, gas hydrate outcrops are likely to be encountered more frequently (Boatman and Peterson 2000; Roberts 2001b; MMS 2006a).

In addition to their natural occurrence in sediments, gas hydrates may also form on drilling equipment and in pipelines in deep water, trapping methane and other gas molecules and posing hazards such as drilling difficulties, blockages and pressure buildup in valves and pipelines, and an increased risk of well control loss (Boatman and Peterson 2000).

Shallow Water Flow. Shallow water flow is a deepwater drilling hazard that occurs when overpressured, unconsolidated sands are encountered at shallow depths, 460 to 2,100 m (1,500 to 7,000 ft) below the seabed (Huffman and Castagna 2001). When encountered, these sands are prone to uncontrolled flow, potentially damaging the well and causing well casing failure — which could result in the loss of the well.[7] In extreme cases, overpressured sands have been known to erupt, creating seafloor craters (due to collapse), mounds, and cracks. Shallow water flow sands are difficult to detect seismically because there is little contrast in acoustic impedance at sand/shale interfaces at shallow depths (Lu et al. 2005; Ostermeier et al. 2002); however, some investigators are having success using high-resolution multi-component seismic data to delineate anomalies to identify zones that might produce shallow water flow (e.g., Huffman and Castagna 2001).

Slope Failure. Submarine slope failures result from processes that reduce the shear strength of sediment on submarine slopes and/or increase the main driving force (gravity) that promotes the downslope movement of sediments. Hance (2003) summarizes the published literature on submarine slope failure and identifies 14 triggering mechanisms, a subset of which is relevant to the GOM shelf and slope: (1) sedimentation processes that involve rapid deposition, especially in offshore delta areas and at the base of submarine canyons; (2) increased fluid pressures resulting from the disassociation of gas hydrates and the release and accumulation of free gas; (3) ocean storm waves and subsurface current (internal) waves; (4) tidal events,

[7] Shallow water flow is estimated to have occurred in about 70% of all deepwater wells (Hoffman and Castagna 2001).

especially along coastlines; (5) human activities such as construction and dredging, usually along coastlines; (6) salt diapirism, which oversteepens soils on the flanks of diapirs; (7) mud-related volcanic activity; and (8) sediment creep, a process involving the slow movement of large masses of sediment.

Mudflows occur within well-defined gullies along the submerged portion of the Mississippi Delta, creating unstable conditions vulnerable to failure. Areas between the mudflow gullies have lower sedimentation rates and are considered to be generally stable. Active deposition takes place downslope of the gullies. Damage to pipelines and production facilities due to mudflow overruns has been documented in this region (Hitchcock et al. 2010). Other forms of sediment instability along the delta front include collapse depressions, submarine landslides, and shelf-edge slumps (Coleman et al. 1991; Coleman and Prior 1988).

Nodine et al. (2006) also reported pipeline damage by mudslides within (and confined to) the mudflow lobes along the delta front during Hurricane Ivan in 2004.

Faulting. Faulting occurs on a range of scales within the GOM continental shelf and slope, from major growth faults[8] that cut across thousands of meters of sedimentary section to much smaller faults related primarily to salt movement in the shallow subsurface. Vertical offsets along faults create steep scarps on the seafloor, leading to various forms of subaqueous mass movement (falls, slides or slumps, flows, and turbidity flow) that contribute to the seafloor's irregular topography. Faults also provide pathways for the upward migration and expulsion of fluids and gas at the seafloor surface (Roberts 2001b; Coleman and Prior 1988).

Active faults could pose a hazard to oil and gas activities in areas of rapid deposition and subsidence (such as the Mississippi Delta), especially in areas where formation fluids such as water and oil are withdrawn. In the GOM, fault activity is thought to be most prevalent on steep slopes at the shelf edge where sediment accumulation creates loading stress that is periodically relieved by sudden faulting and associated with active salt diapirs on the upper slope (Foote and Martin 1981).

4.2.1.2 Alaska – Cook Inlet

The Cook Inlet Planning Area encompasses the lower half of Cook Inlet (referred to as lower Cook Inlet) and Shelikof Strait. The following descriptions of physiography, bathymetry, and geologic hazards address physiographic features and geologic processes throughout Cook Inlet (including the upper inlet) for completeness.

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8 Growth faults are normal (extensional) faults that form at the same time massive volumes of sediments are accumulating within an area of high deposition, such as the Mississippi Delta. The fault plane is typically well-defined and is linear or concave and fairly steep. Growth faults exhibit greater offset with increasing depth and extend more than 150 m (500 ft) below the sea floor. They are most common on the outer shelf and upper slope where sediment accumulation and subsidence are greatest (Foote and Martin 1981; MMS 2006a; Teague et al. 2006b).

4.2.1.2.1 Physiography and Bathymetry. Cook Inlet is a northeast-trending, 350-km (220-mi) long tidal estuary on the south-central coast of Alaska. It is situated between the Kenai Peninsula and Alaska Peninsula and extends from Anchorage to the Gulf of Alaska (Figure 4.2.1-2). The inlet is composed of three distinct physiographic regions: the head, the upper inlet, and the lower inlet. The head region lies at the northernmost end of Cook Inlet and consists of two long and narrow bays: Knik and Turnagain Arms, both of which have extensive tidal marsh flats during low tide. Knik Arm begins at the confluence of the Knik and Matanuska Rivers, about 50 km (31 mi) inland; it ranges in width from about 2 to 10 km (1.2 to 6.2 mi). The Port of Anchorage is located on the southeast shore of Knik Arm, at the mouth of Ship Creek. Turnagain Arm extends about 75 km (47 mi) inland to the railroad depot at Portage; it ranges in width from about 2 to 26 km (1.2 to 16 mi). Fire Island is located at the midpoint between Knik and Turnagain Arms, just off the coast of Anchorage (Mulherin et al. 2001).

Upper Cook Inlet is about 95 km (59 mi) long and extends from Point Campbell to the East and West Forelands (Figures 4.2.1-2 and 4.2.1-3). It ranges in width from 20 to 30 km (12 to 19 mi) and narrows to 16 km (10 mi) between the Foreland peninsulas. Several shallow shoals occur in this region, including Middle Ground Shoal, just north of the Forelands and north of the inlet's midline; Beluga Shoal, due south of the mouth of Susitna River, at the inlet's midline; and Fire Island Shoal, due west of Fire Island. Water depths in upper Cook Inlet are generally less than 37 m (120 ft), with the greatest depths at Trading Bay, the largest bay in the upper inlet, just east of the mouth of McArthur River (Mulherin et al. 2001; ADNR 2009a).

Lower Cook Inlet is about 200 km (120 mi) long and lies between the Foreland peninsulas and the inlet's mouth, which opens to the Gulf of Alaska between Cape Douglas on the Alaska Peninsula and Cape Elizabeth on the Kenai Peninsula (Figures 4.2.1-2 and 4.2.1-4). There are several islands within the lower inlet, including Augustine Island, in Kamishak Bay; Chisik Island, at the mouth of Tuxedini Bay; and Kalgin Island, about 30 km (19 mi) south of the Forelands. The Barren Islands and Chugach Islands are located at the inlet's mouth. The bathymetry is characterized as having sloping sides forming a central depression (Cook Trough) that gradually deepens to the south and widens as it approaches the Cook Plateau near the mouth of the inlet. The depression bifurcates to the north into two channels, divided by a narrow shoal (Kalgin Platform) extending southward from Kalgin Island. The Cook Plateau lies between the lower end of the Cook Trough and the top of Cook Ramp, a gently sloping ramp delineating the sandy sediments to the north and muddy sands to the south. The Cook Plateau and parts of the Cook Ramp are covered by bedforms of various sizes. The ramp slopes from a water depth of about 70 m (230 ft) to about 120 to 130 m (390 to 430 ft) as it approaches the north end of the Shelikof Trough (Mulherin et al. 2001; ADNR 2009a; Bouma 1981; Bouma et al. 1978a).

The Chinitna Platform covers most of the western part of lower Cook Inlet (Figure 4.2.1-2). Its surface is smooth with numerous small topographic highs and lows. Most of the bottom is hard and covered by coarse-grained sediment and shells (although embayments may have muddy bottoms). Augustine Island is located on the platform, and a shallow area, known as the Augustine Apron, encircles the island (Bouma 1981).

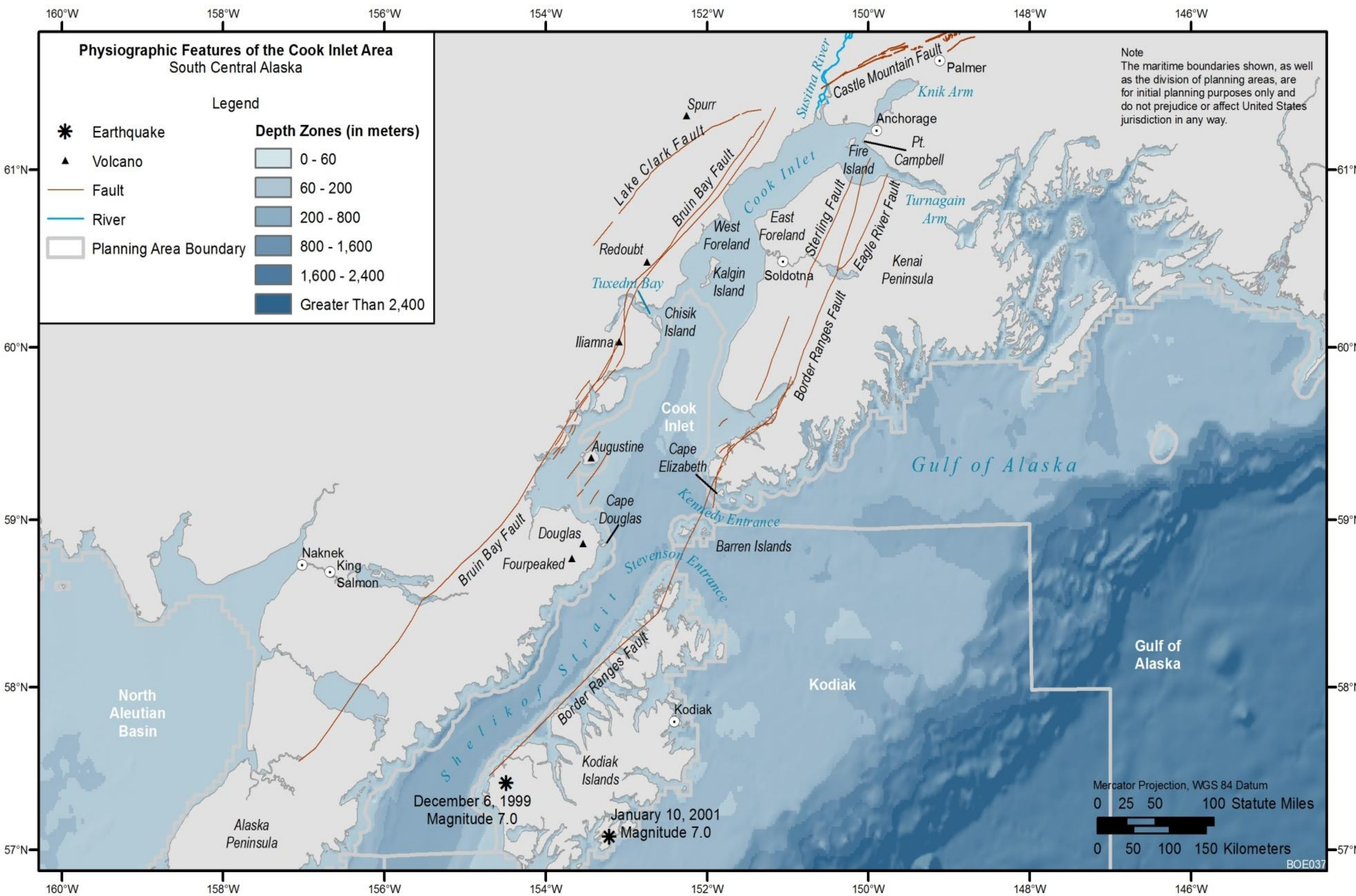

FIGURE 4.2.1-2 Physiographic Features of Cook Inlet (Earthquake data from USGS 2011a; map data for faults from Labay and Haeussler 2001; Troutman and Stanley 2003; and Clough 2011.)

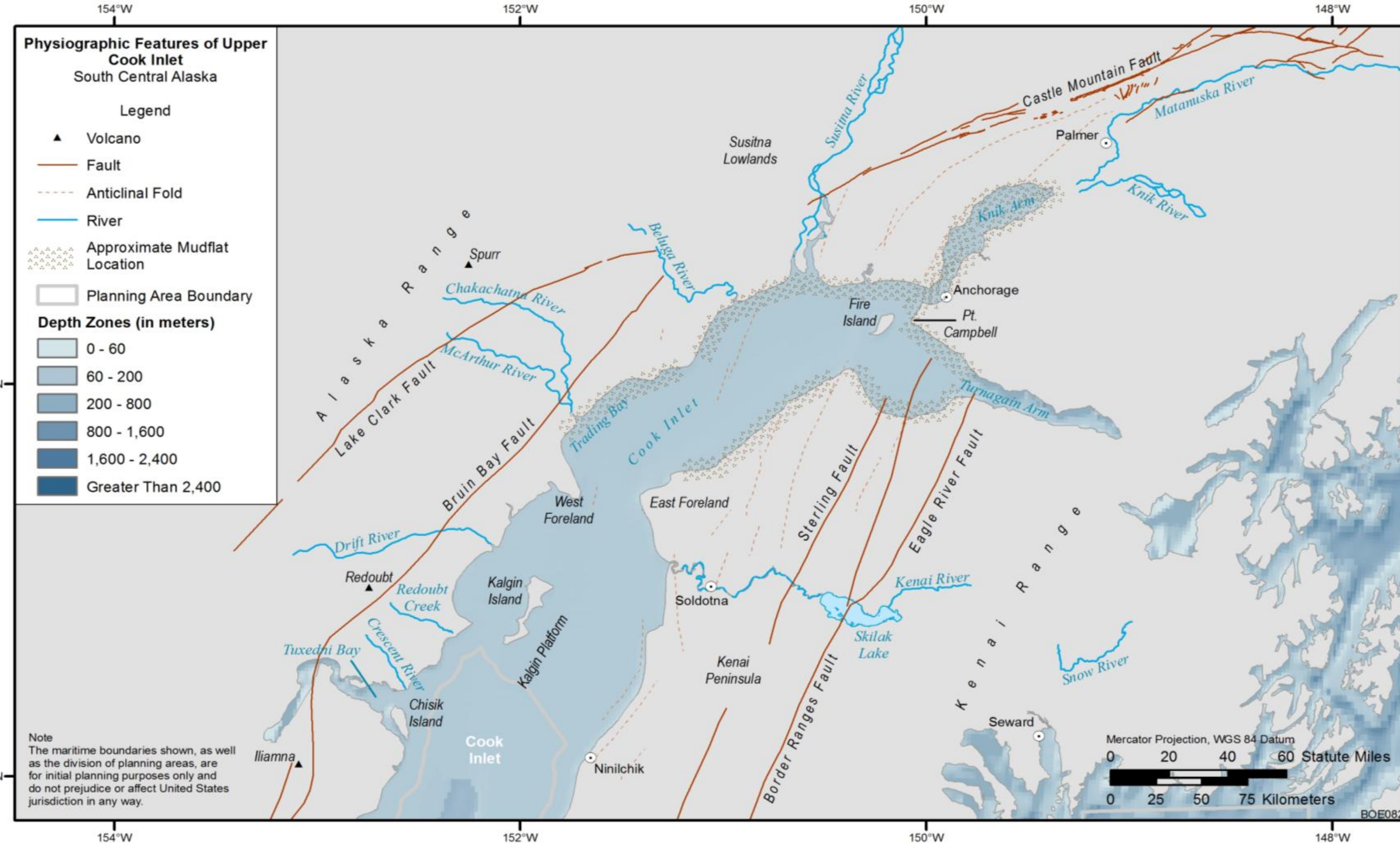

FIGURE 4.2.1-3 Upper Cook Inlet (Map data for faults from Labay and Haeussler 2001; Troutman and Stanley 2003; and Clough 2011; mudflat data from Mulherin et al. 2001.)

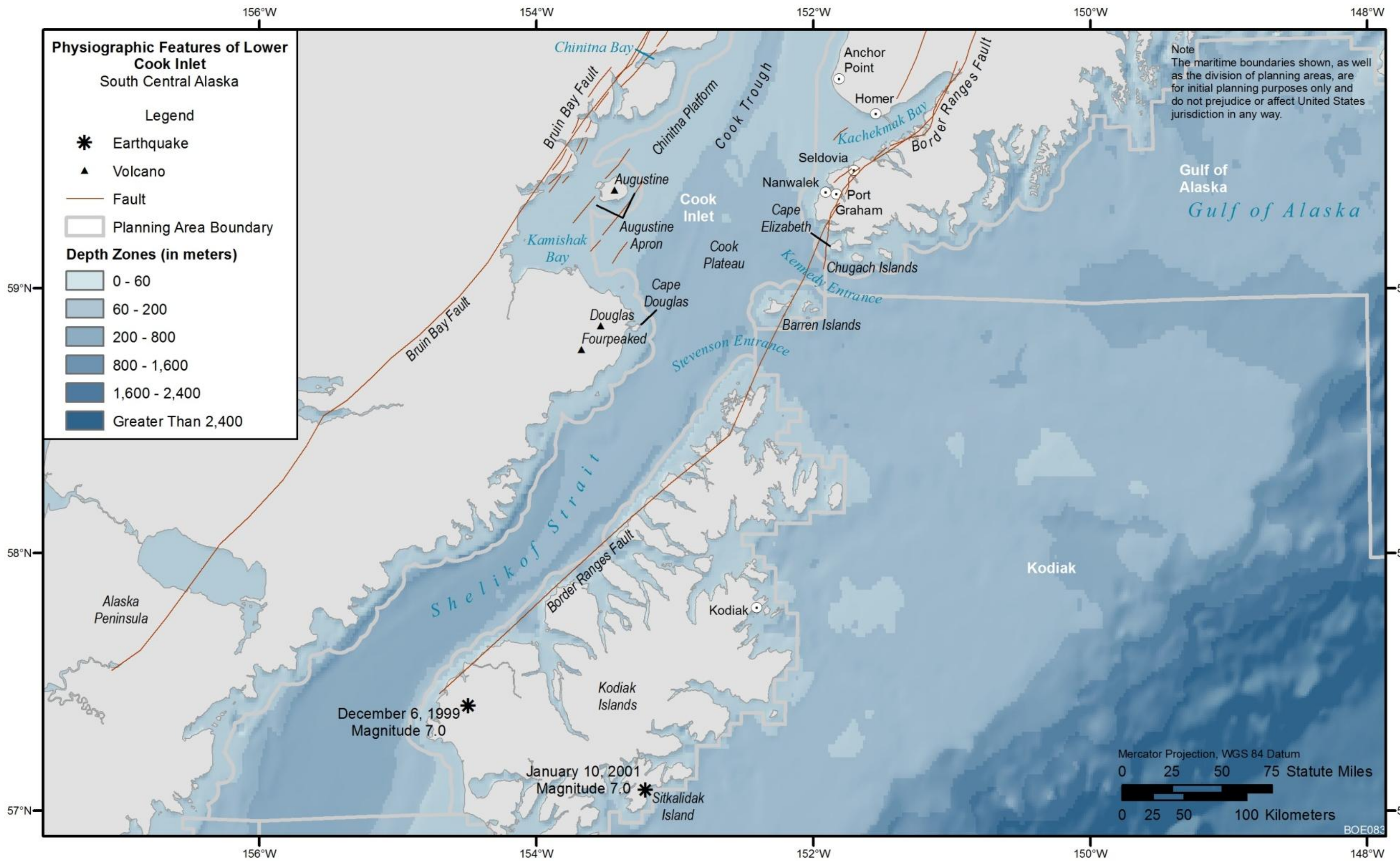

FIGURE 4.2.1-4 Lower Cook Inlet (Earthquake data from USGS 2011a; map data for faults from Labay and Haeussler 2001; Troutman and Stanley 2003; and Clough 2011.)

There are three entrances to the lower inlet from the Gulf of Alaska; these are the Kennedy and Stevenson Entrances on either side of the Barren Islands off the northeastern end of the Kodiak Islands and the opening of Shelikof Strait on the inlet's southwestern end.

Shelikof Strait lies between the Kodiak Island group and the Alaska Peninsula and also has a northeast orientation (Figure 4.2.1-2). The strait is about 200 km (120 mi) long, with an average width of about 45 km (27 mi). The seafloor in this region consists of a flat, central platform (coinciding with the Shelikof Trough) that slopes gently to the southwest. The platform is flanked by narrow marginal channels than run alongside the Kodiak Islands and the Alaska Peninsula. Relief on the platform and within the marginal channels can be as high as 100 m (330 ft) locally. Water depths in Shelikof Strait increase gradually in a southwestward direction, ranging from about 80 m (260 ft) at the mouth of Cook Inlet to more than 300 m (980 ft) off the west end of the Kodiak Islands (Hampton et al. 1978; Bouma 1981; Hampton et al. 1981). Deep subsurface faults (offsetting rocks of Tertiary age or older) occur along the margins of Shelikof Strait and run parallel to the shorelines of Kodiak Island and the Alaska Peninsula. Shallow faults are more recently active and occur throughout the strait — along its margins, as growth faults, and in association with structural highs (horsts or remnant volcanic necks) — and trend predominantly to the northeast (Hoose and Whitney 1980).

4.2.1.2.2 Geologic Hazards. Several types of geologic hazards are known to occur in the marine environment of Cook Inlet and Shelikof Strait and may present a risk to offshore oil and gas activities because they are dangerous to navigation or potentially damaging to marine structures. The potential geologic hazards in Cook Inlet and Shelikof Strait, except for sea ice, which is addressed in Section 4.2.2.1.1, are described below.

Seafloor Instability. The generally shallow nature and large tidal range of Cook Inlet (9 m [30 ft]) produce rapid currents. The Coriolis effect is also pronounced at this latitude, and during peak flow, all these factors combine to create strong cross-currents and considerable turbulence (strong currents and turbulence are also generated as tides flow through the constricted Forelands area). High current velocities and turbulence keep fine sediments (silt and clay) in suspension, so they are transported far from their source in the head region — the Susitna and Knik Rivers — and then back again with the incoming tide. As a result, bottom sediments throughout most of the inlet are predominantly coarse-grained (cobbles, pebbles, and sand) with only minor amounts of silt and clay. Grain size distribution in the inlet, which reflects the type and energy of transportation during the tidal cycle, is as follows: (1) sand, in the head region to the east of the Susitna River; (2) sandy gravel and gravel, in the upper inlet and the upper part of the lower inlet (to Chinitna Bay); and (3) gravelly sand with minor silt and clay, in the lower inlet as far as the Barren Islands (Sharma and Burrell 1970).

MMS (1996b) concluded that the bottom sediments in Cook Inlet provide a stable substrate with no unusual geotechnical issues. This conclusion was based on the nature of bottom sediments in Cook Inlet (mainly coarse-grained), the low rate of sediment accumulation, and the low relief of the seafloor. Previous studies found no areas of soft, unconsolidated sediments or evidence of failed or unstable slopes.[9]

Bedforms and Bedform Migration. Bedforms are depositional features on the seabed that form by the movement of sediment by strong bottom currents. Bedforms are common in Cook Inlet and occur as sand waves, dunes, sand ribbons, sand ridges, and megaripples with wavelengths ranging from 50 to 800 m (160 to 2,600 ft) and heights from 2.0 to 14 m (6.6 to 46 ft). The type of bedform occurring at a given location depends on factors such as sediment size and availability, water depth, and current velocity (Hampton 1982a). Bedform migration and the strong bottom currents that cause it are known to be hazardous to offshore operations in upper Cook Inlet because they undermine or bury bottom-founded structures such as anchors and pipelines (Bouma et al. 1978b; Bouma and Hampton 1986; Whitney et al. 1979; Bartsch-Winkler 1982). Several pipeline failures in Cook Inlet have been attributed to sediment movement that results from current-sediment interaction (ADNR 2009a).

The largest bedform fields in lower Cook Inlet occur in its central and southern parts (especially on Cook Plateau and Cook Ramp) where bottom current velocities may be as high as 50 cm/s (20 in./s) (Whitney and Thurston 1981; Bouma et al. 1978b; Bouma 1981). Studies conducted in the lower inlet indicate sand grains move mainly during storm events and in response to ebb and flood cycles, especially during spring tide (Bouma and Hampton 1986).

Shallow Gas. Shallow gas is a hazard to drilling operations when encountered because it increases the potential for loss of well control. Shallow gas-charged sediments[10] have been documented in Cook Inlet, and loss of well control incidents have occurred at the Steelhead platform (well M-26; 1987–1988) and Grayling platform (well G-10RD; 1985) in upper Cook Inlet north of the West Foreland. The incident at the Grayling platform stopped on its own as a result of well bore collapse that naturally sealed off the escaping fluids and gases. At the Steelhead platform, however, some injuries to workers and damage to the platform occurred as a result of escaping gases that caught fire (ADNR 2009a).

Whitney and Thurston (1981) delineated shallow gas-charged sediment areas at depths of less than 50 m (160 ft) below the seafloor in lower Cook Inlet based on high-resolution seismic profiles. The areas occur to the west of the Barren Islands between bathymetric contours 150 km

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[9] Studies of sediments in the head region (at the northernmost end of Cook Inlet), however, do indicate soft sediments (e.g., in Knik Arm) that have unstable banks and bottoms and a high liquefaction potential. Surface bedforms are common features in these sediments (Bartsch-Winkler 1982).

[10] Natural gas (predominantly methane) in Cook Inlet sediments likely originates from the decay of trapped organic matter in recent sediments and seepage from deeper sources, as reported by Molnia et al. (1979) for the Gulf of Alaska. Gas from deeper sources in the Cook Inlet basin has two types of occurrences: (1) the shallow reserves of biogenic gas in the Sterling, Beluga, and upper Tyonek Formations of the nonmarine Kenai Group of Tertiary age, at depths less than 2,300 m (7,500 ft); and (2) the oil-associated (thermogenic) gas in the lower Tyonek Formation, the Hemlock Conglomerate, and the West Foreland Formation at the base of the Tertiary section, having migrated from underlying marine source rocks of Jurassic age (Claypool et al. 1980). Regardless of origin, high-pressure methane is highly mobile, flammable, and buoyant and poses a great hazard to drilling operations when encountered (Judd and Hovland 2007).

and 180 km (93 mi and 110 mi) and to the southeast of Augustine Island between bathymetric contours 20 km and 100 km (12 mi and 62 mi) (Whitney and Thurston 1981). Although areas of gas-charged sediments can be identified in high-resolution marine seismic data, the concentrations of gas in sediments are highly variable over small lateral and vertical distances (Hampton 1982b).

Hoose and Whitney (1980) mapped possible gas-charged sediments in the shallow subsurface at the northeast end of Shelikof Strait (also based on high-resolution marine seismic data).

Seismicity. Seismicity in the Cook Inlet region is related to movement along the Alaska-Aleutian megathrust fault as the northwestward-moving Pacific plate subducts into the mantle beneath the North American plate (Figure 4.2.1-5). Shallow crustal earthquakes are generated as a result of deformation of the overriding North American plate; deeper earthquakes occur along the interface of the plates (Benioff Zone) that extends from the trench to depths of 40 to 60 km (25 to 37 mi), deepening to the northwest. Within the subducting Pacific plate, earthquakes can be as deep as 300 km (186 mi) (Rhea et al. 2010).

Major fault systems occur along the margins of the Cook Inlet basin. They include the Castle Mountain, Lake Clark, and Bruin Bay Faults, located to the north and northwest, and the Border Ranges Fault, on the Kenai Peninsula to the southeast (Figure 4.2.1-2). The faults have a northeast strike and are among the largest strike-slip fault systems in Alaska. Of these, only the Castle Mountain Fault has been active in recent times (with several earthquakes with an inferred moment magnitude (M_W)[11] of 7.1 occurring in the past 4,100 years along the southern slopes of the Talkeetna Mountains) (Labay and Haeussler 2001; Haeussler et al. 2000). There is no evidence of recent or Quaternary movement along the Lake Clark or Bruin faults. Haessler and Saltus (2004) identified a 26-km (16-mi) right-lateral offset on the Lake Clark Fault that likely occurred in the past 34 to 39 million years (Late Eocene), based on aeromagnetic data. The Border Ranges fault system is considered to be inactive. The most recent activity on the Border Ranges fault system likely occurred less than 24 million years ago (Neogene); some investigators suggest activity may have been as recent as several thousand years ago (Stevens and Craw 2004).

Numerous anticlinal folds present throughout the Cook Inlet basin are also potential sources of earthquakes. The folds are discontinuous, fault-cored (transpressional) structures that result from active deformational processes within the basin. The folds are generally oriented subparallel to the margins of the basin (Figures 4.2.1-3 and 4.2.1-4). Haeussler et al. (2000) have identified 22 such structures that, if active, are large enough to generate earthquakes of M 6.0 or greater. Fault slip rates along these structures are estimated to be on the order of a few millimeters per year or less, suggesting earthquake recurrence intervals between 50 and 6,000 years. The highest magnitude earthquakes in Alaska are associated with the

[11] Moment magnitude (M_W) is used for earthquakes with magnitudes greater than 3.5 and is based on the moment of the earthquake, equal to the rigidity of the earth times the average amount of slip on the fault times the amount of fault area that slipped. Moment magnitude is the preferred magnitude for all earthquakes listed in USGS databases. It replaces the more general usage of "M," which is used to describe historical earthquakes in the literature. An "M" denotes a magnitude consistent with the Richter scale (USGS 2010).

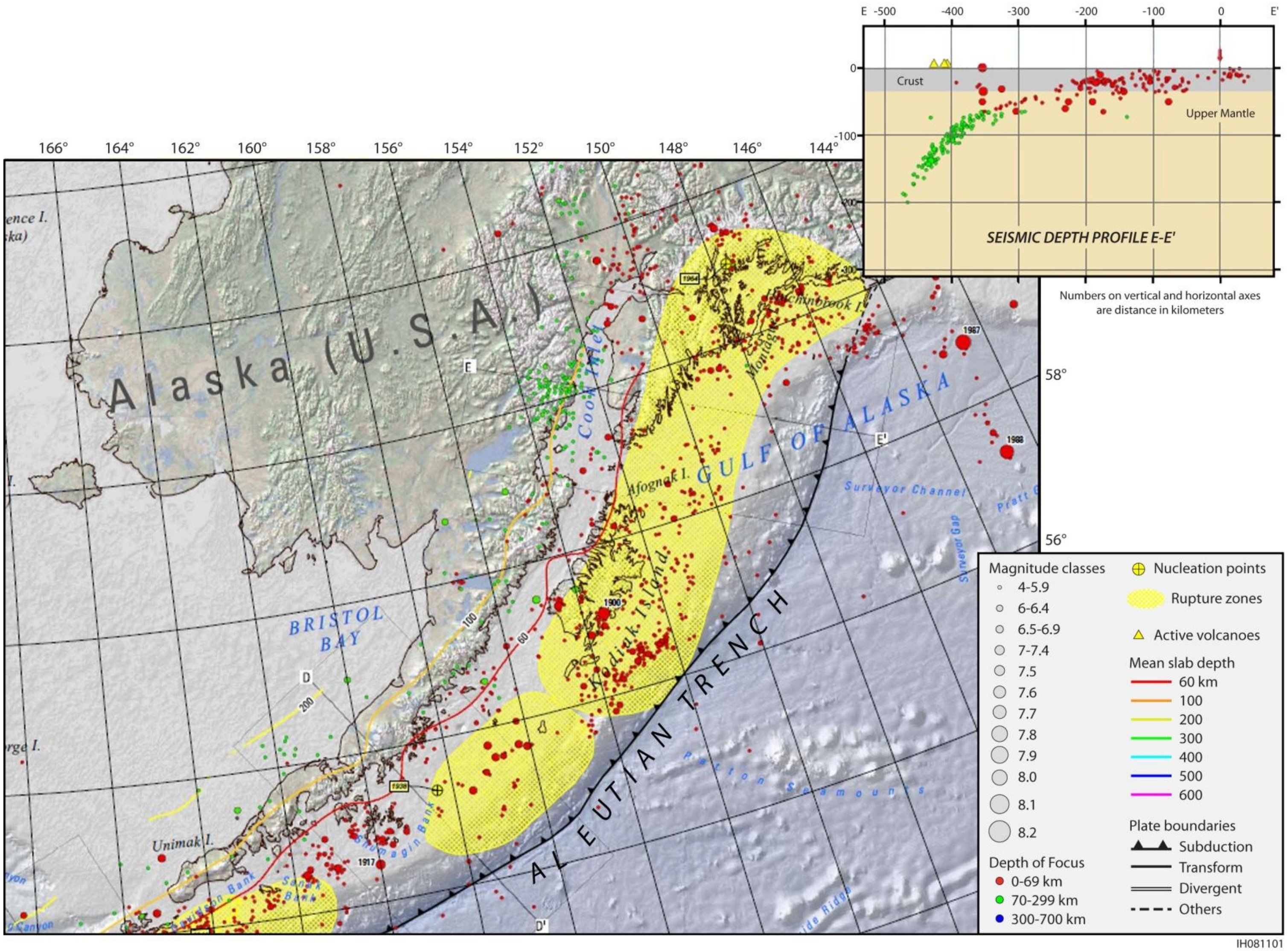

FIGURE 4.2.1-5 The Alaska-Aleutian Megathrust Fault and Subduction Zone (Aleutian Trench) with Seismicity Depth Profile across Cook Inlet (modified from Rhea et al. 2010)

Alaska-Aleutian megathrust zone and are common in the Aleutian Islands, the Alaska Peninsula, and the Gulf of Alaska. Since 1900, six earthquakes over magnitude 8.4 have occurred in these regions (some of which predate oil and gas activities in Cook Inlet) (Rhea et al. 2010).

Since 1973, more than 1,200 earthquakes with magnitudes greater than 3.0 have been recorded in the Cook Inlet region (USGS 2011a). Of these, 10 had magnitudes greater than 6.0. The two largest earthquakes occurred in 1999 and 2001 and were located on Kodiak and Sitkalidak Islands (Figure 4.2.1-2). Each earthquake registered a M_W of 7.0 (Figure 4.2.1-2).

Cook Inlet lies within an area where the peak horizontal accelerations of 0.30 and 0.40 g have a 10% probability of exceedance in 50 years (USGS 1999). Shaking associated with this level of acceleration is generally perceived as very strong to severe, and the potential for damage to structures is moderate to heavy (Wald et al. 2006). Given the high intensity of ground shaking and the high incidence of historic seismicity in the Cook Inlet region (i.e., 1,200 earthquakes in the past 40 years with 10 exceeding M 6.0), the potential for liquefaction in inlet sediments is also likely to be high, but only in areas like the head region and upper inlet where sediments are composed of glacial silt and fine sands, as demonstrated by the widespread liquefaction documented in Turnagain Arm during the Great Alaska Earthquake of 1964 (there was little damage to oil and gas-related structures within the inlet). Areas like the OCS where bottom sediments are more coarse-grained are not likely to be affected (Greb and Archer 2007).

Earthquakes greater than M 6.0 pose a risk to the Cook Inlet region by triggering floods and landslides. Earthquakes greater than M 7.0 may trigger a tsunami and cause emergency events such as fires, explosions, and hazardous material spills and a disruption of vital services (water, sewer, power, gas, and transportation).

Volcanic Activity. There are four monitored volcanoes located in the Cook Inlet region (from north to south): Spurr, Redoubt, Iliamna, and Augustine (Figure 4.2.1-2; Table 4.2.1-1). These volcanoes are part of the Aleutian Island Arc, a chain of volcanoes extending from south central Alaska to the far western tip of the Aleutian Islands. Three of these volcanoes (Spurr, Redoubt, and Iliamna) are located to the west of Cook Inlet. Augustine is an island volcano in lower Cook Inlet; it is the most active volcano in the region. All but Iliamna have erupted several times in the past 150 to 200 years and may erupt again in the future (Waythomas et al. 1997; Waythomas and Waitt 1998). Because of their composition, volcanoes in the Cook Inlet region are prone to explosive eruptions. Hazards in the immediate vicinity of the eruption include volcanic ash fallout and ballistics, lahars (mudflows) and floods, pyroclastic flows and surges, debris avalanches, directed blasts, and volcanic gases. Lease areas in Cook Inlet would be out of the range of most of these eruption hazards except during very large eruptions (on the scale of the 1980 Mount St. Helens eruption), which tend to be rare events (Combellick et al. 1995; ADNR 2009a). Ash fall associated with the 2009 eruption of Redoubt forced the temporary closure of the Anchorage Airport (ADN 2009); however, there were no reports that it affected oil and gas operations or damaged infrastructure within or around Cook Inlet.

Drainages with headwaters near the three onshore Cook Inlet volcanoes are susceptible to lahars (mudflows) and floods during volcanic eruptions due to the permanent snow and ice

TABLE 4.2.1-1 Monitored Volcanoes near Cook Inlet[a]

Volcano	Description/Location	Historical Eruptions	Potential Hazards
Mount Spurr	Ice- and snow-covered stratovolcano on the west side of Cook Inlet, about 120 km (75 mi) west of Anchorage. Peak elevation is 3,374 m (11,070 ft).	1953 and 1992 (Crater Peak flank vent about 3.5 km [2 mi] south of summit).	Ash clouds, ash fall and bombs, pyroclastic flows and surges, and mudflows (lahars) that could inundate drainages on all sides of the volcano, but primarily on south and east flanks. Eruptions at the Crater Peak vent were brief and explosive, producing columns of ash.
Redoubt	Stratovolcano on the west side of Cook Inlet, about 170 km (106 mi) southwest of Anchorage. Peak elevation is 3,108 m (10,197 ft).	1902, 1966–1968, 1989–1990, and 2009.	Ash clouds, ash fall and bombs, pyroclastic flows and surges, debris avalanches, directed blasts, volcanic gases, tsunamis, and mudflows (lahars) and floods that could inundate drainages on all sides of the volcano, primarily on the north flank. The 1989–1990 eruption produced a lahar that traveled down the Drift River and partially flooded the Drift River Oil Terminal facility. Significant ash plume. Ash fall from the 2009 eruption forced the airport in Anchorage to close temporarily (ADN 2009); there were no reports of damage to oil and gas operations in Cook Inlet. Tephra from future eruptions could travel several hundred kilometers from the volcano (carried by prevailing winds to the northeast).
Iliamna	Ice- and snow-covered stratovolcano on the west side of lower Cook Inlet, about 225 km (140 mi) southwest of Anchorage and 113 km (70 mi) southwest of Homer. Peak elevation is 3,053 m (10,016 ft).	No historical activity.	Ash clouds, ash fall and bombs, pyroclastic flows and surges, debris avalanches, and mudflows (lahars) and floods that could inundate drainages on all sides of the volcano.
Augustine	Island stratovolcano in lower Cook Inlet, about 290 km (180 mi) southwest of Anchorage and 120 km (75 mi) southwest of Homer. Peak elevation is 1,260 m (4,134 ft).	Most active volcano in region with significant eruptions in 1812, 1883, 1908, 1935, 1963–1964, 1976, 1986, and 2006.	Ash clouds, ash fall and volcanic bombs, pyroclastic flows and surges, debris avalanches, directed blasts, mudflows (lahars) and floods, volcanic gases, tsunamis, and lava flows. A large avalanche on the volcano's north flank during the 1883 eruption flowed into Cook Inlet and may have initiated a tsunami at Nanwalek, about 90 km (56 mi) to the east.

[a] Volcanoes listed are monitored by the Alaska Volcano Observatory in Anchorage. Other volcanoes in the region west of Cook Inlet include Hayes and Double Glacier. The Hayes volcano is a stratovolcano remnant, almost completely ice-covered; no fumeroles have been observed. Most recent eruptions were more than 3,000 years ago. The Double Glacier volcano is a dome remnant surrounded by the Double Glacier; it is considered to be inactive. There are also numerous unmonitored volcanoes (e.g., Mt. Douglas and Fourpeaked Mountain) on the Alaska Peninsula to the west of the Kodiak Islands.

Sources: USGS 2011b; Waythomas and Waitt 1998; Waythomas et al. 1997; Till et al. 1990.

stored in snowfields and glaciers on the upper flanks of the volcanoes that can generate flooding upon melting. For example, the Redoubt eruption that occurred in 1989–1990 caused significant melting of the Drift Glacier, generating lahars that inundated the Drift River valley and threatened the Drift River Oil Terminal. Oil storage tanks were damaged (although the tanks did not rupture) and loading operations at the terminal (and associated pipeline and platform services) were interrupted for several months, but resumed once a protective dike was installed around the tank farm and support facilities. The interruption in operations at the terminal caused a significant financial impact to the area (Waythomas et al. 1997; ADNR 2009a; Kenai Peninsula Borough 2011). Drainages vulnerable to volcanically induced floods are the Chakachatna River drainage (from Trading Bay to the McArthur River), the Drift River drainage (from Montana Bill Creek to Little Jack Slough), Redoubt Creek, and the Crescent River. The Drift and Chakachatna Rivers are the most likely to host such floods. Volcanogenic mudflows and floods could affect roads and onshore and offshore infrastructure such as pipelines (Combellick et al. 1995; ADNR 2009a).

Other (more distal) volcanic-related hazards include volcanic ash clouds and tsunamis. Volcanic ash is ejected high into the atmosphere and stratosphere by explosive eruptions and drifts downwind, eventually falling to the ground. Hazards related to ashfalls include damage to mechanical and electronic equipment (e.g., engines, computers, and transformers) and, in more rare events, building collapse. Volcanic ashfalls in Cook Inlet are typically less than a few millimeters in thickness and occur with an average frequency of a few every 10 to 20 years (Combellick et al. 1995; ADNR 2009a).

An eruption from Augustine volcano in 1883 caused a debris avalanche that entered Cook Inlet and initiated a tsunami that caused four 4.6 to 9.1 m (15 to 30 ft) waves to hit Nanwalek about 90 km (56 mi) to the east (Waythomas and Waitt 1998; Kenai Peninsula Bureau 2011). Waves of 4.6 m (15 ft) also reportedly struck Port Graham. Boats were swept into the harbor and several residences were flooded, but damage was minor because the tide was low at the time (Kenai Peninsula Bureau 2011). While the risk of coastal damage from locally generated tsunamis is potentially high, the probability of occurrence is low. The configuration of Cook Inlet and its narrow entrances reduce the likelihood that a tsunami generated outside the inlet would create a significant hazard (Bouma and Hampton 1986).

Flooding. The U.S. Geological Survey (USGS) reports that floods in the Cook Inlet drainage basin result from intense, warm rains originating in the Pacific Ocean. They are also caused by the release of water from glacier-dammed lakes or ice jams (and by tsunamis and seiches, discussed in the next section). Nearly all major floods occur between July and early October, but they can also occur during snowmelt season (May to June) if the snowpack is above average (Brabets et al. 1999).

Since streamflow monitoring began in the late 1940s, at least four major floods have occurred in the drainage basin, covering large areas of the basin and causing considerable property damage (Brabets et al. 1999):

- *May 1971*. Snow cover was greater than average along the Alaska Range, and below-normal air temperatures delayed snowmelt until July, creating conditions conducive to flooding. Inundated areas included northeast and west Anchorage and parts of the Susitna and Matanuska River basins.

- *October 1986*. A large Pacific storm system moved onshore over south central Alaska, causing record-setting rainfall that caused flooding in the lower Susitna River Valley, with recurrence intervals greater than 100 years.

- *August 1989*. Record rainfall caused several streams in the Anchorage area to exceed prior record peak discharges. The Knik River also recorded a peak discharge at a 100-year recurrence.

- *September 1995*. Remnants of a tropical storm caused flooding along the Skwentna River, the Knik River and tributaries, the Kenai River, and along Glacier Creeks (Girdwood). Several rivers discharging to Knik Arm had peak flows estimated to have been greater than the 100-year flood.

Other floods in the Cook Inlet drainage basin have occurred from glacier-dam outbursts that result when glacial movement opens a pathway for water trapped behind a glacier to be released. Rivers on the west side of the upper inlet are subject to outburst floods of great magnitude as a result of sudden drainage of large, glacier-dammed lakes; among these are the Beluga, Chakachatna, Middle, McArthur, Big, and Drift Rivers. One of the largest outburst floods occurred in 1969 (and again in 2007) when water released from glacier-dammed Skilak Lake lifted ice on the frozen river and severely scoured the river banks as a surge of water and large chunks of ice travelled downstream. Outburst floods also occur on the Kenai River (east of Cook Inlet) where a glacier-dammed lake at the headwaters of the Snow River fails every two to five years. Historically, the Knik River near Palmer (at the northernmost end of Cook Inlet) has flooded when glacier-dammed Lake George fails. Such floods occur more frequently in the fall and can be especially severe if the lakes or the Kenai River are already high or frozen (Brabets et al. 1999; Combellick et al. 1995; ADNR 2009a; Kenai Peninsula Borough 2011; Post and Mayo 1971).

Ice jam flooding occurs during the spring breakup process when strong ice or constrictions in a river (bends or obstructions like islands or gravel bars) create jam points that cause moving ice along the breakup front to stop (NOAA 2011a). It also occurs when low-density ice masses (frazil ice) become trapped and pile up under surface ice. The ice stoppage causes water levels to rise and flood the adjacent land. Ice jams are more often associated with single-channel rivers in interior and northern Alaska than in rivers of the Cook Inlet drainage basin, but a flood from an ice jam downstream of Skilak Lake in the Kenai River watershed (east of Cook Inlet) occurred in 1969 after an outburst from Skilak Glacier at the head of Skilak Lake, creating a record high river stage (74.25 m [22.63 ft]) and causing severe damage in Soldotna. Ice jams are unpredictable and have the potential to be worse than 100- or 500-year events, causing heavy damage to bridges, piers, levees, jetties, and other structures along the riverbank (Brabets et al. 1999; NOAA 2011a; ADNR 2009a; Kenai Peninsula Borough 2011).

Hazards from flooding result from inundation, riverbank instability and erosion, high bedload transport, deposition at the river mouth, and channel modification and mainly affect onshore facilities (e.g., terminal facilities and pipelines) (ADNR 2009a). Assessing flood potential and community vulnerability is difficult because significant natural and man-made changes occur within floodplains over short time intervals. Federal Emergency Management Agency (FEMA) flood insurance rate mapping updates for Kenai Peninsula Borough are currently under way. A vulnerability assessment to identify the population, property, and environment that may be exposed to flooding is also planned for Seward (Kenai Peninsula Borough 2011).

Tsunamis and Seiches. A tsunami is a series of long ocean waves generated by the displacement of a large volume of water caused by earthquakes, volcanic eruptions, submarine landslides, or onshore landslides that rapidly release large volumes of debris into the water. Most tsunami waves affecting south central Alaska are generated along subduction zones bordering the Pacific Ocean where motion along a dip-slip fault and the elastic rebound of subducting crust, produced by an earthquake of magnitude greater than 6.5 on the Richter scale, causes vertical displacement of the seafloor. The great seismicity associated with the subduction zone of the Aleutian-Alaskan megathrust fault system makes the southern coastal region of Alaska, especially the Gulf of Alaska and the Aleutian Islands, highly susceptible to tsunamis (Costello 1985).

Tsunamis are typically not hazardous to vessels and floating structures on the open ocean because of their small wave heights (less than a few feet). However, they are potentially very damaging to coastal regions and nearshore facilities because wave heights can increase significantly as tsunamis approach shallow water. High, breaking waves that reach the shoreline at high tide cause much more damage than waves that are low and nonbreaking or that occur at low tide (Combellick and Long 1983; MMS 1992).

Because of the shallow, elongated configuration of Cook Inlet and its narrow entrances, the hazard from distant tsunamis is low. The hazard from local tsunamis is also low because there are no active surface faults in the inlet, no adjacent steep slopes to serve as sources of massive slides into the inlet, and no evidence of thick, unstable seafloor deposits that could fail and create massive underwater slides. Local landslide-generated tsunamis, however, can be quite large and potentially damaging, as demonstrated by the series of 4.6 to 9.1 m (15 to 30 ft) waves that reportedly hit Nanwalek and Port Graham on the east side of lower Cook Inlet as a result of a debris avalanche caused by the eruption of Augustine volcano in 1883 (Waythomas and Waitt 1998; Kenai Peninsula Borough 2011). Future eruptions of Augustine could potentially generate a tsunami in lower Cook Inlet if significant volumes of volcanic debris were to enter the sea rapidly (although this remains a topic of debate). Modeling studies indicate that a moderate wave is possible (with lead times of about 27 to 125 min), but the likelihood of a tsunami is considered to be low. None of the last five eruptions of Augustine volcano, including the latest one in 2006, resulted in a tsunami; nevertheless, the West Coast and Alaska Tsunami Warning Center and the Alaska Volcano Observatory continue to refine their public outreach strategy to deal with a volcanogenic tsunami because local consequences of such an event could be high (Neal et al. 2011; Waythomas and Waitt 1998; ADNR 2009a).

Seiches are periodic oscillations of standing waves in partially or completely enclosed water-filled basins like lakes, bays, or rivers triggered by changes in wind stress or atmospheric pressure and, less commonly, by landslides and earthquakes (McCulloch 1966). In Alaska, they may also be generated by the collapse of deltas into deep glacial lakes (Kenai Peninsula Borough 2011). An example is the Lituya Bay earthquake of 1958 (M_W 8.2), which caused a landslide at the head of Lituya Bay (on the Gulf of Alaska) and generated a seiche with a wave run-up of about 530 m (1,750 ft) (MMS 1992; Bouma and Hampton 1986).

During the Great Alaska Earthquake of 1964 (M_W 9.2), tsunamis were generated by uplift of the seafloor and seiches were generated by landslides in semiconfined bays and inlets (USGS 2011b; MMS 1992). Because the Kenai Peninsula is susceptible to earthquakes with magnitudes greater than M 6.0, the Kenai Peninsula Borough mitigation plan rates the coastal communities and facilities in lower Cook Inlet (south of the Forelands) as highly vulnerable to tsunamis — vulnerable communities include Port Graham, Nanwalek, Seldovia, Homer, Anchor Point, and Ninilchik. The tsunami risk for upper Cook Inlet, however, is considered low because of its relatively shallow depth and its distance from the lower end of the inlet (Kenai Peninsula Borough 2011).

4.2.1.3 Alaska – Arctic

4.2.1.3.1 Physiography and Bathymetry. The Arctic region is located along the Arctic coastline of Alaska. It is composed of the Beaufort Sea, Chukchi Sea, and Hope Basin Planning Areas (Figure 4.2.1-6). The Beaufort Sea stretches from the Alaska-Yukon border westward to Point Barrow. Here, the continental shelf has very low relief (on average 1 m/km; Craig et al. 1985) and extends 60 to 120 km (37 to 75 mi) from shore to water depths of 60 to 70 m (200 to 230 ft). Large-scale physiographic features are rare on the shelf, although barrier islands (rising several meters above sea level) and shoals (rising 5 to 10 m [16 to 33 ft] above the seabed) occur in a chain on the inner shelf along the 20-m (66-ft) depth contour, parallel to the shoreline. These features are migrating to the west at rates of about 20 to 30 m (66 to 98 ft) each year (MMS 2008c). Beyond the shelf is the Alaska rise and slope, an area where gravity-driven slope failures greatly influence the seafloor morphology (Grantz et al. 1994).

The Chukchi Sea is a broad embayment of the Arctic Ocean. It lies to the west of the Beaufort Sea, between Point Barrow to the east and Cape Prince of Wales to the west (Figure 4.2.1-6). The continental shelf in this region has low relief and a gentle slope to the north. Water depths range from about 30 to 60 m (98 to 200 ft) on the shelf and drop sharply to greater than 3,000 m (9,800 ft) into the Arctic basin to the north and east. There are several shoals on the shelf. Two prominent shoals, Herald Shoal to the west and Hanna Shoal to the east (at depths less than 20 m [66 ft] below sea level), are separated by a broad area that is about 35 to 40 m (110 to 130 ft) deep with a central channel. Isolated shoals also occur in the nearshore region (along the north and west coasts) in water depths of 20 to 30 m (66 to 98 ft). Hope Basin, a broad and shallow valley with water depths of about 50 m (160 ft), is located to the southwest of Point Hope (MMS 2008c). The outer edge of the shelf is dissected by gullies and large erosional features (Phillips et al. 1988).

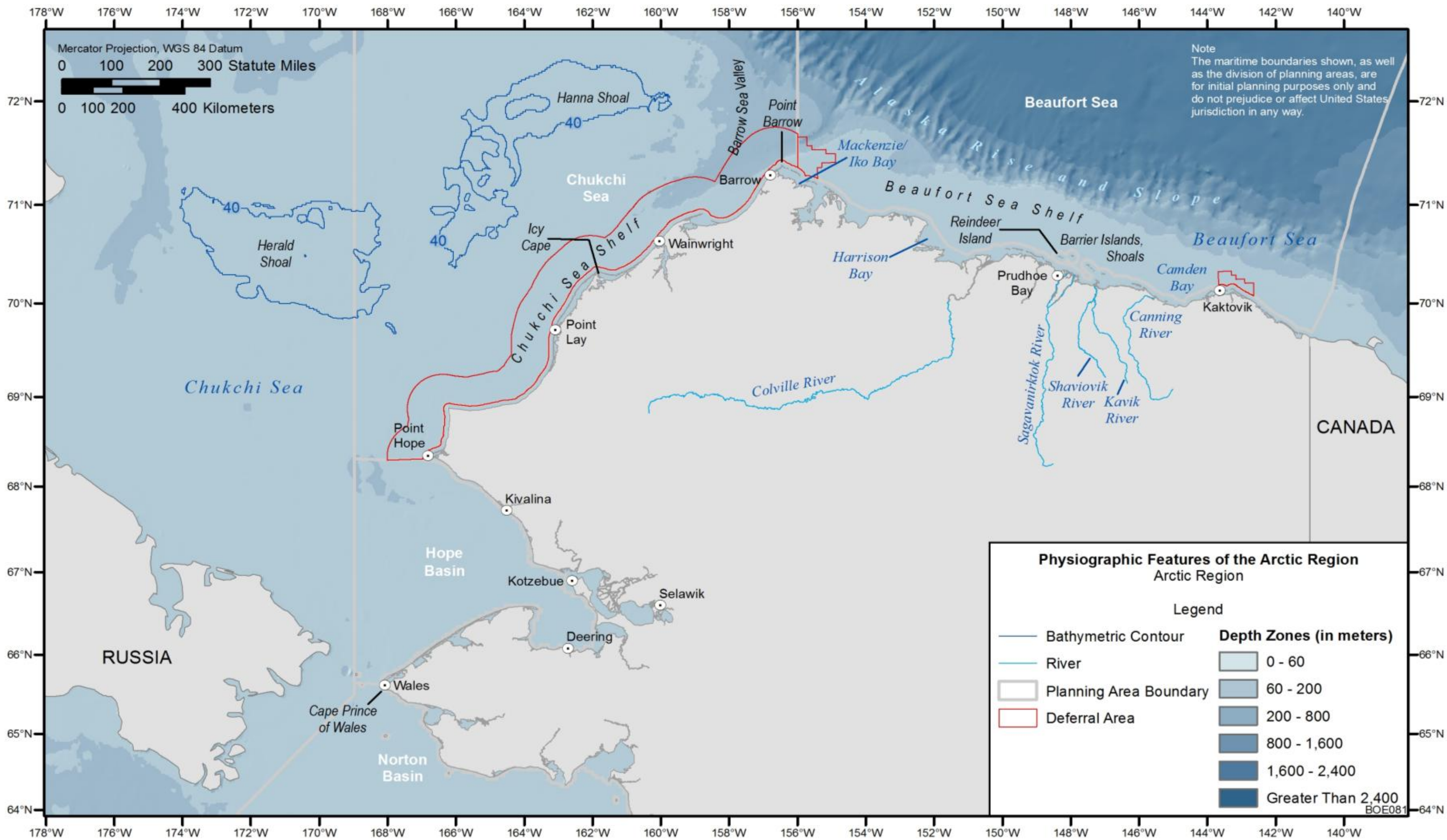

FIGURE 4.2.1-6 Physiographic Features of the Arctic Region

The Beaufort and Chukchi shelves are separated by the Barrow Sea Valley, a 200-km (120-mi) long, flat-bottomed basin incised by fluvial erosion during the Pleistocene epoch and interglacial marine currents (Figure 4.2.1-6). The valley ranges in depths from about 100 to 250 m (330 to 820 ft) (Craig et al. 1985; Phillips et al. 1988).

4.2.1.3.2 Geologic Hazards. Several types of geologic hazards are known to occur in the marine environment of the Beaufort and Chukchi Seas and may present a risk to offshore oil and gas activities because they are dangerous to navigation or potentially damaging to marine structures. The potential geologic hazards in the Arctic region, except for sea ice and permafrost, which are addressed in Sections 4.2.2.1.2 and 4.2.2.2, are described below.

Offshore and Coastal Currents. Marine currents along the central Beaufort shelf are primarily wind-driven and are strongly regulated by the presence or absence of ice. Sediment is transported by these currents along the barrier islands and the coastal promontories, although, because of the short open water season, the annual rate of longshore sediment transport is relatively low. The currents along the inner shelf generally flow to the west in response to the prevailing northeast wind, with current reversals occurring close to shore during storms. Farther from the shoreline, on the open shelf, the currents average between 7 and 10 cm/s (2.8 to 3.9 in./s). During storms, east-flowing currents have been measured with velocities of up to 95 cm/s (37 in./s), although typical storm current velocities are an order of magnitude lower. Under the ice in the winter, the currents are usually less than 2 cm/s (0.79 in./s), although some currents have been measured at up to 25 cm/s (9.8 in./s) in areas around grounded ice blocks (Hopkins and Hartz 1978; ADNR 2009a).

Geostrophic currents occur on the outer shelf, flowing parallel to the shelf-slope break. These currents have been measured at velocities of up to 50 cm/s (20 in./s) and can travel in both easterly and westerly directions. Since the tidal range on the central Beaufort shelf is small, approximately 15 to 30 cm (5.9 to 12 in.), the tidal currents exert only minor influences on the sedimentary regime. When the water flow on the shelf is restricted by bottomfast ice, these currents can act as important scouring agents (Craig et al. 1985; ADNR 2009a).

Offshore structures must be designed to withstand strong marine currents, loading from ice forces, and severe storms in the Beaufort Sea. Production platforms will typically be bottom-founded (gravity base) to withstand conditions that change with the seasons. Drillships for exploration are not bottom-founded; therefore, they can only operate in low ice cover conditions. Artificial or natural gravel islands must be fortified and built to withstand coastal currents as well as the forces of moving sea ice for the lifespan of the producing field. To this end, they may require periodic maintenance in response to heavy storms (ADNR 2009a).

Flooding. Floods due to seasonal snowmelt and ice jams occur annually along most of the rivers in the Arctic region and many of the adjacent low terraces. Spring ice breakup on rivers often occurs over the first few days of a three-week period of flooding in late May through early June. Up to 80% of the flow occurs during this period. The impact of flooding is in large part related to the magnitude and timing of seasonal ice breakup. The formation of ice jams is especially associated with catastrophic flooding. Some of the most damaging floods are associated with an above-average snowpack that is melted by rainstorms and sudden warming (ADNR 2009a).

Significant bank erosion may occur during flooding, depending on the amount of water and its level with respect to the river bank and the nature of the sediment (or ice) load. Ice carried along by rivers can produce significant erosion, especially if breakup occurs during a low river stage. Spring floodwaters inundate large areas of the deltas, and on reaching the coast spread over stable ground and floating ice up to 30 km (19 mi) from shore. When floodwater reaches openings in the ice often associated with tidal cracks, thermal cracks, and seal breathing holes, it rushes through with enough force to scour the bottom to depths of several meters (a process known as strudel scouring) (ADNR 2009a).

Along the Beaufort shelf, strudel scour craters have formed up to 6 m (20 ft) deep and 20 m (66 ft) across. In a study for the Northstar Pipeline, strudel scours were found in water depths of 2.2 to 5.4 m (7.2 to 18 ft), with the greatest scour occurring at depths of 3 to 4 m (9.8 to 13 ft). Sheltered coastal areas and bays adjacent to major rivers (such as the Colville, Sagavanirktok, and Canning) are particularly susceptible to strudel scouring. In these areas, deltas can be totally reworked by strudel scouring in several thousand years, although the scours can be filled in very rapidly (ADNR 2009a).

In addition to seasonal flooding, many rivers along the coast are subject to seasonal icing before spring thaw. This is due to overflow of the stream or groundwater under pressure, often where frozen or impermeable bed sections force the winter flow to the surface to freeze in a series of thin overflows, or where spring-fed tributaries overflow wide braided rivers. In areas of repeated overflow, residual ice sheets often become thick enough to extend beyond the floodplain margin. These large overflows and residual ice sheets have been documented on the Sagavanirktok, Shaviovik, Kavik, and Canning Rivers (ADNR 2009a).

Seasonal flooding of lowlands and river channels is extensive along major rivers of the Arctic region. Thus, measures must be taken before facility construction and field development to prevent impacts on structures and environmental damage (ADNR 2009a).

Barrier Island and Bedform Migration. Barrier islands along the Beaufort shelf consist of dynamic constructional islands and remnants of the Arctic coastal plain (ACP). As the barrier islands along the Beaufort shelf are migrating westward and landward due to erosion and redeposition by waves and currents, they are generally becoming narrower and breaking up into smaller segments (Hopins and Hartz 1978). During the open water season, longshore drift, storm surges, and ice push contribute to the erosion, migration, and breakup of these islands, which may permanently affect their size and influence on coastal processes.

Along the Chukchi shelf, asymmetrical bedform features, including small sand waves, larger shore-parallel shoals, and the grouped features of the Blossom Shoals, occur in water depths ranging from less than 15 m (50 ft) to approximately 60 m (200 ft) and extend to distances of up to 160 km (100 mi) offshore. The migration of sand waves and other bedforms can cause problems to offshore facilities by undermining or burying fixed structures, anchors, moorings for submersibles, and pipelines, which can rupture (Bouma and Hampton 1986).

Overpressured Sediments. Along the Beaufort and Chukchi shelves, extremely high pore pressures are likely to be found in deep basins (Kaktovik, Camden, and Nuwuk) where Cenozoic strata are very thick. For example, in the Point Thomson area, pore pressure gradients as high as 0.8 psi/ft (far exceeding the normal gradient of 0.433 psi/ft) have been measured in sediments at burial depths of 4,000 m (13,100 ft) (Craig et al. 1985; ADNR 2009a).

Encountering overpressured sediments during drilling can result in a loss of well control or uncontrolled flow (if formation pressures exceed the weight of drilling mud in the well bore). Identifying locations of overpressured sediments by seismic data analysis and adjusting the drilling mud mixture accordingly reduce this risk (ADNR 2009a).

Shallow Gas Deposits and Natural Gas Hydrates. Shallow gas deposits have been mapped using high-resolution seismic data in isolated areas within the continental shelf and slope regions of the Beaufort and Chukchi Seas. A recent investigation by the Joint Russian-American Long-Term Census of the Arctic Project team identified a pockmark field on the Chukchi Plateau. The pockmarks are typically related to the explosive release of gas (or gas-saturated water or oil)[12] (Astakhov et al. 2010). On the middle and inner shelf, gas is concentrated in buried Pleistocene delta and channel systems, along active faults overlying natural gas sources, and in pockets within and beneath permafrost very near to shore. On the outer shelf and slope, shallow gas is likely to occur in association with a large body of gas hydrate and at the head of the landslide terrain on the outermost region of the shelf and upper slope. The origins of shallow gas may be biogenic or thermogenic; in either case, its presence poses a hazard to bottom-founded structures because it can reduce the shear strength of sediments. Loss of well control may also occur when drilling operations encounter overpressured gas below the seabed (Grantz et al. 1982a, b; ADNR 1999).

Natural gas hydrates are unique compounds consisting of ice-like substances composed of gas trapped by water molecules. They are common in offshore regions under low-temperature, high-pressure conditions as well as at shallower depths associated with permafrost. In the Beaufort and Chukchi Seas, gas hydrates have been found at shallow depths under permafrost along the inner shelf and onshore at Prudhoe Bay and at the Mount Elbert well in Milne Point where downhole coring and logging operations were recently completed (ADNR 2009a).

One of the main problems associated with gas hydrates is dissociation, which causes unstable conditions by increasing fluid pressure and reducing sediment shear strength. Natural mechanisms leading to gas hydrate dissociation include sea level decrease and sediment temperature increase. Man-made mechanisms include heat transfer during petroleum production that leads to melting of hydrates. During drilling, rapid decomposition of gas hydrates can cause a rapid increase in pressure in the wellbore, gasification of the drilling mud, and the possible loss of well control. If the release of the hydrate gas is too rapid, a loss of well control can occur, and the escaping gas could ignite. In addition, the flow of hot hydrocarbons past a hydrate layer

[12] On the Chukchi Plateau, pockmarks may indicate areas of rapid gas release; however, their size and morphology are also consistent with thermokarst depressions developed along the Arctic shoreline (Astakhov et al. 2010).

could result in hydrate decomposition around the wellbore and loss of strength of the affected sediments (ADNR 2009a).

Dissociation of gas hydrates is a potential cause of submarine slope failures. Acoustic records indicate a stretch of slumps in the Beaufort Sea along the shelf-edge break. The slumps extend for at least 500 km (310 mi) in an area of known gas hydrates and should be considered during exploration and development activities (ADNR 2009a).

Because gas hydrates and shallow gas deposits pose risks similar to overpressured sediments, the same mechanisms for well control should be employed to reduce the danger of loss of life or damage to the environment (ADNR 2009a).

Sediment Sliding, Slumping, and Subsidence. Locally high rates of deposition of unconsolidated sediments on the increased gradient of the continental shelf edge may form unstable slopes that lead to intensive soil movements such as slumping, gravitational creep, turbidity or debris flows, and mudslides. A chaotic sediment slide terrane exists along the length of the Beaufort shelf and upper slope, seaward to the 50- to 60-m (160- to 200-ft) isobath. The distinct landslide types in this area include large bedding-plane slides and block glides. Sediment slumping, possibly associated with permafrost melting, has been observed north of the Mackenzie Delta in Canadian waters and may also disrupt buried pipelines and damage drilling structures (Grantz et al. 1982b).

Sediment slumping may also occur in association with active faulting. Regionally high rates of deposition on the continental shelf may cause isostatic adjustments and deep-seated gravity faulting (active faulting). Active gravity faults related to large rotational slump blocks occur on the outer Beaufort shelf and upper slope due to increased gradients along the shelf-slope break (Grantz and Dinter 1980).

Seismicity. Ground shaking during a major earthquake can cause consolidation problems in artificial gravel islands used as drilling platforms and affect bottom-founded structures. Earthquakes can also cause vertical and/or horizontal displacement along faults, uplift or subsidence, surface tilt, ground failure, and inundation (due to tsunamis) — all of which may affect the integrity of development infrastructure.

Several types of shallow faults occur on the Beaufort shelf, including high-angle, basement-involved normal faults (Barrow Arch in Harrison Bay); listric growth faults; and down-to-the-north gravity faults along the shelf-slope break. There has been no seismicity associated with the high-angle faults in Harrison Bay in recent times (Holocene) and there is little evidence of Quaternary movement,[13] but these faults may act as conduits for gas migration. Slow movement (creep) and detachment occurring along listric growth faults could affect the integrity of infrastructure over time (Grantz et al. 1982a, b; Craig et al. 1985).

[13] Craig and Thrasher (1982) conclude that the upper extent of shallow faults in Harrison Bay is uncertain based on seismic data. The irregular surface of Pleistocene (Quaternary) sediments and the ice-gouged nature of the seafloor obscure any fault displacement of these sediments. Most faults terminate below the unconformity marking the Cretaceous-Pleistocene contact; therefore, tectonic activity is likely to have occurred only infrequently (if at all) in the Quaternary.

The Camden Bay area, located at the northern end of a north-northeast trending band of seismicity extending northward from east-central Alaska, is seismically active, and near-surface faults show marked evidence of Quaternary movement. Since monitoring began in 1978, numerous earthquakes ranging in magnitude from 1 to 6 have occurred in the area along the axis of the northeast-southwest trending Camden anticline (Craig et al. 1985; Grantz et al. 1982a, b).

Sediment-covered fault scarps in the northern Chukchi Sea suggest Quaternary movement along faults in this region (Thurston and Theiss 1987; Grantz et al. 1982a).

A search of the Alaska Earthquake Information Center (AEIC) database for the Chukchi Sea coastal zone region (including Wainwright) found that 303 earthquakes with magnitudes ranging from less than M 2.0 to M 5.3 occurred between January 1, 1898, and October 31, 2011. Most of these earthquakes (172, or about 57%) measured less than M 3.0; another 35 (or about 12%) measured M 4.0 or greater. Earthquakes with M 5.0 or greater occurred in 1968, 1993, 1995, 2006, and 2007 (AEIC 2012).

Earthquakes are frequently felt on the Russian Chukchi Peninsula (also known as the Chukotka Peninsula), especially along the coastal zone of the Chukchi Sea. The USSR has published a map of seismic zonation in which it places Chukotka Peninsula in a 6 to 7 MSK[14] zone (Avetisov 1996). A 6 to 7 MSK zone is rated as strong to very strong with serious damage to buildings in poor condition and isolated cracks in soft ground and landslides on steep slopes (Alden 2012).

The region along Alaska's northern coast lies within an area where the peak horizontal acceleration with a 10% probability of exceedance in 50 years is between 0.03 and 0.07 g (Wesson et al. 2007). Shaking associated with this level of acceleration is generally perceived as weak, and the potential for damage to structures is negligible (Wald et al. 2006).

4.2.2 Sea Ice and Permafrost

4.2.2.1 Sea Ice

4.2.2.1.1 Cook Inlet. Ice cover in Cook Inlet is seasonal, forming in the fall (October to November, although the lower inlet is usually still ice-free in December) and disappearing completely in the spring. However, the dates of onset and clearance can vary considerably from year to year. The U.S. Army Corps of Engineers' (USACE) report *Marine Ice Atlas for Cook Inlet, Alaska* (Mulherin et al. 2001) provides a description of the factors that favor and discourage ice growth. It notes that offshore platforms built in Cook Inlet follow ice design criteria specified by the American Petroleum Institute. Since 1984, the National Weather

[14] MSK is the Medvedev-Sponheuer-Karnik scale of seismic intensity that has been in use in Europe and India since 1964 (Alden 2012).

Service (NWS) has provided analysis and forecasts for the extent, concentration, and stage of development of ice to aid commercial navigation, as well as fishing and tourist activities in the inlet (NWS ice chart archives are maintained by the Alaska State Climate Center in Anchorage); the National Ice Center also prepares semiweekly analyses throughout the ice season.

There are four types of ice that form in Cook Inlet: pack ice, shorefast ice, stamukhi, and estuarine and river ice. Pack ice is freely floating sea ice that forms directly from the freezing of seawater. In the shallow and turbulent waters of Cook Inlet, a major component of pack ice is "frazil" ice, which occurs as low-density masses of slushy, unconsolidated ice on the water surface. Floating ice poses the greatest hazard to navigation and marine structures. Between 1964 and 1986, at least eight incidents involving sea ice in Cook Inlet were recorded by the U.S. Coast Guard (USCG), most resulting in damaged pilings and docks in the Port of Anchorage area. In 1988, a small crude oil spill resulted when a tanker was punctured by ice. Several similar ice-related incidents have been recorded since then (Mulherin et al. 2001).

Shorefast ice is unmoving ice that remains firmly attached to the shoreline or other stationary structures once it forms. It forms directly by the freezing of seawater and from the piling and refreezing of ice or the flooding of snow on top of the ice. One form of shorefast ice, "beach ice," forms during flood tide as water freezes with mud and bonds to the sea bottom. When the air temperature is colder than seawater, this ice becomes progressively thicker with each successive high tide, accumulating as much as 2.5 cm (1 in.) of ice per tidal flood. The ice usually breaks free before it reaches about 0.5 m (1.6 ft) in thickness. Once freed, it becomes floating (pack) ice and drifts into deeper water (Mulherin et al. 2001).

Stamukhi are a form of sea ice that have broken and piled upward (hummocked) due to winds, tides, or thermal expansion. Under the right conditions (e.g., repeated wetting and accretion of seawater), they form the massive ice blocks (ice cakes) common to Cook Inlet. Stamukhi as thick as 12 m (40 ft) have been reported. Their large size makes them very hazardous to shipping vessels (Mulherin et al. 2001).

Much of the ice in Cook Inlet derives from freshwater sources — estuaries and rivers — especially in the head region and upper inlet. Estuarine ice is similar to sea ice but is significantly stronger. It is commonly entrained in pack ice and presents the same hazards to navigation and marine (shoreline) structures. River ice is discharged into the inlet during spring breakup; ice pieces can be as thick as 2 m (6.7 ft) (Mulherin et al. 2001).

4.2.2.1.2 Arctic Region. The Beaufort shelf is ice-covered between mid-October and mid-June, with a typical ice-free period during August and September. Sea ice begins forming in late September to early October and becomes continuous nearshore by mid-October. This ice remains through the winter and starts to break up in July, but the nearshore region is not ice-free until early August. In recent years, breakup has occurred earlier by as many as 21 and 6 days along the Beaufort and Chukchi coasts, respectively. Ice-free coastlines now occur over a month earlier along the Beaufort coast (ADNR 2009a; MMS 2008c).

During the winter months, ice occurs within three main nearshore and offshore zones: the landfast zone, the shear zone (also called the active or stamukhi zone), and the pack ice zone. Landfast ice forms along the shore and develops seaward in the early fall, extending 25 to 50 km (16 to 31 mi) from shore by late winter. This ice is up to 2 m (6.6 ft) thick and is considered stable because it is relatively stationary (moving less than a few meters after it forms). Small movements of the ice are related to storm fronts, which cause narrow leads and rubble fields in this zone (Reimnitz and Barnes 1974; MMS 2008c; ADNR 2009a).

The shear zone (stamukhi zone) is a transitional zone between landfast ice and the highly mobile pack ice, occurring approximately 20 to 60 km (12 to 37 mi) from the coast in water depths of about 20 to 100 m (60 to 330 ft). Fragments of seasonal ice and multiyear ice ridges are common in this zone. Ice ridges range in thickness from 10 to 12 m (33 to 39 ft) with an average thickness of 6 m (20 ft). It is here where ice is constantly being reworked and shifted and ice gouging (discussed below) occurs most intensely (ADNR 2009a; MMS 2008c).

Seaward of the stamukhi zone is the pack ice zone, which marks the shoreward edge of the permanent polar ice cap. It consists of multiyear ice, ice ridges, and ice island fragments that migrate westward in response to the clockwise circumpolar gyre (Reimnitz and Barnes 1974; ADNR 2009a). The drift rate of ice in this zone can be as high as 20 km/day (12 mi/day) (MMS 2008c).

The Chukchi shelf is largely covered by ice between mid-November and mid-June; August and September are typically ice-free. Ice thicknesses in the region are generally less than 1.2 to 1.4 m (3.9 to 4.6 ft) during the annual cycle. Multiyear ice is common in the Chukchi Sea; extensive ridging (with a ridge frequency of 3 to 5 per kilometer and sail heights of 1.5 to 3.7 m [4.9 to 12 ft]) is also common (MMS 2008c).

Sea ice poses a potential hazard to coastal and offshore structures; for example, concrete island drilling structures could be pushed off location, ice could override a fixed structure, or a marine pipeline could be damaged where it comes ashore. Facilities exposed to the potential risks of each sea ice zone must be designed and fortified to accommodate ice forces (ADNR 2009a).

Ice Scouring (Ice Gouging and Strudel Scour). The continental shelf below the Beaufort and Chukchi Seas is vulnerable to ice gouging and strudel scour, both of which must be taken into consideration when siting and designing subsea pipelines. Ice gouging results when ice ridges or icebergs with deep keels, moving under the influence of forces such as wind and ocean currents, run aground and penetrate the seabed, leaving linear to curvilinear deep furrows. Strudel scour occurs in relatively shallow water in the spring during river breakup when overflood waters spreading over bottomfast ice sheets and draining with high velocity through holes in the ice sheet (e.g., tidal cracks, thermal cracks, and seal breathing holes) erode the underlying sediments, leaving behind circular or linear areas of scour in the seabed. The magnitude and frequency of strudel scour events are affected by the timing and location of overflooding river discharge (and the effects of ice jams) and the types of surface features present (e.g., drainage cracks and fissures). Pipelines should be trenched to depths below the predicted scour depth and should be designed to withstand the forces associated with the gouging process, which can cause significant soil displacement (MMS 2008c; ADNR 2009a).

Although ice gouges are found across the entire Beaufort shelf, they are concentrated in the stamuhki zone, between the 10- and 30-m (33- and 98-ft) depth contours, with the most intense gouging on the up-drift side of shoals and islands bordering the stamuhki zone. In this region, crossing frequencies of 1 to 6 gouges/km/yr and a maximum gouge depth of 3.9 m (13 ft) have been reported. Ice gouges have a general east-west orientation, reflecting the prevailing wind and surface current directions; however, on the inner shelf where shoals and other bottom features deflect the ice, orientations are more variable. Off Prudhoe Bay, the inner boundary of high-intensity ice gouging is controlled by the location of the island chains, about 15 to 20 km (9.3 to 12 mi) offshore. In Harrison Bay, where there are no barrier islands, ice gouges are concentrated in areas of abundant ice ridge formation (MMS 2008c; Craig et al. 1985).

Ice gouging is less frequent inshore of the stamuhki zone (with reported crossing frequencies ranging from 1 to 2 gouges/km/yr) (MMS 2008c). It is also less severe in this region because gouges are rapidly buried by sand waves or sediment sheets (loose, coarser grained sediments in the nearshore region degrade more rapidly than the more cohesive, fine-grained sediments offshore). The incidence of ice gouging also decreases with increasing water depth offshore of the stamuhki zone since the number of ice keels large enough to reach the bottom decreases. Along the outer shelf edge, strong geostrophic currents smooth the older ice gouges by eroding or filling them in (ADNR 2009a).

Little survey data on ice gouging features are available for the Chukchi Sea, and repetitive mapping that would allow observed gouges to be dated and gouge rates to be estimated has not been done. However, gouge geometry (depth and width) and density have been recorded over broad areas in the Chukchi Sea, to a maximum water depth of 60 m (200 ft). The most significant ice gouging occurs on the main part of the continental shelf at water depths of 30 to 60 m (98 to 200 ft) where surficial sediments consist of thin deposits of sand and gravel overlying stiff consolidated clay or dense sandy gravel. In this region, a maximum gouge depth of 4.5 m (15 ft) was observed within a water depth of 35 to 40 m (110 to 130 ft). Gouges may be many kilometers long and tens of meters wide, and their dominant orientation is northeast-southwest (MMS 2008c; Phillips et al. 1988).

The areas adjacent to the Herald and Hanna shoals have only limited ice gouging (no gouge depths were recorded). Nearshore areas where water is shallow (less than 30 m [98 ft]) have an average gouge depth of 0.8 m (2.6 ft) and also have a low ice gouging density (MMS 2008c; Toimil 1978). Nearshore sediments are reworked by waves and currents to the extent that ice gouge morphology is readily obliterated by erosion and/or burial (Barnes and Reimnitz 1979). In general, ice gouging is more prevalent in the northern part of Chukchi Sea because the extent and duration of ice cover is greater. In the southern part of the Sea, the longer open water season allows for more reworking of the seabed by wave and current action, which likely masks evidence of past gouging (MMS 2008c).

Ice Movement (Ice Ride-up, Ice Override, and Icebergs). Continuous, large-scale ice movements in the Beaufort Sea are caused by major current systems (e.g., the Beaufort Gyre), tidal currents, or geostrophic winds. Local, short-term movements result mainly from wind, wave, and current action, particularly during storms. During a single ice season, ice movements create zones of landfast and pack ice. Zone boundaries fluctuate with seasonal ice growth and movement. Ice movements at a given site may have a predominant direction due to geography and environmental conditions (ADNR 2009a).

On islands and coastal regions throughout the Beaufort Sea, both ice ride-up (or ice push) and ice override events erode and transport significant amounts of sediment. Ice ride-up occurs where strong wind or currents force ice blocks onshore, pushing the sediment from the coast into the ridges farther inland. These processes are particularly important to consider for the outer barrier islands, where ice ride-up ridges may be as high as 2.5 m (8.2 ft) and extend 100 m (330 ft) inland, and where man-made structures are along the coast. They also have the potential to alter shorelines and nearshore bathymetry, increasing the risk of damage to man-made structures by erosion. Several accounts of damage to structures due to ice ride-up events have been documented along the Beaufort coast. For example, in January 1984, ice overtopped the Kadluck, an 8-m (26-ft) high caisson-retained drilling island located in Mackenzie Bay (MMS 2003e; ADNR 2009a).

Ice override occurs both offshore and onshore wherever ice overrides rafted ice or ice ride-ups along the coastline. Ice override onshore will add an additional dead load to a buried pipeline in the transition area from offshore to onshore beginning where the ice contacts the sea floor. This dead load, along with the force being exerted by the ice and the strength of soil, must be considered in pipeline design (ADNR 2009a).

Icebergs in the Beaufort Sea are rare but may be present as a result of calving off Nansen Island. Natural ice islands have also been observed on occasion. Ice islands are produced by the breakup of portions of the Ellesmere Ice Shelf and occur as tabular icebergs of the Arctic Ocean. They are usually 40 to 50 m (130 to 160 ft) thick with lateral dimensions that range from tens of meters to tens of kilometers. The annual risk of an iceberg or ice island impacting an offshore production facility is estimated to be 1 in 1,000 years; however, there is no threat to exploration or development activities in more shallow, nearshore regions (MMS 2008c; ADNR 2009a).

4.2.2.2 Subsea and Coastal Permafrost (Arctic Region)

The presence of subsea permafrost has been confirmed in several nearshore areas of the Beaufort shelf, where the onshore Pleistocene section and upper portions of the Brookian sequence (with a permafrost layer of up to 460 m [1,500 ft] thick) is thought to continue northward beneath the Beaufort shelf, grading into unfrozen strata farther offshore (and thinning to the west toward the Chukchi Sea). Seismic data indicates that subsea permafrost occurs at least 15 km (9.3 mi) north of Reindeer Island and at least 25 km (16 mi) offshore of Harrison Bay. Depths to permafrost vary, but wells drilled on Reindeer Island encountered two layers of ice-bonded sediments — an upper layer from 0 to 18.9 m (0 to 62 ft) and a lower layer from 91 to 128 m (300 to 420 ft). Investigators have suggested that the lower layer represents relict Pleistocene permafrost, while the upper layer was likely formed under modern Arctic conditions (Craig et al. 1985).

Permafrost along the coast of the Chukchi Sea is sparse or nonexistent, and the extent and distribution of subsea permafrost is largely unknown. Although the presence of subsea permafrost has not been determined from most seismic data collected from the Chukchi Sea, ice-bonded sediments were detected in seismic data collected in 5 m- (16 ft-)deep water north of Icy Cape, midway between Point Lay and Wainwright (MMS 2007b). Temperature gradients measured by Osterkamp and Harrison (1982) in shallow boreholes (less than 50 m, or 164 ft) along the southern Chukchi Sea coastline near Wainwright and Barrow indicate that the shoreline is generally stable and that ice-bearing subsea permafrost in the southern Chukchi Sea is thin or absent beyond a 1.0 km (0.62 mi) distance offshore. The absence of offshore permafrost is attributed to either melting by relatively warm currents moving north from the Bering Sea or the presence of near-surface consolidated rock that inhibited permafrost from developing in the first place (MMS 2007b).

Thaw subsidence (also known as thermokarst subsidence) and frost heave associated with permafrost in the Arctic region can create potential hazards to onshore oil and gas operations, especially for foundations, gravel excavation, and pipeline routing (Craig et al. 1985). The geologic record during the last Arctic glacial-to-interglacial transition indicates that global warming played a key role in disrupting the thermal balance of permafrost and initiating regional thaw subsidence. And some of the thermokarst activity (e.g., melting of ice wedges) over the last 100 to 150 years can also be attributed to global warming (Murton 2008). Oil and gas-related activities may also contribute to this process. These include drilling through permafrost layers; building and maintaining crude oil pipelines; placement and operation of bottom-founded structures; and construction of artificial islands, causeways, and berms. Subsea permafrost that contains trapped gas may melt during the drilling of wells or the subsequent production activities in areas surrounding the borehole, causing subsidence and rupture of the well casings and potentially leading to loss of well control.

4.2.3 Physical Oceanography

4.2.3.1 Gulf of Mexico

The physical conditions of ocean waters have the potential to disrupt activities relating to oil and gas production that occur on the continental shelf and slope, as well as in deepwater regions of the GOM. Coherent water motions and breaking waves can fatigue and damage oil and gas platforms and facilities, limit the timing of supply boats and drilling operations, and suspend all operations during extreme conditions such as hurricanes or tropical storms (MMS 2005a; Kaiser and Pulsipher 2007). As waves approach deck heights of platforms and supply ships, they can put equipment and personnel at risk (MMS 2005b). Storm events can also produce large forces near the ocean bottom that can scour sediments and affect pipelines and platform structures (DNV 2007; Cruz and Krausmann 2008; Wijesekera et al. 2010). Additionally, water currents and waves affect the horizontal and vertical transport of spilled oil, as well as contribute to the physical conditions that control natural weathering processes such as evaporation, emulsification, and oxidation (NOAA 2002; NRC 2003b).

The GOM is a partially enclosed sea covering an area of approximately 1.5 million km^2 (579,153 mi^2) and is connected to the Caribbean Sea and the Atlantic Ocean. The bathymetry of the GOM can be generalized as having a wide continental shelf along its northern and southern edges, prominent escarpments, and a relatively flat ocean floor (Bouma and Roberts 1990; see Figure 4.2.1-1. Circulation patterns in the GOM are the result of complex interactions among the bathymetry of the basin and forcing mechanisms that include winds, atmospheric conditions, water density (related to temperature and salinity), and the Loop Current (described below) (e.g., Oey et al. 2004; Sturges and Kenyos 2008). The GOM can be characterized as a two-layered system with respect to circulation patterns having a surface layer of up to 1,000 m (3,281 ft) in depth and a deep layer reaching down to the ocean floor at depths of approximately 4,000 m (13, 123 ft) (Lugo-Fernandez and Green 2011).

A generalized depiction of major, depth-averaged circulation patterns and bathymetry of the GOM is shown in Figure 4.2.3-1. The Loop Current and its associated mesoscale eddies are the dominant circulation features (Oey et al. 2005). Effects associated with Earth's rotation set up a western boundary current that is a part of an anticyclonic (clockwise) circulation pattern found in the western half of the GOM (Sturges and Blaha 1975; Sturges 1993). Over the continental shelf of Texas and Louisiana, wind-driven downcoast currents are common, with an opposite current along the continental slope (Cochrane and Kelly 1986; Nowlin et al. 1998; Zavala-Hidalgo et al. 2003). Currents along the continental shelf off Mississippi-Alabama show a pattern of complex cyclonic and anticyclonic eddy pairs with strong inter-annual variability, and they are also influenced by the positioning of the Loop Current (Brooks and Giammona 1991; Jochens et al. 2002). Deepwater circulation follows a counterclockwise pattern and consists primarily of low-frequency waves that receive energy from the Loop Current and its eddies (Hamilton 1990, 2007). In addition to depth-averaged circulation patterns, surface circulation patterns that are primarily driven by winds, as well as heat fluxes and river flows, are important to oil and gas operations, especially with respect to forecasting oil spill trajectories (Ji et al. 2011). Figure 4.3.2-2 shows seasonal averages and the annual mean of surface current patterns in the GOM from 1993 to 1998.

Understanding the circulation patterns and physical oceanographic conditions is vital for improving oil and gas production and exploration activities with respect to preserving the environment (Ji 2004; Lugo-Fernandez and Green 2011). In the GOM, the energetic water currents and waves that have the greatest potential to affect oil and gas activities can be characterized as those associated with episodic weather events (e.g., hurricanes and tropical storms), large-scale circulation patterns including the Loop Current and its associated mesoscale eddies, vertically coherent deepwater currents, and high-speed jets (DiMarco et al. 2004).

4.2.3.1.1 Hurricanes and Tropical Storms. Tropical conditions normally prevail over the GOM from June until October, and in a typical year, 11 tropical storms will form in the region with approximately 6 reaching hurricane status (Blake et al. 2007). Hurricanes and tropical storms can increase surface current speeds to between 1 and 2 m/s (3.2 and 6.8 ft/s) in continental shelf regions (Nowlin et al. 1998; Teague et al. 2007), as well as produce current speeds of more than 0.5 m/s (1.6 ft/s) in deeper waters on the continental slope (Brooks 1983; Teague et al. 2007). Recorded wave heights during recent hurricanes have shown an increasing

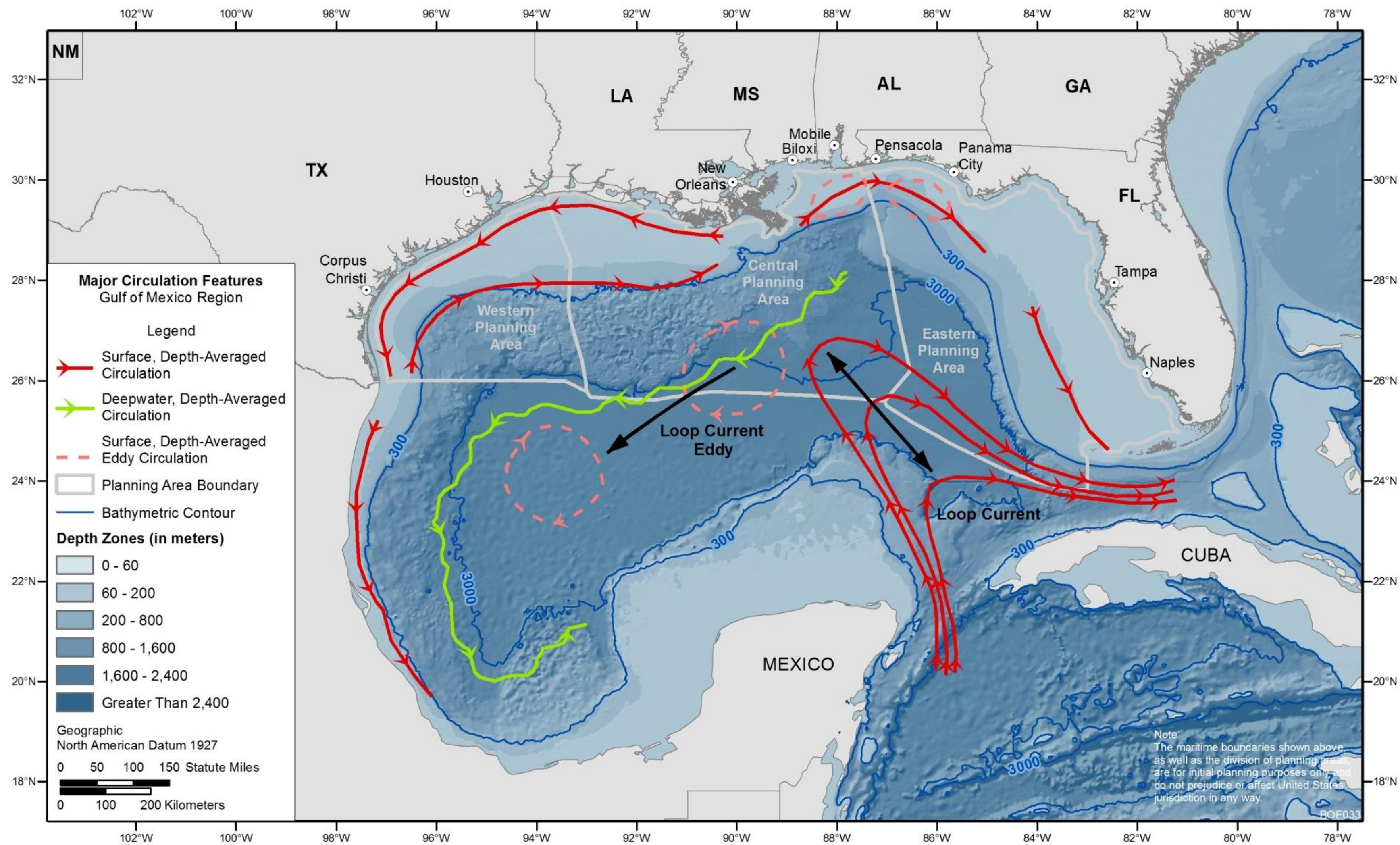

FIGURE 4.2.3-1 Generalized, Depth-Averaged Circulation Patterns in the GOM

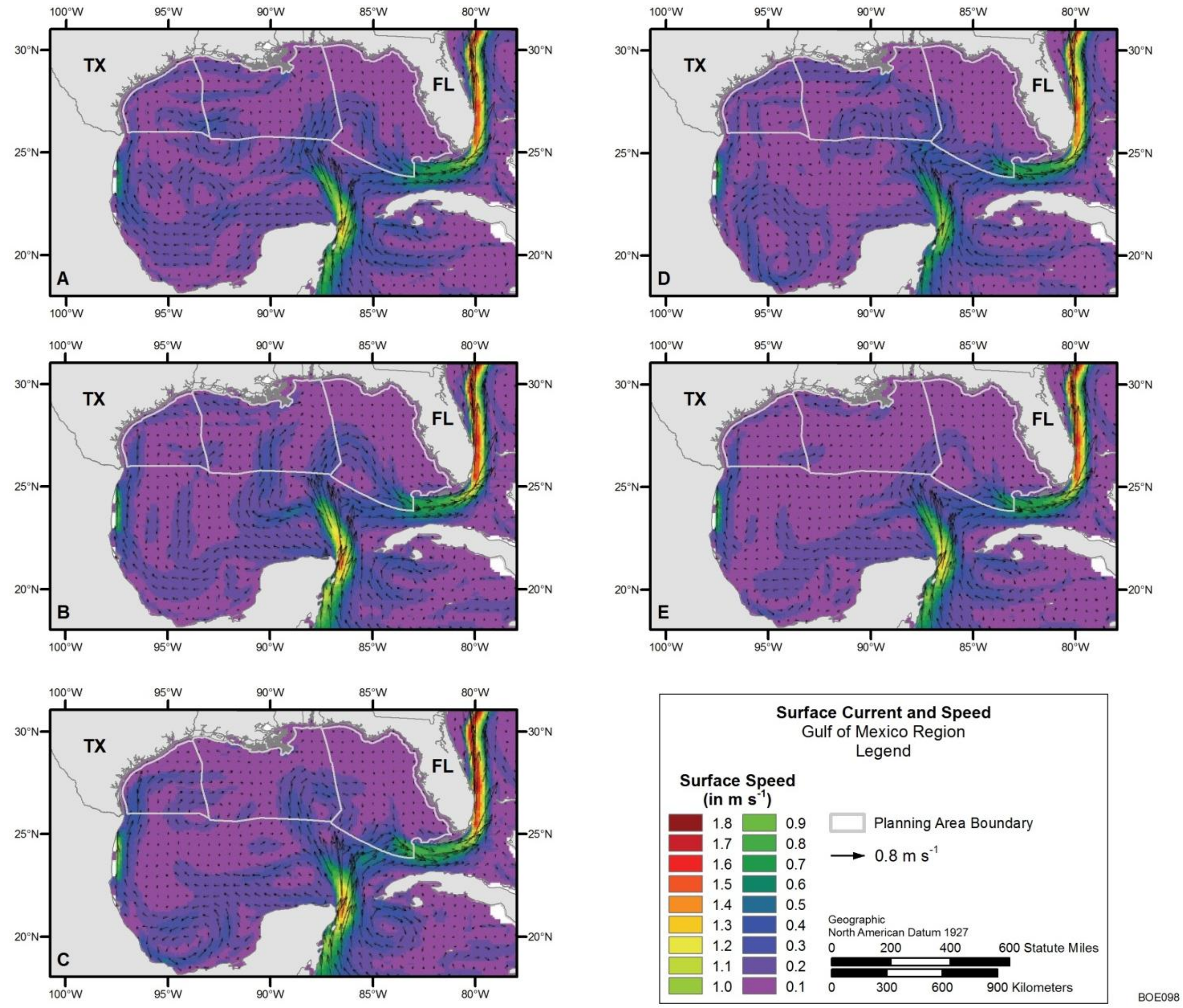

FIGURE 4.2.3-2 Surface Circulation Patterns in the GOM from 1993 to 1998: (a) Winter (January–March), (b) Spring (April–June), (c) Summer (July–September), (d) Fall (October–December), and (e) Annual Mean (January–December) (units are in m/s) (Ji et al. 2011)

pattern, with maximum wave heights exceeding 30 m (98 ft), which are greater than the current 100-year storm criteria for platform deck heights (MMS 2005b; Jeong and Panchang 2008). Storm surges can impact infrastructure along coasts and have been reported to range between 2 and 8 m (7 and 26 ft) for hurricanes reaching the northern coast of the GOM (NOAA 2011b).

Extensive observations of hurricane-induced currents and waves were not available until recent years, starting with Hurricane Ivan in 2004, which passed over an extensive array of instrumented moorings of the U.S. Naval Research Laboratory's Slope to Shelf Energetics and Exchange Dynamics (SEED) program (Stone et al. 2005; Teague et al. 2006a). As Hurricane Ivan approached the northern GOM in the fall of 2004, wind stresses produced downwelling conditions on the continental shelf with advective onshore surface currents and offshore currents in the lower portion of the water column (Mitchell et al. 2005; Teague et al. 2007). Current speeds on the continental shelf were often greater than 1.1 m/s (3.6 ft/s) with many flow reversals during the passage of the hurricane, and strong waves prevailed for up to 10 days in the wake of the hurricane's passage (Teague et al. 2007; Wijesekera et al. 2010). Sediment scour on the continental shelf was observed to be more than 100 million m^3 (81071 ac-ft) over a region of 525 km^2 (203 mi^2) (Teague et al. 2006b). Maximum wave heights associated with Hurricane Ivan reached 28 m (92 ft) with significant wave heights (average wave height of the upper-third-largest waves) reach 16 m (52 ft) (Jeong and Panchang 2008).

Hurricanes Ivan, Katrina, and Rita (2004 and 2005) were some of the most powerful hurricanes to enter the GOM (Stone et al. 2005) and were very damaging to oil and gas facilities and production operations (Cruz and Krausmann 2008). The strong winds, rapid currents, high waves, and sediment scour associated with Hurricane Ivan damaged offshore platforms, production wells, and pipeline systems resulting in a disruption of 10% of the GOM's production over a four-month period (MMS 2005c). Hurricanes Katrina and Rita resulted in more than 150 platforms (approximately 4% of the total number of platforms in the GOM) being damaged or destroyed primarily by effects associated with wave inundation (Cruz and Krausmann 2008). In response to these recent and severe hurricane events, industry and regulators are reexamining offshore oil and gas structural designs to improve their resistance to hurricanes, especially with respect to deck heights to resist wave inundation, as well as mooring anchors and pipeline designs to prevent damage by sediment scouring and mudslides (Abraham 2005; MMS 2005b).

4.2.3.1.2 Loop Current and Loop Current Eddies. The dominant circulation pattern in the GOM is the Loop Current, which can be generalized as a horseshoe-shaped circulation pattern that enters through the Yucatan Channel and exits through the Florida Straits (Figure 4.2.3-1). The Loop Current covers approximately 10% of the GOM's area (Hamilton et al. 2000; Lugo-Fernandez and Green 2011), has surface current speeds up to 1.8 m/s (5.9 ft/s) (Oey et al. 2005), and is present down to an 800-m (2,625-ft) depth (Nowlin et al. 2000; Lugo-Fernandez 2007). The incoming water of the Loop Current through the Yucatan Channel is typically warmer and saltier than the GOM waters, which in combination with its highly inertial circulation pattern generates energetic conditions that drive circulation patterns throughout the entire GOM (Lugo-Fernandez 2007; Jochens and DiMarco 2008; Lugo-Fernandez and Green 2011).

The Loop Current is not a stagnant circulation, as it alters its orientation angle and periodically extends northwesterly into the GOM with filaments being observed to intrude onto the continental slope near the Mississippi River Delta (Figure 4.3.2-1) (Muller-Karger et al. 2001; Oey et al. 2005). As the Loop Current extends north to approximately 27°N, an instability causes the formation of an anticyclonic eddy (Loop Current Eddy) to separate off from the Loop Current (Hamilton et al. 2000; Vukovich 2007). The physical mechanisms that trigger these Loop Current Eddy separations and their frequency of occurrence are not fully understood (Chang and Oey 2010; Sturges et al. 2010), but the period between Loop Current Eddy separations ranges from 0.5 to 18.5 months (e.g., Vukovich 2007). A linear relationship that exists between the period between Loop Current Eddy separations and the retreat latitude of the Loop Current following separation results from a balance in vorticity between water entering and water exiting the GOM that is displaced by the intrusion of the Loop Current moving toward the northern slope region (Lugo-Fernandez and Leben 2010). Loop Current Eddies typically have a diameter of 300 to 400 km (186 to 248 mi), current speeds between 1.5 to 2 m/s (4.9 to 6.6 ft/s), and speeds up to 0.1 m/s (0.3 ft/s) at a 500-m (1,640-ft) depth (Brooks 1984; Cooper et al. 1990). Loop Current Eddies migrate to the west and southwest under forces induced by the Earth's curvature and rotation with translation speeds ranging from 2 to 5 km/day (1.2 to 3.1 mi/day) (Brooks 1984; Oey et al. 2005).

Loop Current Eddies typically affect deepwater regions (depths greater than 400 m [1,312 ft]) of the GOM and have the potential to disrupt exploration, drilling, and production activities (Crout 2009). Currents associated with Loop Current Eddies have the ability to cause vortex-induced vibrations that can damage platforms and drilling equipment (Kaiser and Pulsipher 2007). It has been estimated that a sustained current of 2 m/s (6.6 ft/s) can use up the fatigue life of certain mooring system components in 1 week (DiMarco et al. 2004).

4.2.3.1.3 Deepwater Currents and Subsurface Jets. Oil and gas exploration and production activities are expanding more and more to deepwater regions of the GOM, which is what motivates the current research emphasis in deepwater currents (McKone et al. 2007; Lugo-Fernandez and Green 2011). Energetic waves and high-speed jets can affect the transport of pollutants such as drilling fluids and oil, as well as physical structures relating to oil and gas operations (DiMarco et al. 2004). For example, the Deep Water Horizon oil spill of 2010 demonstrated the need to understand how deepwater currents affect underwater oil spill plumes (e.g., Adcroft et al. 2010).

Deepwater currents (depths greater than 1,000 m [3,281 ft]) along the northern GOM are typically characterized as meandering waves (referred to as topographic Rossby waves [TRWs]) that are vertically coherent with some degree of bottom intensification, have periods greater than 10 days, are largely decoupled from surface circulations, and have a propagation velocity on the order of 9 km/day (5.6 mi/day) (Hamilton 1990, 2009; Sturges et al. 2004). The energy source of these deepwater currents is not fully realized, but recent studies suggest that the Loop Current generates deepwater eddies near the Campeche Terrace that excite wave propagation westward along the continental slope of the northern GOM (Oey 2008). Additionally, high-energy waves (with periods of less than 10 days) have been observed locally along the Sigsbee Escarpment with maximum speeds of 0.9 m/s (3 ft/s) at depths below 1,500 m (4,921 ft) (Donohue et al. 2008). The analysis by Hamilton (2009) suggests that highly energetic TRWs along the Sigsbee Escarpment generate a mean deepwater flow to the west along the steep escarpment, which acts as the main deepwater transport pathway from the western to the eastern GOM, and that in the western GOM, TRWs are less energetic but interact in a similar fashion with the continental slope to form a generalized mean deepwater flow to the south along the base of the continental slope off Mexico (the generalized deepwater flow path is shown in Figure 4.2.3-1).

Subsurface jets are characterized as currents with no surface expression, having durations on the order of hours to days, speeds in excess 0.4 m/s (1.3 ft/s), and observed currents up to 2 m/s (6.6 ft/s) (DiMarco et al. 2004). Subsurface jets occur at shallow depths (150–600 m [492–1,968 ft]) and in deep waters, and they are typically produced by the downward propagation of inertia in the wake of a storm passage or the interactions of eddy circulations and the topography of the continental slope (DiMarco et al. 2004; Fan et al. 2007). Deepwater jets are difficult to measure because of their limited spatial and temporal extents, but observations from moored instruments in the northwestern GOM show deepwater jets having maximum currents speeds between 0.5 and 0.8 m/s (1.5 and 2.6 ft/s) with durations on the order of 1 to 8 days (Hamilton and Badan 2009).

4.2.3.2 Alaska Region

Sea ice, ocean currents, tides, waves, and storm surges affect offshore oil and gas operations on the Alaska continental shelf and facilities located near the coastline. Typical currents and waves do not threaten the physical integrity of production equipment; however, cold air temperatures and the spray from waves can freeze on structures, causing structural damage as well as affecting the buoyancy of supply and drilling vessels to the extent of capsizing ships (Jones and Andreas 2009). Tides are considered minor along the coastal regions of the Arctic Ocean (NRC 2003a; Weingartner 2003), but tidal ranges in Cook Inlet are considered among the largest in the world (Archer and Hubbard 2003). Impacts of storm surges vary by season from coastal flooding during summer and fall events to ice gouging and damage associated with ice ride-up (wind-driven surge of ice onto shore) during winter and spring storm events (Lynch et al. 2008). While all these oceanographic factors influence oil and gas operations, the primary design consideration for platforms, vessels, pipelines, and other structures is the presence of sea ice and its interactions with currents, tides, and the bathymetry of the Alaska continental shelf (Weeks and Weller 1984; NRC 2003a).

The climate of the Arctic region is complex because of its multiple interactions with oceanic and terrestrial systems, and effects associated with global climate change have resulted in significant changes to the Arctic’s atmospheric and oceanographic conditions over the past couple of decades (e.g., Morison et al. 2000; Arctic Council and IASC 2005). Air temperatures in the regions north of 60°N have warmed at a faster rate than that of the overall northern hemisphere over the past century (Arctic Council and IASC 2005). During the 1990s, several studies revealed a warming trend in the layer of Arctic Ocean water with origins from the Atlantic Ocean (Carmack et al. 1995; Grotefendt et al. 1998; Gunn and Muench 2001), as well as an overall increase in Arctic Ocean sea surface temperatures and lower surface-layer salinities along regions of the Beaufort Sea and the Chukchi Sea (Morison et al. 2000; Comiso 2003; Comiso et al. 2003).

The warming of air and water temperatures in Arctic regions generates variability in key factors and processes controlling oceanographic conditions, which include precipitation and snow patterns, freshwater and sediment inputs to oceans, thermohaline circulation patterns (controlled by temperature and salinity gradients), and the aerial coverage and composition of sea ice (Morison et al. 2000; Arctic Council and IASC 2005; Bonsal and Kochtubajda 2009). Changes in oceanic conditions have also corresponded with sea level rise in the Arctic Ocean (Proshutinsky et al. 2001). Predicting oceanic responses to climate change is difficult because of complex interactions (often nonlinear) among factors such as water and air temperatures, sea ice, sea level rise, and thermohaline circulation patterns (e.g., Wang et al. 2003).

Alaskan coastal waters are largely covered by sea ice with some open-water areas for three-quarters of the year, from October until June, with the minimum sea ice extent occurring in September as sea ice begins to form and the maximum extent in March (Weeks and Weller 1984). Sea ice properties vary according to its age and the physical conditions under which it forms, melts, refreezes, and reforms (Gow and Tucker 1991). A general classification of sea ice includes ice formed along shores known as landfast ice and ice formed at sea called drift ice, which can conglomerate to form pack ice or ice floes (Mulherin et al. 2001). Landfast ice gradually advances seaward in the fall, rapidly retreats in the spring, and can break up and reform several times in between. Ice floes move according to wind and currents and can collide and pile on top of one another to form pressure ridges, as well as converge to form well-defined ice-free openings, or polynyas (Mahoney et al. 2007). Another important distinction in sea ice is the difference between newly formed first-year sea ice and multi-year sea ice, which by definition is summer minimum sea ice extent (Lemke et al. 2007).

The spatial and temporal variability in sea ice extent and thickness are controlled by local climate and oceanic factors, with many studies indicating a decreasing trend in Arctic sea ice over recent decades (e.g., Johannesen et al. 1995; Parkinson 2000; Comiso 2002). Sea ice extent, as observed mainly by remote sensing methods, has decreased at a rate of approximately 3% per decade starting in the 1970s (Johannesen et al. 1995; Parkinson et al. 1999). However, multi-year sea ice has decreased at a rate of nearly 9 to 12% per decade since the 1980s (Comiso 2002; Perovich et al. 2010). Since 2000, the extent of summer sea ice was at record lows in 2002 (Serreze et al. 2003), 2004 (Stroeve et al. 2005), 2007 (Perovich et al. 2008), and 2010 (Richter-Menge and Jeffries 2011). Sea ice thickness has also decreased during recent decades, with average sea ice draft (the depth of ice below sea level) values decreasing by as much as 1.3 m (4 ft) (Rothrock et al. 1999) and sea ice volumes decreasing at a rate of 4% per decade since 1948 (Rothrock and Zhang 2005). These recent trends in declining sea ice are a result of anthropogenic influences and natural climate variability, and recent climate simulations suggest that natural climate variability has the potential to cause a stabilization to a slight recovery of sea ice trends over short times scales on the order of a decade or less in the beginning part of the twenty-first century (Kay et al. 2011).

The interactions of sea ice with currents and waves have the potential to create hazardous conditions and damage physical structures though ice gouging, ice ride-up, and scouring, and to block vessel traffic (Weeks and Weller 1984). Landfast ice is typically not a concern as it exerts nominal internal stresses to structures, but ice floes formed during breakup conditions near shore or out in open pack ice areas have velocities on the order of 1 m/s (3 ft/s) (Stringer and Sackinger 1976). Ice gouging is caused by grounded ice keels within ice floes moving in response to wind and currents that typically occur in regions parallel to shorelines (Shapiro and Barnes 1991). Ice gouging is of particular concern for pipelines, as seabed gouging depths can often exceed 3 m (10 ft), affecting coastal regions with up to 50 m (164 ft) of water depth (Weeks and Weller 1984). Ice ride-up occurs as repeated ice floes converge on shore, pile on top of each other, and pile shoreward under continued momentum. Ice ride-up events frequently occur during the spring and fall and can affect structures that are on the order of 50 m (164 ft) inland (Kovacs and Sodhi 1980). In spring, river floodwaters can inundate coastal areas covered by sea ice and potentially break through the ice, generating jet flows and scour craters in the sediments below (process referred to as strudel scour), which can damage pipelines and support structures. Strudel scour craters can be more than 4 m (13 ft) deep and 15 m (49 ft) across and can last up to 2–3 years before being refilled (Reimnitz and Kempema 1982). Strudel scour occurs most commonly near river deltas extending outward to water depths of 6 m (20 ft) (Hearon et al. 2009).

Sea ice also affects oil spill cleanup and weathering processes, as well as acting as a transport mechanism for spilled oil (Stringer 1980). Oil transport and reaction processes are significantly altered for waters that contain more than 30% aerial coverage of sea ice in comparison to open ocean waters (NRC 2003b). The presence of ice and lower water temperatures typically result in lower rates of oil weathering processes such as evaporation, emulsification, and oxidation (Thomas 1983); lower rates of dispersion because of the increased viscosity of oil at lower temperatures (Payne et al. 1991) and the presence of sea ice also has the potential to confine oil spills (Weeks and Weller 1984). Conversely, enhanced transport of oil by sea ice conditions can occur along open water channels or polynyas or by oil incorporation into moving ice floes (Payne et al. 1987). Empirical relationships describing the fate and transport of spilled oil-sea ice interactions are presented in Buist et al. (2008). Ultimately, the fate of oil in the presence of sea ice largely depends on the season (summer ice free, winter ice cover, and fall ice formation), as well as the age and morphology of the sea ice, because these factors determine the ability of the oil to reach reactive areas for oil weathering processes to occur as well as the weathering reaction rates (Payne et al. 1991; NRC 2003b).

4.2.3.2.1 Arctic Ocean: Beaufort Sea and Chukchi Sea. The Beaufort Sea and Chukchi Sea are semi-enclosed seas connected to the Arctic Ocean located along the northern coast of Alaska. The Chukchi Sea is a shallow, continental shelf sea with depths typically less than 50 m (164 ft) that receives Pacific Ocean water through the Bering Strait (Woodgate et al. 2005). The Beaufort Sea consists of a narrow (approximately 100 km [62 mi] wide) continental shelf before a shelfbreak that occurs near the 200-m (656-ft) water depth contour followed by a portion of the Canadian Basin of the Arctic Ocean (Weingartner 2003). The continental shelf region of the Beaufort and Chukchi Seas contains small shoals and barrier islands that affect shelf circulation patterns and are typically associated with the location of ice ridges (NRC 2003a).

The general, depth-averaged circulation patterns in the Beaufort and Chukchi Seas are shown in Figure 4.2.3-3. Circulation in the Canadian Basin of the Arctic Ocean is dominated by the Beaufort Gyre, which is typically a clockwise (anticyclonic) circulation forced by prevailing atmospheric high pressure over the Arctic, but can reverse to a counterclockwise (cyclonic) circulation during summer months or prolonged periods of atmospheric low pressure (Proshutinsky et al. 2003; Asplin et al. 2009). The sea level slope between the Pacific Ocean and the Arctic Ocean drives water through the Bering Strait into the Chukchi Sea, which separates into three principal branches of northward flow among Herald Shoal, Hanna Shoal, and the Alaskan coast (Weingartner et al. 2005; Woodgate et al. 2005; Weingartner et al. 2010). Currently, it is not fully understood how Pacific Ocean waters moving across the Chukchi Sea interact with circulation patterns off the shelfbreak of the Beaufort Sea, but evidence suggests the presence of narrow currents near the Beaufort shelfbreak with prevailing eastward flow and seasonal variability in surface and subsurface intensified currents (Pickart 2004;

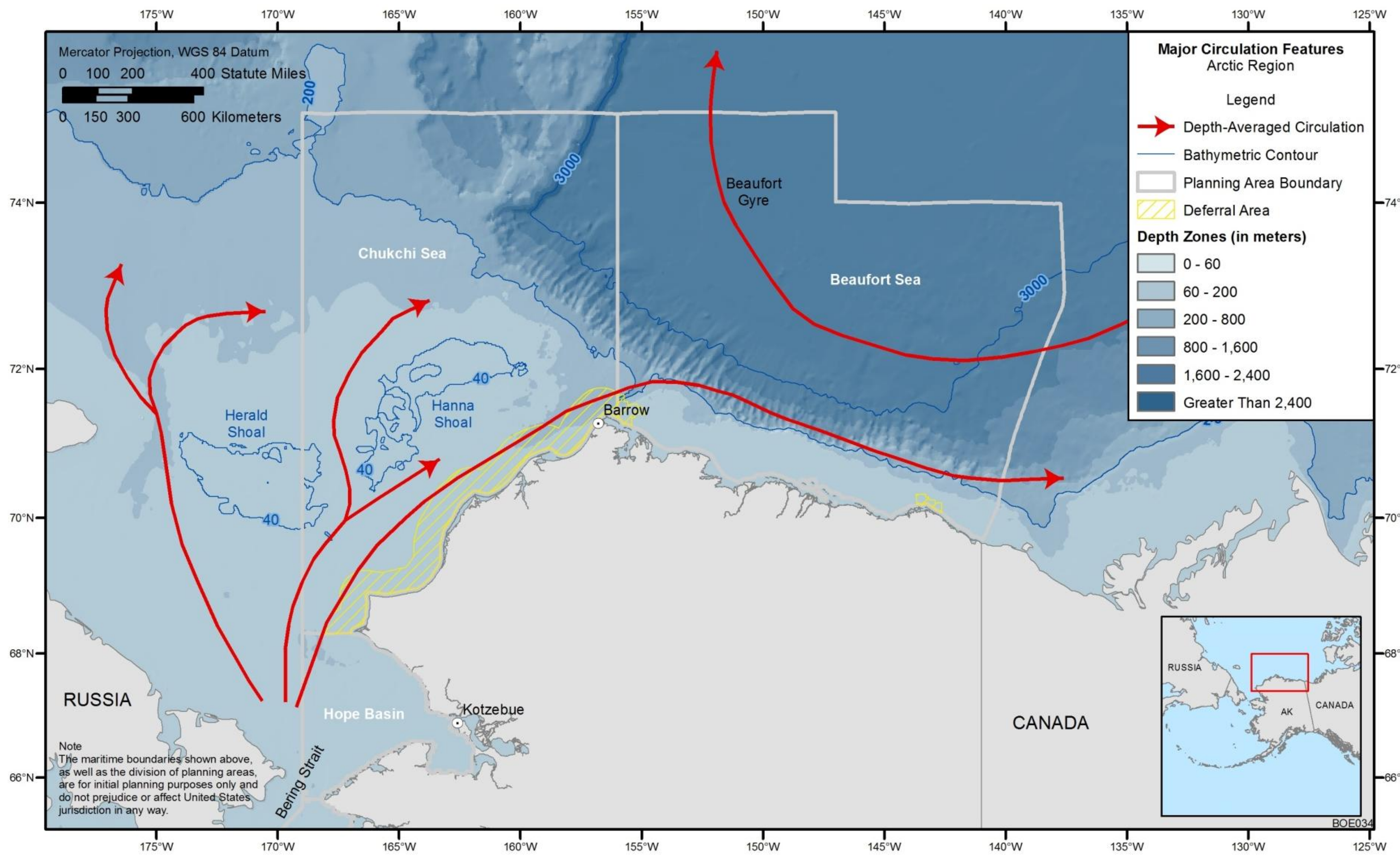

FIGURE 4.2.3-3 Generalized, Depth-Averaged Circulation Patterns in the Chukchi Sea and Beaufort Sea

Spall et al. 2008; Nikolopoulos et al. 2009; Okkonen et al. 2009; Pickart et al. 2010; Weingartner et al. 2010). The currents along the shelfbreak of the Beaufort Sea are highly unstable and prone to eddy circulations resulting from seasonal patterns of sea ice, wind direction, and storm events. For example, westerly winds along the Beaufort Sea shelf can accelerate the shelfbreak currents, resulting in downwelling conditions, while easterly winds can slow the shelfbreak currents, producing downwelling conditions (Weingartner et al. 2010). During the summer open-water season, current speeds along continental shelf areas often exceed 0.2 m/s (0.7 ft/s) with maximum speeds as high as 1 m/s (3 ft/s) in certain regions of constricted flow such as the Bering Strait and Barrow Canyon; during ice-covered seasons, current speeds are generally less than 0.1 m/s (0.3 ft/s) (Weingartner et al. 1998, 2009; Weingartner and Okkonen 2001).

The coasts of the Beaufort Sea and Chukchi Sea consist of river deltas, barrier islands, exposed bluffs, and large inlets; inland is characterized by low-relief lands underlain by permafrost (Jorgenson and Brown 2005). The combination of wind-driven waves, river erosion, and sea ice scour with highly erodible coastal lands creates the potential for high erosion rates along the Beaufort Sea and Chukchi Sea coasts (Kowalik 1984; Mars and Houseknecht 2007). From 1950 to 1980, the coastal erosion rates averaged 0.6 m/yr (2 ft/yr), and over the period from 1980 to 2000 this rate has increased to 1.2 m/yr (3.9 ft/yr) (Ping et al. 2011).

Present and future offshore oil and gas operations in the Beaufort and Chukchi Seas need to take into account climate change impacts on circulation and sea ice patterns. The complex circulation patterns on the Arctic continental shelf are affected by water temperature and density gradients and freshwater inputs of varying temperature from rivers as well as increased sea ice and glacier melting over recent years (Yamamoto-Kawai et al. 2009). Furthermore, reductions in sea ice have been more apparent in nearshore areas associated with landfast ice (typically extending out between 5 and 50 km [3 and 31 mi] from shore) in comparison to offshore regions (Mahoney et al. 2007; Fissel et al. 2009). A recent study has also shown that remote-sensing of sea ice extent may not always distinguish between first-year and multi-year sea ice, which is an important distinction in sea ice quality for supporting exploration activities, biotic habitats, and waterway access (Barber et al. 2009). The summer open ice season that determines when ships can enter the coastal regions along the north Alaskan coast has trended toward an earlier opening date in the spring and a later closing date in the fall (Fissel et al. 2009; Markus et al. 2009). While decreased sea ice has the potential to support more shipping activity in the Arctic, it is likely that hazardous ice floes will persist (Stewart et al. 2007), and decreases in landfast ice could result in increased impacts on coastlines through wave damage and ice ride-up (Arctic Council and IASC 2005).

4.2.3.2.2 Cook Inlet and Shelikof Strait. Cook Inlet and Shelikof Strait are located on the continental shelf of the Gulf of Alaska, which is a semi-enclosed basin of the Pacific Ocean surrounded by the steep terrain of the Alaskan coast. The continental shelf region is characterized as having a complex bathymetry of channels, island chains, and embayments. Cook Inlet is a large embayment with a length of 330 km (205 mi) along a northeast to southwest axis that is approximately 37 km (23 mi) wide in the northeast near Anchorage and 83 km (52 mi) wide at its mouth (Gatto 1976). The upper and lower portions of Cook Inlet are formed by the coastline constriction that occurs near the West Forelands to the north of Kalgin Island. The Shelikof Strait, located southwest of Cook Inlet between the Alaskan coast and the Kodiak Islands, forms a fairly uniform channel that is approximately 270 km (168 mi) in length and 45 km (28 mi) wide (Muench and Schumacher 1980). Figure 4.2.3-4 shows the location of Cook Inlet and Shelikof Strait along with major circulation patterns.

The circulation along the continental shelf of the Gulf of Alaska is dominated by the Alaskan Coastal Current, which is driven by winds and freshwater runoff of the numerous rivers and glaciers along the Alaskan coast (Stabeno et al. 2004). Alaskan Coastal Current waters enter Cook Inlet through the Kennedy and Stevenson Entrances and flow northward along the eastern side of the inlet as the result of Coriolis forces (induced by the rotation of the Earth) and then cross over to the western side of the inlet because of the shoreline geometry near the Forelands (Rappeport 1982). Observed circulation patterns suggest a net outflow of surface flows out of the inlet, which implies that there is a net inflow of deepwater flows into the inlet (Potter and Weingartner 2010). Cook Inlet is estuarine in character because of the mixing of marine waters from the Alaskan Coastal Current and freshwater inflows from several rivers, resulting in complex density-driven circulation patterns (Rappeport 1982; Mulherin et al. 2001). The Matanuska River, Knik River, and Susitna River combined contribute more than 70% of the freshwater inputs to Cook Inlet in the northern basin, as well as act as a significant source of suspended sediments that can reach concentrations greater than 1,700 mg/L (Gatto 1976). Riverine inputs of freshwater and sediments to the northern portion of Cook Inlet vary seasonally, and their resulting influences on temperatures and salinity generate seasonal variability in circulation patterns in Cook Inlet (Okkonen et al. 2009).

The circulation patterns in Cook Inlet are significantly influenced by the strong semidiurnal tide pattern with corresponding tidal amplitudes that range between 4.2 and 5 m (14 and 16.4 ft) in the lower portion and up to 9.0 m (29.5 ft) in the upper portion of Cook Inlet near Anchorage (Rappeport 1982; Archer and Hubbard 2003). Tidal currents travel at speeds ranging between 1 and 4 m/s (3 and 13 ft/s) (Whitney 2000; Oey et al. 2007). Average water depths in Cook Inlet vary from 18.3 m (60 ft) in the upper portion to 36.6 m (120 ft) near its mouth, with several deep channels along its longitudinal axis that contain sand dunes with heights on the order of 2 m (7 ft) (Haley et al. 2000). The interaction of density-driven circulation and tidal currents results in rip currents that form persistently along the deep channels (Haley et al. 2000; Whitney 2000), which can often be observed by turbidity color changes, as well as the accumulation of surface debris and foam along rip current edges (Rappeport 1982). The ebbing flow out of Cook Inlet combines with Alaskan Coastal Current waters and enters the Shelikof Strait, where water depths are on the order of 200 m (656 ft) and average current speeds range between 0.2 m/s (0.7 ft/s) in the winter and 0.1 m/s (0.3 ft/s) in the summer (Muench and Schumacher 1980). The southwest flow out of the Shelikof Strait merges with the Alaskan Stream (the western boundary current of the Gulf of Alaska) approximately 200 km (124 mi) southwest of Kodiak Island (Stabeno et al. 2004; Rovegno et al. 2009).

Significant wave heights (average wave height of the upper-third-largest waves) are typically 0.6 m (2 ft) in the lower portion of Cook Inlet and the Shelikof Strait, but maximum wave heights of 5.5 m (18 ft) have been recorded during storm events (Rappeport 1982). Tsunamis can occur in response to volcanic activity of Mount St. Augustine on Augustine Island

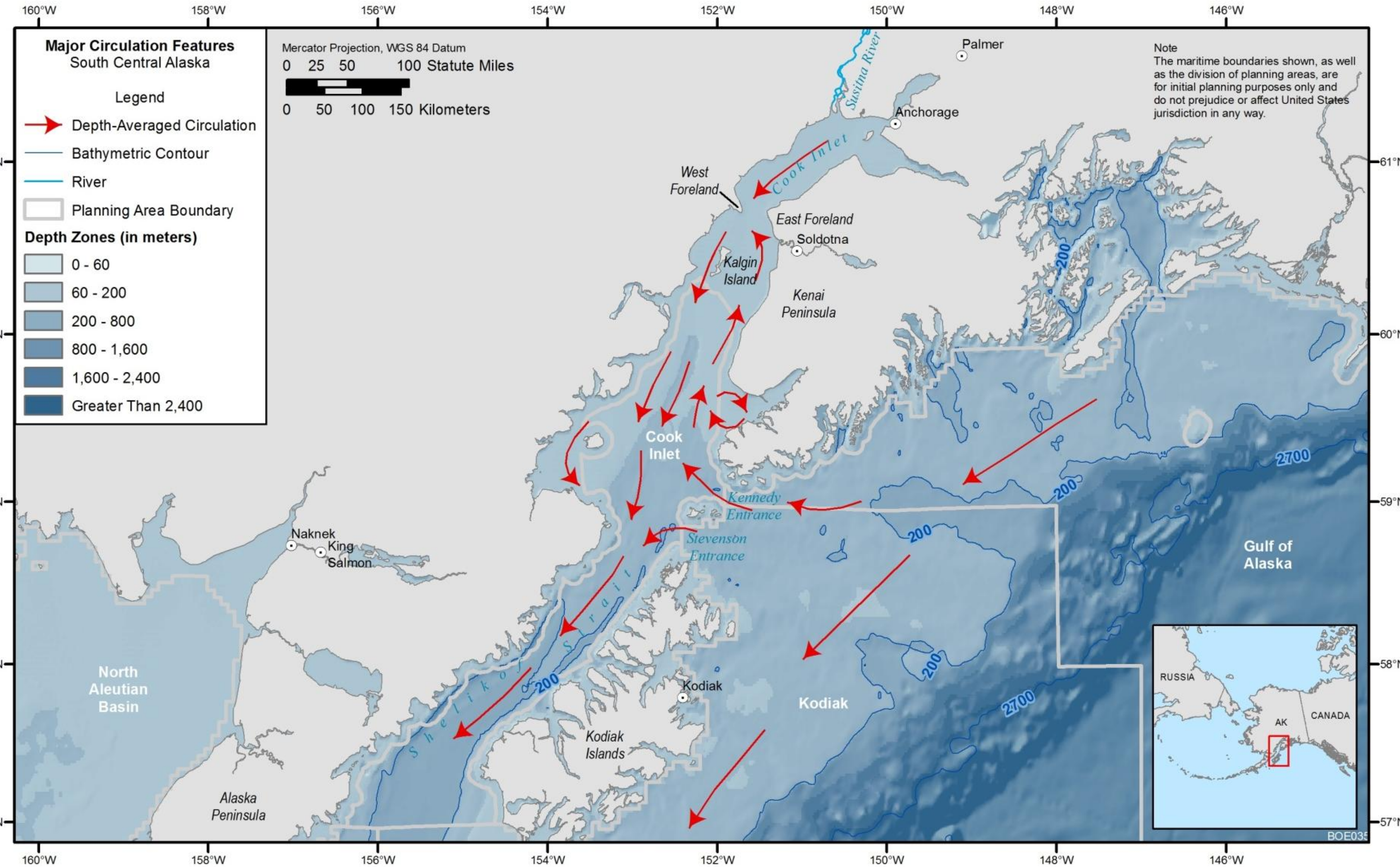

FIGURE 4.2.3-4 Generalized, Depth-Averaged Circulation Patterns in Cook Inlet and the Shelikof Strait

in the southwestern portion of lower Cook Inlet. Modeling results of the 1883 tsunami suggested wave heights of amplitude 1.2 to 1.8 m (3.9 to 5.9 ft) (Kienle et al. 1986). However, more recent modeling results suggest that the timing of a tsunami with the tidal phase can result in a fivefold amplification of wave heights near the shores of Anchor Point (Kowalik and Proshutinsky 2010).

Ice floes moving with tidal currents are the largest threat to navigation and marine structures in Cook Inlet. According to Mulherin et al. (2001), three types of sea ice form in Cook Inlet: pack ice, landfast ice, and stamukhi ice (forms by stacking of low-tide formed ice sheets on the sediment surface). The sea ice forms in the upper portion of Cook Inlet in the fall, while the lower portion is typically ice free until December. Stamukhi ice stacks can reach 7.5 to 12.2 m (24.6 to 40 ft) in thickness and typically become ice floes that move away from the shore because of buoyancy forces. In the upper Cook Inlet basin, ice floes are typically on the order of 320 m (1,050 ft) in width and up to 6 m (20 ft) in thickness on their edges (elevated by pressure ridges from collisions with other ice floes), and move with tidal currents on the order of 4 m/s (13 ft/s) (Gatto 1976). During the fall-winter ice-covered season, the ice pack can cover between 10 and 80% of Cook Inlet, which becomes completely ice free each spring (Muench and Schumacher 1980; Mulherin et al. 2001). In the upper Cook Inlet, there is a greater than 75% probability of sea ice coverage over the entire area by early January (Mulherin 2001). The highest concentration of sea ice in the lower Cook Inlet occurs along the western shores, and the eastern portion often remains ice free (Figure 4.2.3-5).

4.3 ASSESSMENT OF ISSUES OF PROGRAMMATIC CONCERN

4.3.1 Multiple Use Issues and Marine Spatial Planning

The activities that may occur and the facilities that may be installed on the OCS as a result of the Program are described in Section 4.4.1, which presents a scenario for the projected amounts of oil and gas exploration and development activities and the number of facilities and pipelines that are estimated to take place or be installed during the program, if Alternative 1, the Proposed Action, is implemented. Comparisons with other alternatives are provided later in the document, but the analyses presented in Sections 4.3 and 4.4 would apply, as appropriate, across all the alternatives. Much of the rest of this chapter is concerned with assessing potential impacts from these activities and facilities on the environmental resources that are analyzed in the PEIS. In some areas, these oil and gas facilities and activities also create a potential for space use conflicts with other activities and facility sitings not related to oil and gas development. This section discusses the other major activities and facilities on the OCS that could occur and coexist with oil and gas construction and activities during the program and, as a result, create potential space use conflicts. These conflicts could include situations in which the presence of oil and gas infrastructure and associated support, exploration, and production activities preclude, or are precluded by, other uses of the OCS; or situations in which oil and gas facilities and activities in combination with other types of activities and infrastructure could threaten the ecological sustainability of the area. Typically, the BOEM has managed OCS space and multiple use issues through coordination with other State and Federal agencies that manage and regulate activities on or near the OCS, and has developed regulations, lease stipulations, and other mechanisms to

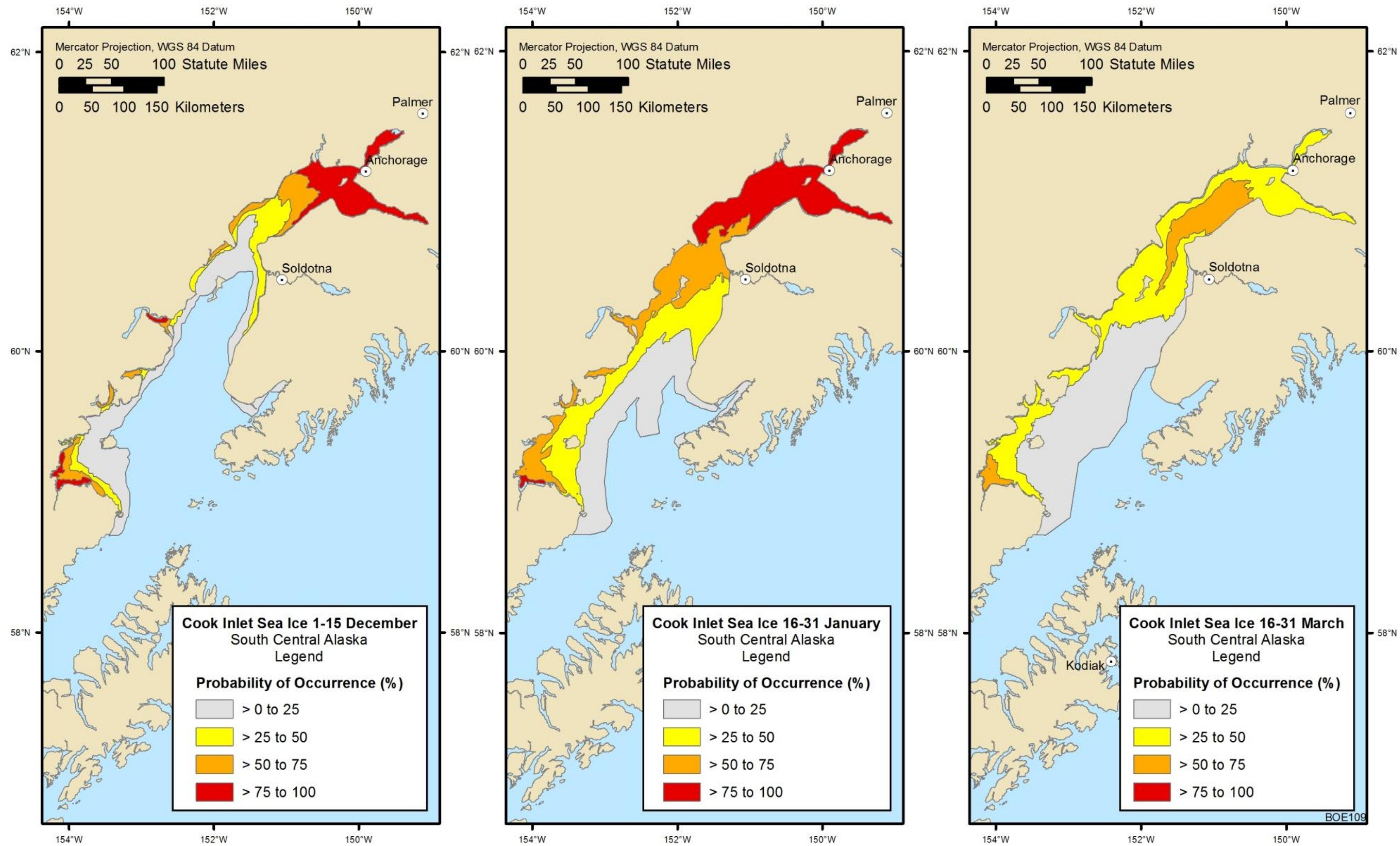

FIGURE 4.2.3-5 Probability of Sea Ice Occurrence in Cook Inlet From Early December to Late March (Mulherin et al. 2001)

restrict oil and gas activities to avoid conflict with other activities taking place in the same area. In recent years, Coastal and Marine Spatial Planning (CMSP) has emerged as a new paradigm and planning strategy for coordinating all marine and coastal activities within an ecosystem-based framework.

4.3.1.1 Multiple Use Issues

4.3.1.1.1 Department of Defense Use Areas. Military Use Areas, established off all U.S. coastlines, are required by the U.S. Air Force (USAF), Navy, Marine Corps, and Special Operations Forces for conducting various testing and training missions. Military activities can be quite varied, but they normally consist of air-to-air, air-to-surface, and surface-to-surface naval fleet training; submarine and antisubmarine training; and Air Force exercises. Offshore military areas (including military dumping areas) are present in some OCS planning areas. Section 3.9.1.2.3 of this draft PEIS discusses offshore military use areas in the OCS planning areas being considered for the proposed action.

Aircraft operated by all U.S. Department of Defense (USDOD) units train within a number of special use airspace (SUA) locations that overlie the military operating areas, as designated by the Federal Aviation Administration (U.S. Fleet Forces 2010). SUAs are the most relevant to the oil and gas leasing program because they are largely located offshore, extending from 5.6 km (3 NM or 3.5 mi) outward from the coast over international waters and in international airspace.

There are 21 U.S. military bases along the coasts of the planning areas being considered for oil and gas leasing in the proposed action: 18 bases along the GOM coast and 3 in the vicinity of the Cook Inlet Planning Area. In addition, there are four active USAF radar sites located on the coast bordering the Beaufort and Chukchi Sea Planning Areas. They are all Long-Range Radar Sites, and each site has restricted areas within certain facilities. Access to each is only for personnel on official business and with approval of the commander of the USAF's 611th Air Support Group. While there are a number of military use restriction areas (danger zones or restricted areas) in the GOM (see Figure 3.9.1-2), there are no such restrictions in the waters of the Cook Inlet Planning Area or the Beaufort and Chukchi Sea Planning Areas (National Marine Protected Areas Center 2008). In the Cook Inlet Planning Area, the closest danger zone is Blying Sound, which is managed by the U.S. Navy and located to the east of Cook Inlet near Prince William Sound. The Blying Sound Danger Zone is rarely activated, and there are no use restrictions for most of the year.

Danger zones are defined as water areas used for a variety of hazardous operations (National Marine Protected Areas Center 2008; U.S. Fleet Forces 2010). Danger zones may be closed to the public on a full-time or intermittent basis. Restricted areas are water areas defined as such for the purpose of prohibiting or limiting public access. Restricted areas generally provide security for Federal Government property and/or protect the public from the risks of damage or injury that could arise from the Federal Government's use of that area.

There are more than 40 military warning areas in the northern GOM area, designated by the USAF for the conduct of various testing and training missions, and by the U.S. Navy for various naval training and testing operations. Most of these areas overlie waters that are less than 800 m (2,600 ft) in depth (Figure 3.9.1-2).

Although offshore oil and gas activities have the potential to affect military activities, the USDOD and U.S. Department of the Interior (USDOI) have cooperated on these issues for many years and have developed mitigation measures that minimize the potential for conflicts. For example, stipulations are applied to oil and gas leases in critical military use areas. Whenever possible, close coordination between oil and gas operators and the military authorities for specific operational areas is encouraged and, in some cases, is required under these lease stipulations. In some instances where the military requires unimpeded access to specific areas on the OCS, specific lease blocks have been deleted from one or more proposed lease sales.

The USDOI will continue to coordinate with the USDOD regarding future lease offerings, new areas of industry interest, and current or proposed areas of military operations. As part of this coordination, applicable stipulations would continue to be routinely evaluated and modified, as necessary, to minimize or eliminate conflicts. An example of this process was the inclusion of three previously deferred blocks (Mustang Island Blocks 793, 799 and 816) in the Western GOM Planning Area in OCS Lease Sales 192 and 196, subject to a recently revised Lease Stipulation of Operations in the Naval Mine Warfare Area.

Offshore oil and gas development under the proposed action within the Alaska Region would not interfere with standard or routine military practices. Additional vessel traffic resulting from industry development and exploration would simply increase existing traffic and not affect military activities. BOEM works in cooperation with the USCG regarding industry exploration and development in waters off the coast of Alaska.

4.3.1.1.2 Liquefied Natural Gas Facilities. Natural gas is liquefied to concentrate a much greater volume of product in a given space to facilitate storage and/or transportation. Use of liquefied natural gas (LNG) reduces the volume it occupies by a factor of more than 600, making the transportation of gas in tankers economical. Environmental effects specific to LNG transportation and facilities are associated with explosions and fires and with the cryogenic and cooling effects of either an accidental release of LNG or the release of cooled water during the vaporization process. In the GOM, most, if not all, LNG facilities are expected to use an open-loop vaporization process that uses a throughput of approximately 130 to 250 million gallons per day of seawater to raise the temperature of the LNG from –260°F to 40°F. This process produces a discharge of seawater that has been cooled by as much as 20°F. These discharges are expected to occur in water depths ranging from 18 to 55 m (60 to 280 ft). This large volume of cool, dense water could create an impact on the surrounding environment, rendering the area uninhabitable by local species of invertebrates and fish, especially in the GOM. The magnitude of this impact is still unknown since there is only one facility (the Gulf Gateway facility) currently operating. The potential cumulative effect of multiple facilities also needs consideration. In addition to the thermal discharge, biocides are added to prevent fouling of the flow through the system.

These facilities operate by offloading vaporized LNG from tankers into the existing offshore natural gas pipeline system. Although BOEM does not permit or regulate these facilities, their increased presence and use on the OCS will create space use issues and will add to the existing mix of potential offshore cumulative impacts. Currently, only one LNG facility has been constructed and is operating on the GOM OCS. The Gulf Gateway Energy Bridge, which was brought into service in March 2005, is located in 85.3 m (280 ft) of water in West Cameron, South Addition Block 603, approximately 116 mi (187 km) offshore of the Texas–Louisiana border. The Gulf Gateway Energy Bridge is capable of delivering natural gas at a base load rate of 500 Bcf per day.

Other LNG facilities on the OCS are currently in some stage of the permitting process. The Bienville Offshore Energy Terminal is a planned LNG facility located 63 mi (101 km) south of Mobile Point, Alabama. The initial application for the facility was withdrawn on October 9, 2008, and a revised application, submitted on June 30, 2009, featured a redesigned terminal using "closed-loop" ambient air technology for LNG vaporization. The application was approved in 2010. In Louisiana, the Main Pass Energy Hub is a converted sulfur and brine mining facility. This LNG facility is expected to begin operations sometime in 2011 or 2012.

4.3.1.1.3 Alternate Energy Development. In April 2009, the President and the Secretary of the Interior announced the final regulations for the OCS Renewable Energy Program, which was authorized by the Energy Policy Act of 2005. The final regulations (74 CFR Part 81: 19638–19871) govern management of the BOEM Renewable Energy Program by establishing a program to grant leases, easements, and right-of-ways (ROWs) for renewable energy development activities on the OCS. Renewable energy from the OCS may come from technologies and projects that harness offshore wind energy, ocean wave (hydrokinetic) energy, or ocean current (hydrokinetic) energy.

Multiple Federal agencies have responsibilities for the regulation and oversight of renewable energy development on the OCS. BOEM issues leases and grants for both OCS wind and hydrokinetic projects and permits the construction and operation of wind facilities. The Federal Energy Regulatory Commission will permit the construction and operation of hydrokinetic facilities on BOEM-issued wave and current energy leases. BOEM also has the authority to issue ROWs for offshore transmission lines that would link OCS renewable energy projects in order to facilitate efficient interconnection of the OCS projects to the onshore electric grid.

As required by the Energy Policy Act, BOEM will issue leases on a competitive basis unless it determines that no competitive interest exists. After a lease is acquired, the developer must submit and receive approval of appropriate plans (for wind energy projects) or license applications (for hydrokinetic projects). At the end of the lease term, the developer must decommission the facilities in compliance with BOEM regulations.

There are currently no commercial hydrokinetic or wind energy projects on the OCS in the planning areas under consideration for the Program. BOEM, in coordination with relevant States, has identified Wind Energy Areas (WEAs) offshore of the mid-Atlantic coast. Although

OCS oil and gas leasing and development activities could interfere with future OCS wind energy renewable energy projects (and vice-versa), BOEM offshore oil and gas and offshore renewable energy programs will be coordinated to ensure that leasing and development activities under both programs are carried out with as little conflict between the two programs as possible. The identification of any future WEAs in areas with high or expected levels of oil and gas development (such as the GOM) will also be closely coordinated between the two programs. No such WEAs, however, have been identified in any of OCS planning areas being considered for oil and gas leasing under the proposed action, nor are any wind or kinetic energy developments anticipated there during the program.

4.3.1.2 Coastal and Marine Spatial Planning

On July 19, 2010, the President signed Executive Order (EO) 13547, *Stewardship of the Ocean, Our Coasts, and the Great Lakes*, establishing a national policy for the stewardship of these resources. This national policy identifies Coastal and Marine Planning (CSMP)[15] as one of the nine objectives. Furthermore, it outlines a framework for effective CMSP to address conservation, economic activity, user conflict, and sustainable use of the ocean, coasts, and Great Lakes.

Despite the existence of numerous articles on CMSP (e.g., see papers in *Marine Policy*, Vol. 32, 2008) and the incorporation of marine spatial planning principles by various nations into their resource management practices (e.g., EO 13547;), a standard, universally accepted definition of MSP currently does not exist. Most existing definitions are phrased in broad terms and objectives, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) definition, "[MSP] … is a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that have been specified through a political process" (UNESCO-IOC 2010). E.O. 13547 also provides a working definition of CMSP as a "comprehensive, adaptive, integrated, ecosystem-based, and transparent spatial planning process, based on sound science, for analyzing current and anticipated uses of ocean, coastal, and Great Lakes areas. Coastal and marine spatial planning identifies areas most suitable for various types or classes of activities in order to reduce conflicts among uses, reduce environmental impacts, facilitate compatible uses, and preserve critical ecosystem services to meet economic, environmental, security, and social objectives. In practical terms, coastal and marine spatial planning provides a public policy process for society to better determine how the ocean, our coasts, and Great Lakes are sustainably used and protected — now and for future generations."

Although NEPA is not usually seen as a spatial planning exercise, the PEIS for the Program and subsequent NEPA evaluations effectively are, at least in part, just that. The draft PEIS identifies broad areas of the OCS where oil and gas leasing may occur and identifies in a spatial and temporal context the potential for impacts on natural and social resources and systems that could occur with subsequent oil and gas leasing in those areas. The subsequent lease sale

[15] CMSP is also referred as regional ocean planning.

and post-lease NEPA analyses identify the specific areas and time frames where and when mitigating measures need to be applied to address potentially unacceptable impacts on natural resources and socioeconomic resources and systems. One outcome of this NEPA process, therefore, is the identification of areas on the OCS where BOEM regulates and manages oil and gas operations to meet economic and social objectives in a manner compatible with environmental sustainability objectives.

Table 4.3.1-1 describes ways in which the objectives and methods of CMSP are compatible with or differ from those of the Five-Year Programmatic EIS. While there are fundamental similarities and overlaps between the objectives and approaches of CMSP and the 2012-2017 PEIS, a major distinction between the two planning approaches is that the PEIS perspective focuses on the single use of the OCS for hydrocarbon exploration, extraction, and transportation, whereas CMSP is a multi-sector approach to planning which, through the development of a regional plan, aims to facilitate compatible uses and preserve ecosystem services to meet our nation's economic, environmental, security, and social goals.

The National Ocean Policy framework document divides U.S. waters (mean high water mark to 200 NM) into nine regions based primarily on Large Marine Ecosystem (LME) boundaries. It is anticipated that the plans will serve as an overlay for decisions made under existing regulatory mandates. In effect, regional CMS plans once approved by the National Ocean Council (NOC) will assist the BOEM programmatic EIS process in making informed decisions. It is important to note that CMSP is intended to be implemented within the framework of existing laws and authorities, and not to supersede them.

BOEM is the Federal Regional Planning Body (RPB) co-lead for CMSP implementation in the Mid-Atlantic region and, in one year, will take over Federal co-lead responsibility for the Alaska region. Additionally, BOEM will participate on RPBs in the Northeast, Mid-Atlantic and West Coast as the DOI lead. In the Gulf of Mexico region, BOEM representatives will assist US Fish and Wildlife Service (US FWS), the DOI regional lead, with various Federal working group activities.

BOEM's function as a Federal co-lead involves coordinating overall Regional Planning Body (RPB) responsibility on behalf of the Federal partners and providing administrative, personal and financial support as needed to move the CMSP initiative forward. Also as part of the planning process, BOEM facilitates data and information availability, provides research on potential environmental impacts of new technologies, and identifies conflict resolution and avoidance strategies. BOEM is revamping its information systems such as ESPIS (Environmental Studies Program Information System) to enhance the availability of its scientific and spatial data. The update will also make available some of the important spatial datasets through the Multipurpose Marine Cadaster (MMC). Relevant scientific data will also be linked through the newly formed ocean.data.gov portal. This project will ensure that BOEM science and data are available to planners and stakeholders as they engage in regional CMSP initiatives and that regional data portals have access to the ESPIS & MMC data sets. BOEM also plans to continue funding ocean planning focused studies in coordination with other Federal agencies.

TABLE 4.3.1-1 Comparison of the Objectives and Methods of CMSP with Those of the 2012-2017 OCS Oil and Gas Leasing Program PEIS[a]

Coastal and Marine Spatial Planning	Programmatic EIS
Envisioned as a tool to make ecosystem-based management of marine resources possible.	Uses a broad scale appropriate for an ecoregional approach for evaluating potential impacts.
Large Marine Ecosystems (LMEs) used to define spatial boundaries.	Large Marine Ecosystems (LMEs) used to define spatial boundaries.
Based on hierarchal scale-based approach addressing different issues and at different scales at each level of analysis, and in which each level provides context for the next lower level.	The NEPA concept of tiering is based on a hierarchal scale-based approach in which the programmatic EIS provides the general context for the more detailed analyses in the lease sale EIS.
Used to develop areas identifying ecologically sensitive regions as well as areas suitable for specific human uses.	Used as the first step in a planning process to develop areas where oil and gas operations will be regulated to be consistent, in combination with other uses of the area, with current environmental sustainability objectives.
Used to plan for existing and proposed offshore uses, while reconciling economic, social, and environmental demands on an area.	Programmatic cumulative analysis evaluates all differing economic, social, and environmental demands on an area to inform the decision on program timing, size, and locations.
Based on multiple sector planning approach.	Focused on the effects of a single sector on other sectors.

[a] Highlighted text shows areas of particular similarity.

4.3.2 Programmatic Deferrals and Mitigations

4.3.2.1 Introduction

BOEM received comments on the Draft PEIS requesting that more focused leasing, various temporal and spatial deferrals, and other mitigation measures be evaluated and possibly adopted for the program in the Final PEIS. Focused leasing, deferral, and mitigation concerns first arose in scoping comments and were echoed in BOEM's discussions with PEIS cooperating agencies, which included the State of Alaska, the North Slope Borough in Alaska, and NOAA. Related comments suggested BOEM delay leasing until there is more complete information on the Arctic ecosystem (including the effects of climate change), on the effectiveness of oil-spill response and containment in the Arctic, on drilling safety, and on the effects of the Deepwater Horizon (DWH) event on GOM baseline environmental conditions. These comments are considered related to deferral and mitigation comments because they argue that leasing should be constrained during the 2012-2017 Program.

A 5-year program PEIS does not typically analyze specific deferrals and mitigations as alternatives. A deferral decision requires a balancing of many important considerations, including oil and gas resource potential and environmental, sociocultural, and socioeconomic impacts. Chapters 1 (Section 1.3 and Section 1.4.2) and 2 (Section 2.9) of this PEIS explain how more detailed analyses during subsequent program stages evaluate the need for additional mitigation, including deferrals and exclusions, in different Program areas. The PEIS contributes to subsequent decisions through tiering, a concept introduced to NEPA by the Council on Environmental Quality (CEQ) to facilitate the process of conducting a sequence of interrelated impact assessments with each analysis focused on the actual issues ripe for decision at that level of environmental review. Tiering allows an agency to address a broad general program, such as the 2012-2017 OCS Oil and Gas Program, in an initial EIS, and then analyze narrower lease sale and project-specific proposals under the initial program in subsequent, more focused NEPA analyses. CEQ guidance has encouraged agencies to use a PEIS and tiering in these situations such as in the NEPA Task Force report, Modernizing NEPA (CEQ 2003), which highlighted the PEIS and tiering as important instruments for streamlining and modernization.

BOEM recognizes that a useful approach for addressing the issues raised in deferral- and mitigation-related comments is to strengthen the Program's tiering process so that it is more effective and transparent, rather than attempting to develop specific mitigations and spatial/temporal deferrals at the preliminary planning stage of the Program, when information needed for an informed decision may not be available, consultations and coordination may not have occurred, and the analytic granularity is generally too coarse for site-specific or resource-specific decisions.

This section has been included in the Final PEIS to describe and facilitate an ongoing evaluation of mitigation strategies throughout the different stages of the leasing process, with the goal of ensuring that these strategies are analyzed and, where appropriate, ready for implementation at the appropriate stage in the process. Since the process for developing and implementing mitigation strategies could require research and coordination and consultation over an extended time, the 5-year PEIS serves its planning and tiering functions best by establishing a process that will be used during the Program to evaluate, track, and provide for stakeholder input into the development of mitigation strategies. Toward these objectives, the section evaluates mitigation identified through the programmatic public input process in the following ways:

Identification of mitigation categories: Individual mitigation suggestions for the GOM and Arctic Program areas are grouped into categories according to common objectives. Specific mitigation strategies for the Cook Inlet Planning Area are not discussed because no deferral or mitigation issues were identified through the public input process.

Programmatic assessment of mitigation strategies: The term 'mitigation strategy' is used in this section because the final application of mitigation for the issues identified through public and stakeholder input could include multiple measures that together would be the most effective strategy for protecting the resource. The implementation of effective mitigation strategies requires the availability or development of a knowledge base sufficient to consider several factors, including the spatial and temporal aspects of activities and impacts, the specific resources to be targeted by the mitigation, and the nature of the impacts to be mitigated. This section evaluates these factors as they apply to the identified mitigation categories to provide a framework for further evaluation and development of mitigation strategies during Program implementation.

Mitigation tracking process for the 2012-2017 OCS Program: The process that BOEM will follow to track mitigation development is described in Section 4.3.2.4.

4.3.2.2 Program Decision Points

Table 4.3.2-1 shows major Program decision points at which actions can be taken to identify and mitigate potential OCS-related environmental impacts. At the programmatic stage, BOEM balances its OCSLA mandate to foster expeditious development of OCS mineral and energy resources and to protect marine and coastal environments through prudent size, timing, and location decisions. These decisions are made within the constraints of finite agency resources to do the necessary studies, analyses, coordination, consultations, and planning to support potential leasing and development in all Program areas. Mitigations are usually developed and applied to specific leases or areas at the lease sale decision point in order to reduce the potential for significant environmental impacts. At the project decision point, which includes exploration, development, production, pipeline, and facility decommissioning activities, additional site-specific mitigations, regulations, and other requirements and conditions, including those related to monitoring and enforcement, are attached to specific projects as conditions of plan approval.

4.3.2.3 Identification and Assessment of Mitigation Strategies

4.3.2.3.1 Gulf of Mexico Program Areas. Table 4.3.2-2 lists the temporal and spatial deferrals suggested for the 2012-2017 Program in the GOM. These deferrals and mitigations address concerns about the effects of DWH on GOM environmental baseline conditions and its resilience to additional impacts, and the risk of occurrence of and impacts from future CDEs in the GOM. Accordingly, the table identifies the CDE component that the mitigation addresses (for more information about the components that contribute to the risk for a CDE, see Section 4.3.3, Risk of Low-probability Catastrophic Discharge Event).

Drilling/Containment Issues. The first two deferrals listed in Table 4.3.2-2 are based on concerns that OCS drilling safety and oil-spill containment capabilities are inadequate at this time, and that leasing should not occur or be restricted during the 2012-2017 Program. The first deferral would exclude deepwater areas from the Program, based on a presumed higher level of drilling risk there. BOEM's formal definition of deepwater is the area of the GOM greater than 305 m (1,000 ft) water depth. The second deferral would not allow leasing until drilling safety had improved to some benchmark.

Reducing drilling risk and increasing the containment and response capabilities at the accident site are the most effective ways to protect against the potential occurrence of a CDE

TABLE 4.3.2-1 OCS Program Environmental Decision Points

Program Stage	Decisions
Programmatic	What planning areas will be included in the Program? How many lease sales will be scheduled? When should sales be scheduled?
Lease Sale	What mitigations and deferrals need to be developed and applied to leases to reduce potential environmental impacts?
Project (Plan)	What specific mitigations, regulations, and other requirements and conditions apply to the activity? What mitigation enforcement and monitoring requirements apply to the activity?

TABLE 4.3.2-2 Gulf of Mexico Deferrals and Mitigations

Deferral	CDE Component	Concern
Exclude deep water	Drilling/Containment[a]	Deep water drilling is inherently riskier.
Delay leasing until drilling safety is improved	Drilling/Containment[a]	Regulatory and technological changes to improve safety have not been sufficient.
Do not allow drilling in areas with strong ocean currents such as the Loop Current	Fates[b]	Major ocean currents could entrain and transport oil to areas in Florida and into the Atlantic Ocean.
Gulf of Mexico baseline	Effects[b]	State of recovery or resilience of post-DWH GOM environmental baseline is not known.
Identify and protect sensitive ecosystems	Effects[b]	More ecologic areas need to be identified and protected.

[a] See Section 4.3.3.2.1 for more information on risk factors affecting drilling safety and physical containment at the well site.

[b] See Section 4.3.3.2.3 for more information on the fates and effects of discharged hydrocarbons.

because they reduce the likelihood that a drilling accident would occur, and, should it occur, reduce the amount of discharged hydrocarbons expected to be released into marine and coastal environments. Mitigating the effects of an accidental discharge becomes more difficult and problematic after oil enters open marine and coastal areas. Public and stakeholder concerns about drilling safety and related containment issues are shared by BOEM and BSEE which made improvements in drilling safety the top priority in the regulatory changes that occurred immediately after the DWH event. Section 4.3.3 includes a discussion of regulatory measures that have been promulgated since the DWH, event additional regulations BSEE plans to promulgate in 2012, and other government and industry activities and accomplishments related to improving safety.

BOEM and BSEE do not consider broad exclusions or deferrals in the GOM to be the appropriate strategy at this time for mitigating drilling risk within the context of OSCLA's mandate to foster expeditious development of the OCS while protecting marine and coastal environments. A trend has been established of ongoing drilling safety and containment improvements through regulatory changes and new technologies. This trend is expected to continue under the close scrutiny and evaluation of government, industry, and other concerned stakeholders. While broad statistics can be used to describe the overall likelihood of occurrence of different sizes of accidental oil discharges on the OCS, drilling risk must be assessed ultimately on a well-by-well basis because the factors that affect actual risk at a well site vary from area to area and from well to well (see Section 4.3.3). BOEM and BSEE are engaged in developing a better understanding of the distribution of drilling risk on the GOM OCS and of the factors that affect drilling risk in different areas, including Arctic Program areas. This information will become part of the knowledge base that supports a drilling safety and oil spill risk mitigation strategy. These mitigations could include targeted deferrals but also could be based on enhanced regulations, inspections, improved technologies, and more governmental involvement at higher risk well sites.

Fate and Transport of Oil Issues The fate of oil refers to the movement of oil away from its discharge source and the changes to its chemical and physical properties and composition that occur over time. During the DWH event, there was concern that the Loop Current in the GOM would extend into the area of the northern GOM where the spill was occurring and entrain and rapidly transport large amounts of oil as far away as south Florida and into the Atlantic Ocean. Although the Loop Current did not entrain and transport a large amount of oil during the DWH event, concern remains that entrainment could have been more substantial under different oceanographic conditions and that entrainment and transport could be problematic in the event of future large oil spills. The evaluation of a Loop Current mitigation strategy is organized into discussions of the risk of the Loop Current's intersecting an OCS area experiencing a catastrophic discharge, the risk of oil being entrained into the Loop Current, and the risk that entrained oil would contact and affect distant environmental resources at risk.

Risk of strong current intersecting an oil discharge area: The spatial variability of water movement associated with the Loop Current in the GOM is shown in Figure 4.3.2-1. This figure shows that a relatively small amount of oil and gas leasing and exploration has occurred within the area of the Central and Eastern GOM that is affected by the presence of the Loop Current from 5% to 20% of the time.

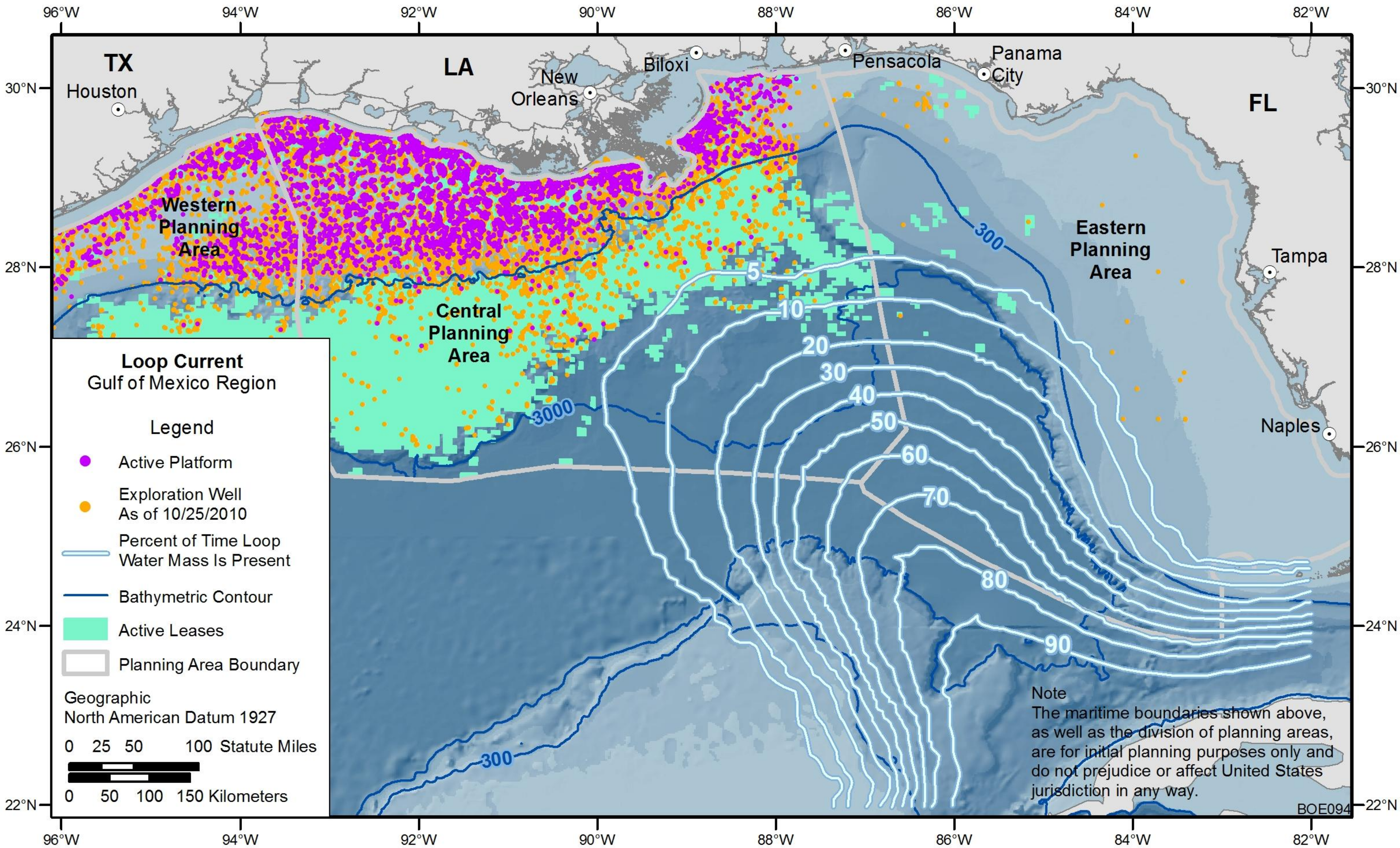

FIGURE 4.3.2-1 Spatial Variability of the Loop Current in Relation to Oil and Gas Activity (Loop Current information based on Vukovich 2007.)

Risk of oil entrainment into a strong current: The mitigation is based on the concern that the entrainment process could incorporate a large amount of oil into a strong current that passes through the discharge area and transport it rapidly toward southern Florida and into the Atlantic Ocean. Liu et al. (2011) attribute the Loop Current's not entraining a large quantity of oil during the DWH event to its location south of the discharge area much of time. The authors believe that entrainment would have been a more significant factor under different oceanographic conditions. Hamilton et al. (2011), on the other hand, conclude that the Loop Current presents a material boundary that would impede the entrainment of oil into the current. BOEM and BSEE recognize the need for improved understanding of the oil-current-current-eddy entrainment process. A new BOEM study entitled *Remote Sensing Assessment of Surface Oil Transport and Fate during Spills in the Gulf of Mexico*, which is anticipated to be conducted from 2012 to 2015, includes a specific task to identify the mixing processes that influence surface oil transport, including an analysis of material boundaries such as the Loop Current that serve as barriers to transport. Another issue being investigated is how winds could contribute to potential transport and mixing across the material boundary.

Risk of entrained oil contacting and impacting distant resources at risk: This mitigation is intended to provide broad protection for ecosystem resources located in the Eastern GOM, southern Florida, and the Atlantic from the effects of very large oil spills that could occur in the Central or Eastern GOM planning areas. These ecosystem resources are located in areas that, prior to the DWH event, might have been considered outside the area that would likely be affected by GOM OCS activities. The specific ecosystem resources and areas of concern have not been fully identified in these areas, nor has the potential for impacts under different Loop Current and CDE scenarios been assessed to determine the actual amount of environmental risk from the unmitigated effects of current transported oil.

It is worth noting that BSEE currently requires operators to monitor ocean currents on Mobile Offshore Drilling Units operating in water deeper than 400 m (1,312 ft) (NTL No. 2009-G02, available at http://www.bsee.gov/Regulations-and-Guidance/Notices-Letters-and-Information-to-Lessees-and-Operators.aspx). Monitoring is performed to evaluate the effects of currents on structural integrity and to ensure the sharing of ocean current data to develop a better understanding of ocean currents and bathymetry and to track the Loop Current and associated eddy currents. Operators and regulators are aware of the prevailing currents and their anticipated change in position over time, which allows for intervention in drilling and positioning of spill response and containment technology when warranted by the strength of currents and other risk factors.

Summary: An ocean current mitigation strategy requires further consideration. Its development would require more knowledge of several cascading risk factors, including the following:

- Risk of discharge event occurrence,
- Risk of strong current intersecting a discharge area,
- Risk of oil entrainment into a strong current,

- Risk of entrained oil contacting distant at-risk resources, and
- Risk of impact from contact with distant at-risk resources.

Effects of Oil Issues. This mitigation would address comments that the state of recovery of the GOM environmental baseline after the DWH event has not yet been determined and that BOEM should delay leasing until missing information is known, or at least for several years (see Section 2.9.3). The basis for the deferral is the concern that additional leasing could contribute to an incremental increase in the chance of another CDE or that routine cumulative actions could have devastating environmental effects on an ecosystem still recovering from a previous event. A related concern was to identify and protect important habitat areas that had been impacted by the DWH event and to make areas or habitats off limits to leasing. Others made more general comments that other sensitive habitat areas of the GOM should be protected as well.

The GOM contains habitat for many threatened, endangered, and sensitive species that are stressed by oil and gas, commercial fisheries, and other human activities, including the recent catastrophic spill. Similarly, climate change may impose additional stress on an ecosystem whose resilient capacity is not well studied. The underlying mitigation concept is not different from existing BOEM requirements that have been in place and continually improved since 1973 for the avoidance and protection of biologically sensitive features and areas on the shelf and slope, such as topographic features, pinnacles, live bottoms, and other potentially sensitive biological features (e.g., NTL No. 2009-G39 at http://www.gomr.boemre.gov/homepg/regulate/regs/ntls/2009NTLs/09-G39.pdf, and NTL No. 2009-G40 at http://www.gomr.boemre.gov/homepg/regulate/regs/ntls/2009NTLs/09-G40.pdf). Rather, a more deliberate strategy would be implemented for future OCS activities.

BOEM anticipates that a large number of new impact assessments and scientific information will become available during the Program to clarify the nature and pathways of potential exposure and contribution to short-term effects. Examples include the Natural Resource Damage Assessment (NRDA), BOEM, and other GOM restoration studies. The BOEM Environmental Studies Program is also fully engaged in studies that are evaluating the effects of the DWH event. While new information may not provide definitive data about chronic or persistent effects, it may indicate that new mitigation strategies are neeeded. BOEM and other State and Federal resource management agencies have monitoring programs in place that will be indespensible in tracking ecosystem changes relative to baseline conditions. BOEM plans to integrate that information as it becomes available, and adapt mitigation or leasing strategies as warranted.

4.3.2.3.2 Arctic Program Areas. Table 4.3.2-3 lists specific Arctic mitigation and deferral suggestions received through the PEIS public input process. They are organized into spatial and temporal deferrals, and by the region to which the mitigations apply: the entire Arctic Program area, the Chukchi Sea Planning Area, or the Beaufort Sea Planning Area. There is considerable overlap among the individual suggestions so some are contained within or have elements in common with others.

TABLE 4.3.2-3 Programmatic Arctic Deferral and Mitigation Suggestions

Location	Mitigation	Mitigation Concerns[a]
Arctic Wide		
Spatial	Exclude ecologically and culturally important areas	SU/ER
	Exclude important subsistence and biological areas	SU/ER
	Create buffers around sensitive areas and resources	ER
	Protect areas upstream and downstream of important ecological areas	ER
	Exclude areas that will protect both bowhead whales and subsistence communities	SU/ER
Temporal	Seasonal restrictions in subsistence areas	SU
	Restrictions during migratory, breeding, and birthing periods	ER
	Delay leasing until adequate spill control and response available	SPILL
	Delay leasing until ecological baseline data is developed	AE
Chukchi Sea		
Spatial	Hannah Shoal	ER
	Herald Shoal	ER
	Point Barrow	SU
	Chukchi ice lead system	SU/ER
	80–97 km (50–60 mi) coastal buffer	SU/ER
	Barrow Canyon	ER
	Buffers around boulder areas such as Kasegaluk Lagoon, Peard Bay, near Skull Cliffs, 25 km (16 mi) southwest of Wainwright	ER
Temporal	During Bowhead whale migration	SU/ER
Beaufort Sea		
Spatial	Within 24–97 km (15–60 mi) of the coast	SU/ER
	32 km (20 mi) to the east of Cross Island	SU
	Cross Island	SU
	All Beaufort Sea areas essential to the success of subsistence whaling	SU/ER
	Boulder Patch	SU/ER
	Camden Bay	ER
	Along coast of the Arctic Refuge and Teshekpuk Lake	ER
	Barrow Canyon	ER
Temporal	During bowhead migration and Nuiqsut whaling	SU
	In Camden Bay during Nuiqsut and Kaktovik bowhead hunts	SU

[a] SU = subsistence use; ER = ecosystem resources; AE = Arctic ecosystem; SPILL = Oil spill.

The table also lists the mitigation issue category that each suggestion has been grouped into. Mitigation categories were developed to organize the numerous mitigation concerns listed above into major themes that will be followed and tracked during the Program. Two broad categories were identified: Subsistence and Oil Spills.

4.3.2.3.3 Subsistence. Many of the requests for Arctic deferrals and mitigations came from Arctic subsistence communities. Some mitigation was intended to protect subsistence use in areas where potential space use conflicts with OCS activities may occur. BOEM has studied subsistence-use densities and identified areas of high use (Downs and Calloway 2008; SRBA 2010). BOEM has also considered specific subsistence-use deferrals in previous Arctic lease sale-stage EISs (Figure 4.3.2-2). In the 2007-2012 Program, BOEM implemented specific subsistence-use spatial deferrals at the programmatic stage. These same deferrals have been included in the proposed action.

Other comments were intended to protect the Arctic ecosystem and its biotic resources. Governmental and non-governmental entities also proposed mitigations to protect Arctic ecologic resources unrelated to their use in subsistence. While the full range of public and stakeholder concerns about mitigations for the Arctic ecosystem and its biologic communities and habitats is broader than specific concerns related to subsistence, subsistence is used as an overall descriptor for this category because of the direct dependence of the traditional subsistence lifestyle on the Arctic ecosystem. In this sense, subsistence mitigation concerns incorporate broader concerns about the potential effects of OCS development on Arctic ecological conditions.

Subsistence mitigation concerns identified in Table 4.3.2-3 have been organized into three categories: Subsistence Use (SU), Ecosystem Resources (ER), and the Arctic Ecosystem (AE). These three categories capture most of the Arctic mitigation and deferral comments listed in Table 4.3.2-3. Principal benefits, relative to the proposed action, would include reduced effects on ecosystems and their biota, as well as reduced effects on time and space conflicts with subsistence practices. Potential adverse impacts may include cascading socioeconomic effects, such as decreased employment opportunities and labor income, related to potentially reduced oil and gas production.

Subsistence Use — Mitigations addressing subsistence use are intended to maintain access to subsistence use areas by either deferring these areas from leasing or restricting industry activity seasonally.

Ecosystem Resources — Mitigation of potential impacts to ecosystem resources are intended to protect the Arctic marine and coastal biota and habitats, many of which are used for subsistence. Subsistence use and ecosystem resource mitigations are closely related as shown in Table 4.3.2-3, which lists numerous mitigations that address both categories. Governmental and non-governmental entities also requested mitigation of potential impacts on Arctic ecosystem resources unrelated to concerns over subsistence use.

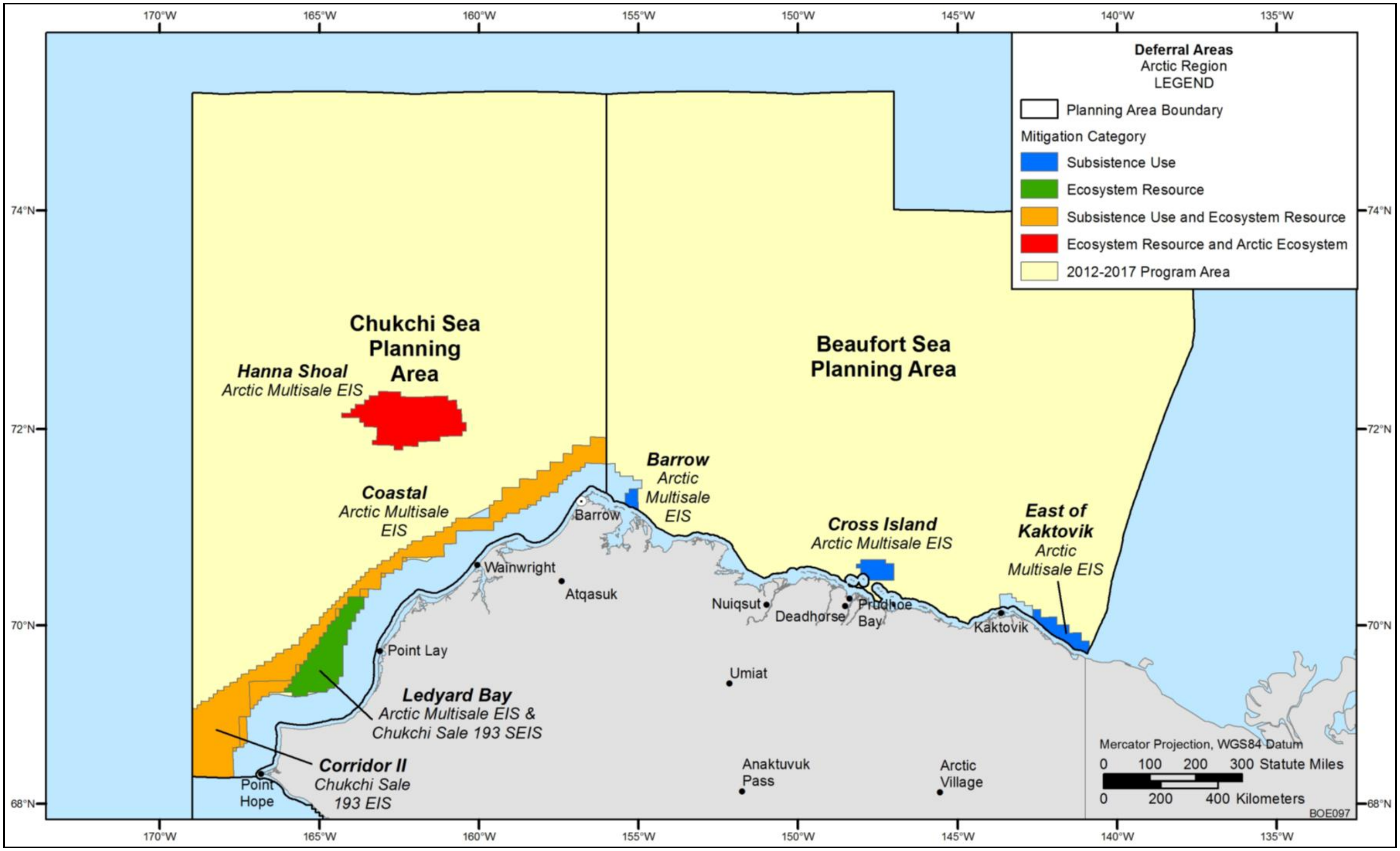

FIGURE 4.3.2-2 Arctic Deferrals Considered as Lease Sale EIS Alternatives, 2007–2012

Arctic Ecosystem — Concerns were raised that the fundamental processes affecting the productivity and sustainability of Arctic ecosystems have not been adequately studied. The comments argue that without further development of foundational knowledge it will be difficult to assess ecosystem responses and resiliency to perturbations from OCS related impacts, and to develop effective mitigation for specific resources in specific areas. A related concern was that the effects of climate change on atmospheric and ocean warming, the sea-ice biome, species migrations, and ocean acidification would result in dynamic conditions that the Arctic ecosystem would be adjusting to during the life of the 2012-2017 Program. Furthermore, new economic uses, such as commercial fishing, marine shipping, and tourism, are anticipated in a warmer and more ice-free Arctic region (Arctic Council 2009). These uses would introduce the potential for additional environmental stresses, and would make conflict resolution among subsistence use and other stakeholder interests more complex.

The nested and cascading relationships among subsistence use, ecosystem resources, and Arctic ecosystem concerns suggest that the process for developing Arctic mitigation strategies would benefit from being done in an integrated way. Considering a subsistence-use mitigation strategy as an example, lease block deferrals, such as those shown in Figure 4.3.2-3 and listed in Table 4.3.2-3, can be effectively applied as subsistence-use mitigation measures, but may not be sufficient by themselves as an effective subsistence-use mitigation strategy within the context of the issues raised in the previous paragraphs. For example, specific spatial and temporal deferrals to protect subsistence use may require re-evaluation and reconfiguration periodically as a result of anticipated climate change effects on species distributions, sea-ice biomes, and the position and configuration of the shoreline, as well as in response to the introduction of new economic uses of the Arctic. A subsistence-use mitigation strategy would need to be adaptable under these dynamic conditions, and include not only specific deferral measures but also a process to facilitate the re-evaluation, reconfiguring, and development of deferral areas and other mitigations over time as needed.

A comprehensive framework would be needed to evaluate subsistence-use mitigation strategies within a dynamic Arctic ecosystem subject to multiple human uses. Developing these strategies will be based on knowledge of:

- The Arctic ecosystem;
- The effects of climate change on the Arctic ecosystem and its components;
- Arctic ecologic community dynamics, including subsistence resources, and their anticipated responses to climate change effects; and
- Human uses of a warmer Arctic, including tourism, commercial fishing, marine shipping, and associated potential environmental stresses.

While studies and investigations are not mitigations per se, they are essential for developing the knowledge base needed to support the implementation of effective mitigation strategies. BOEM has made the acquisition of information and knowledge of the Arctic ecosystem and the biological communities and human uses it supports a high priority for its

Environmental Studies Progam. The Synthesis Of Arctic Research (SOAR) study, which began in 2011, brings together a multidisciplinary group of scientists and Arctic residents to explore and integrate information from completed and ongoing marine research in the Arctic to increase scientific understanding of the relationships among oceanographic conditions, benthic organisms, lower trophic prey species (forage fish and zooplankton), seabirds, and marine mammal distribution and behavior. BOEM is also funding a Hanna Shoal Ecosystem Study. This multiyear study will investigate the importance of Hanna Shoal in the northeast Chukchi Sea as a biological oasis bordering the boundary between Chukchi and Arctic Ocean waters.

In addition, BOEM is collaborating with Federal partners in government-wide research programs such as the Arctic Science Engineering Education for Sustainability (ARCSEES) program, North Pacific Research Board, Interagency Arctic Research Policy Committee, and National Academy of Sciences Polar Research Board research initiatives, as well as the National Research Council "Responding to Oil Spills in the Arctic Environment" review.

4.3.2.3.4 Oil Spill. Concerns about a perceived lack of industry and government ability to handle a large oil spill under Arctic conditions were expressed in comments related to subsistence use, ecosystem resources, and the Arctic ecosystem. A mitigation strategy was suggested to defer Arctic leasing until industry has proven ability to respond to a large Arctic oil spill event effectively. BOEM does not consider a broad deferral of Arctic leasing the appropriate strategy for mitigating oil spill risks within the context of fulfilling its OSCLA balancing mandate. BOEM and BSEE are commited to improving oil spill prevention and containment/response capabilities in advance of future potential Arctic drilling activities. These activities would not likely occur until sometime near or after 2020, based on the scheduling of the first Arctic sale under the new Program in 2015 and an assumed 5-year lag after the sale before exploration drilling begins. Section 4.3.3 evaluates catastrophic discharge event risk factors in the Arctic and discusses regulatory improvements and technologic advances that have been accomplished to date and are planned for the future. These efforts are expected to result in more robust and proven strategies and technologies for managing Arctic oil spill risks that will be available at the exploration well decision point. Concerns about Arctic oil spill risks will be followed through Program decision points.

4.3.2.4 Measures to Enhance Transparency and Effectiveness in Tiering Process

BOEM realizes that each region is different in terms of mineral resources and dependent economies, the relative state of infrastructure and support industries, the sensitivity of ecosystems, environmental resources and communities; and that a leasing strategy needs to be sensitive to those differences, but also must be consistent with OCSLA principles. BOEM envisions a phased OCSLA process that minimizes multiple-use and environmental conflicts to the extent possible during Program implementation, that makes lease sale decisions in the context of the best available information, and that discloses clear reasons for those decisions, even in the face of uncertainty. This vision is consistent with the National Ocean Policy Implementation Plan and related Coastal and Marine Spatial Planning initiatives, all of which provide a complementary framework for space-use conflict considerations.

BOEM is committing to several process enhancements to ensure transparency during the phased OCSLA and tiered NEPA processes of this Program. Although specific approaches to implementation may be tailored to the different needs of the Regions and their stakeholders, BOEM is determined to improve the effectiveness of the tiering process through the following:

Alternative and Mitigation Tracking Table. BOEM is establishing an alternative and mitigation tracking table to provide increased visibility into the consideration of recommendations for deferrals, mitigations, and alternatives at different stages of the leasing process. Beginning with the 5-year PEIS, the table tracks the lineage and treatment of suggestions for spatial exclusions, temporal deferrals, and/or mitigation from the 5-year Program, to the lease sale phase, and on to the plan phase. This table will allow commenters to see how and at what stage of the process their concerns are being considered. BOEM will maintain a table that will be updated as deferral requests are considered at the sale and plan stages and new requests are made. A link to the table will be provided in sale documents and in the annual report, discussed below.

Strengthening the Pre-Lease Sale Process. BOEM is taking a number of steps to enhance opportunities for members of the public to comment and provide new information in the pre-leasesale planning process. Historically, the Call for Information (the Call), which is the first step in the Pre-Lease Sale Process, has generally asked for industry to nominate specific blocks or descriptions of areas within the Program area for which they have the most interest while the Notice of Intent (NOI) requests comments on issues that should be addressed and alternatives that should be considered in the NEPA documents that will be prepared for the action.

Annual Progress Report. BOEM will publish an annual progress report on the approved Program that includes an opportunity for stakeholders and the public to comment on the Program's implementation. Under Section 18(e) of the OSCLA, the Secretary must review an approved Program each year. Historically, this has been an internal review process that reported to the Secretary any information or events that might result in a revision to the Program. If the revision is considered significant under the Act, the Program can only be revised and reapproved by following the same Section 18 steps used to originally develop the Program. However, once the Section 18 process has been initiated for the next 5-year Program, the annual review is subsumed in that process, as the same substantive and procedural requirements are being addressed.

The findings of this progress report may lead the Secretary to revise the Program by reducing the size of, delaying, or canceling scheduled lease sales. If the desired revisions are considered significant, such as including new areas for consideration or more sales in areas already included, the entire Section 18 process must be followed, in essence resulting in the preparation of a new Program.

Systematic Planning. BOEM is committed to engaging in systematic planning opportunities that foster improved governmental coordination, communication, and information exchange. As the only agency authorized to grant renewable energy, marine mineral, and oil and gas leases on the OCS, BOEM has been assigned as the Federal co-lead, along with the U.S. Coast Guard for systematic regional planning efforts in the Mid-Atlantic. Additionally, BOEM will participate on Regional Planning Bodies (RPB) in the Northeast, Mid-Atlantic and West Coast as the USDOI lead. In the GOM region, BOEM representatives will assist the U.S. Fish and Wildlife Service, the USDOI regional lead, with various working group activities. This will facilitate data and information availability, provide research of new technologies, and identify conflict resolution and avoidance strategies. BOEM anticipates that its CMSP engagement will enhance regulatory efficiency through improved coordination and collaboration, and, in the long term, enhance the stewardship of ocean and coastal resources.

These strategies will allow BOEM to not only address the activities that take place under the 2012-2017 Program, but also lay the groundwork for decisions that will be faced in subsequent 5-year periods. It includes efforts to gather information while enhancing opportunities for stakeholders and other interested parties to participate and be engaged in the decision-making process. The initiation of studies and long-term planning now will facilitate future decisions by ensuring the best information is available when making leasing decisions on the approved program and before the development of future OCS programs.

4.3.3 Risk of a Low-Probability, Catastrophic Discharge Event

4.3.3.1 Introduction

The risk of potentially severe consequences of oil spills, especially the risk and consequence of low-probability, large volume spills, is an issue of programmatic concern. Although unexpected and accidental, large spills may result from OCS exploration, development and production operations involving facilities, tankers, pipelines, and/or support vessels. Large accidental platform and pipeline spills (≥1,000 bbl) are addressed in Section 4.4. Incidents with the greatest potential for catastrophic consequences are losses of well control with uncontrolled releases of large volumes of oil, where primary and secondary barriers fail, the well does not bridge (bridging occurs when the wellbore collapses and seals the flow path), and the flow is of long duration (Holand 1997). The term "catastrophic discharge event" is used in this section to describe an event that results in a very large discharge into the environment that may cause long-term and widespread effects on marine and coastal environments.

In general, historical data show that loss of well control events resulting in oil spills are infrequent and that those resulting in large accidental oil spills are even rarer events (Anderson and Labelle 2000; Anderson et al. 2012; Bercha Group, Inc. 2006; Bercha Group, Inc. 2008a,b; Bercha Group, Inc. 2011; Izon et al. 2007). The Norwegian SINTEF Offshore Blowout Database, which tracks worldwide offshore oil and gas blowouts, where risk-comparable drilling operations are analyzed, supports the same conclusion (IAOGP 2010; DNV 2010c; DNV 2011a). Blowout frequency analyses of the SINTEF database suggest that the highest risk operations are associated with exploration drilling in high–pressure, high-temperature conditions (DNV 2010c; DNV 2011a). New drilling regulations and recent advances in containment technology may further reduce the frequency and size of oil spills from OCS operations (DNV 2010c; DNV 2011a). However, as the 2010 DWH event illustrated, there is a risk for very large spills to occur and result in unacceptable impacts, some of which have the potential to be catastrophic.

A fundamental challenge is to accurately describe this risk, especially since there have been relatively few large oil spills that can serve as benchmarks (Scarlett et al. 2011). Prior to the DWH event, the three largest blowout spills on the OCS were 80,000 bbl, 65,000 bbl, and 53,000 bbl, and all occurred before 1971 (Anderson et al. 2012). From 1964 to 2010 there were 283 well control incidents, 61 of which resulted in crude or condensate spills (drilling mud or gas releases not included) (Table 4.3.3-1). Excluding the DWH event, less than 2,000 bbl of crude or condensate were spilled from fewer than 50 well control incidents after 1971. During the 1971–2010 period, more than 41,800 wells were drilled on the OCS and almost 16 Bbbl of oil produced. The National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling has recently argued for a more rigorous and transparent oil-spill risk assessment and planning process to support government and industry decision-making (National Commission 2011). At the present time, there is a not an ideal, standardized approach to characterizing the risk of spill occurrence and consequence across all relevant space and time scales germane to the 5-year Program, consistent with inherent uncertainties associated with different regional factors and different exploration or production operations (Pritchard and Lacy 2011). Figure 4.3.3-1 provides a quantitative, however nonetheless aggregated, characterization of the frequency of loss of well control resulting in oil spills.

Historically, BOEM has also characterized oil-spill risk using the Oil Spill Risk Analysis (OSRA) model to identify the risk of oil released from numerous locations on the OCS occurring and contacting environmental, social and economic resources. BOEM performs OSRA modeling in the evaluation of individual lease sales and certain exploration/development plans. BOEM or BSEE also considers risk during the review of an operator's Exploration Plan, Development and Production Plan (or Development Operations Coordination Document), and/or Application for Permit to Drill (APD). The same OSRA runs often form the basis for spill risk and resource contact analysis in industry-submitted oil-spill response plans. The APD describes the drilling procedures and technology that are planned to be used to drill a specific well under the specific geologic, geophysical, and environmental conditions that exist at the site. BSEE evaluates the APD to determine whether the operator's drilling plan is appropriate for the drilling risk of the site, including use of a new well-containment screening tool developed in collaboration with industry (see Section 4.3.3.3.4).

TABLE 4.3.3-1 Loss of Well Control during OCS Operations (1964–2010)

Region	Exploration Wells	Development Wells	Loss of Well Control Events	Loss of Well Control with Oil Pollution Events
Alaska	84	6	0	0
Atlantic	51	0	0	0
Gulf of Mexico	16,889	29,733	278	59
Pacific	324	1372	5	2
Total	17,348	31,111	283	61

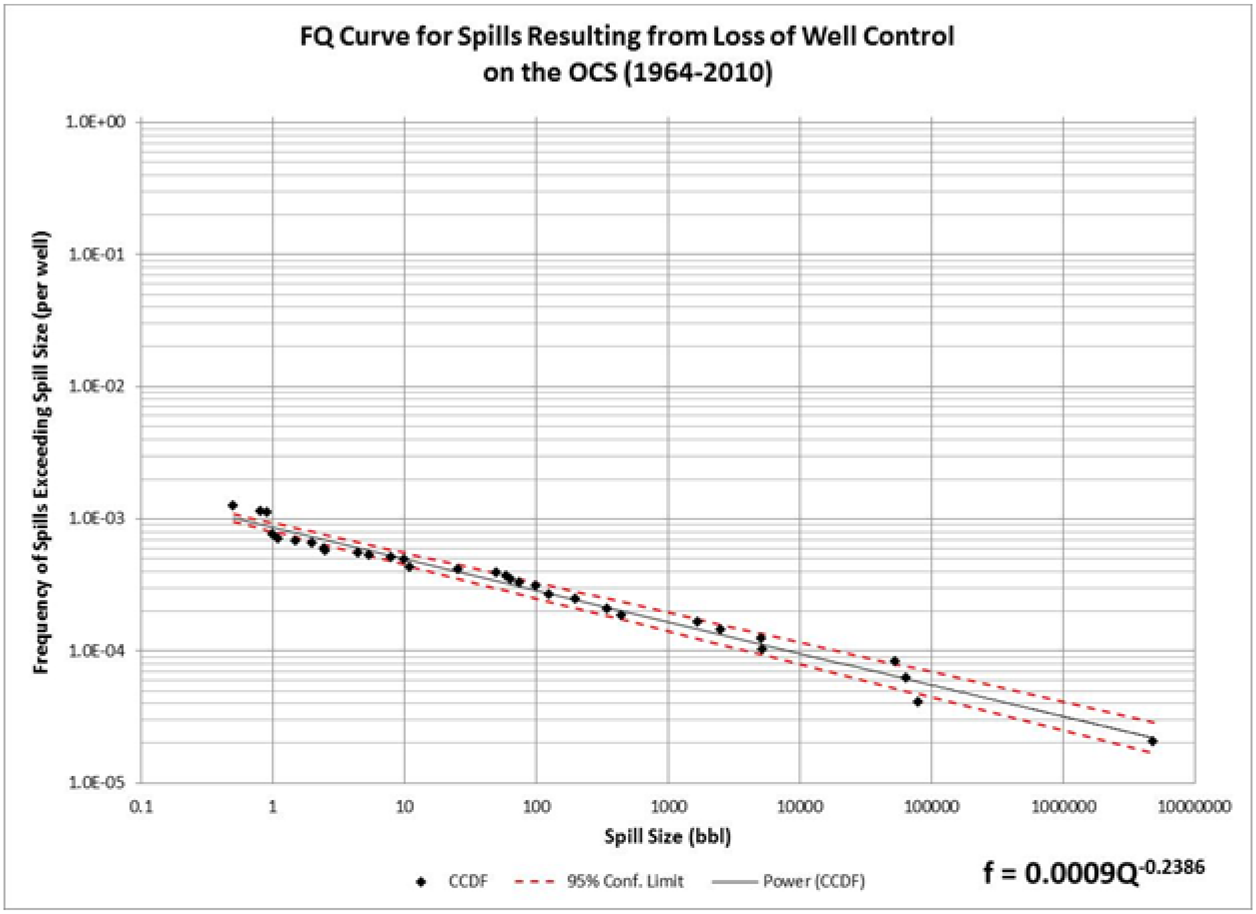

FIGURE 4.3.3-1 Estimated Frequency of OCS Crude and Condensate Spills Both Resulting from Loss of Well Control per Well Drilled and Exceeding a Specified Spill Size (See figure notes 1–13.)

FIGURE 4.3.3-1 Notes

1. The figure shows the frequency of loss of well control (LWC) per well exponentially decreases as spill size increases. See note 9 for more detail about the formula.

2. The BSEE database on LWC includes incidents from 1956 to present day. Most records in the BSEE database can be viewed at http://www.bsee.gov/Inspection-and-Enforcement/Accidents-and-Incidents/Listing-and-Status-of-Accident-Investigations.aspx. The BSEE database also contains a few additional observations besides those available online. As can be expected, the quality of information improves as a function of time. Only the period 1964–2010 is considered herein because of improved quality of information. BOEM undertook a substantial effort to quality control data, when possible identifying and confirming for each incident the relevant API well number, bottom OCS lease number, platform and/or rig, etc. This allowed BOEM to check the timing of a particular LWC incident relative to well operations documented in shared BSEE/BOEM information management systems. BOEM successfully validated more than 90% of all records to well type and operational phase in advance of completing this analysis.

FIGURE 4.3.3-1 Notes (Cont.)

3. The sample size of OCS LWC incidents is small, even when including all OCS Regions. No LWC incidents have occurred or have been reported in the Alaska or Atlantic OCS regions. To obtain a sufficiently large sample size to estimate both historical frequency of LWC and the relative frequency of different sized oil spills (resulting from LWC), 283 incidents between 1964 and 2010 are considered. LWC incidents occurred during exploration drilling/coring (75/2), development drilling/coring (82/1), completion (21), workover (55), production and shut-in (37; a number during hurricanes), and temporary and permanent abandonment (10) operations. Most historical LWC incidents resulted in the surface release or diversion of natural gas; in fact, the database only includes 61 instances of crude or condensate surface releases since 1964. Moreover, the typical crude or condensate spill size is relatively small; the median spill size, including the DWH event, between 1964 and 2010 was 2 bbl.

4. The MMS changed the definition of and reporting requirements for LWC in 2006; prior to that, there was a reporting requirement for blowouts. This resulted in a detectable difference in LWC frequency after 2006 (see trend discussion below in note 7). It is possible that certain incidents that occurred before 2006 were not historically considered LWC incidents that would be considered such following the 2006 change. The BSEE database also contains records for the Gulf of Mexico OCS that SINTEF's worldwide blowout and well release database does not and vice versa. For example, there is a difference of twelve records in the 1983–2007 period. These differences can be attributed in part to the fact that BSEE and SINTEF use overlapping, but different definitions of LWC.

5. This analysis essentially assumes that wells spudded or drilled is an unbiased exposure variable (in aggregate) to estimate the frequency of LWC from all OCS operations. It is relatively simple to understand and collate and can be readily compared to BOEM's scenario of OCS exploration and development for the 5-year Program. However, BOEM recognizes that number of wells spudded or drilled likely underestimates all exposure over the varied exploration, development, and production operations during which LWC may occur. While the number of wells spudded or drilled works well for drilling-related incidents, the number of well completions, number of well workovers, number of active producing wells or well producing years, and number of temporary and permanent abandonment operations are expected to be comparatively better exposure variables for LWC incidents occurring during those operations. Not including that additional exposure (either in terms of an activity level or time exposure) results in a relatively conservative treatment of frequency estimation. For example, more than 42,000 downhole completion intervals were completed on wells in the Gulf of Mexico OCS alone during the same time frame, not accounting for injection intervals. Completion may involve a distinct re-entry into the borehole. While BOEM/BSEE has compiled the data for most of these other exposure variables for the historical period (1964–2010), the spill size data for such operational categories cannot be statistically analyzed (using this methodology) due to the small number of crude/condensate spills from LWC in each category.

6. The exposure variable, OCS wells spudded or drilled, includes original boreholes, sidetrack boreholes, and bypass boreholes for both exploration and development wells. No boreholes associated with both surface and bottom state leases are included in the exposure data. Similarly, no relief, stratigraphic test, COST, or other wells are included in exposure data.

FIGURE 4.3.3-1 Notes (Cont.)

Approximately 48,450 exploration and development boreholes were spudded or drilled in the Alaska, Atlantic, Pacific, and Gulf of Mexico OCS Regions from 1964 through 2010 (36% exploration/64% development). Many wells in the Pacific and Gulf of Mexico OCS actually have numerous boreholes, especially when including bypasses and sidetracks. Approximately 25% of boreholes in the Gulf of Mexico and Pacific OCS Regions are bypasses and/or sidetracks. Note that less than 5,000 boreholes have been spudded or drilled in water depths greater than 200 m in the Gulf of Mexico and Pacific OCS Regions. Injection wells are included in the count of development boreholes. In the Gulf of Mexico OCS, boreholes originally spudded as exploration boreholes are often later completed and eventually produced. In this analysis, if LWC occurred during completion, workover or production operations, such incidents were considered development related.

7. There is no statistically significant trend in the frequency of LWC or LWC with spills (when standardized by wells spudded per year) except after the LWC rule changes introduced in 2006. Incident reporting associated with non-drilling operations increased by a factor of ~2 compared to the historical reporting rate. This suggests that it is likely that equivalent events were unreported prior to 2006. Because of the overall lack of definitive trend, the period from 1964 through 2010 was used in aggregate, despite rather substantial changes in regulation, technology, and industry operations/practices. This allows for the inclusion of some relatively large (≥ 1,000 bbl) oil spills before 1971 when major regulations changes were introduced; otherwise, after 1971, the spill next largest to the DWH event is 450 bbl.

8. LWC frequencies can be standardized by operational phase and well type as is available for the SINTEF database (see DNV 2011a). The LWC frequency across exploration, development and production operations is not the same and treating them in aggregate introduces some error/uncertainty because of the lack of treatment of specific exposure. In aggregate, the OCS LWC frequency is 0.006 incidents per well spudded or drilled when accounting for all LWC incidents regardless of operational phase and oil spill occurrence. The OCS LWC frequency for exploration drilling is 0.0044 incidents per well spudded or drilled, whereas the OCS LWC frequency for development drilling is 0.0027 incidents per well spudded or drilled. While it has been suggested that there is greater incidence of kick (a precursor to LWC) in deepwater (defined here as >200 m) (see note 11 below), the frequency for LWC in deepwater is less than shallow water. Of the 283 OCS LWC incidents considered, 21 instances of LWC occurred in >200 m (13 LWC incidents from drilling; 7 of these 13 incidents were exploratory). In fact, only 5 crude/condensate spills (2 during exploration drilling; 2 during exploration well abandonment; 1 during a development well workover) have resulted from LWC incidents in > 200 m. Over the same time period, the total vertical depth and average water depth of boreholes notably increased, especially since the early 1990s as industry moved into relatively deeper water and/or targeted relatively deep gas plays on the shallow Gulf of Mexico shelf. That trend is coincident with a decrease in the number of boreholes being spudded and drilled per year. Similarly, the number of boreholes relative to each well also increased over the time period considered. Despite these notable trends, the actual frequency of LWC in deepwater is less than in shallow water. Although frequency of LWC for wells characterized by HP/HT downhole conditions was not calculated, it is expected to show a comparatively greater incidence (DNV 2011a).

FIGURE 4.3.3-1 Notes (Cont.)

9. The power law fitting ($f = \alpha Q^{\beta}$) follows the methodology presented in DNV (2011b). In this equation, f corresponds to the frequency of crude/condensate spills per well exceeding spill size Q (bbl). Alpha (α) describes the relative frequency of spill occurrence, whereas beta (β) defines the power relation between spill size and frequency. For scaling purposes, alpha can be compared to the frequency for all LWC discussed above in note 8. The complementary cumulative density function (CCDF), or sample complementary cumulative frequency distribution, shows the number of spill events per exposure that are greater than or equal to a given spill size. The cumulative density function (CDF) is first estimated by ranking the OCS LWC spill observations by size and counting the observations equal to or less than that spill size. The CCDF essentially reverses the observation count for the CDF. The uncertainty in both the CDF and CCDF must be acknowledged, given the limited sample size and relatively few observations in the extreme value tail. In fact, there are no observations between 80,000 bbl and 4,900,000 bbl, and approximately 96% of the cumulative spill volume following LWC is accounted for in a single incident (i.e., DWH event). The power law is fitted to the CCDF using least squares regression. The fit is statistically significant at the 99% level ($r^2 = 0.98$). Confidence intervals at the 95% level were calculated and are displayed above.

10. The power law parameters and confidence limits only offer an approximation of the exceedance frequency of spill sizes related to LWC. The distribution of spill sizes resulting from LWC (n=61) could not be definitively shown to follow a power law distribution, so estimates using least squares regression of the power law parameters may be biased (see Clauset et al. 2009). Dozens of other non-normal, extreme value probability distributions (e.g., log normal, exponential, general extreme value, etc.) were also tested against data observations using maximum likelihood estimators, and no distribution could confidently be fitted to the limited LWC spill data observations.

11. Using this method, there is insufficient LWC spill occurrence data to confidently differentiate by well type or operational phase, water depth, downhole parameters, etc., although these variables may contribute to well complexity and LWC risk. For example, Pritchard and Lacy (2011) report that wellbore instability (kick/loss of circulation) occurs as much as 10% of total deepwater time, and, moreover, that kick incidence (fluid influx from formation into the wellbore) is greater in deepwater wells than other "normal" wells. Holand and Skalle (2001) also suggested an increased kick frequency with borehole depth and water depth. The Mechanical Risk Index (MRI) has been suggested as a complementary analytical tool to better characterize well complexity and well control risk, as well as evaluate non-productive time and drilling cost (Pritchard and Lacy 2011; Skogdalen and Vinnem 2012). The MRI, described in detail in Kaiser (2007), accounts for the following principal factors: total measured depth, vertical depth, horizontal displacement, water depth, number of casing strings, and mud weight at total depth. The Macondo well has been classified as a particularly complex well according to the MRI criteria. It is important to note that drilling complexity and difficulty does not necessarily equate to frequency of LWC, despite the apparent relationship between kick frequency and certain borehole parameters (Holand and Skalle 2001). Although certain parameters may contribute to additional risk, the OCS data suggests, primary and redundant secondary barriers, newer technology, and better trained personnel (all common to deepwater wells given the investment requirements) may in part contribute to lower LWC frequency.

FIGURE 4.3.3-1 Notes (Cont.)

12. Alternative methods could be used to estimate the likelihood of occurrence of a catastrophic spill from LWC based on an event tree, fault tree, bow tie or modeled approach (DNV 2010a; DNV 2010c). For example, a different means to calculate the expected frequency of LWC could follow this example event tree: frequency of LWC for a specific operational phase, factor adjustment for different incident rates by water depth, factor adjustment for not being a shallow gas blowout, factor adjustment for surface flow as compared to underground flow, factor adjustment for whether the surface release is gas or crude/condensate, factor adjustment for BOP reliability or other barriers, etc. This could then be coupled with stochastic spill size distribution modeling based on historical spill size observations, predictions of worst-case discharge, and/or historical/predicted discharge durations. The DNV 2010a analysis provides a recent example in part for exploration drilling in the Canadian Beaufort Sea; following such methods, DNV calculated that the likelihood of uncontrolled flow of oil after considering certain technological barriers was 1 per 100,000 exploration wells drilled. That assessment did not address the reduced expected frequency related to varying spill sizes from an uncontrolled surface flow.

13. This analysis does not account for new risk-reducing measures (including those required by new BSEE regulations), which are likely to reduce the likelihood of a blowout (DNV 2010b, c) or control its potential size (e.g., capping, containment and well control technologies). This analysis of historical OCS LWC and crude and condensate spill observations again represents a conservative approach to frame the risk.

Industry often prepares sophisticated, well-specific risk assessments for exploration or development wells. The hazards-based or well-specific approach can use event-tree, fault-tree, and “safety case” analytical methods (Cooke et al. 2011; DNV 2010b). Well-specific quantitative risk analysis (QRA) is frequently performed by operators (e.g., Mechanical Risk Integrity, BlowFAM, BowTieXP), where complexity or risk is quantified and compared to acceptance criteria and thresholds. Such quantitative risk analysis considers formation/well characteristics, technology and procedures, and human error/management (which is frequently a root cause of many well control incidents). The recently promulgated Safety and Environmental Management System (SEMS) rule, building on API Recommended Practices (RPs) 14C, 14J, and 75, now requires all OCS operators to identify, address, and manage safety and environmental hazards during design, construction, start-up, operation, and maintenance activities.

To support the planning decision involved in establishing a 5-yr schedule of lease sales, detailed analyses of highly variable, region-specific and/or well-specific risk is neither feasible nor appropriate. At this decision juncture, the critical realization is that the risk of a spill with catastrophic consequences, albeit small, is not zero. Different OCS regions and operations may have different risk profiles (Scarlett et al. 2011). This section assesses the importance of different catastrophic discharge event risk factors in different program areas. This discussion is presented to bring into focus critical risk factors, acting individually or in combination, that may occur in program areas so that additional consideration is given to these issues during decision-making on the Program.

Following the DWH event, the National Oil Spill Commission, the National Academy of Engineering/Natural Research Council, and the Department of the Interior Inspector General, among others, offered numerous recommendations about possible regulatory and technology changes, industry practices, and risk assessment approaches that could potentially contribute to safety improvements and oil-spill risk reduction (National Commission 2011; NAE and NRC 2011; DOI IG 2010). In Section 4.3.3.3.4 of the PEIS, recently implemented and ongoing regulatory and industry reforms are organized around prevention, containment, and response themes and summarized accordingly. In addition, the PEIS highlights promising study, research, and collaboration addressing improvements along the same central themes. BOEM believes, in totality, the wide-ranging reform measures and promising research will contribute to further risk reduction, safety improvements, and incident preparedness and response capability over the 40- to 50-year life of this 5-year Program.

4.3.3.2 Risk Factors Influencing Occurrence, Size, Containment, Response, and Fate/Consequence of a Catastrophic Discharge

Risk is the combination of the probability of an event and the magnitude of the consequences of that event. While BOEM primarily analyzes spills in context of accidental small spills (<1000 bbl) and large spills (≥1,000 bbl), this programmatic discussion on risk focuses on low-probability, very large volume, long-duration OCS spills with the potential for catastrophic effects (40 CFR 1502.22) (see Table 4.3.3-2). Such a catastrophic discharge event may result in "large-scale damage involving destruction of species, ecosystems, infrastructure, or property with long-term effects, and/or major loss of human life" (Eccleston 2010). Such a spill would be defined by the National Oil and Hazardous Substances Pollution Contingency Plan as a "spill of national significance" or "a spill which due to its severity, size, location, actual or potential impact on the public health and welfare or the environment, or the necessary response effort, is so complex that it requires extraordinary coordination of Federal, State, local, and responsible party resources to contain and cleanup the discharge" (40 CFR Part 300, Appendix E). Note that some spills potentially classified as spills of national significance would not necessarily be catastrophic discharge events. For a spill to be considered a catastrophic discharge event, its potential discharge volume must be such that catastrophic effects could occur. As previously discussed, long duration uncontrolled flows from a well control incident provide the greatest volumes of potential flow and are the spill sources considered in this section. A scenario of maximum spill volume and duration is presented in Table 4.3.4-3, describing catastrophic discharge characteristics in different program areas. The discharge rate, volume, extent, and duration varies with geologic formation, well design, and engineering characteristics, spill response capabilities, and time to containment. The potential volume of oil that could enter the environment fundamentally depends on the success of intervention, containment, response efforts at the incident site, and the length of time needed to stop the flow from the well by drilling a relief well. The effect of discharged oil not recovered is influenced by various weathering processes and response measures, such as use of dispersants and burning. The potential adverse effects also vary with time of year and location of release relative to winds, currents, land, and sensitive resources, specifics of the well (i.e., flow rates, hydrocarbon characteristics, and infrastructure damage), and response capability (i.e., speed and effectiveness). A catastrophic discharge event does not inherently equate to a spill with

TABLE 4.3.3-2 Risk Factors That Affect a Catastrophic Discharge Event

Risk Factors	Factors That Affect Occurrence	Factors That Contribute to Catastrophic Consequences
Geology	Drilling location, drill depth; mature vs. frontier areas Formation and reservoir pressure; reservoir volume Seabed complexity Shelf hazards	Larger reservoir volume Higher reservoir pressures and temperatures Uncertainty associated with drilling in frontier areas
Water Depth	Increased water depth increases complexity of operation	Shallow water depth increases probability of contact with humans, sensitive species and sensitive environments
Well Design and Integrity	Drill string length Mud program Cementing and casing design Well integrity New technologies (e.g., associated with expansion) Secondary barrier systems (e.g., BOPs, Backup control systems, ROVs) Human error Scale of operations and expansion	Exploratory drilling and improper well construction Prevention system failure Source of blowout: wells and platforms (as opposed to pipelines) Human error, often involving lack of understanding of new technologies
Loss of well control prevention and intervention	Improperly maintained or operated equipment Mechanical failure Equipment failure	Mechanical failure Equipment failure
Scale and expansion	Complexity of operations both physical and operational Human error Coordination and management	Human error Coordination and management
Human error	Lack of training and preparedness Extreme working environments	Lack of training Failure to take precautionary measures
Containment Capability	N/A	Subsea vs. surface containment
Response Capability	N/A	Distance from shore (duration) Response capability in remote areas Capping at the well; drilling relief well chemical and mechanical response
Geography	Region-specific meteorology: temperature, extreme weather, prevalence of ice	Distance to shore: proximity to coastline increases probability of catastrophe Hurricanes associated with high-volume spills

TABLE 4.3.3-2 (Cont.)

Risk Factors	Factors That Affect Occurrence	Factors That Contribute to Catastrophic Consequences
Oil types, weathering and fate	Temperature of oil: higher oil temperatures and lower water temperatures (e.g., Arctic) increase likelihood of breakage Tidal patterns Currents and hurricanes	Oil weathering and evaporation Mechanical recovery, dispersal, or burning Transport/ice Oil persistence Ambient temperatures affect rate of oil flow from blowout location

catastrophic effect. Instead, impacts depend critically on the spill size, oil type, environmental conditions, resources present and exposed, toxicity and other impact mechanisms, and population/ecosystem resilience and recovery following direct exposure.

Industrial Economics, Inc., and Environmental Research Consulting, under contract to BOEM, identified a suite of factors that may contribute to loss of well control and affect the size and duration of catastrophic discharge event, differences in efficacy of containment and response, and differences in fate. They include the following:

- Geologic formation and hazards;
- Water depth and hazards;
- Geographic location (including water depth);
- Well design and integrity;
- Loss of well control prevention and intervention;
- Scale and expansion;
- Human error;
- Containment capability;
- Response capability;
- Oil types and weathering/fate; and
- Specific regional geographic considerations, including oceanography and meteorology.

Many of these factors apply to drilling, abandonment, containment, response, and effects of the event and contribute to the overall catastrophic discharge risk associated with an OCS area, or even a particular well. The interplay of these factors is relevant to evaluating the risk of a catastrophic discharge event and ensuing consequences (Table 4.3.3-2). As BP concluded in its report on the DWH event, a complex series of connected mechanical failures, human judgments, engineering design mistakes, and operational, implementation, and team interactions often contribute to incidents (BP 2010). Many of the risk factors are interrelated, and some factors both increase and decrease cumulative risk depending upon whether one is evaluating the risk of occurrence or the consequence of that occurrence. Moreover, some risk factors may contribute to more or less risk depending on the specific situation.

4.3.3.2.1 Loss of Well Control Occurrence.

Geologic Conditions. Depending on the region, the geology of the OCS varies greatly in character and oil and gas exploration potential. Risk assessments of mature areas (areas where prior drilling operations have occurred) benefit from previous geological exploration and well development. For example, from 1964 to 2010, there have been more than 46,500 exploration and development boreholes spudded or drilled on the GOM OCS. In comparison, frontier areas, such as the Arctic, are relatively underexplored and do not have long registries of geological data or previous attempts at well drilling; in the Arctic, only 84 exploration wells, 14 COST wells, and 6 development wells have been drilled since 1975. This lack of detailed geologic characterization adds additional risk to frontier operations. Though improvements in seismic technology allow three-dimensional modeling of sub-seafloor geology, frontier areas inherently are characterized by greater risk (USGS 2011d; National Commission 2011). Geologic data in deepwater and ultra-deepwater frontiers in the GOM is growing, as is the industry's understanding of the geological variability and risks, especially as operators continue to develop leases tied to these oil-rich areas.

Because of variations in shallow and deep geologic framework, exploration and drilling often encounter numerous challenges including shallow hazards, such as seafloor instability, shallow water flow, permafrost, and gas hydrate, shallow gas and sour gas zones, as well as relatively deeper hazards, such as salt bodies and tar zones (Close et al. 2008; Nuka and Pearson 2010; Shaughnessy et al. 2007). In deepwater reservoirs in the GOM, narrow margins in pore pressure and fracture gradient, over-pressurized and low pressure zones, and reservoir compartmentalization (including low flow assurance) can represent key engineering challenges because of often greater drill depths (Cunha et al. 2009; IHS/GPT 2011). Such geological differences across the different regions represent key concerns for the potential influence geology exerts on wellbore integrity, a key element in drilling and developing wells. Section 4.2 includes a more detailed discussion of the geologic hazards that represent important safety and operation considerations.

Most of the larger reservoirs being targeted on the shallow GOM shelf produce natural gas. There are comparatively fewer plays capable of very large oil discharges as compared to deep water. In shallower wells, the relatively lower formation pressure typically results in a higher margin of safety, although encountering shallow gas represents a substantial hazard. The pressure margin allows operators to change the weight of the drilling mud by several pounds per gallon to balance formation or reservoir pressures. In additional, a large number of shallow-water wells actually require positive external stimulation to produce and facilitate flow of the product from the drilling site.

In general, geologic pressure (pore pressure) and temperature increase with depth. Offshore oil reservoirs can be highly pressurized and compressed under thousands of feet of unconsolidated sediment, salt bodies, and sedimentary rock. The true vertical depth of some reservoirs may exceed 9,144 m (30,000 ft). Deep wells are known to have pressure ratings exceeding 20,000 pounds per square inch (psi) (USDOI 2010; Midé 2010). As pressure and pressure gradients increase, drilling operations become more challenging and necessitate careful balancing of pressures to prevent either the collapse of the well (from excessive pore pressures) or fracturing of the rock and loss of circulation (from excessive drilling pressure). Deeper reservoirs also tend to feature larger volumes of oil. In the event of a well blowout, wells tapped into larger reservoirs can potentially release more oil into the environment and at greater discharge rates since flow rates depend in part on temperature and pressure. Uncontrolled flow rate, or "open flow potential," can be over 100,000 bbl per day. While ultra-deep wells frequently encounter very high formation or reservoir pressures, some wells, such as the Perdido field, have low reservoir pressures and require pumping to facilitate production.

Water Depth: Rig and Well Complexity. Water depth alone is not a strong predictor of well control incidents, but it has been related to the complexity of technology and operations, as well as the frequency of safety incidents (Jablonowski 2007; Malloy 2008; Muehlenbachs et al. 2011). True vertical depth of the well, which includes water depth and well depth, may be a better exposure variable for blowout risk because it encompasses risk factors associated with downhole conditions (Holand 2006). Exploration wells are most often drilled in open water where no platform exists. Jackups, submersibles, semisubmersibles, and drillships, collectively referred to as mobile offshore drilling units (MODUs), are commonplace in exploration drilling, whereas modular rigs installed on platforms are more commonly used in production wells. Drilling of a production well often involves interaction with a production platform and the existing wells on the platform. Water and well depth not only drives the drilling technology, but also influences well design and construction practices, as well as safety measures used to mitigate risk of well control incidents. As oil prices remain relatively high, exploration and production firms venture into deeper waters where larger reservoirs of oil are known to exist. While contingent on a number of factors, deepwater and ultra-deepwater oil operations may have higher safety incidence rates owing to rig technology (Jablonowski 2007), although there have been and continue to be a greater number of loss of well control events in shallow water (Shultz 1999; Izon et al. 2007).

Although definitions of exact depth ranges vary, shallow water depths are generally defined as less than 200 m (656 ft). Shallow water exploration and development rigs involve comparatively simple operations and well construction, allow direct access to well control prevention mechanisms, are less susceptible to deepwater currents (although waves and strong coastal currents are in play), and do not face as frequent complications with pressure and temperature variations often found with deepwater and ultra-deepwater wells. In addition, shallow water depths allow surface blowout preventer (BOP) placement where preventative maintenance and service can be done directly by rig operators, although surface BOPs have fewer redundancies (see discussion below). At the same time, GOM infrastructure in shallow water tends to be older and may be more prone to mechanical failure. Depending on water depth, OCS exploration wells in the Arctic may be drilled from an artificial island; large, usually bottom-anchored drilling structures; or a drill ship.

The greater complexity of wells and specialized equipment used on deepwater and ultra-deepwater rigs may present more opportunity for mechanical breakdown and accidents (Jablonowski 2007). Well complexity increases the number of routine operations and incidence of unusual operations, such as stuck pipe and complex casing and cementing programs (Jablonowski 2007). Complexity also increases the number of individual tasks that need to be performed on a well, complicating procedures and communication.

Deepwater depths are roughly defined as seabed depths that exceed 200 m (656 ft) but are less than 1,500 m (4,921 ft). Because of the extreme depths of deepwater drilling, these operators can no longer utilize traditional fixed platforms directly on the seabed, and different technologies and procedures are required. Deepwater drilling rigs are multi-point moored to the sea floor or dynamically positioned. More complex operations such as mooring, station keeping, riser management, and deepwater well control may complicate operations and increase the number of procedures prone to errors and equipment prone to failure. The newest platforms incorporate advanced technology about which few data on long-term success or incidents have been gathered (USGS 2011d). Deepwater wells require subsea BOP placement at depths unreachable for human service; ROVs, which are designed for such conditions and have relatively higher rates of reliability compared to surface BOPs, become necessary for intervention operations (Midé 2010). Maintenance, repair, and assurance of proper functioning of such technology are more difficult at greater depths.

Ultra-deepwater is a relatively new class of wells defined as exceeding wellhead depths of 1,500 m (4,921 ft). Similar to deepwater platforms, ultra-deepwater rigs are floating semi-submersibles and dynamic positioned drill ships. Ultra-deepwater wells require intricate and complex platforms, structures, and equipment to operate. High hydrostatic pressures and low ambient temperatures in such deep waters necessitate heavier and more specialized equipment and redundant systems because of intervention difficulties. The extended depth demands larger platforms and operating rigs to handle the added drilling materials, as well as storage capacity.

Well Design and Integrity. Well construction is a process with numerous stages preceding well abandonment or production. Construction of an offshore well involves different types of setting agents, pipe, casing, cements, wellhead technology, rigs and platforms, drilling muds (synthetic or water based), and cleaning/preparation agents. These differ by environment, with deepwater wells requiring distinctly different construction and technologies to withstand conditions at extreme hydrostatic pressures and lower temperatures compared to shallow-water wells.

Since the process of sub-seabed drilling cannot be directly observed, drilling operators in an offshore environment are reliant on secondary indicators to ensure proper construction of the well. Geophysical imaging, pressure readings, and reclaimed fluid testing are some of the secondary indicators used in drilling at depth. Though these tests lend accuracy in mapping pressure zones, impediments such as pockets of gas, shallow water flows, faults, salt deposits, or rubble zones are not always forecast.

The primary function of a well system is to reliably contain, control, and transport hydrocarbons to the surface. In general, risks are determined by well bore parameters and an operator's familiarity with the well bore. Drilling engineers must constantly monitor pore pressures, fracture gradients, fluid circulation, and abnormal pressure zones to avoid loss of well control. When drilling into frontier or new reservoirs, limited knowledge of wellbore parameters can increase risk of accidents. The number of barriers is often scaled with the likely consequence of failure; multiple barriers are often used to achieve adequate reliability and avoid leaks (SINTEF 2011). Complex hole sizing, drilling string, wellhead technology, and mud programs, as well as casing and cementing designs are required to reach target depths in deep water and ultra-deep water. Mud, casing, and cementing programs must be designed, refined, and implemented as well bore parameters and formation characteristics are being monitored.

Drilling mud/completion fluid pressure is the primary well control barrier for drilling and well intervention operations (PCCI 1999). When this fluid hydrostatic pressure drops below that of the formation, a kick occurs, which means that formation fluid enters the wellbore (Holand and Skalle 2001). Casing and cementing programs, diverters, BOPs, and wellheads can provide backup (secondary or redundant) barriers to prevent a blowout when a kick occurs. Casing and cement, as well as drilling or completion fluids, are used to ensure the fluids in a formation do not enter the wellbore during drilling and completion operations. For production operations, a packer/tubing string and tree may provide the primary well control barrier. The production casing and wellhead system provide a backup barrier in case of a packer or tubing string leak.

In 2008, BOEMRE published guidelines on the various steps towards managed pressure drilling, a process that avoids the continuous flow of formation fluids, to facilitate better planning of drilling operations (Eschenbach and Harper 2011). Further drilling safety procedures and practice requirements have been developed by BOEMRE (or BSEE) since the 2010 DWH event, including the new Drilling Safety Rule and SEMS Rule. Under these and other rules, drilling practices must properly address and manage known and possible risks with adequate mitigation and safety technology (USDOI 2010; USGS 2011d).

Well integrity issues arise with the cement used in construction. Fluids used to clean and prepare the well for cement are either water-, synthetic-, or oil-based, which can contaminate cement. At sub-seabed depths of 5,486 m (18,000 ft) or more, heavy cleaning fluids run the risk of not filling their intended purpose and contaminating subsequent cementing jobs. Cementing problems were associated with 18 of 39 blowouts between 1972 and 1999 in the GOM (Izon et al. 2007). However, the majority of these cement-related blowouts were of short duration, primarily released natural gas, and involved shallow strings in a well-surface casing. Mechanical indicators such as negative pressure testing and pressure and heat gauges to test cement integrity have also come under scrutiny for lack of accuracy; the pressure gauges used for negative pressure testing for Macondo were accurate to ± 400 psi, an arguably imprecise measure (IAOPG 2011). It is presumed both cementing issues and mechanical failure may have been a factor in the Macondo well blowout (National Commission 2011).

When considering the risk of loss of well control, it can be important to distinguish among the different types of wells, including exploration, development, and production wells. Exploration wells are generally drilled in open water from a mobile offshore drilling unit, jack-up rig, or gravel island, whereas production and development wells are often drilled from an existing platform. In general, exploration may involve greater uncertainty due to the availability of geologic data, nature of drilling technology, and unique barrier factors, such as BOP placement (Eschenbach and Harper 2011). Despite the increased risk of drilling wells on undeveloped frontiers, procedures followed in drilling exploratory wells may be more conservative (i.e., safer) to account for this increased level of uncertainty (Eschenbach and Harper 2011).

In the GOM from 1980 through 2004, there were a relatively higher number of well releases during development drilling and well workover operations as compared to exploration drilling. This contrasts with worldwide trends where more well releases tend to occur during exploratory drilling (Holand 2006). Holand (2006) attributes this to the fact that more development wells are actually drilled. Hurricanes or ship collisions caused approximately 50% of the historical production blowouts (Holand 2006). Since 2004, the loss of petroleum during hurricanes was minimized by shutting in OCS wells. No blowouts occurred during 6 hurricanes in the Gulf of Mexico (Anderson et al. 2012). Simultaneous operations of drilling and production also increase the risk of incidents when drilling production wells. Another root cause of sustained blowouts during completion and workover is the positive potential for pressurized hydrocarbons and limited bridging tendency with flow through perforations or gravel pack (Flak 1997).

In general, the riskier wells include wildcat wells (first well into formation), offset wells (wells drilled near another well that encountered drilling trouble zones or past well control problems), and extended or ultra-deep drilling (SPE Advisory Summit 2011). Deepwater and ultra-deepwater wells require complex infrastructure, planning, and execution to construct; therefore, facilities and volume of production tend to get larger with distance from shore and water depth (Shultz 1999). The complex nature of the formations, combined with the drilling depths in high-pressure/high-temperature conditions required to reach the target zones, presents a challenge to drilling engineers (Close et al. 2008). This challenge is highlighted in the greater number of casing strings required to drill to target depth, which in turn creates the challenge in achieving good cement isolation in a tight tolerance annuli (Close et al. 2008; Chatar et al. 2010). Despite such challenges, over 2,300 deepwater development boreholes and approximately 2,600 deepwater exploration boreholes have been drilled (if deepwater is considered >500 ft). Of these, the Macondo well is the only exploration well to involve a blowout and large oil spill. No spills have occurred for deepwater development wells.

Loss of Well Control Prevention and Intervention. A blowout occurs when there is failure to control a kick and regain pressure control, and can be defined as an uncontrolled flow of formation fluids. Oskarsen (2004) classifies offshore operations blowouts in three groups:

- Surface blowouts characterized by fluid flow from a permeable formation to the rig floor;

- Subsurface blowouts characterized by fluid flow at the well at the mudline, where the exit conditions are controlled by the seawater; and

- Underground blowouts characterized by fluid flow from one formation zone to another, typically by using the wellbore as a flow path.

Loss of well control, under BSEE regulations, can also include flow through a diverter and uncontrolled flow resulting from a failure of surface equipment or procedures (30 CFR 250.188). Potential scenarios for each blowout type are described in Oskarsen (2004). Blowout frequencies by different phases of exploration and production operations and relative water depths are available in Holand (2006). Although high hydrostatic pressures at depth will aid in choking any flow from potential blowout points (PCCI 1999), two independent barriers are typically used for well control. The primary barrier is usually the hydrostatic pressure exerted by the well mud/synthetic fluid column (either static or dynamic). The secondary barriers typically include the pressure control equipment such as the BOP, the diverter system, the wellhead (innermost casing hanger seal), and the choke/kill line valves. These barriers are routinely used during drilling, completion and workover operations. If the well is flowing (i.e., producing oil and/or gas), the primary barrier is that closest to the reservoir (PCCI 1999). BSEE regulations now require at least two independent tested barriers, including one mechanical barrier, across each flow path during well completion activities (30 CFR 250.420(a)(6)).

Individual BOP systems are used during drilling operations to prevent unrestrained release of crude oil from reservoirs. BOPs are composed of all systems required to operate them, including flexible joint, annular preventer, ram preventer, connector, choke and kill lines, choke manifold and auxiliary equipment (MMS 1996c). The specific type of BOP may influence the loss of well control and well releases. For example, fault tree analysis in the DNV Beaufort Sea Study showed that there is substantial risk reduction with BOPs having two sets of blind shear rams spaced at least 1.2 m (4 ft) apart (DNV 2010a). The study concluded that the reliability of a two blind shear system is 99.32%, compared to 99% for a single blind shear ram (Midé 2010). Despite the seemingly low percentage, an increase of 0.32% in BOP reliability raises the estimated number of wells that can be drilled before an uncontrolled blowout to 6,213 from 4,225 (Midé 2010).

In shallow-water wells, BOPs are placed above the sea on the rig, allowing for periodic repair and maintenance. The operations of surface BOPs are not subject to the same complicating factors associated with subsea BOPs, and they are more accessible for repair and intervention. However, surface BOPs that are placed on floating facilities (as opposed to jack-up rigs) present other risks. The high-pressure riser and casing from the seafloor to the rig can be exposed to dynamic stresses. A failure of a high-pressure riser due to these stresses can lead to uncontrolled flow below the surface BOP system located on the floating facility. Well operations from a floating platform with a surface BOP stack and a high-pressure riser (through the water column) are higher risk operations than drilling from a jack-up rig or a fixed platform. The single high-pressure riser (or in some cases, a dual riser system) used by floating platforms is subject to environmental forces such as current induced vibration that make it more susceptible to stress fatigue. Jack-up rigs and fixed production platforms have more casing strings tied back to the surface of the rig or platform, which provide additional external support for the pressured casing. In addition, because these tied-back casing strings are used in shallower water operations with a shorter water column, they are less exposed to current-induced stress. Numerous studies have examined the reliability of surface and subsurface BOP stacks where redundancies in different designs and maintenance requirements contribute to differences in failure rate (Sattler and Gallander 2010; MCS 2010; Midé 2010; Melendez et al. 2006; West Engineering Services 2004; Holand 1999; Tetrahedron 1996; Holand 1992). Some studies have indicated that subsea stacks are more reliable than surface stacks (Sattler and Gallander 2010).

Deepwater and ultra-deepwater wells have subsea BOPs that are affixed directly to the well on the seafloor. Deepwater and ultra-deepwater seafloor depths exceed depths at which human operators can work, thus requiring submersibles and emergency backup control systems. These systems can demonstrate failures. For example, in the relatively few documented instances when BOP systems have failed, the main control system is responsible for approximately 50% of these failures (Midé 2010). Important technology includes the secondary deadman system, acoustic backup system and ROV. ROV activation of the BOP using the secondary control system has a 75% success rate. DNV (2010a) reported a 25% reliability of current acoustic backup systems.

Overall, more research and development is necessary to increase the success rates of control systems in order to reduce the risk of deepwater drilling operations. Evidence for the initial containment response to the DWH event, as well as a review of industrial and governmental containment response, suggests that mitigation technology has not kept pace with extraction technology that enabled industry to drill in increasingly deeper waters (IPIECA 2008; Cohen et al. 2011). However, industry and regulatory enhancements are underway to improve control systems (USDOI 2010; DNV 2010b) (see Section 4.3.3.3.4 for more details).

Scale and Expansion. Scale and expansion of OCS operations increases the complexity of drilling and production operations. Factors associated with scale include the number of wells, new types of production facilities, new methods of transporting oil, higher levels of production, the addition of simultaneous operations during production, and higher rates of pumping. Expansions in scale of oil production require more well and platform construction, along with higher production volumes. New technologies necessitated by an increased scale of operations may be associated with higher levels of risk, especially when technologies are not fully developed. The number of incidents reported increases with more complex operations, which by their very nature, often entail greater scale, expansion, and complexity (Jablonowski 2007; Pritchard and Lacy 2011; Muehlenbachs et al. 2011). Large-scale oil production involves the use of subsea well complexes and large central processing and storage facilities, about which little data on long-term success and incidents have been gathered. The OCS operations in the GOM are moving farther offshore and incorporate more complex drilling and production operations. For example, the Shell Perdido Project is simultaneously connected to 22 different wellhead sites (Shell 2011b). A production facility of this scale, in addition to being in ultra-deep water, typifies the trend in scale and expansion (Shell 2011a). Increased production from comparatively fewer surface facilities may concentrate the safety risks during drilling and production, but it also provides for the opportunity to better track indicators and manage and regulate the factors that contribute to safety incidents.

More complex facilities and operations require equally complex management structures. Operations of greater scale entail a complex set of relations between different operators, contractors, and management groups. While the probability of release on more complex facilities has not been actively studied, it is noted that the Macondo well suffered from insufficient correction of known concerns prior to blowout because of management and communication issues between operators and contractors (Winter 2010; JITF 2010).

Human Error. Human error, or combinations of human and mechanical failure, are the root cause of many OCS accidents and spills (Jablonowski 2007; Muehlenbachs et al. 2011). Low-probability, high-impact failures such as the Macondo well blowout indicated more stringent requirements were necessary to address human error (Winter 2010; USDOI 2010). In the case of the Macondo well, operators misread pressure readings, authorized high-risk activities, disregarded warning signs, and overlooked the checks and balances that exist in regulatory assignments, while mechanical BOP failure compounded the severity of the release (Winter 2010; National Commission 2011). The new SEMS rule recognizes this gap and establishes a mandatory program to ensure OCS operators identify, address, and manage safety and environmental hazards and impacts during design, construction, start-up, operation, inspection, and maintenance activities. This systemic approach to managing risk and ensuring safety and environmental protection should provide more focus on the risk of system failures as well as on the human factors that could contribute to an incident (SPE Advisory Summit 2011) (see Section 4.3.3.3.4 for more detail).

Level of training and safety culture are important factors in determining the number of safety and well control incidents (Jablonowski 2007; Vinnem et al. 2010). A well-trained crew that has participated in numerous practice exercises will decrease the probability of a spill caused by human error. Lack of proper training has been a significant issue in the last decade, probably because of a lack of incidents (Etkin 2011). Previously, standard industry practice often permitted operation of technical equipment with on-the-job training or one-week training courses. The MMS published final regulations for Well Control and Production Safety Training (30 CFR 250, Subpart O) in 1997 (amended on August 14, 2000), and revised them in 2000 to provide for training system audits, interviews, and tests to measure training results. Recently, the advent of new regulations (the SEMS rule) and requirements for personnel on platforms and working on drilling operations aims to eliminate the current gaps in industry-required trainings. Individuals working in specific technical jobs are now required to attend annual training and certification, and operators are required to perform job safety and hazards analyses (USDOI 2010; BOEMRE 2010e; IAOGP 2011).

Other factors such as climate and temperature could affect worker performance. For instance, colder temperatures in the Arctic lead to higher probabilities of human error due to the extreme working conditions (Eschenbach and Harper 2011).

4.3.3.2.2 Containment and Response. The effectiveness of containment and spill response dictates the amount of oil released in the environment. Area and operation-specific oil-spill contingency plans, as well as actual containment and response efforts, will be designed around many of the factors that contribute to the risk of spill occurrence and fate of oil in the water. Assuming the correct containment plan is in place, the risk of poor planning and containment execution still exists (USCG 2010).

If the BOP fails, other options are available to control the blowout, including capping/shut-in, capping/diverting, surface stinger, vertical intervention, offset kill, and relief wells (Neal Adams Firefighters, Inc. 1991). Of these methods, a relief well is often considered most important, and may be required immediately (even if it is not the first choice), since it is typically considered the most reliable solution for well control. The amount of time required to drill a relief well may depend upon the complexity of the intervention (e.g., depth of formation), the location of a suitable rig, the operations that may be required to release the rig, and any problems mobilizing personnel/equipment.

Once the oil has reached the sea's surface, the first few hours of a spill are the most critical for response efforts. Boomers and skimmers should be deployed immediately to contain the oil and *in situ* burning and dispersant use should be evaluated to supplement mechanical collection methods. Since *in situ* burning and dispersant use are time sensitive, responders should ensure the necessary supplies for either method (e.g., flame-resistant booms) are available.

If a spill cannot be contained at the site's wellhead (subsea), a response effort may be required to restrict the surface spreading of oil in the water, especially from the shore. The following sections outline the methods of containment, as well as the risks and considerations unique to each. In some circumstances, non-traditional spill response measures may also be proposed to contain or prevent oil from being transported into sensitive ecosystems, such as coastal wetlands. For example, following the DWH event, temporary sand berms were constructed in the GOM along the northern Chandeuler Islands. Although all oil-spill response measures require advance approval of the On-Scene Federal Coordinator in the USCG, some measures may be relatively untested and lead to unintended consequences (Lavoie et al. 2010).

Water Depth, Distance from Shore, and Other Variables. As shown by the DWH event, the loss of well control in deeper depths presents containment obstacles and challenges that would not necessarily be encountered during a loss of well control in shallow waters. Although many of the same techniques used in shallow water were used to attempt to control the Macondo well, the well control efforts were hindered by water depth, which required reliance solely upon the use of ROVs for all well intervention efforts. This is a concern in deep water because the inability to quickly regain control of a well increases the size of a spill, as occurred during the DWH event. Other complications associated with responding to a deepwater blowout include inaccessibility of the well, methane hydrate formation at lower seafloor water temperatures, and the need to work with larger and less-available support equipment due to the greater water pressure. The inverse relationship holds true for emergency response to spills. The closer the well is to shore, the quicker the potential response.

Distance from shore, coupled with response measures, fundamentally drive the size of the impacted area. Oil-spill contact potential, the likelihood of released oils contaminating areas or materials of interest (e.g., beaches, wildlife, sensitive environments), decreases with greater distance from shoreline (IPIECA 2008; JITF 2010). As physical distance from sensitive areas and shores increases, sea waters, currents, waves, and biological processes are able to dilute and digest more of the spilled oil. Volume alone does not determine the impact of the releases. Releases close to shore may have greater effects, especially when concentrated into inlets or smaller areas (IPIECA 2008).

Oil-spill response options in Arctic environments will vary depending on seasonal oceanographic and meteorological conditions (Potter et al. 2012). Oil-spill response strategies and tactics for cold climates must be designed to deal with a mix of open water and ice conditions that could occur throughout any portion of the operating period and extending beyond the operating period to account for response for a spill occurring on the last day of planned operations. Different environmental conditions prevalent in the Arctic and sub-Arctic may in part impede or facilitate different response windows and methods (Bjerkemo 2011; MMS 2009b). Ice can serve as a natural oil boom and dampen surface waves, while cold weather slows the rate of oil evaporation – making it easier to burn (Bjerkemo 2011). Shore ice may also provide a physical barrier, allowing oil to concentrate in greater thickness, limiting shore contact and promoting *in situ* burning (Bjerkemo 2011). However, spill removal companies have testified that icy waters make traditional techniques (booming and skimming) significantly less effective (CRRC 2009). A spill during the fall freeze-up would be the most dangerous time for a spill, and even chemical response methods would be limited (Nuka and Pearson 2010). The Arctic is sparsely populated and infrastructure is not abundant. Thus, the ability to appropriately respond to incidents remains a concern (USGS 2011d). Ice-free seasons are relatively short (around three months a year), and ice state may influence the ability to drill a relief well. The relatively shallow Arctic depths could result in more contact potential in the event of a catastrophic spill. Should spilled oil persist in the water column, there is concern that oil could become trapped in ice. A substantial government and industry-sponsored investment in oil-spill response research in varying ice states using different methods has occurred in the past few decades (Dickins 2011; MMS 2009b). Recent research in the Arctic focuses on high-capacity mechanical recovery systems for varying ice types and states, improving techniques for surface and subsurface dispersant application in coldwater environments and in drift and pack ice, ignition techniques and oil-herder applications to improve the efficacy of *in situ* burning, fate and biodegradation studies of dispersed oil in cold water environments, and detecting and tracking spilled oil under ice and within ice matrix (IAOGP 2012; Dickins 2011; Kanocz and Johnsen 2011; S.L. Ross et al. 2010). In addition to these challenges, government and industry must augment logistical, personnel, and infrastructure capacity to accommodate the level of response expected for a worse-case scenario Arctic oil spill.

Status of Technology to Physically Contain. OCS operators are required to submit documentation that they are able to deploy adequate containment resources to respond to a blowout or other loss of well control (30 CFR 254; Certification NTL). In general, subsea containment at the wellhead is ideal and most effective because it contains the oil at the source. Perhaps the most significant hurdle to the development of containment at the blowout point (subsea) has been cost (BOEMRE 2010f; PCCI 1999). Given the low historical probability of a significant blowout occurrence and limited use of subsea containment equipment, industry development of cost-effective equipment had not historically occurred prior to the DWH event, although that has changed in response to new regulatory requirements.

As mentioned, containing oil at the wellhead is the ultimate goal in the event of a blowout. However, subsea collector technologies have historically presented some operational challenges given design and installation difficulties (PCCI 1999). For subsea oil containment, the technical hurdles to be overcome during a deepwater blowout include the behavior of deepwater currents; the ability to manipulate heavy objects on the seabed; the ability to design subsea collectors that are flexible enough to cap a large range of subsea wellhead assemblies and accommodate a high volume of recovered oil, gas, and water; the ability to approach the blowing well and install containment devices on the seafloor; and the lack of standardization in subsea wellhead design.

ROVs capable of manipulating heavy objects, especially collector technologies, near the seafloor and in turbulent conditions caused by the blowout, are limited. In fact, even relatively minor blowout plumes have rendered many ROVs useless. Aside from the risk of physical damage from plumes, the following risk factors exist related to ROV use:

- Sufficient surface support or subsea lifting devices such as syntactic foam buoys are required to assist the ROV with heavy object lifting;

- Subsea currents can complicate ROV use; and

- Navigation systems and/or sensors can be damaged from the blowout plume.

In comparison, subsea containment in shallow water is less complicated; for example, it is easier to mobilize equipment and avoid hydrate formation at the relatively warmer seafloor temperatures.

The DWH event and implementation of NTL No. 2010-N10 (Certification NTL), however, has created new impetus for industry-driven containment technology. For example, Marine Well Containment Company (MWCC) – a partnership between ExxonMobil, Chevron, ConocoPhillips, and Shell – has announced the release of its seabed containment system (Helman 2011). According to the company, the unit features the ability to do the following:

- Contain 60,000 bbl per day of liquid and 120 million standard ft^3 of gas;

- Inject dispersants; and

- Be placed in water up to 3,048 m (10,000 ft) deep.

This system is intended to address the weakness of the BP containment dome that caused its initial failure during the DWH event (Helman 2011). The system can inject antifreeze-like chemicals to inhibit natural gas hydrate build-up, which created spill containment complications during the DWH event. The MWCC's system is based on design changes made by BP that led to effective capture during response efforts to the DWH event.

Another option for source control and containment is through the use of the equipment stockpiled by Helix Energy Solutions Group, Inc. The Helix initiative involves more than

20 smaller energy companies and supplements the MWCC response effort. Helix has maintained the equipment it found useful in the DWH event response and is offering it to oil and gas producers for use. Together, the ships and related equipment can accommodate up to 55,000 bbl of oil/day, 70,000 bbl of liquid natural gas, and 95 MMcf of natural gas at depths up to 2,438 m (8,000 ft).

Shell is developing equivalent shallow-water containment technology for use in the Arctic. The company is under increasing scrutiny from industry stakeholders to ensure that an event similar to the one that happened in the GOM will not occur in the Arctic. Shell has pre-staged response equipment and vehicles designed for Arctic conditions that can be activated immediately (Dyer 2011). For example, in the 2011 Revised Outer Continental Shelf Chukchi Exploration Plan, Shell's spill response plan includes oil-spill response (OSR) vessel (Nanuq); an ice-capable Oil Spill Response Barge (OSRB) and associated tug (Point Oliktok tug and Endeavor barge); MSV Tor Viking and M/V Fennica vessels for ice management; a secondary relief well rig (Noble Discover); an oil storage tanker with a 500,000 bbl capacity for storage of any recovered liquids (Affinity); associated smaller workboats and aerial support (Shell 2011c). In addition, Shell's plan includes two vessel of opportunity skimming systems (VOSSs) to assist with containment and recovery, along with an Arctic oil storage tanker to provide storage of recovered oil (BOEMRE 2011m; Shell 2011c). Shell has committed to having a pre-fabricated subsea capping system with surface capability to capture and dispose of oil, and has indicated that this system is in final design and construction (Shell 2011c). Similar containment and response capabilities are also planned for exploration drilling activities in the Beaufort Sea, and some response capabilities will serve both locations (Shell 2011d).

Aside from subsea containment, subsea dispersant injection into the well or blowout jet zone is considered to be one of the most promising measures to contain the *effects* of the oil spill. Design concepts to date require advanced planning to incorporate the appropriate equipment for dispersant injection into the drilling infrastructure/equipment (e.g., subsea stack or BOP). The industry is now focused on wellhead-independent injection systems; this method involves applying dispersants into the blowout plume. As noted above, MWCC's system includes a subsea injection capability. However, the environmental tradeoffs of subsea dispersant use (similar to surface dispersant use, discussed in the following section) continue to be debated and have been poorly documented based on limited prior application (USEPA 2011n).

Mechanical Recovery Methods. Mechanical recovery methods include the use of booms, barriers, and skimmers, as well as natural and synthetic sorbent materials (NRC 2003b). Of all response efforts, mechanical methods exhibit the least impact on the environment and are considered to be the first line of defense against surface oil spread (USEPA 2011p).

Booming and skimming are the two most widely used mechanical containment methods. The effectiveness of these two measures will depend on the volume of the oil spill, location of the well, and sea conditions. For example, at remote open-sea well locations, the immediate availability of sufficient oil storage and/or oil-water separators may be limited (BOEMRE 2010f; PCCI 1999). Booms and skimmers become less effective in higher wave swells and wind, and in fast currents. Three main types of skimmers exist, each with characteristics that may make them more effective given certain ocean and spill conditions. Weir and suction skimmers operate best on smooth water with little debris; oleophilic skimmers are the most flexible, can be used on spills of any thickness, and may work most effectively on water that has rough ice debris (e.g., in Alaska) (USEPA 2011q). Although oil recovery efforts must withstand the harsher climate conditions of the Arctic, a research program conducted by SINTEF in 2010 concluded that the mechanical recovery of oil spills is possible despite difficulties associated with ice management and maneuvering vessels and skimmers through ice (Sørstrøm et al. 2010). Varying ice states (i.e., type, thickness, coverage) may require different ice management tactics and/or substantially reduce options for mechanical recovery and recovery rates, or in the case of oil in or under pack or solid ice, mechanical recovery may not be possible during several months of the year (S.L. Ross 2011; Nuka Research and Planning Group 2007b). In any environment, collection rates of 20% are considered exceptional in most cases (USEPA 2011g). In the case of the DWH event, skimmers only accounted for the removal of 3 or 4% of the released oil because of relatively low efficiency (USCG 2010).

The DWH event tested new, "enhanced" booms and skimmers, which may help expand the range and efficiency of recovery in open water and near shore. Advances have been made to create booms that can withstand rough sea conditions and more viscous oil, including in cold-water conditions offshore Norway (McKay 2011). As a result, the effectiveness of recovery both on open water and near shore can be expected to increase, especially given the attention of the USCG to this matter (USCG 2010).

Sorbent materials capture oil through absorption or adsorption and are often used to supplement booming and skimming. Lighter oil products (e.g., gasoline, diesel fuel, benzene) are absorbed more easily, while thicker oil responds better to adsorption (USEPA 2011r). While generally effective, the use of sorbents is less practical with extremely large spills or in windy conditions.

Chemical and Biological Methods. Surface dispersants (chemical-based) can be applied via boats, aircraft, helicopters, or through subsea injection techniques. A two- to three-day window following an event generally exists to use dispersants (BOEMRE 2010f); therefore, pre-approval of dispersal as a contingency method and of specific dispersant use is essential (NRC 2005b). The USEPA maintains a list of chemicals and spill-mitigating devices that may be deployed during an oil spill in coastal waters of the United States; this is a part of the National Contingency Plan (NCP). Actual approval of response measures is required by the USCG and USEPA chairs of the Regional Response Team (RRT). Since the toxicity of dispersants is an important consideration (IPIECA 2008; NRC 2005b), mechanical containment methods are generally the preferred initial response. However, very large spills may require immediate application of dispersants, because mechanical recovery may not be adequate or weather conditions may prevent mechanical recovery and *in situ* burning. Further study is needed to understand the effects of subsea and surface application of dispersants in marine ecosystems, but following the DWH event, subsea injection of dispersants at the source is viewed as an effective method for reducing the amount of oil that reaches the surface. In certain situations, dispersants may provide the only means of removing significant quantities of surface oil quickly. It is essential that the effectiveness of chemical dispersion be monitored continually and the response terminated as soon as the dispersant is no longer working. While modern dispersants and oil/dispersant mixtures exhibit relatively low toxicity to marine organisms, concerns remain about the overall volume used and persistence in the environment (Berninger et al. 2011; Hemmer et al. 2011; Hamdan and Fulmer 2011; Wooten et al. 2012). The Joint Industry Oil Spill Preparedness and Response Task Force (2011) summarizes ongoing research initiatives addressing the effectiveness, fate (e.g., biodegradation, bioaccumulation), and toxicological effects of dispersants in marine environments, including subsea application in deep water. In addition, the Oil Spill Preparedness and Response Joint Industry Task Force is working closely with Federal agencies, such as USCG, USEPA, NOAA and BSEE, to make more informed decisions about dispersant use in the context of trade-offs (e.g., draft National Response Team guidance on dispersant use).

The effectiveness of dispersants (compared to booming and skimming methods) is more dependent on sea conditions. Studies indicate that dispersants are most effective at salinities close to that of normal seawater (NRC 2005b). In addition, dispersants work best in warmer water (USEPA 2011n), although some research suggests dispersants also can be applied in cold waters (S.L. Ross 2007, Potter et al. 2012).

Gelling agents react with oil to form rubber-like solids that can then be removed from the water via nets or skimmers. Gelling agents can be most effective for small to moderate spills in moderately rough seas. The volume of gelling agent required can be as much as three times that of the oil spill; therefore, for larger spills, it is impractical to use this method. Moderately rough seas provide increased mixing effect of the agents with the oil, resulting in greater solidification (USEPA 2011o).

The use of biological agents (i.e., bioremediation) for oil-spill response is an emerging area of research. Bioremediation is the act of adding materials (e.g., microorganisms) to the environment to increase the rate of natural biodegradation. Currently, two technologies – fertilization and seeding – are being used in the United States for oil-spill remediation (USEPA 2011m). Unlike the other methods covered in this section, bioremediation is a longer-term response effort.

***In Situ* Burning.** Burning is an effective method to remove much of the oil once it has reached the water’s surface and reduces the need for storage of recovered oil. Weathering properties of the oil will affect whether or not surface burning is a viable option. For burning to work effectively, oil thickness must be at least 1 to 2 mm and water-in-oil emulsion must be 50% or less (NOAA 1997).

The weathering properties of oil in icy waters are also important for recovery efforts. Studies have shown that, in general, oil in icy waters weathers at a slower rate than in open waters. The slower weathering process of oil in the Arctic Ocean increases the opportunity of successful *in situ* burning, which efficiently reduces free floating oil and oil collected in booms (Sørstrøm et al. 2010). *In situ* burning has been successful in cases where oil was trapped in ice (Nuka and Pearson 2010; Ross et al. 2010). Herding agents can also be added to the water surface surrounding an oil slick, causing the slick to contract, thus reducing the slick’s area and increasing its thickness, facilitating burning (Buist et al. 2011). However, under certain ice and environmental conditions, the effectiveness of *in situ* burning is limited (S.L. Ross 2011).

A factor that could limit the application of *in situ* burning is the impact on human health due to gas and particulate release from oil burning. Studies estimate that 5 to 15% of the oil is converted to particulates (mostly soot) but that public exposure is not expected unless the smoke plume sinks to ground level. However, *in situ* burning raises general concerns over air quality impacts (NOAA 1997a).

4.3.3.2.3 Fate.

Oil Type. Various oil types have varying characteristics, including pour point, viscosity, weight, and composition. In general, lighter oils tend to be less viscous and can be byproducts of crude oils such as diesel and gasoline. Lighter oils tend to be less toxic, although some from the GOM tend to have higher concentrations of toxic compounds (Etkin 2011). Heavier oils tend to resist weathering and dispersant application, and then may persist in the water column for long periods of time (USGS 2011d; USDOI 2010; Etkin 2011). Similarly, oils that persist in marine and coastal sediments may be physically or biologically remobilized after initial sedimentation or burial, such that longer-term re-exposure is an important consideration (NRC 2003b; Clement et al. 2011).

Evaporation. Evaporation occurs when oil comes in contact with air on the surface of the water. Evaporation rates are a function of numerous dynamics including oil viscosity, ambient temperature, sunlight exposure, and oil type (IPIECA 2008). In general, lighter oils such as diesel or gasoline will dissipate quickly or evaporate from the water, although evaporation is slower in colder temperatures. More viscous or heavy forms of oil will tend to persist longer and resist evaporation (USGS 2011d). Compared to other oil-producing regions, a greater portion of oils extracted from the GOM tend to be lighter crude oils. Because such oils persist for a shorter period of time, they may cause less long-term damage and lower cleanup costs. The viscosity of Arctic oils varies, but due to colder surface temperatures and a generally cooler average climate, these oils are thought to evaporate more slowly, become trapped in ice, or become viscous and suspended in the water column (USGS 2011d).

Weathering. Weathering of oil in the sea results from a number of factors, including exposure to atmosphere, currents, biological organisms, and tidal patterns. In general, lighter oils such as diesel and gasoline weather quickly (Dickins 2011; IPIECA 2008; Etkin 2011). Higher ambient temperatures also accelerate weathering. The warm waters of the GOM are thought to help oil to dissipate, although this may not be the case for all oils, especially those generated in deepwater environments where ambient temperatures can be lower (USDOI 2010; IPIECA 2008; Etkin 2011). In cases where releases become suspended in the water column, long-term persistence may occur and potentially threaten marine life and economic activity tied to the marine environment.

The weathering characteristics of spilled oil influence the range of drift and spreading considered within spill trajectory assessments and dictate the effectiveness of chemical dispersants, *in situ* burning, or mechanical responses. Conditions in the Arctic may lead to longer term oil persistence. Denser, more viscous oils in colder temperatures weather at very slow rates, potentially persisting in sensitive environments for years (USGS 2011d;

Short et al. 2004; Siron et al. 2003; Peterson et al. 2003). Cold water also increases the probability that oil from a spill will solidify in the water, persisting indefinitely and rendering cleanup more difficult. However, weathering in the Arctic will be contingent on the season and weather (Dickins 2011). If oil is exposed to more air and sunlight, evaporation and dispersion due to weathering may also accelerate. Due to the variability in seasons (and in particular the ice pack), it is important to consider the timing of the release in the Arctic to evaluate the potential for long-term damage to the surrounding marine and coastal environments.

Transport. The transport and behavior of oil and gas released into oceans varies greatly depending on the conditions of the area. The magnitude and spread of transport may depend on water depth, ocean currents, meteorological events, and geographic specific factors including the prevalence of ice. Fluids released into deep water, for instance, are subject to high hydrostatic pressure and low ambient temperature, increasing the oil's persistence and its potential to transport to coastlines. A shallow water release from a high-pressure formation with a high velocity may result in a turbulent mixing of the gas, oil, and water, with the mixture quickly transported to the surface by the expanding gas under decreasing hydrostatic pressure (PCCI 1999). Research as part of the DeepSpill Joint Industry Project indicates that above the point of separation, gas bubbles and large oil droplets rise toward the surface while smaller, dispersed oil droplets may be entrained in deepwater currents at the terminus of the jet phase (Johansen et al. 2001; S.L. Ross Environmental 1997). Deepwater spills increase the potential for oil remaining trapped throughout the water column, and this increases the risk of oil transport to other regions and water bodies, although the oil is expected to be highly dispersed.

Meteorological events specific to the GOM may potentially transport spilled oil to shallow and coastal areas, increasing the risk of catastrophic consequences. Major meteorological events specific to the GOM are cold fronts and hurricanes. The wind force and magnitude of the storms in the area have the potential to expand the affected area of an oil spill. Typically occurring between June 1 and November 30, hurricanes also have the potential to destroy production facilities and precipitate releases. Data on platform spills also show that oil spills that result from hurricane damage in the GOM have been larger in volume, accounting for approximately 43% of large (>1,000 bbl) spills (Eschenbach and Harper 2011). During hurricane passages in the GOM, production is shut-in and facilities are evacuated. This reduces the probability of a very large release of oil from facilities.

Strong coastal currents on the Louisiana-Texas shelf, characterized by seasonal reversals, are important to physical transport on the shelf (see Section 4.2). Another major consideration related to physical transport in the GOM is the Loop Current and associated eddies. The current dominates upper ocean circulation in the eastern and central GOM, and transports approximately 30 million m^3 of water per second, with a variance of about 10%. Speeds may exceed 150 cm/s at the surface with velocities as high as 5 cm/s at 1,000-m (3,280-ft) depths. In both shallow and deep water, currents are dominated by cyclonic and anticyclonic eddies that vary in magnitude and frequency, which increases the uncertainty associated with effects on drilling operations (Donohue et al. 2006). The characteristics exhibited by the GOM Loop Current impose uncertainties during drilling operations and in the event of an oil release. The vast amount of water transported throughout the GOM by the Loop Current provides the potential for the current and its associated eddies to transport oil from a spill to the shelf and coastal areas, as well as water bodies outside of the GOM (MMS 2007c). Due to the proximity of the current to the shelf and sensitive coastal areas, there is a general concern regarding the rapid transport of oil in the event of a release. In many cases, the frontal boundary at the edge of the Loop Current may limit the extent of transport (see Section 4.3.2). In addition, highly persistent oil, especially in deepwater locations, may remain in the ocean for an indefinite period of time, increasing the potential for eddies to entrain oil and slope and shelf currents transport to sensitive coastal areas (MMS 2007c).

The Alaska Coastal Current, sensitive to wind forcing, is an important factor in determining surface transport of oil in the Arctic. An equally important transport vehicle and barrier is ice. Offshore of the shore-fast zone, the motion of the ice will be expected to transport the oil that is associated with the ice matrix. Field tests conducted by SINTEF Materials and Chemistry demonstrated that ice can help contain a spill, and act as a natural barrier to the spread of oil (Brandvik et al. 2006). Studies have shown that when ice coverage exceeds 10–20%, the higher ice coverage can trap spilled oil within newly formed ice (Sørstrøm et al. 2010). Ice concentrations of 60% or higher may prevent the spilled oil from spreading (Nuka Research and Planning Group 2010) and potentially affecting sensitive habitats, coastal areas, and adjacent bodies of water. Physically removing ice that encases spilled oil is a potential solution in extreme cold temperatures. During the winter of 1998, 90% of the oil spilled in the St. Lawrence River was recovered by removing 1,369 tons of ice (recovering 10 tons of oil) (S.L. Ross et al. 2010). Ocean currents in the Arctic are influenced by cyclonic and anticyclonic eddies pushing released oil in numerous directions.

4.3.3.3 Regional Risk Profiles

The previous discussion of risk factors has been used to develop generalized regional risk profiles for the areas under consideration for the Program. Figure 4.3.4-1 presents a conceptual framework for considering the sequence of events, circumstances, and factors that define a low-probability discharge event and contribute to the even lower potential for catastrophic consequences. The catastrophic discharge event sequence is divided into two principal phases: risk of occurrence and containment, and risk of fate and consequence. This framework conservatively assumes that a relief well is needed to kill a wild well following a loss of well control incident.

The top part of Figure 4.3.3-2 shows risk factors related to the occurrence of a well incident and the ability to contain and recover oil discharge at the well site up to the time needed to drill a relief well. The ability to mitigate these risks factors directly reduces the duration and volume of the oil spill and likelihood that the spill will be a catastrophic event. Reducing the risk of well control incidents, particularly for frontier exploration wells with the potential to release catastrophic discharge volumes, is of primary importance to avoid any risk of oil in the environment. As detailed in Section 4.3.3.3.4, BOEM and BSEE implemented substantive regulatory improvements following the DWH event to identify and mitigate risk factors that contribute to well integrity and operational safety incidents.

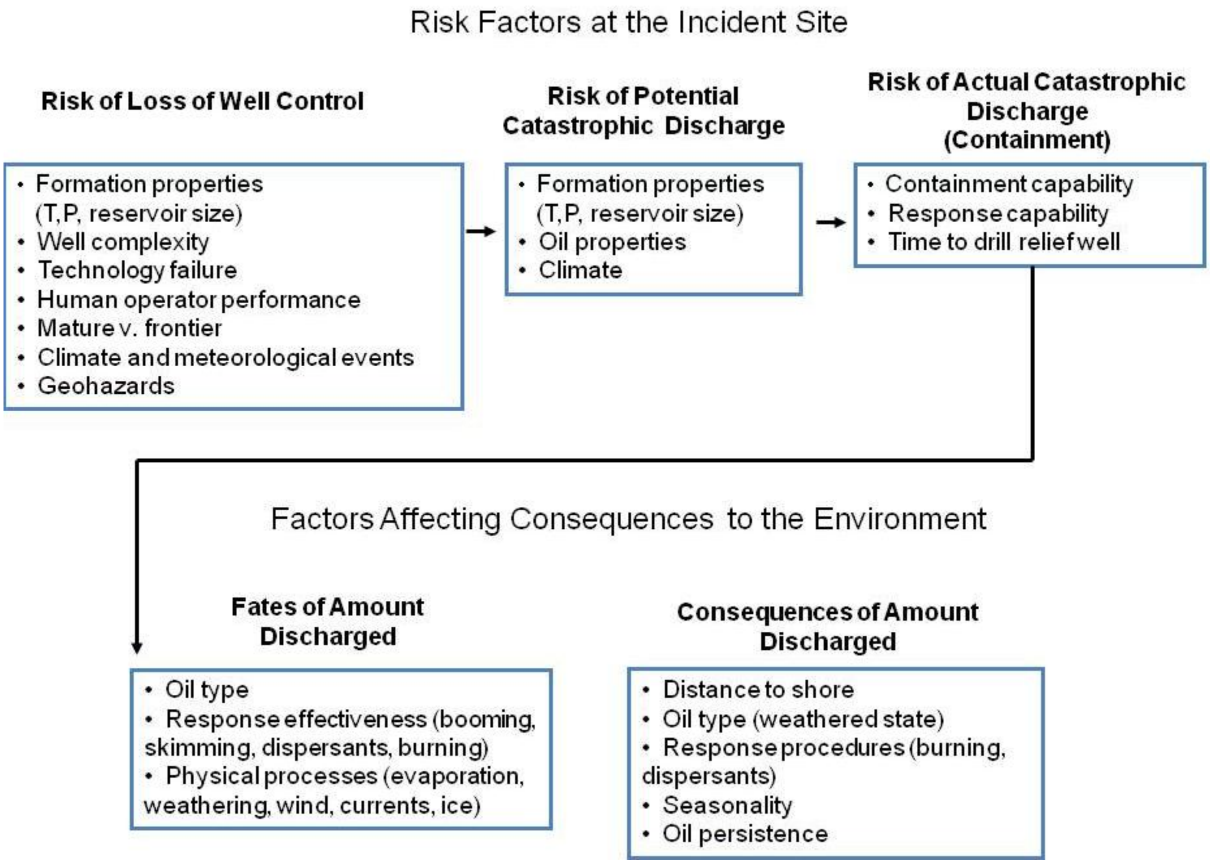

FIGURE 4.3.3-2 Factors Affecting a Catastrophic Discharge Event

If well barriers and intervention fails, containment and response at the well site becomes the next critical line of defense to minimize the volume of oil being released into the ocean. Mitigating the factors that constrain the ability to contain oil at the well site minimizes the degree and duration of exposure that may otherwise occur prior to a relief well being completed weeks to months later (or potentially longer in the Arctic depending on location and ice conditions). New seabed containment systems developed for the GOM have the potential to contain 60,000 bbl of oil per day. This system, if as effective as stated, could contain over 5,000,000 bbl of oil during a 90-day discharge period and significantly reduce the nature of exposure. Equivalent systems and/or capabilities are being developed to enhance containment in the Arctic (Shell 2011c, d). As detailed in the subsequent discussion in Section 4.3.3.3.4, BOEM and BSEE have implemented substantive regulatory improvements following the DWH event to ensure industry has appropriate containment capability.

The lower part of Figure 4.3.3-2 shows factors that affect the fate and, in part, drive the consequences of oil released into and transported through the larger environment. These factors are not absolute risk factors, *per se*, because they do not operate in one direction, either increasing or decreasing risk, across all ecological and human use resources. Usually response actions taken to manage the fates or consequences of a spill involve considerations of tradeoffs among potential impacts. For example, dispersants may be applied at the spill site to protect coastal habitats and resources from contact with a heavy, surface oil slick, but at the risk of exposing resources occupying the marine water column to the effects of dispersants and dispersed oil.

Physical processes such as the Loop Current in the GOM could transport dispersed oil across large areas within and potentially outside the GOM, but whether or not this effect is considered a risk factor depends on whether the ecological or human use concerns focus on the effects of a widespread but dilute oil presence or on the effects of higher oil concentrations on critical resources within a more localized area. Even distance to shore does not operate unambiguously as a risk factor since drilling in deeper waters located farther offshore could increase drilling risk and potential impacts to pelagic marine resources, but at the same time reduce the risk of contact with coastal habitats and resources.

4.3.3.3.1 Catastrophic Discharge Event Scenarios. BOEM has prepared credible scenarios of catastrophic discharge for each planning area that are used in later effects analyses (Table 4.3.3-3). In each planning area, such a scenario is a low-probability, accidental event, and a conservative estimate of likelihood is provided based on historical frequency alone. The scenarios do not account for potential discharge mitigating factors such as new reform measures including enhanced well barriers, well intervention, or containment and response requirements. The scenario, consistent with the requirements of 40 CFR 1502.22, assumes that there is some unintended failure or failures in the spill prevention or containment systems, although the likelihood of that occurrence is assumed to be low and not an expected outcome. Engineering analyses of comparable regulatory reforms suggest that effective or redundant barriers and safety measures can substantially decrease the likelihood of occurrence of loss of well control (DNV 2010c; DNV 2011a). Herein, oil is conservatively assumed to flow from the well until the well is killed using a relief well. The volume presented is a potential volume released. When accounting for containment, subsurface and surface dispersion, evaporation, mechanical recovery, and *in situ* burning, the actual amount released is assumed to be less. The principal factors driving the potential release amount and duration are geologic, well design, and oil type properties (which determine maximum discharge rate) and time frame required for drilling a relief well. The time frame required for drilling a relief well is principally governed by water and reservoir depth, timing of year, and availability of drilling rigs.

Bercha Group, Inc. (2011, 2008a,b) has previously modeled the historical spill size distribution frequency for a spill greater than or equal to 150,000 bbl for GOM and North Sea well drilling as 3.42×10^{-4} per well for exploration drilling, 1.96×10^{-4} per well for development drilling, and 0.29×10^{-4} per well year producing. Modal frequencies are also presented in Bercha Group, Inc. (2011). Bercha Group, Inc., calculated a slightly smaller well incident frequency of 3.94×10^{-4} per well for Arctic spills greater than or equal to 150,000 bbl. This finding suggesting lower risk in the Arctic is also supported by Willemse and van Gelder (2011). The difference relates to the underlying Gulf of Mexico spill and spill cause data analyzed, the methods used to reflect specific effects of the Arctic, and resultant fault tree model simulations applied in context of the Arctic. In the Gulf of Mexico, there is generally speaking a higher incident rate because of more offshore traffic, hurricanes, and more corrosion due to aging facilities and technologies. The Arctic does have unique effects, such as ice gouging, strudel

TABLE 4.3.3-3 Program Area Catastrophic Discharge Scenarios[a]

Program Area	Volume (Mbbl)	Duration (days)	Factors Affecting Duration	Exceedance Frequency (per well) for Spill Volume Range[b]
Gulf of Mexico	0.9–7.2	30–90	Water depth and drill depth determines timing of relief well	$>10^{-4} – <10^{-5}$
Arctic				
Chukchi Sea	1.4–2.2	40–75	Type of drill rig used and rig availability to drill relief well during open water season	$>10^{-4} – <10^{-5}$
Beaufort Sea	1.7–3.9	60–300	Type of drill rig, timing of drilling relative to ice conditions, and rig availability to drill relief well	$>10^{-4} – <10^{-5}$
Cook Inlet	0.075–0.125	50–80	Availability of rig to drill relief well	$>10^{-4} – <10^{-5}$

[a] The GOM OCS Region has estimated the discharge rate and duration for a catastrophic spill event for both shallow and deep water (in part) based on information gathered from shallow water and deepwater well tests and flow rates validated by the Ixtoc (1979) and the DWH (2010) oil spills. The Alaska OCS Region has estimated a very large oil-spill scenario based on a reasonable, maximum flow rate for each OCS planning area, taking into consideration geologic conditions and well log data. The Alaska OCS Region modeled the flow of fluids from a representative reservoir into the well and flow up through the borehole based on formation thickness, porosity, and permeability; oil saturation, viscosity, and gas content; and reservoir pressure and temperature. The number of days until a hypothetical blowout and discharge from a well could be contained was also estimated. Different assumptions about the type of drilling rig, timing of drilling, nature of ice conditions, and relief well operations underlie the CDE scenarios in the Chukchi Sea and Beaufort Sea; therefore, the scenarios are not directly comparable. The time period required to drill a relief well and kill the well in the Chukchi Sea is explained in detail in BOEMRE (2011j). The relief well is drilled and killed within the open water season. Over half of the 75-day estimate includes transport of relief well rig to the site and drilling of the actual relief well. The greater range in spill duration in the Beaufort reflects different assumptions about the drilling rig and timing of drilling relative to seasonal ice conditions. The scenario range incorporates both open- and late open-water season and winter blowout scenarios (the late open-water season may delay the relief well drilling until the following open-water season). These are discharge volumes and do not account for decreases in volume from bridging, containment, or response operations.

[b] See the figure notes for Figure 4.3.3-1 for a detailed discussion of 1) the method used to approximate exceedance frequency and 2) the method’s limitations. These conservative estimates are based on historical frequency alone. No new reform and safety measures are considered. Similarly, reliability of primary and secondary barriers is not explicitly considered. The only factor quantitatively considered across the different OCS regions is spill size. Although more precision is possible, further precision has not been reported here as not to overstate the results. The empirical formula is referenced in Figure 4.3.3-1. The difference in likelihood between the smallest and largest spill size, when using the 95% confidence intervals, is only a factor of 5. This is because very large spill events resulting from loss of well control have been, historically speaking, rare.

scour, thaw settlement, and upheaval buckling, which can contribute to the spill frequency, but largely for pipeline spills.

The principal risk factors that would affect drilling operations, containment, and response in Gulf of Mexico and Arctic program areas are summarized below. Cook Inlet is not considered further because of the relatively small size of the estimated catastrophic discharge event there compared to other program areas.

4.3.3.3.2 Gulf of Mexico Risk Profile. Drilling operations in deep water came under close scrutiny following the DWH event in April, 2010. A suspension on approving drilling plans and permits in deep water was imposed by the Secretary in July 2010. The Secretary lifted the suspension in October 2010 based on the implementation of new regulatory reforms to improve OCS drilling safety and a better understanding of the root causes of the DWH event. The safety of drilling in deepwater areas of the GOM remains an issue of concern, as witnessed by comments received during scoping and on the Draft PEIS. As stated earlier, water depth by itself does not impose risk and not all deepwater wells are characterized by the same degree of risk; rather, it is high–pressure, high-temperature conditions, large reservoir volumes, complexity in drilling technology and operations, and the relative inaccessibility of the well site on the seafloor that may impose additional risk from deepwater operations. Figure 4.3.3-3 highlights factors that apply to risks particular to deepwater wells (red text). The figure also highlights risk reduction factors associated with drilling in deep water compared to drilling in shallow water (green text). In recognition of the complexity of operations, industry often employs redundant systems to increase safety margins.

Loss of Well Control.

Geologic Properties. Deepwater geologic formations tend to have higher temperatures and pressures than shallow water formations, although that is not uniformly true and shallow water wells can be drilled under high-pressure, high-temperature conditions. In addition to varying oil properties, the differences in pressure regimes may contribute to relatively greater discharge rates. In addition, deepwater formations tend to hold larger volumes of hydrocarbons so worst-case discharges tend to be greater. The combination of the high temperature and pressure regime and comparatively large reservoir volumes create conditions that favor potentially catastrophic releases. When considering all OCS wells, the average true vertical drill depth for boreholes in shallow water (less than 201 m [660 ft]) is approximately 2,864 m (9,400 ft), compared to 4,115 m (13,500 ft) in waters deeper than 201 m (660 ft). The drill depth required to reach target reservoirs requires more information about shallow and deep geologic hazards to avoid engineering and well integrity challenges. The time required to intervene using a relief well is also greater, because of the relative depth of the intervention zone. Because of the steeper gradient of the continental slope where deepwater wells are often drilled, compared to the gentler slope on the continental shelf, deepwater wells may be more subject to mass movement and other seafloor instabilities that, if unanticipated, may increase the risk of a loss of well control incident. To avoid these complications, BSEE requires well shut-in prior to the passage of hurricanes, which are the most frequent cause of large-scale seafloor movements.

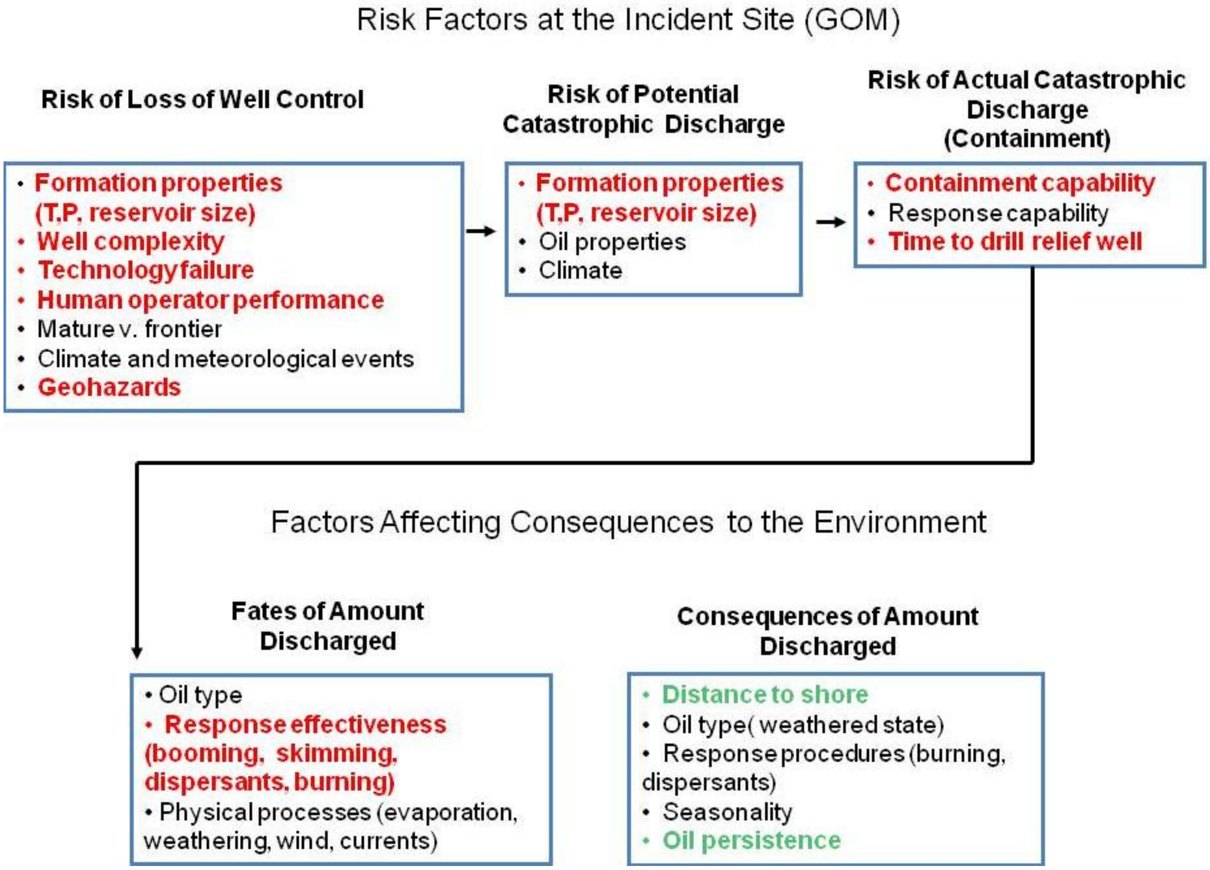

FIGURE 4.3.3-3 Principal Factors Affecting a Catastrophic Discharge Event in the Gulf of Mexico

***Well Complexity, Technology Failure and Human Performance*.** More complex wells and technology are often required in deepwater drilling to address the higher pressures and temperatures and greater drilling depths that will be encountered. This places greater demands on human and technology performance, especially where hydrostatic pressures are substantial greater due to an average 762-m (2,500-ft) greater water depth. Furthermore, the inaccessibility of the seafloor to humans at deepwater well sites means that the subsea BOP systems used at deepwater drill sites are inaccessible to human maintenance, inspection, and intervention in the event they are activated as a result of a loss of well control event. Deepwater drilling sites use ROVs and other indirect methods of intervening in a loss of well control incident at the seafloor. Recognizing this, redundant systems and multiple barriers are often incorporated into well design.

Containment and Response. The drilling of a relief well in deep water will likely take longer than in shallow water because of the greater water depth, greater drill depth, and more complex drilling conditions the relief well would encounter. Table 4.3.3-3 estimates that up to 90 days may be needed after the loss of well control event to drill the relief well and kill the wild well. During that time, the success of containment and response at the well site would be a critical factor governing whether sufficient oil is released into the environment to have catastrophic consequences. Containment and response is expected to be more challenging in areas with deeper water because of the greater distances from land support bases and staging areas. Progress has been made in the GOM to develop effective containment and response technology for deepwater conditions, including deep dispersant application.

Fate and Consequence. Should containment and response at the well site fail to prevent discharge of oil into the ocean environment, response and oil recovery would continue as the oil discharge spreads. Response operations could be more challenging to support in deeper water because of the greater distances from shore bases, as well as the fact that the area of surfaced oil would continue to increase as deepwater currents exported oil to the shelf.

Because deepwater wells are located at greater distances offshore than shallow water wells, high concentrations of oil are less likely to contact important ecological and human use coastal resources. In addition, the risk of persistence of the oil in the environment would likely be less in deepwater events because oil released there would be less likely to contact coastal wetland and estuarine areas where it could become incorporated into wetland soils and persist for long periods of time.

Summary. The principal risk that applies to deepwater drilling in the GOM occurs as a result of drilling and containment/response risks associated with the use of drilling technologies at these depths. As described below, BOEM has been aggressively pursuing regulatory changes to address and mitigate risks associated with these deepwater drilling and containment issues. It is not necessarily true that a deepwater, large volume spill would have more environmental consequences than a smaller spill occurring in shallow water. Deepwater spills may, in part, impose less risk on highly valued coastal areas because of their distance offshore, which allows for more natural weathering and dispersion. In comparison, shallow shelf spills may more rapidly contact low-energy estuarine and wetland areas.

4.3.3.3.3 Arctic Risk Profile. An ongoing concern in the Arctic is the environmental effects of a large oil spill on sensitive marine and coastal habitats that occur there within a land-sea-ice biome that supports a traditional subsistence life style for Alaska native populations and provides important habitats for migratory and local faunal populations. The ability to respond to and contain a very large discharge event under the extreme climatic conditions and seasonal presence of ice is of particular concern. Figure 4.3.3-4 highlights factors that apply to risks particular to operations in the Arctic related to extreme cold and the presence of ice.

Loss of Well Control. While some formation properties of the Arctic OCS are expected to have pressures, temperatures, and volumes sufficient to produce a discharge that could result in catastrophic consequences (Table 4.3.3-2), drilling risks associated with these formation characteristics are not directly related to issues of extreme cold and presence of ice. Instead, the fact that the Arctic OCS is largely a frontier geologic province contributes risk to Arctic drilling operations (USGS 2011d).

Human error while working under extreme weather conditions on the Arctic OCS could increase the risk of loss of well control in certain circumstances where established procedures are not followed. However, when accounting for other Arctic specific variables, the incident rate of

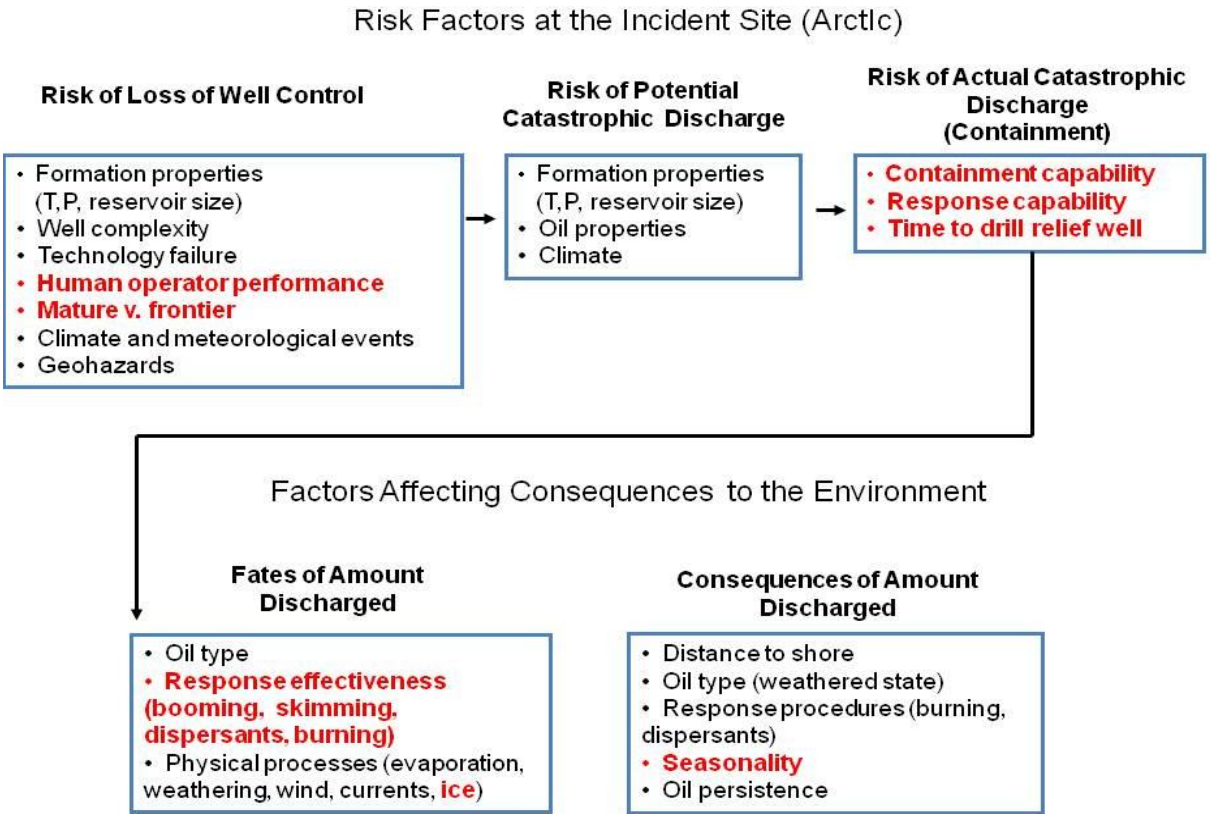

FIGURE 4.3.3-4 Principal Factors Affecting a Catastrophic Discharge Event in the Arctic

loss of well control is expected to be slightly lower than for exploration and development operations in the GOM (Bercha Group, Inc. 2008a, b, 2011).

To address some of the risk inherent in Arctic operations, BSEE regulations include specific requirements for conducting operations in the Arctic, such as locating the BOP in a well cellar (a hole constructed in the sea bed) to position the top of the BOP below the maximum potential ice gouge depth, using special cements in areas where permafrost is present, enclosing or protecting equipment to assure it will function under subfreezing conditions, and developing critical operations and curtailment procedures which detail the criteria and process through which the drilling program would be stopped, the well shut in and secured and the drilling unit moved off location before environmental conditions (such as ice) exceed the operating limits of the drilling vessel.

Containment and Response. Much of risk from a catastrophic event that is particular to the extreme climate of the Arctic is associated with containment and response issues at the well site. The time needed to drill a relief well varies from 40 to 300 days depending on the timing of the event relative to the ice free season, since the well site may become inaccessible when solid or broken ice is present. During that time, the ability to mount effective containment and response efforts under broken or solid ice conditions is a critical factor. Specialized containment structures are being engineered and tested to withstand the ice and weather conditions in the

Arctic drilling season conditions (Shell 2011c, d). Under BSEE regulations and the Certification NTL, OCS operators must have containment equipment staged and ready for deployment to adequately contain oil released from a wild well. However, it is important to acknowledge the rare possibility that primary and secondary barriers and the required containment system may not be fully successful and response gaps may exist during certain ice, weather, daylight and visibility, or temperature conditions such that advance planning is essential and unique seasonal management strategies are required (Nuka Planning and Research Group 2010; S.L. Ross 2011; Wendler and Sharma 2011). For example, different ice regimes (solid ice, open water, fall freeze-up, spring breakup) will limit the safety, effectiveness, or operational feasibility of oil-spill response systems (Nuka Planning and Research Group 2010). Limits may be imposed not only by environmental considerations and technology limitations, such as the need for icebreakers and on-water storage capability, but also by the limited existing infrastructure, such as roads, airfields, and ports, and human capital resources that are found in the North Slope. Equipment and human capital problems may exist for larger response efforts because of the remoteness of the area, time required for mobilization, and difficulties in transporting supplies and workers across the North Slope given the limited infrastructure and severe weather conditions (Wendler and Sharma 2011). Individual operators, in support of exploration and development plans, must mobilize specialized equipment, such as icebreaking support and on-water storage capabilities, that are not otherwise available in the region. Therefore, advance logistical planning and staging of equipment is paramount, as recognized under BSEE oil-spill response plan (OSRP) requirements (30 CFR 254). Required components of the OSRP include introduction and plan contents; emergency-response-action plan; equipment inventory; contractual agreements for spill-response services; worst-case discharge scenario; dispersant-use plan; *in situ* burning plan, and a training and drills plan. Plans are required to be reviewed and updated every 2 years or when a change occurs that significantly reduces response capabilities; a significant change occurs in the worst-case discharge scenario or in the type of oil being handled, stored or transported at the facility; there is a change in the name(s) or capabilities of the oil-spill removal organizations cited in the plan; or there is a significant change to the Area Contingency Plans. OCS operating regulations also require operators to develop a Critical Operations and Curtailment Procedure (COCP) with exploration or development and production plans. The COCP addresses the methods by which an operator will cease, limit, or not initiate specific critical operations because of environmental conditions that may be encountered at the site.

Operator's plans are developed in context of the National Contingency Plan (NCP), the Alaska Federal and State Preparedness Plan for Response to Oil and Hazardous Substance Discharges and Releases (Unified Plan), and in close coordination with Federal and State agencies. In addition to the Unified Plan, Alaska has divided the State into 10 geographic regions and developed subarea contingency-response plans for each area. The North Slope Subarea Contingency Plan addresses specific response issues for the Beaufort and northern Chukchi Seas. These plans include sections that identify spill-sensitive biological and cultural resources and geographic response scenarios, which identify shoreline types in the subarea and lists spill-response tactics that can be used to protect those areas. Subarea contingency plans provide for coordinated and integrated response by departments and agencies of the Federal and State governments to protect human health and the environment and to minimize adverse effects due to oil and hazardous substance discharges. The Alaska Regional Response Team (ARRT) provides the appropriate regional mechanism for planning and preparedness activities before a response action is taken and for coordination and advice during an event. In the event of a spill, the USCG would be in charge of overall command and control activities. These command and control activities, supported by BSEE, USEPA, NOAA, and other Federal and State agencies, would proceed in conformance with federally-mandated contingency plans for the North Slope area that have recently been revised and updated (see Section 4.3.3.3.4). Section 4.3.3.3.4 further highlights major new field testing and technology research, planning exercises, and capacity building efforts that are underway to improve response technology, response capability, and spill preparedness.

Fate and Consequence. Response away from the well site could also be hindered and/or aided by sea state, visibility, and broken and solid ice. In addition, some options available to manage fates of spills have not been previously used in larger-scale operations the Arctic to fully evaluate their effectiveness, such as burning and dispersant use, although state-of-the art research on these response techniques suggest they could decrease the volume of oil in the water (SINTEF 2010).

4.3.3.3.4 Reforms and Research to Reduce Risk. In the aftermath of the DWH event, President Obama directed the Secretary of the Interior to identify new precautions, technologies, and procedures needed to improve the safety of oil and gas development on the OCS. At the same time, the Secretary directed BOEMRE to exercise its authority under the OCSLA to suspend certain drilling activities so that the Bureau could (1) ensure that drilling operations similar to those that led to the DWH event could operate in a safe manner when drilling resumed, (2) ensure extensive spill response resources directed toward the spill would be available for other spill events, and (3) provide adequate time to obtain input for enhancing intervention and containment capability and promulgate regulations that address issues described in the *Increased Safety Measures for Energy Development on the Outer Continental Shelf* report (USDOI 2010a). In addition, incident investigations provided numerous other recommendations detailed in reports including the National Oil Spill Commission (OSC) report (National Commission 2011), the National Academy of Engineering (NAE) and the National Research Council (NRC) report *Macondo Well–Deepwater Horizon Blowout: Lessons for Improving Offshore Drilling Safety* (NAE and NRC 2011), the Deepwater Horizon Joint Investigation Team (JIT) Report consisting of the USCG's *Report of Investigation into the Circumstances Surrounding the Explosion, Fire, Sinking, and Loss of Eleven Crew Members Aboard the Mobile Offshore Drilling Unit Deepwater Horizon in the Gulf of Mexico* (USCG 2011c) and USDOI's *Report Regarding the Causes of the April 20, 2010 Macondo Well Blowout* (USCG and BOEMRE 2011p), the USCG *Incident Specific Preparedness Review BP Deepwater Horizon Oil Spill* (USCG 2011a), and the USDOI OCS Safety Oversight Board *Report to Secretary of the Interior Ken Salazar* (USDOI 2010b).

In response to Administration directives and numerous report recommendations, and in recognition that advances in prevention and safety were critical, the USDOI launched the most aggressive and comprehensive reform program to offshore oil and gas regulation and oversight in U.S. history. BOEM and BSEE overhauled and continue to proactively reform the offshore regulatory process. Similarly, the oil and gas industry has voluntarily responded with rigorous reform measures including new and revised industry standards, recommended practices (RPs), specifications, and guidelines.

In 2010 and 2011, BOEMRE collected a large amount of information through public hearings and other meetings held specifically on the DWH oil spill and through public comments on rulemaking efforts. The information collection, review, and analysis efforts aided in the development of new regulations, Notices to Lessees and Operators (NTLs), and BOEM/BSEE procedures that address drilling safety, oil spill response, and enhanced inspection procedures. New exploration plans, applications for permits to drill, and oil-spill preparedness and response plans are subject to higher engineering and environmental review standards.

BOEM and BSEE recognize that a proactive government and industry are critical to ensure safe and environmentally sound OCS oil and gas operations. This section highlights (1) previously implemented and ongoing reforms in BOEM, BSEE, other Federal agencies, and industry for improving oil-spill prevention, which include well design, workplace safety, corporate accountability, oil-spill containment, and oil-spill response, and (2) promising research in these areas that respond to the various reform recommendations. Table 4.3.3-4 summarizes these efforts. The measures described below contribute to a more robust regulatory system and industry practice to ensure that energy development is conducted safely and in an environmentally responsible manner, while also being more efficient, transparent, and responsive. Enhanced measures, such as improved BOP reliability, improved cementing and other secondary barrier programs, better-defined operational and risk assessment procedures, and integrated treatment of human risk factors, have been show to effectively reduce risk (DNV 2010b).

Recent and Ongoing Regulatory Reform and Government-Sponsored Research. BOEM and BSEE have already instituted regulatory reforms responsive to many of the recommendations expressed in the various reports prepared following the DWH event. To date, regulatory reform has occurred through both prescriptive and performance-based regulation and guidance, as well as OCS safety and environmental protection requirements. The reforms strengthen the requirements for all aspects of OCS operations. The discussion below also addresses ongoing reform and research endeavors to improve workplace safety and strengthen oil-spill prevention planning, containment, and response.

BSEE Regulatory Review. BSEE is currently conducting a comprehensive evaluation of its operations regulations to identify important issues related to regulatory gaps and implementation. This effort addresses specific recommendations from the USDOI OCS Safety Oversight Board, National Commission, and NAE. The review will do the following:

- Address the effectiveness, comprehensiveness, and timeliness of the regulations based on BSEE's authority under the OCSLA.

- Review internal sources of information that could be used to identify regulatory needs.

TABLE 4.3.3-4 Prevention, Containment, and Response Reforms and Research Initiatives

	Current	Ongoing
Prevention	Government • Proposed and final regulations: Drilling Safety Rule, SEMS • NTL/guidance: NTL-2010-N06, blowout prevention (BOP) guidance • Well Containment Screening Tool • Enhanced inspection and enforcement procedures, including strengthened training program • Implementation Teams • JIT, Ocean Energy Safety Advisory Committee (OESC) • Research: BSEE Technical Assessment and Research (TA&R) Program, Operational Safety and Engineering Research (OSER), Ohmsett National Oil Spill Response Test Facility	Government • Clarify existing regulations and develop new proposed and final regulations • Develop NTLs/guidance • Enhanced inspection and enforcement procedures, including strengthened training program • Implementation Teams • OESC • Research: BSEE TA&R OSER, Ohmsett
	Industry • New and revised industry standards, recommended practices, guidelines • Joint Industry Task Forces (JITFs): Procedures and Equipment JITFs, Center for Offshore Safety (COS), International Association of Oil and Gas Producers (OGP) • Joint industry research programs/projects: Blowout Risk Assessment Joint Industry Project (BORA JIP), DeepStar	Industry • Revise industry standards, recommended practices, guidelines • Procedures and Equipment JITFs, COS, OGP • Joint industry research programs/projects: BORA JIP, DeepStar
Containment	Government • • NTL/guidance: NTL-2010-N10 • Well Containment Screening Tool • 12/13/2010 BOEMRE Guidance • Enhanced inspection and enforcement procedures, including strengthened training program • Implementation Teams • JIT, OESC • Research: BSEE TA&R OSER, Ohmsett	Government • Clarify existing regulations and develop new proposed and final regulations • Develop NTLs/guidance • Enhanced inspection and enforcement procedures, including strengthened training program • Implementation Teams • OESC • Research: BSEE TA&R OSER, Ohmsett

TABLE 4.3.3-4 (Cont.)

	Current	Ongoing
	Industry • New and revised industry standards, recommended practices, guidelines • Subsea JITF, COS, OGP Wells Expert Committee (WEC) • Joint industry research programs/projects: OGP Subsea Well Response Project	Industry • Revise industry standards, recommended practices, guidelines • Subsea JITF, COS, OGP WEC • Joint industry research programs/projects: OGP Subsea Well Response Project
Oil Spill Response	Government • NTL/guidance: NTL-2010-N10 • Enhanced inspection and enforcement procedures, including strengthened training program • Implementation Teams • Environmental Response Management Application (ERMA®) • JIT, OESC • Research: BSEE TA&R OSER, BSEE Oil Spill Response Research (OSRR) Program, Ohmsett	Government • Clarify existing regulations and develop new proposed and final regulations • Develop NTLs/guidance • Enhanced inspection and enforcement procedures, including strengthened training program • Implementation Teams • ERMA® • OESC • Research: BSEE TA&R OSER, BSEE OSRR, Ohmsett, National Research Council
	Industry • New and revised industry standards, recommended practices, guidelines • Oil Spill Preparedness and Response JITF, OGP Arctic Oil Spill Response Technology Joint Industry Programme, Oil Spill Removal Organizations (OSROs) • Joint industry research programs/projects	Industry • Revise industry standards, recommended practices, guidelines • Oil Spill Preparedness and Response JITF, OGP Arctic Oil Spill Response Technology Joint Industry Programme, OSROs • Joint industry research programs/projects

- Evaluate the adequacy of BSEE regulations to address current offshore technology.

- Identify items within the regulations that need to be addressed and prioritize those items for future rulemakings.

- Identify areas of BSEE regulations that may be ineffective and identify issues related to implementation.

- Assess the advantages and disadvantages of creating regulations to specifically address deepwater operations.

Improving Prevention.

Workplace Safety Rule (SEMS Final Rule). The National Commission and the NAE recommended a variety of changes to USDOI's regulatory scheme, such as the expanded use of safety management systems. BOEMRE promulgated the performance-based Safety and Environmental Management System (SEMS) rule on October 15, 2010 (75 FR 63610) (30 CFR Part 250, Subpart S), requiring full implementation for all OCS facilities and operators no later than November 15, 2011. The SEMS rule establishes a holistic, performance-based management tool that requires offshore operators to establish and implement programs and systems to identify potential safety and environmental hazards when during exploration, development, and production operations; clear protocols for addressing those hazards; and strong procedures and risk-reduction strategies for all phases of activity, from well design and construction to operation, maintenance, and decommissioning. It also requires operators to have a comprehensive safety and environmental management program designed to reduce human and organizational errors. SEMS applies to all OCS oil and gas operations and facilities under BOEM and BSEE jurisdiction, including drilling, production, construction, well workover, well completion, well servicing, and USDOI pipeline activities. SEMS also applies to all OCS oil and gas operations on new and existing facilities under BOEM and BSEE jurisdiction, including design, construction, startup, operation, inspection, and maintenance. The performance-based SEMS rule helps to define clear roles and responsibilities in which BSEE defines the performance goals, and the operator is responsible to ensure that these goals are met. Empowering industry to develop the framework specific to improving safety and environmental performance of facilities and operations and holding them responsible for meeting that greater standard should significantly reduce the most frequent causes of historic incidents that have occurred during OCS activities. Training and auditing are integral parts of the SEMS rule, which ensures operators are accountable for verifying that contractors and subcontractors have robust policies and procedures in place.

The SEMS rule is based on API RP 75 (API 2004), which was previously a voluntary program to identify, address, and manage safety hazards and environmental impacts in oil and gas operations. The 13 elements of API RP 75 that 30 CFR 250 Subpart S now make mandatory include the following:

- Defining the general provisions for implementation, planning and management review, and approval of the SEMS program;

- Identifying safety and environmental information needed for any facility, including design data, facility process such as flow diagrams, and mechanical components such as piping and instrument diagrams;

- Requiring a facility-level hazard risk assessment;

- Addressing any facility or operational changes, including management changes, shift changes, contractor changes;

- Evaluating operations and written procedures;

- Specifying safe work practices, manuals, standards, and rules of conduct;
- Training, safe work practices, and technical training (including contractors);
- Defining preventive maintenance programs and quality control requirements;
- Requiring a pre-startup review of all systems;
- Responding to and controlling emergencies, evacuation planning, and oil-spills;
- Putting contingency plans in place and validating them with drills;
- Investigating incidents, procedures, corrective action, and follow-up;
- Requiring audits every 4 years, with an initial 2-year reevaluation and then subsequent 3-year audit intervals; and
- Specifying records and documentation that describes all elements of the SEMS program.

Implementation of SEMS requires periodic lessee or independent third-party comprehensive audits of the 13 elements defined in API RP 75 (API 204) and included above. BSEE may participate in lessee or independent third-party audits and may also conduct audits. BSEE-conducted audits may be announced or unannounced. BSEE may also direct an operator to have an independent 3rd party audit. Any deficiencies found in SEMS audits must be addressed in a corrective action plan (CAP) and must be submitted to BSEE within 30 days of submittal of the audit report. If BSEE determines that an operator's SEMS program is not in compliance, BSEE may issue an incident of noncompliance (INC), assess civil penalties, or initiate probationary or disqualification procedures from serving as an OCS operator. The required SEMS plan and audits are designed to improve, enhance, communicate, and document the identification and mitigation of safety and environmental hazards for offshore facilities and activities, resulting in safer and environmentally sound working conditions through teamwork, training, and communication among all parties for all activities on the OCS.

One of the most important elements fostering improved industry-wide risk management is the facility-level hazard analysis. The purpose of the analysis is to identify, evaluate, and reduce the likelihood and/or minimize the consequences of uncontrolled releases of oil and gas and other safety or environmental incidents. API RP 14C, *Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms* (API 2001a), and API RP 14J, *Recommended Practice for Design and Hazards Analysis for Offshore Production Facilities* (API 2001b), identify accepted practices. In addition, the facility-level hazard analysis requires a job hazard analysis (operations/task level) be performed to identify and evaluate hazards of a job/task for the purpose of hazards control or elimination.

Upcoming BSEE Final Rule: Revisions to Safety and Environmental Management Systems (SEMS II). On September 14, 2011, BOEMRE published a Notice of Proposed Rulemaking (76 FR 56683) to require operators to develop and implement additional provisions in their SEMS. The upcoming SEMS II final rule will include refinements to the existing SEMS program. The SEMS II rule will amend the existing regulations to require operators to develop and implement additional provisions involving stop-work authority and ultimate work authority, establish requirements for reporting unsafe working conditions, require employee participation in the development and implementation of their SEMS programs, and establish requirements for reporting unsafe working conditions. In addition, the final rule will require the use of independent third parties to perform the audits of the operators' programs.

Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS (Plans NTL). The National Commission recommended that the USDOI improve its oil-spill risk analysis and response planning process with a focus on the importance of worst-case scenario planning and analysis. Although effective June 18, 2010, prior to the National Commission Report publication in 2011, the Plans NTL (NTL-2010-N06) (BOEMRE 2010j), is consistent with the recommendations and sets new standards regarding the content of information needed in exploration and development plan submittals to describe a blowout and worst-case discharge scenario. This NTL explains the procedures for the lessee or operator to submit supplemental information for new or previously submitted exploration plans (EPs), development and production plans (DPPs), or Development and Coordination Documents (DOCDs). The required supplemental information includes the following: (1) a description of the blowout scenario as required by 30 CFR 250.213(g) and 250.243(h); (2) a description of the assumptions and calculations used in determining the volume of the worst-case discharge required by 30 CFR 250.219(a)(2)(iv) or 30 CFR 250.250(a)(2)(iv); and (3) a description of the measures proposed that would enhance the ability to prevent a blowout, to reduce the likelihood of a blowout, and to conduct effective and early intervention in the event of a blowout, including the arrangements for drilling relief wells and any other measures proposed. The early intervention methods of the third requirement could include the surface and subsea containment resources that BOEMRE announced in NTL2010-N10 (Certification NTL) (BOEMRE 2010k).

Increased Safety Measures for Energy Development on the Outer Continental Shelf (Drilling Safety Rule) (Interim Final Rule). The USDOI Secretary recommended in the May 27, 2010 USDOI Report, *Increased Safety Measures for Energy Development on the Outer Continental Shelf*, the implementation of a number of specific measures to ensure sufficient redundancy in the BOPs, to promote the integrity of the well and enhance well control, and to facilitate a culture of safety through operational and personnel management. In response to these recommendations, BOEMRE published the Interim Final Drilling Safety Rule (75 FR 63346). The subsequent NAE and JIT recommendations were consistent with the Safety Measures report and the Rule. The NAE and JIT recommended improving BOP reliability and performance through such actions as more testing, independent certification, and improvements in ROV interface capabilities. The NAE also recommended significant redesigns of BOP systems. In addition, the NAE and JIT both recommended additional safeguards for well design and construction, including standards for negative pressure testing, third-party review of engineering plans, and better testing of cement jobs. The Drilling Safety Rule (amended 30 CFR Part 250, Subparts A, D, E, F, O, and Q), issued October 14, 2010, addresses well bore integrity and well control equipment and procedures. The rule effectively implements many of the recommendations made in the May 27, 2010, USDOI report *Increased Safety Measures for Energy Development on the Outer Continental Shelf* (USDOI 2010a). BOEMRE amended its drilling regulations related to subsea and surface blowout preventers, well casing and cementing, secondary intervention, unplanned disconnects, recordkeeping, well completion, and well plugging. To ensure compliance with requirements of interim drilling safety regulations, BSEE has implemented the review of BOP system schematic drawings.

Well integrity provides the first line of defense against a blowout by preventing a loss of well control. It includes the appropriate use of drilling fluids and the well bore casing and cementing program. These are used to balance pressure in the borehole against the fluid pressure of the formation, preventing an uncontrolled influx of fluid into the wellbore. Provisions in the rule addressing well bore integrity include the following:

- Making mandatory the API Standard, 65–Part 2 , *Isolating Potential Flow Zones During Well Construction* (an industry standard program) (API 2010);

- Requiring submittal of certification by a professional engineer that the casing and cementing program is appropriate for the purposes for which it is intended under expected wellbore pressure;

- Requiring two independent test barriers across each flow path during well completion activities (certified by a professional engineer);

- Ensuring proper installation, sealing, and locking of the casing or liner;

- Requiring BSEE approval before replacing a heavier drilling fluid with a lighter fluid; and

- Requiring enhanced deepwater well-control training for rig personnel.

Well-control equipment is used to regain control of a well in the event of a loss of well control. Well-control equipment includes the BOP and control systems that activate the BOP, either through a control panel on the drilling rig or through ROVs that directly interface with the BOP to activate appropriate rams. Provisions in the rule that focus on the enhancement of well control equipment include the following:

- Submittal of documentation and schematics for all control systems;

- Requirements for independent third-party verification that the blind-shear rams are capable of cutting any drill pipe in the hole under maximum anticipated surface pressure;

- Requirement for a subsea BOP stack equipped with ROV intervention capability (at a minimum, the ROV must be capable of closing one set of pipe rams, closing one set of blind-shear rams, and unlatching the lower marine riser package);

- Requirement for maintaining a ROV and having a trained ROV crew on each floating drilling rig;

- Requirement for auto shear and deadman systems for dynamically positioned rigs;

- Establishment of minimum requirements for personnel authorized to operate critical BOP equipment;

- Requirement for documentation of subsea BOP inspections and maintenance according to API RP 53, *Recommended Practices for Blowout Prevention Equipment Systems for Drilling Wells* (API in prep. c);

- Requirement for testing all ROV intervention functions on the subsea BOP stack during stump test and testing at least one set of rams in initial seafloor test;

- Requirement for function testing auto shear and deadman systems on the subsea BOP stack during the stump test, and testing the deadman system during the initial test on the seafloor; and

- Requirement for pressure testing if any shear rams are used in an emergency.

A section-by-section summary of major regulatory changes is provided below.

Subsea ROV and Deadman Function Testing — Drilling. Previous regulations at 30 CFR 250.449(b) required a stump test of the subsea BOP system. In a stump test, the subsea BOP system is placed on a simulated wellhead (the stump) on the rig floor. The BOP system is tested on the stump to ensure that the BOP is functioning properly. The new regulatory section at 30 CFR 250.449(j) requires that all ROV intervention functions on the subsea BOP stack must be tested during the stump test and one set of rams must be tested by an ROV on the seafloor. Autoshear and deadman control systems activate during an accidental disconnect or loss of power, respectively. The new regulatory section at 30 CFR 250.449(k) requires that the autoshear and deadman systems be function-tested during the stump test, and the deadman system tested during the initial test on the seafloor. The deadman-switch test on the seafloor verifies that the wellbore closes automatically if both hydraulic pressure and electrical communication with the drilling rig are lost. The initial test on the seafloor is performed as soon as the BOP is attached to the subsea wellhead. These new requirements will help ensure that a well can be secured in an emergency situation and prevent a possible loss of well control. The ROV test requirement will ensure that the dedicated ROV has the capacity to close the BOP functions on the seafloor. The deadman-switch test on the seafloor verifies that the wellbore closes automatically if both hydraulic pressure and electrical communication are lost with the drilling rig. These regulatory changes will not affect shallow wells or facilities since they do not use subsea BOPs or ROVs.

Subsea ROV and Deadman Function Testing — Workover/Completions. Previous regulations did not require subsea ROV function testing of the BOP during workover or well completion operations. The new regulatory sections 30 CFR 250.516(d)(8) and 250.616(h)(1) extend the requirements added to deepwater drilling operations (discussed in the previous section) to well completion operations and workover operations using a subsea BOP stack.

Negative Pressure Tests. Previous regulation at 30 CFR 250.423 required a positive pressure test for each string of casing, except for the drive or structural casing string. This test confirms that fluid from the casing string is not flowing into the formation. The new regulatory section at 30 CFR 250.423(c) requires that a negative pressure test be conducted for all intermediate and production casing strings. This test will reveal whether gas or fluid from outside the casing is flowing into the well and ensures that the casing and cement provide an effective seal. Maintenance of pressure under both tests ensures proper casing installation and the integrity of the casing and cement.

Installation of Dual Mechanical Barriers. Previous regulations did not require the installation of dual mechanical barriers. The new regulatory section at 30 CFR 250.420(b)(3) requires that the operator install dual mechanical barriers in addition to cement barriers for the final casing string. These barriers prevent hydrocarbon flow in the event of cement failure at the bottom of the well. The operator must document the installation of the dual mechanical barriers and submit this documentation to BSEE within 30 days after installation. These new requirements will ensure that the best casing and cementing design will be used for a specific well.

Professional Engineer Certification for Well Design. Previous regulations at 30 CFR 250.420(a) specified well casing and cementing requirements, but did not require verification by a registered professional engineer. The new regulatory section at 30 CFR 250.420(a)(6) requires that a registered professional engineer certify that the well casing and cementing design is appropriate for the purpose for which it is intended under expected wellbore conditions.

Emergency Test of Activated Shear Rams. Previous regulations did not address BOP inspection following use of the blind-shear ram or casing-shear ram. The new regulatory section at 30 CFR 250.451(i) requires that, if a blind-shear ram or casing-shear ram is activated in a well-control situation where the pipe is sheared, the BOP stack must be retrieved, fully inspected, and tested. This provision will ensure the integrity of the BOP and that the BOP will still function and hold pressure after the event.

Third Party Shearing Verification. Regulation 30 CFR 250.416(e) requires information verifying that BOP blind-shear rams are capable of cutting through any drill pipe in the hole under maximum anticipated conditions. This regulation has been modified to require verification of this capability by an independent third party. The independent third party provides an objective assessment that the blind-shear rams can shear any drill pipe in the hole if the shear rams are functioning properly.

Upcoming BSEE Final Rule: Increased Safety Measures for Energy Development on the Outer Continental Shelf (Drilling Safety Rule). The Drilling Safety Final Rule will address public comments received on the interim final rule and will modify and clarify some provisions of the interim final rule based on public comments, including modifications of the negative pressure test requirements for casing strings, clarifications involving standards that are incorporated by reference, and a revised definition of mechanical barriers. The rule will also incorporate new industry best practices on cementing.

Safety Alert No. 10 for the Macondo Well Blowout. The BSEE National Safety Alert No. 10 was initially published on April 30, 2010, and consequently updated on November 10, 2011, following USCG and BOEMRE JIT Report (USCG and BOEMRE 2011). The updated Safety Alert incorporated the investigative findings related to areas of BSEE responsibility. The Safety Alert reminds lessees and contractors of the new requirements under 30 CFR 250.415(f) effective with the publication of the interim final Drilling Safety Rule (see above) requiring lessees to submit a written description of how they have evaluated the best practices included in API RP 65–Part 2 (API 2010). The written description must identify the mechanical barriers and cementing practices they will use for each casing string. This description must be included as part of the operator's casing and cementing programs, required in 30 CFR 250.411.

The Safety Alert urges lessees and contractors to thoroughly examine the detailed investigation findings, conclusions, and recommendations in the JIT Report, and, based these findings, BSEE recommends that lessees and contractors:

- Minimize the amount of fluid transfers during well operations so that accurate monitoring of flow-in versus flow-out can be achieved (refer to Safety Alert No. 284, Diverter Flow Event).

- Recognize the potential for a well to flow during a negative pressure test. It is recommended that lessees and contractors ensure that their procedures for conducting negative pressure tests outline expected test results including failure indicators. These expected test results should be discussed at a pre-kill meeting prior to conducting the negative pressure test.

- Review their well-control procedures to ensure that the initial response actions default to routing the well flow to the overboard diverter line(s) when appropriate.

- Evaluate and consider relocating the mud-gas separator vent line(s) to prevent directing gas, condensate, and oil back down toward the rig floor.

- Inspect all dynamically positioned Mobile Offshore Drilling Units (MODUs) and determine if all air intakes are located as far as practically possible from the rig floor.

- Evaluate the configuration and operation of subsea BOP stacks to maintain central alignment of the drill pipe and minimize the effects of elastic buckling during emergency activation of blind shear rams (http://www.bsee.gov/Regulations-and-Guidance/Safety-Alerts/National-Safety-Alert-No--10.aspx).

***Upcoming BSEE Proposed Rule: Blowout Prevention Systems*.** This proposed rule will upgrade regulations related to the design, manufacture, and repair of BOPs. BSEE regulations for BOPs currently consist of (1) field pressure and functions tests, (2) generic performance statements related to BOP capabilities, and (3) several generic industry practices related to inspection and maintenance. This rule will incorporate upcoming improved industry standards for BOP design and testing along with supplemental BSEE requirements to increase the regulatory oversight over this critical equipment.

***Upcoming BSEE Proposed Rule: Production Safety Systems and Lifecycle Analysis*.** This proposed rule will amend and update 30 CFR Part 250, Subpart H, Oil and Gas Production Safety Systems, by addressing issues such as production safety systems, subsurface safety devices, and safety device testing.

Forum on Next-Generation Blowout Preventer and Control System Technology, Management, and Regulations. As part of its ongoing efforts to improve the safety of offshore oil and gas operations, BSEE hosted a public Forum on Next-Generation BOP and Control Systems Technology, Management, and Regulations in May 2012. The forum brought experts from government organizations, trade associations, equipment manufacturers, offshore operators, consultants, and training companies from around the country that served on panels to discuss next steps in offshore drilling safety including:

- BOP technology needs identified from DWH event investigations;

- Real time technologies to aid in diagnostics and kick detection;

- Design requirements to ensure the ability of BOPs to cut casing or drill pipe and seal a well effectively;

- Manufacturing, testing, maintenance and certification requirements to ensure operability and reliability of BOP equipment; and

- Training and certification needs for industry personnel operating or maintaining BOPs (http://bsee.gov/BSEE-Newsroom/Press-Releases/2012/press05082012.aspx).

USCG Risk-Based Targeting of Foreign-Flagged Mobile Offshore Drilling Units. The new USCG Office of Vessel Activities Policy Letter 11-06, "Risk-Based Targeting of Foreign Flagged Mobile Offshore Drilling Units (MODUs)," became effective on July 7, 2011 (USCG 2011e)). This policy letter is one of the steps the USCG has taken to improve oversight of foreign-flagged MODUs in response to the DWH event. The new policy details the inspection procedures that utilize the newly developed MODU Safety and Environmental Protection Compliance Targeting Matrix. This matrix enables the USCG to prioritize inspections of foreign-flagged MODUs that may require increased oversight through a systematic determination of probable risk based on vessel characteristics, accident and violation history, past discrepancies, flag state performance, and classification society performance.

Improving Containment. The National Commission highlighted the need for stronger requirements for well-containment capabilities, as well as the need for improved industry resources. Although BOEMRE issued the Certification NTL (NTL-2010-N10) (BOEMRE 2010k) prior to the National Commission Report, its development and implementation is consistent with the Report recommendations. BSEE also developed an evaluation tool, the Well Containment Screening Tool (WCST), to apply during permit and plan approval to demonstrate whether a well's design and equipment are adequate for well containment.

Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources (Certification NTL). The Certification NTL (NTL-2010-N10) (BOEMRE 2010k), effective on November 8, 2010, requires lessees and operators using subsea or surface BOPs on floating facilities (i.e., deepwater facilities) to provide a statement verifying compliance with new well containment and oil-spill response requirements prior to being granted a permit to drill/modify. Specifically, the statement, signed by an authorized company official, indicates that authorized activities will be in compliance with all applicable regulations, including the requirements of the Drilling Safety Rule.

The NTL also informs lessees and operators that BSEE will be evaluating whether or not each operator has submitted adequate information demonstrating that it has access to and can deploy surface and subsea containment resources to promptly respond to a blowout or other loss of well control. Although the NTL does not provide that operators submit revised OSRPs that include this containment information, operators were notified of BSEE's intention to evaluate the adequacy of each operator to comply with their current OSRP; therefore, there is an incentive for voluntary compliance.

The benefits of the new requirements include the following:

- Improved response time for offshore vessels to remove damaged equipment and install a capping stack;

- Reduced amount of time a well flows into the sea compared with previous well blowouts;

- More robust well designs relative to expected pressures and fluids in the well to fully contain the well after installation of the capping stack;

- Determination of the well's potential to broach to the seafloor if the well design fails under the shut-in pressure with installed capping stack; and

- Determination of the surface vessel configuration and containment capacities if the well has to flow to the surface for processing and capture.

OCS operators must demonstrate the capability to remove damaged well equipment and install a capping stack (with a pressure rating higher than the calculated mud line shut-in pressure) to stop the uncontrolled flow of oil from the well in the event of a well blowout. If the well design fails under the shut-in pressure, the operator must demonstrate the capability to flow and process the oil and gas from the well into surface containment vessels. Although not explicitly stated in the Certification NTL notice, BSEE requires operators to demonstrate that the well design is adequate to contain an uncontrolled flow.

BSEE Well Containment Screening Tool. The NAE and JIT recommended additional safeguards for well design and construction. BSEE led a joint industry task force to develop the WCST to demonstrate whether a well's design and equipment are adequate for well containment. This tool is necessary to evaluate industry compliance with the Certification NTL when applying for a permit to conduct drilling activities. The WCST allows BSEE to analyze oil-spill risk based on the mechanical and geological integrity of the well. BSEE also reviews wellbore designs and wellbore integrity to determine whether appropriate containment equipment is accessible or whether additional containment systems are required.

BSEE uses a Level 1 WCST for all initial reviews prior to APD approval. The Level 1 WCST is useful for wells that can be fully shut in without causing underground flow, using very conservative assumptions and simple calculations (no requirement for computer simulations). However, not all wells can pass a Level 1 screening successfully, because of high pressure and/or light formation fluids expected in the well. The Level 2 WCST analysis uses field/offset data and more advanced calculations to demonstrate equipment and well integrity. The Level 2 WCST analysis also identifies failure points and possible loss zones that must be addressed in a consequence analysis. The WCST has resulted in more-robust well designs that reduce the risk of prolonged well flow into the sea and increase the chance of successfully capping and stopping the flow of oil in less than 15 to 30 days. The WCST has been used to evaluate all GOM well operations including drilling, completion, water injection, and permanent abandonment.

BOEMRE Guidance: Approval Requirements for Activities That Involve the Use of a Subsea BOP or a Surface BOP on a Floating Facility. On December 13, 2010, BOEMRE issued additional guidance, *Approval Requirements for Activities That Involve the Use of a Subsea Blowout Preventer (BOP) or a Surface BOP on a Floating Facility* (BOEMRE 2010i), to encourage operators to voluntarily include additional subsea containment information in their OSRPs. The guidance indicates that BSEE will review OSRPs, in support of plan submittals, for the following specific information related to subsea containment (including that listed in the Certification NTL):

- Worst-case discharge scenario flow rate estimates;
- Offshore surface oil containment and recovery;
- Nearshore surface oil containment and recovery;
- Shoreline booming and protection strategies;
- Source abatement through direct intervention;
- Relief wells;
- Debris removal from the site of a blowout, if necessary;
- Subsea containment and capture equipment, including containment domes and capping stacks (in the event that an operator proposes a capping stack as the single containment option, the operator should explain the reasons that the well design is sufficient to allow shut-in without broach to the sea floor);
- Subsea utility equipment, including hydraulic power, hydrate control, and dispersant injection equipment;
- Riser systems;
- Remotely operated vehicles;
- Capture vessels;
- Support vessels;
- Storage facilities;
- Night operations;
- In-situ burning;
- Spotter aircraft;
- Responder communications equipment compatibility; and
- Area Contingency Plan consistency.

MWCC Deepwater Oil and Gas Capping Stack Containment Exercise in the Gulf. In the summer of 2012, BSEE will oversee a live drill conducted by MWCC to deploy and test a state-of-the-art capping stack from its on-shore base to the deepwater seabed of the Gulf of Mexico. The exercise aims to demonstrate MWCC's ability to mobilize well-control equipment in a timely fashion in the event of a well blowout. This demonstration is part of a larger scenario that will also test an operator's ability to obtain supporting systems necessary for successful containment, such as debris removal equipment and oil collection devices. The other oil and gas well-containment equipment consortium, the Helix Well Containment Group, will conduct a similar deployment exercise in the future (http://www.bsee.gov/BSEE-Newsroom/Press-Releases/2012/press05242012.aspx).

Improving Oil-Spill Response. Many of the various report recommendations pertaining to Federal oversight of oil-spill response fall outside of USDOI's immediate jurisdiction. However, BOEM and BSEE are actively collaborating with the USCG and other agencies throughout the Federal Government in this area. Other agencies are also acting on National Commission's report recommendations; for example, the USEPA is conducting dispersant research and revising Subpart J of the National Contingency Plan, which establishes the products list for dispersants.

Memoranda of Agreement between USDOI BSEE and the U.S. Department of Homeland Security USCG. This Memorandum of Agreement (MOA) clarifies the following roles and responsibilities of BSEE and the USCG for any artificial island, installation, pipeline, or other device permanently or temporarily attached to the seabed seaward of the coastline, and certain vessels, including MODUs, support vessels for subsea containment, and floating production, storage, and offloading (FPSO) (or similar) vessels, located in State and Federal waters seaward of the coastline that may be used for the purpose of responding to discharges or substantial threats of discharges:

- Oil discharge research including research and development through the Inter-Agency Coordinating Committee on Oil Pollution Research, pollution event database maintenance, and inter-agency training at BSEE's Ohmsett National Oil Spill Response and Renewable Energy Test Facility and National Offshore Training and Learning Center;

- Planning including participation in the USCG Regional Response Teams and Area Committees, development of Regional Contingency Plans and Area Contingency Plans, and Oil Spill Response Plan review;

- Preparedness including conducting unannounced drills, equipment inspections, administering the National Preparedness for Response Exercise Program, and ensuring appropriate industry oil-spill response and spill management team training;

- Coordinated oil discharge response;

- Oil discharge reporting;

- Enforcement; and

- Abatement and production resumption activities (BSEE and USCG MOA 2012).

Upcoming National NTL Regarding Oil Spill Response Planning and Oil Spill Response. The USCG Incident-Specific Preparedness Review and the National Commission report include an array of recommendations related to planning, preparedness, and response for offshore operations. The BSEE Oil Spill Response Division (OSRD) and USCG Office of Incident Management and Preparedness have established the Response Workgroup, which is a team dedicated to improving coordination of review of oil-spill response plans, coordinating joint equipment reviews, reviewing offshore response planning standards, and conducting joint response exercises. Many of these ongoing activities link directly to recommendations in the reports noted above. The outcomes of much of this work will be published in a National BSEE NTL intended to incorporate lessons learned from the Macondo well spill response.

Upcoming Improvements to 30 CFR Part 254: Oil-Spill Response Requirements for Facilities Located Seaward of the Coast Line. BSEE's OSRD is currently planning to update the regulations governing oil-spill response plan content, which will respond to OSC recommendations to improve oil-spill risk analysis and the response planning process. By the close of 2012, OSRD is planning to publish an Advanced Notice of Proposed Rulemaking to initiate the process to update 30 CFR Part 254.

BSEE Oil Spill Response Implementation Team. As part of USDOI's broad and continuing reform efforts, BSEE created a number of Implementation Teams to evaluate and pursue implementation of the various reform recommendations following the DWH event. The ongoing work of these teams lays the foundation for lasting change in the way the BSEE and BOEM implement oil-spill prevention, containment, and response measures in the future. BSEE's Oil Spill Response Implementation Team is conducting a comprehensive review of spill response and the adequacy of operators' oil-spill response plans. This team is working closely with the USCG and other Federal agencies on developing enhanced spill response plans and more effective reviews of those plans in light of lessons learned from the **DWH** oil spill response (see http://www.bsee.gov/About-BSEE/Reorganization/ImplementationTeams.aspx).

Enhanced Inspection and Enforcement Procedures, Including Strengthened Training Program. As of October 1, 2011, the new BSEE is responsible for enforcement of safety and environmental regulations. BSEE undertakes both annual scheduled inspections and periodic unscheduled (unannounced) inspections of oil and gas operations on the OCS. The inspections are to assure compliance with all regulatory constraints that allowed commencement of the operation. The annual inspections examine all safety equipment designed to prevent blowouts, fires, spills, or other major accidents. These annual inspections involve the inspection for installation and performance of all facilities' safety-system components. The primary objective of an initial inspection is to assure proper installation and functionality of their safety and pollution prevention equipment. After operations begin, additional announced and unannounced inspections are conducted. Unannounced inspections are conducted to foster a climate of safe operations, to maintain a BSEE presence, and to focus on operators with a poor performance record. These inspections are also conducted after a critical safety feature has previously been found to be defective. Poor performance generally means that more frequent, unannounced inspections may be conducted on a violator's operation. The inspectors follow the guidelines as established by the regulations, API RP 14C (API 2001a), and the specific BOEM-approved plan. The BSEE inspectors perform these inspections using a national checklist called the Potential Incident of Noncompliance (PINC) list. This list is a compilation of yes/no questions derived from all regulatory safety and environmental requirements.

BSEE has several Inspection Implementation Teams focused on addressing issues in the development of effective, risk-based approaches to offshore inspections programs, including methodologies for targeting risk, near- and long-term inspection strategies, training programs, inspection and enforcement tool enhancements, and evaluations of compliance with the SEMS rule. The BSEE Environmental Compliance and Enforcement Implementation Team is specifically focused on designing new inspection and enforcement programs relating to environmental compliance. The BSEE Regulatory Enforcement Implementation Team is evaluating the use, adequacy of, and potential gaps in its enforcement tools including incidents of noncompliance, civil penalties, and debarment of unsafe operators. The BSEE Incident Investigations Implementation Team is evaluating and developing investigative procedures for specific categories of accidents and incidents (see http://www.bsee.gov/About-BSEE/Reorganization/ImplementationTeams.aspx).

BSEE administers an active civil penalties program (30 CFR Part 250, Subpart N). A civil penalty in the form of substantial monetary fines may be issued against any operator that commits a violation that the operator fails to correct or that caused or may constitute a threat of serious, irreparable, or immediate harm or damage to life, property, or the environment. BSEE may make recommendations for criminal penalties if a knowing and willful violation occurs. In addition, the regulation at 30 CFR 250.173(a) authorizes suspension of any operation if the lessee has failed to comply with a provision of any applicable law, regulation, order or provision of a lease or permit. Furthermore, the Secretary may invoke his authority under 30 CFR 550.185(c) to cancel a nonproductive lease with no compensation in certain circumstances. Exploration and development activities may be canceled under 30 CFR 550.182 and 550.183 if certain conditions are met.

Predecessor bureaus to BSEE established a robust training program for inspectors to ensure that personnel involved in installing, inspecting, testing, and maintaining safety devices are qualified. BSEE offers numerous technical seminars to ensure that personnel are capable of performing their duties and are incorporating the most up-to-date safety procedures and technology in the petroleum industry. In 1994, the Office of Safety Management created BSEE's Offshore Training Institute to develop and implement an inspector training program. The Institute introduced state-of-the-art multimedia training to the inspector work force and has produced a series of interactive computer training modules. As of June 2011, BOEMRE established the National Offshore Training Center, thereby developing the agency's first formal training curriculum, which has been piloted with new inspectors. An additional 24 courses covering specific areas of offshore inspections will be developed. These additional training initiatives respond to recommendations from the NAE and USDOI OCS Safety Oversight Board reports.

Following the DWH oil spill, BSEE now requires multiple-person inspection teams for offshore oil and gas inspections. This internal process will improve oversight and help ensure that offshore operations proceed safely and responsibly. The new process will allow teams to inspect multiple operations simultaneously and thoroughly, and enhance the quality of inspections on larger facilities. In addition, BSEE engineers and inspectors now fly offshore to witness required testing of all ROV intervention functions on the subsea BOP stack during the stump test (on the rig floor at the surface) and testing of at least one set of rams during the initial test on the seafloor, and required function testing of autoshear and deadman systems on the subsea BOP stack during the stump test and testing of the deadman system during the initial test on the seafloor. These reviews and inspections of the BOP systems and maintenance provide additional oversight by BSEE to reduce the risk of an uncontrolled blowout by ensuring that BOP systems are maintained and functional in the event of a loss-of-well-control event.

BSEE is also developing regulations to address new BSEE enforcement and investigative tools and policies, which responds to recommendations from both the NAE and USDOI OCS Safety Oversight Board. This rule (Clarification of Enforcement and Other Regulatory Authorities) will address BSEE (1) enforcement authority, by clarifying existing practices, authorities, and remedies for violations; (2) inspection responsibilities, by more accurately representing the OCSLA requirement that BSEE will conduct yearly scheduled inspections; (3) incident investigation, by substantially rewriting and strengthening regulations pertaining to the conduct of BSEE incident investigations; and (4) describing in greater detail the sanctions and penalties that could be levied against lessees, operators, or third parties under OCSLA or other relevant legislation.

Other Reform Initiatives.

USDOI Ocean Energy Safety Advisory Committee. The Secretary of the Interior chartered the Ocean Energy Safety Advisory Committee (OESC) on February 8, 2011, to facilitate the development of new regulations, collaborative research and development, advanced training, and implementation of best practices in drilling safety, well intervention and containment, and oil-spill response. The committee has several subcommittees that are working to address the findings of the various DWH event reports; reduce oil-spill risk via drilling and workplace safety, well containment, and oil-spill prevention planning reform; and address oil-spill response. OESC members are appointed by the Secretary of the Interior to represent the interests of the academic community, non-government organizations, offshore energy industry, and the Federal Government (see http://www.doi.gov/news/pressreleases/Ocean-Energy-Safety-Advisory-Committee-Sets-Goals-Agenda.cfm and http://www.bsee.gov/About-BSEE/Public-Engagement/OESC/Index.aspx).

Arctic-Specific Reform Initiatives. The National Commission only had a few recommendations specifically related to the Arctic and other frontier regions. USDOI, BOEM, and BSEE are engaged in initiatives to specifically address the unique concerns of undertaking oil and gas exploration and development in the Arctic. The discussion below highlights a few of these initiatives. More information on the Federal Government’s preparedness and response coordination efforts is available at http://www.bsee.gov/BSEE-Newsroom/BSEE-Fact-Sheet/Arctic-Fact-Sheet.aspx.

Arctic Oil Spill Response Exercise. In May 2012, BSEE participated in an oil-spill response table-top exercise that simulated the response to a well blowout in the Chukchi Sea. The exercise also included representatives from the U.S. Coast Guard, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the National Oceanic and Atmospheric Administration, the State of Alaska and the North Slope Borough, as well as officials from Shell. BSEE will also continue to participate in similar joint exercises to evaluate and improve communication and coordination among federal and state partners and industry. BSEE will also conduct a series of planned and unannounced exercises and inspections throughout the year to verify industry's ability to meet the conditions of their oil-spill response plans and effectively respond to a potential spill in the Arctic. In the event that exploratory drilling activities are approved in the Arctic, on-water exercises and drills will be conducted and on-site inspections of oil-spill response equipment will be required throughout the proposed drilling operation (http://www.bsee.gov/BSEE-Newsroom/Press-Releases/2012/press05252012.aspx).

Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska. Led by the USDOI, the Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska was established by the President to increase interagency coordination regarding the safe and responsible development of onshore and offshore energy resources and associated infrastructure in Alaska while protecting human health and the environment, as well as indigenous populations. A few of the working group's primary functions include facilitating orderly and efficient decision-making regarding the issuance of permits and conduct of environmental reviews; ensuring information sharing and integrity of scientific and environmental information and cultural and traditional knowledge; engaging in long-term planning and ensuring coordination regarding oil-spill prevention, preparedness, and response; coordinating Federal engagement with States, localities, and tribal governments; and collaborating on stakeholder outreach (see http://www.whitehouse.gov/the-press-office/2011/07/12/executive-order-13580-interagency-working-group-coordination-domestic-en).

National Research Council Study: Responding to Oil Spills in Arctic Environments. The NRC is currently working to assess the state of the science regarding oil-spill response and environmental assessment in the Arctic region. BSEE and BOEM are partially funding this study, which will aid in the development of oil-spill responses that adequately address prevention, containment, and response in a manner that reduces potential harm to the environment from increasing development in the Arctic. The study report will address Arctic oil spill (1) planning scenarios and prevention steps, (2) preparedness, (3) response and cleanup under Arctic conditions, and (4) baseline resource information needs for evaluating impacts and improving and developing protection and restoration measures. The study will also review new and ongoing research, identify opportunities and constraints for advancing oil-spill research, recommend strategies to advance research, and address information gaps.

Arctic Environmental Response Management Application. On February 2, 2012, BSEE and NOAA announced their partnership to enhance the Environmental Response Management Application (ERMA®) for the Arctic region by summer 2012. ERMA is a Web-based interactive geographic information system (GIS) tool designed to assist emergency responders and environmental resource managers in addressing incidents that may adversely affect the environment. ERMA integrates and synthesizes real-time and static data into a single interactive map to support response evaluation and decisions, as well as improves communication and coordination among responders and environmental stakeholders. ERMA was invaluable in assisting with response operations during the DWH event and is currently supporting National Resource Damage Assessment determinations. The Gulf ERMA is available for viewing at http://gomex.erma.noaa.gov/erma.html.

The new BSEE-NOAA partnership effort will reconfigure the tool to address the numerous challenges and meet the needs of responders in the remote marine Arctic environment. When operational, the Arctic ERMA will contain information such as the extent and concentration of sea ice; real-time oceanographic observations and weather data from NOAA; and the locations of ports, pipelines, and vulnerable environmental resources for spill responders to make rapid, science-informed response decisions. The BSEE-NOAA partnership aims to have the Arctic ERMA available to the response community ahead of any future drilling in Federal waters offshore Alaska (see http://www.bsee.gov/BSEE-Newsroom/Press-Releases/2012/press02072012.aspx).

***North Slope Subarea Contingency Plan*.** Improvements in planning for large-scale spills in the Arctic are currently being undertaken as part of the revision to the North Slope Subarea Contingency Plan, which serves as the guideline for establishing operations in the event of a major response effort to an oil spill or hazardous material release. This is a joint effort across the USDOI, USEPA, USCG, Alaska Department of Environmental Conservation, and numerous other Federal, State, local, Native and industry participants (ADEC et al. 2007). The most recent version of the plan can be obtained at http://dec.alaska.gov/spar/perp/ns-outreach/index.htm.

***Arctic Council*.** The National Commission recommended developing international standards for Arctic oil and gas exploration and development. The USDOI is actively engaged with other nations, through the Arctic Council and other forums, in addressing oil-spill prevention, preparedness, and response issues in the Arctic. The Arctic Council established a Task Force on Oil Spill Preparedness and Response in 2011 that is co-chaired by the U.S. Government. The task force is charged with developing an international instrument on Arctic marine oil pollution preparedness and response, as well as recommendations and/or best practices on the prevention of marine oil pollution (see http://www.arctic-council.org/index.php/en/about-us/task-forces/280-oil-spill-task-force).

Government Prevention, Containment, and Spill Response Research.

BSEE Research Programs. The BSEE Technical Assessment and Research (TA&R) Program was established in the 1970s to support research regarding operational safety and pollution prevention related to offshore oil and gas exploration and development. The primary objectives of the TA&R Program are to assess industry technological innovations and promote the use of Best Available and Safest Technologies (BAST) through regulations, rules, and operational guidelines and provide (1) technical support to Bureau decision makers; (2) research leadership; and (3) support for international research and development initiatives to enhance offshore safety and regulatory development. The TA&R Program is divided into Operational

Safety and Engineering Research (OSER) and Renewable Energy Research (REnR) (see http://www.bsee.gov/Research-and-Training/Technology-Assessment-and-Research.aspx).

The BSEE Oil Spill Response Research (OSRR) Program, which includes the National Oil Spill Response Test Facility (Ohmsett), has funded oil-spill response research focused on improving the knowledge and technologies used for the detection, containment, and cleanup of oil spills that may occur on the OCS. The BSEE OSRR Program encompasses oil-spill planning, preparedness, containment, monitoring, recovery, treatment, and response on the OCS. Information derived from the OSRR Program is directly integrated into BSEE's offshore operations and is used to make regulatory decisions pertaining to permitting and plan approval, safety and pollution inspections, enforcement actions, and training requirements. The BSEE OSRR Program is openly cooperative, bringing together funding and expertise from research partners in government agencies, industry, and the international community. Many of these collaborations are Joint Industry Projects, in which the Bureau partners with other stakeholders for the sole purpose of participating in research and development projects. BSEE disseminates the results of these projects to make this information widely available to oil -spill response personnel and organizations worldwide (see http://www.bsee.gov/Research-and-Training/Oil-Spill-Response-Research-(OSRR).aspx).

This section discusses the recent and ongoing research activities under BSEE's TA&R, OSER, and OSRR Programs related to workplace safety and incident prevention, containment, and response. For a complete list of TA&R OSER studies and their associated reports, visit http://www.bsee.gov/Research-and-Training/Operational-Safety-and-Engineering.aspx. For a complete list of OSRR and Ohmsett studies and their associated reports visit http://www.bsee.gov/Research-and-Training/Master-List-of-Oil-Spill-Response-Research.aspx and http://www.bsee.gov/Research-and-Training/Technology-Assessment-and-Research/tarprojectcategories/OHMSETT.aspx, respectively.

Improving Prevention. The NAE and JIT offered many recommendations for improving BOP reliability and performance. These reports also recommended additional safeguards for well design and construction. Alongside the regulatory upgrades discussed above, BSEE's TA&R Program is being used to address longer term technical issues involving BOP reliability and performance, and to conduct research to develop better methods of assessing cement performance in the field. These ongoing BSEE TA&R studies related to oil-spill prevention are discussed below.

Blowout Preventer Maintenance and Inspection in Deepwater Operations (Study No. 693). This study (BSEE TA&R Program in prep. j) will address and compare the current BOP maintenance, inspection, and testing practices to codes, standards, existing regulations, and industry recommended practices. Quantitative risk studies will be performed in order to identify the criticality of individual subcomponents within the BOP system, the reliability of the individual component, and the reliability of the complete BOP system.

Deepwater Blowout Preventer (BOP) Reliability & Well Kicks — Phase I Study No. 674). This study (BSEE TA&R Program in prep. f) will establish (1) an updated reliability overview of deepwater subsea BOPs used in the GOMR OCS during 2007–2009, and (2) a quantified overview of the deepwater well kick frequencies and important parameters contributing to the deepwater kick frequency in the various areas.

Analysis of Current Cementing Procedures Employed in the U.S. Outer Continental Shelf: Optimized Methods (Study No. 687). This research (BSEE TA&R Program in prep. i) will identify the current cementing practices used on the OCS and analyze them to determine the best practices. Existing practices that are incongruent with safety risks will be identified and safer alternatives will be proposed. Recommendations will be made for additional research in areas for which no acceptably safe methods exist.

Effects of Water Depth on Deepwater E&P Equipment and Operations on the OCS (Study No. 684). The objective of this study(BSEE TA&R Program 2012b) is to collaborate with offshore deepwater energy industry experts and regulators to (1) identify the critical issues and effects of water depth on equipment and operations and (2) determine the adequacy of current regulations.

Improving Spill Response. Even though much of the oil-spill response Federal oversight falls outside of USDOI's immediate jurisdiction, BSEE conducts a significant amount of research related to oil-spill recovery, treatment, and response on the OCS. The section below presents the ongoing studies currently being conducted.

Assessment of Dispersant Effectiveness using Ultrasound to Measure Oil Droplet Particle Size Distributions (Study No. 697). The goal of this project (BSEE TA&R Program in prep. k) is to develop novel ultrasonic scattering methods to measure the droplet size of dispersed oil to provide technologies to monitor the efficacy of dispersants subsea efficacy as a function of oil type, dispersant type, dispersant-to-oil ratio, water temperature, oil temperatures, and the presence of sediment on the effectiveness of dispersants.

Operational Chemical Dispersant Research at Ohmsett (Study No. 685). The overall objective of this research (BSEE TA&R Program in prep. h) is to advance the state-of-the-art and knowledge in chemical dispersant use in marine spill applications. The Ohmsett facility will be used to (1) validate the time window model for dispersant use, (2) understand the effects of dispersant type with various oil properties, and (3) understand the effectiveness of aircraft spray dosages on OCS crude oils.

Using Oil Herding Agents for Rapid-Response In Situ Burning of Oil Spills on Open Water (Study No. 683). The objective of this research (BSEE TA&R Program 2012a) is to evaluate the feasibility of using herders to enable *in situ* burning as a rapid-response technique in open water.

Laboratory-Scale Investigation of a Method for Enhancing the Effectiveness of Oil Dispersants in Destabilizing Water-in-Oil Emulsions (Study No. 681). The research (BSEE TA&R Program in prep. g) will investigate the feasibility of enhancing the de-emulsifying properties of commercially available oil dispersants by modifying the composition and fraction of polar constituents in the oil phase of water-in-oil emulsions and increasing the pH of the emulsion aqueous phase.

Effective Daily Recovery Capacity Project (Study No. 673). Effective Daily Recovery Capacity (EDRC) is the calculated capacity of oil recovery devices as determined by using a formula defined in 30 CFR 254.44, 33 CFR 154, Appendix C, and 33 CFR 155, Appendix B. The primary objectives of this project (BSEE TA&R Program in prep. e) are to (1) prepare an objective and independent assessment that scientifically validates the most appropriate methodologies for estimating the EDRC of oil-skimming systems, (2) provide recommendations for EDRC improvements to inform oil-spill planning and preparedness, and (3) make recommendations for new EDRC methodologies and guidelines for response systems deployed in nearshore and offshore operating environments.

Combining Mineral Fines with Chemical Dispersants to Disperse Oil in Low-Temperature and Low-Mixing-Energy Environments (Study No. 662). This research aims to assess the feasibility of applying a combination of dispersant and common fine mineral to treat oil slicks in low-energy regimes that are typical in cold water and the Arctic. The study hypothesis is that this combined treatment process would enhance the stability of the oil dispersion and to reduce its toxicity.

Detecting Oil on and under Sea Ice Using Ground Penetrating Radar: Development of a New Airborne System (Study No. 659). The goal is to significantly expand the practical operating window for oil detection using Ground Penetrating Radar (GPR) to cover a wider range of sea ice and climate conditions.

Open Water Multispectral Aerial Sensor Oil Spill Thickness Mapping in Arctic and High Sediment Load Conditions (Study No. 658). This project aims to validate and improve the current aerial thickness mapping system developed under the BSEE-funded research projects *Real-time Detection of Oil Slick Thickness Patterns with a Portable Multispectral Sensor* and *Development of a Portable Multispectral Aerial Sensor for Real-time Oil Spill Thickness Mapping in Coastal and Offshore Waters*. This project aims to test and validate this technology under oceanographic and environmental conditions that were not experienced during initial development, including the high-latitudes and extreme conditions of the Arctic.

Validation of the Two Models Developed to Predict the Window of Opportunity for Dispersant Use in the Gulf of Mexico (Study No. 637). This project aims to validate and improve the two correlation models developed under the BSEE-funded research project *Identification of Window of Opportunity for Chemical Dispersants on Gulf of Mexico Crude Oils*, which predicts the window of opportunity (or time-window) for successful chemical dispersant use in the GOM. The project also aims to evaluate the sensitivity of the models to water temperature, wind speed, and oil viscosity with the aim of including the effects of these parameters into the models.

Upcoming OSRR Research. In addition to the above ongoing studies, the BSEE OSRR Program has also recently identified the following study topics for potential funding this fiscal year and has requested the following information submittals: (1) feasibility of conducting subsea dispersant research at Ohmsett, (2) ice month at Ohmsett to stimulate development of new mechanical and/or chemical technologies for the recovery of oil in ice, (3) dispersant use impact on worker safety, (4) subsea chemical dispersant research, (5) methods to increase encounter rate for skimming and *in situ* burn operations, (6) mechanical technologies to facilitate and improve oil-spill containment and recovery under Arctic conditions, (7) remote sensing techniques, (8) mechanical technologies to facilitate and improve surface oil-spill containment, (9) mechanical technologies to facilitate and improve subsea oil-spill containment and removal, and (10) *in situ* burning.

Recent and Ongoing Industry Reform and Research.

***Joint Industry Task Forces*.** Shortly after the DWH event, various industry trade associations formed four joint industry task forces (JITFs) to learn from the DWH event and advance industry practices. The JITFs are comprised of member companies and affiliates of the API, International Association of Drilling Contractors, (IADC) Independent Petroleum Association of America (IPAA), National Ocean Industries Association (NOIA), and U.S. Oil and Gas Association (USOGA). The ultimate objectives of the JITFs are to reduce risk and improve the industry's capabilities in safety, environmental performance, and spill prevention and response. Collectively, the JITFs have worked to enhance industry drilling standards to form comprehensive safe drilling operations, well-containment and intervention capability, and oil-spill response capability; not only through evaluation and revision of industry guidelines and procedures, but also active engagement with regulatory processes. The JITFs identified gaps in industry operations or practices and are addressing those gaps through recommended practices, procedures, and research and development (JITF 2012a).

Recommendations from the JITFs have led to the reform of industry standards, recommended practices, and guidelines. The JITFs continue to evaluate and improve on both new and current tools. The JITFs functions and accomplishments are summarized below, as well as other current and ongoing reform initiatives spearheaded by industry.

Prevention.

***Joint Industry Operating Procedures Task Force (Procedures JITF)*.** The Joint Industry Operating Procedures Task Force (Procedures JITF) reviewed critical processes associated with the design, drilling, and completion of deepwater wells to identify gaps between existing practices and current regulations and industry best practices. Their recommendations resulted in the revision and new development of API standards: API Standard 65-Part 2: Isolating Potential Flow Zones During Well Construction (revised), API RP 96: Deepwater Well Design and Construction (new), and API Bulletin 97: Well Construction Interface Document Guidelines (new) (see New and Revised Industry Standards below) (Procedures JITF 2012). The Procedures JITF (in conjunction with the Equipment JITF) *Final Report on Industry Recommendations to Improve Offshore Operating Procedures and Equipment* (March 2012) presents detailed information on the status of addressing the JITF's original recommendations.

***Joint Industry Offshore Equipment Task Force (Equipment JITF)*.** The Joint Industry Offshore Equipment Task Force (Equipment JITF) reviewed current BOP equipment designs, testing protocols, and documentation, and developed recommendations to close any gaps or capture improvements in these areas. Based on these initial recommendations, the Equipment

JITF formed three subgroups to address measures to enhance the use of BOPs, including (1) shearing capabilities, (2) acoustics systems, and (3) interface with remotely operated vehicles. These subgroups each produced white papers regarding their topics in January of 2011. The Equipment JITF recommendations resulted in the revision of the API Standard 53: Blowout Prevention Equipment Systems for Drilling Well (see New and Revised Industry Standards below) (Equipment JITF 2012). The Procedures JITF (in conjunction with the Equipment JITF) *Final Report on Industry Recommendations to Improve Offshore Operating Procedures and Equipment* (March 2012) presents detailed information on the status of addressing the JITF's original recommendations.

Containment.

Joint Industry Subsea Well Control and Containment Task Force (Subsea JITF). The Joint Industry Subsea Well Control and Containment Task Force (Subsea JITF) reviewed technologies and practices for controlling the release of oil from its source, including equipment designs, testing protocols, research and development, regulations and documentation to determine if enhancements were needed. The Subsea JITF identified five key areas of focus for GOM deepwater operations: (1) well containment at the seafloor; (2) intervention and containment within the subsea well; (3) subsea collection and surface processing and storage; (4) continuing research and development; (5) and relief wells (Subsea JITF 2012).

One of the first Subsea JITF recommendations implemented was to provide a near-term response capability for well containment. This was achieved through the establishment of collaborative containment companies such as the Marine Well Containment Company (MWCC) and Helix Well Containment Group (HWCG) (see Section 4.3.3.2.2 for more detail). The establishment of these companies allowed industry to comply with the requirements of the Certification NTL (NTL-2010-N10) by developing and making available to operators subsea containment systems, including capping stacks and systems for the capture of flow from a well. In many cases, these containment companies are the responsible party for implementing the recommendations made by the Subsea JITF (Subsea JITF 2012).

The Subsea JITF developed 29 recommendations on specific steps to enhance the industry's subsea control and containment capability, including 15 immediate action items (one of which was the establishment of the above containment companies). The JITF began work on an API RP for containment certification for wells with subsea BOP and BOPs on floating structures, as well as an API RP for capping stacks (Subsea JITF 2012). Both API RPs will incorporate these recommendations as appropriate. The Subsea JITF *Final Report on Industry Recommendations to Improve Subsea Well Control and Containment* (March 2012) presents detailed information on the status of addressing the JITF's original recommendations.

Spill Response.

Joint Industry Oil Spill Preparedness and Response Task Force (OSPR JITF). The Joint Industry Oil Spill Preparedness and Response Task Force (OSPR JITF) issued preliminary recommendations in its *Draft Industry Recommendation to Improve Oil Spill Preparedness and Response Report* (September 2010), which proposed potential opportunities for improvement to the oil-spill response system in the areas of planning and coordination, optimization of each response tool, research and development, and training of all parties preparing for or responding to an oil spill (OSPR JITF 2011).

Following the OSPR JITF Report, the API Oil Spill Preparedness and Response Subcommittee (OSPRS) was tasked with leading industry efforts to develop and implement plans that addressed the preliminary recommendations, while staying abreast of related initiatives on a global scale. The OSPRS prioritized and divided the recommendations into seven categories: oil-spill response planning; shoreline protection and clean-up; oil sensing and tracking, dispersants; *in situ* burning; mechanical recovery; alternative technologies. Since then, the OSPRS supported by the API Oil Spill Preparedness and Response Workgroup (OSPRW) developed a comprehensive work program around these categories and organized project teams to conduct a number of projects under each category (OSPR JITF 2011). The full details on the progress of each project under the above recommendation categories can be found in the OSPR JITF *Progress Report on Industry Recommendations to Improve Oil Spill Preparedness and Response*.

New and Revised Industry Standards.

Improving Prevention.

API Standard 65-Part 2: Isolating Potential Flow Zones during Well Construction (revised). API has worked through the Procedures JITF to improve industry safety and operations by revising its standards and RPs. API published RP 65 – Part 2, Isolating Potential Flow Zones During Well Construction, in May 2010, and then revised the document based on (1) lessons learned from the DWH incident and (2) alignment with the planned Deepwater Well Design and Construction RP (see below). The revisions resulted in the API RP becoming API Standard 65 – Part 2, second edition. The Standard was published in December 2010. The Standard contains practices for isolating potential flow zones, which is integral to maintaining well integrity. The focus of this standard is the prevention of flow through or past barriers that are installed during well construction. Barriers that seal wellbore and formation pressures or flows may include mechanical barriers such as seals, cement, or hydrostatic head; or operational barriers such as flow detection practices that result in activation of a physical barrier. The reliability of achieving flow zone isolation is dependent on the existence of both types of barriers in the total system design. BSEE has incorporated this document by reference into its Interim Final Drilling Safety Rule (see above) (API Standard 65-Part 2, 2010).

API Balloted RP 96: Deepwater Well Design and Construction (new). In June 2010, the Procedures JITFs began developing the new API RP 96 Deepwater Well Design and Construction to provide well design and operational considerations for the safe construction of a deepwater well, including the drilling and completion activity performed with subsea BOPs, a marine drilling riser, and a subsea wellhead. The RP gives examples of physical loads and design practices for subsea well completions and completion configurations that provide maximum reliability. The RP also supplements barrier documentation in API 65-2 with a more detailed description of barriers and discussion of the philosophy, number, type, testing, and management required to maintain well control. The RP has been through a first ballot for consensus and the workgroup is currently addressing comments from the second ballot. The RP is expected to be completed in 2012 (API RP 96, Ballot 1).

API Balloted Bulletin 97: Well Construction Interface Document Guidelines (new). In July 2010, the Procedures JITFs began work on a new technical bulletin entitled *Well Construction Interface Document* (WCID) guidelines. These guidelines were prepared in response to Section III, B, Recommendation 2, of the USDOI report *Increased Safety Measures for Energy Development on the Outer Continental Shelf*, dated May 27, 2010. The USDOI report proposed the development of a bridging document that would bridge the drilling contractor's required safety case to existing well design and construction documents. This WCID aims to meet that object by a bridging document between the drilling contractor's Health, Safety, and Environmental (HSE) safety case and the operator's Safety and Environmental Management System (SEMS), and will address safety and risk management considerations on a well-by-well basis. The WCID has been through a first ballot for consensus and the workgroup is currently addressing comments. The WCID is expected to be completed in 2012 (API RP 97, Ballot 1).

API Balloted Standard 53: Blowout Prevention Equipment Systems for Drilling Well (revised). Through the Equipment JITF, API is revising the third edition of API RP 53, Recommended Practices for Blowout Prevention Equipment Systems for Drilling Well. This fourth edition will be updated to an existing Standard and is likely to be completed in 2012. The third edition is incorporated by reference in the Interim Final Drilling Safety Rule under Documentation Requirements for BOP inspections and maintenance. The new Standard will present operating practices for the installation and testing of blowout prevention equipment systems during drilling; completions and well testing operations; equipment arrangements; and extreme high- and low-temperature operations. Required components of a blowout prevention system include BOPs, choke and kill lines, choke manifold, hydraulic control system, marine riser, and auxiliary equipment. The primary functions of these systems are to confine well fluids to the wellbore, provide means to add fluid to the wellbore, and allow controlled volumes to be withdrawn from the wellbore (API Balloted Standard 53, Ballot Draft 2).

API 16 Series: Drilling Well Control Systems (revised). In addition to the revision of API RP 53, API is also evaluating and revising the complete API 16 Series, Drilling Well Control Systems, which encompasses the following specifications and recommended practices (Patel et al. 2011):

1. Specification 16A (3rd Edition) — Specification for Drill-Through Equipment;

2. Specification 16C (1st Edition) — Choke and Kill Systems;

3. Specification 16D (2nd Edition) — Control Systems for Drilling Well Control Equipment and Control Systems for Diverter Equipment;

4. Specification 16F (1st Edition) — Specification for Marine Drilling riser Equipment;

5. RP 16Q (1st Edition) — Design, Selection, Operation, and Maintenance of Marine Drilling Riser Systems;

6. Specification 16R (1st Edition) — Marine Drilling Riser Couplings; and

7. Specification 16RCD (1st Edition) — Drill-Through Equipment–Rotating Control Devices.

API Specification Q2: Quality Management System Requirements for Service Supply Organizations for the Petroleum and Natural Gas Industries (new). In December 2011, API released the first edition of API Specification Q2 Quality Management System Requirements for Service Supply Organizations for the Petroleum and Natural Gas Industries. This specification defines the quality management system requirements for the oil and gas industry service supply sector. It is intended to apply to upstream activities involved in exploration, development, and production, including well construction, intervention, production, and abandonment, as well as well servicing, equipment repair/maintenance, and inspection activities (API Spec Q2 2011).

API RP 64: Diverter Systems Equipment and Operations (revised). Since diverter systems are important to overall well control capability, the API is planning to revise API RP 64 for Diverter Systems Equipment and Operations (Patel et al. 2011; ISO/TC 67 2011). API RP 64 is intended to aid in the selection, installation, testing, and operation of diverter equipment systems on land and marine drilling rigs, including barge, platform, bottom-supported, and floating rigs (API RP 64, 2007).

API RP 59: Well Control Operations (revised). The API RP 59 for Well Control Operations is currently under revision (ISO/TC 67 2011). This RP is a companion to the API RPs 53 and 64 and serves as a guide for safe well operations, including recommended practices for retaining pressure control of the well under pre-kick conditions, as well as during a kick (API RP 59 2006).

API RP 90: Annular Casing Pressure Management for Offshore Wells (revised). API RP 90 for Annular Casing Pressure Management for Offshore wells is currently under revision (ISO/TC 67 2011). This RP serves as a guide for managing annular casing pressure in offshore wells and includes recommended practices for monitoring, diagnostic testing, the establishment of a maximum allowable wellhead operating pressure (MAWOP), and documentation of annular casing pressure for the various types of offshore wells. A discussion of risk assessment methodologies for evaluating wells with annular casing pressures outside the MAWOP guidelines is also presented (API RP 90 2006).

API Technical Report PER15K-1: Protocol for Verification and Validation of High Temperature High Pressure Equipment (new). API is drafting a new technical report, *Protocol for Verification and Validation of High Temperature High Pressure Equipment,* to develop an evaluation process for high-pressure and high-temperature (HPHT) equipment in the petroleum and natural gas industries that includes design verification analysis, design validation, material selection considerations, and manufacturing process controls necessary to ensure the equipment is fit for service in the applicable HPHT environment (ISO/TC 67 2011; API TR PER15K-1 in preparation).

Other Reform Initiatives. Industry continues its efforts to identify and drive improvements through JITF efforts, as well as a across a broad spectrum of initiatives that will continue to identify and develop improvements in offshore equipment, operations, well design, well control equipment targeted at prevention and containment, and new procedures and tools for oil-spill response. The discussion below highlights several of these initiatives.

Improving Prevention.

Center for Offshore Safety — SEMS. The Center for Offshore Safety (COS) is an industry-sponsored organization focused on improving the safety of offshore operations. The COS's primary objectives are to enhance and continuously improving industry's safety and environmental performance, and provide a platform for industry collaboration and engagement with third-party stakeholders including Federal agencies.

Currently, the COS is focusing its efforts on operators' SEMS Programs and has developed a SEMS Toolkit to aid industry in the development and implementation of its SEMS Programs. Member companies are expected to maintain a level of safety performance established by the COS, as verified through the audit and certification of its SEMS Programs by COS independent third-party auditors. If a company's performance drops below the minimum performance level, the member will be expected to develop an aggressive recovery plan to re-establish adequate performance levels. If requested, the COS will provide technical assistance in the development of the recovery plan (see http://www.centerforoffshoresafety.org).

The Blowout Risk Assessment Joint Industry Project. The Blowout Risk Assessment (BORA) Joint Industry Project (JIP) research was initiated in 2011 to develop a Blowout Risk Assessment Methodology, a Blowout Risk Model, and a Blowout Risk Assessment Tool that can be used by the government and industry to evaluate the risk related to well design and drilling operations in the GOM region (Subsea JITF 2011).

BORA will identify the threats associated with every phase of drilling operations, including well design and planning, well-drilling execution, and source control and containment technology. BORA will aid in the reduction of overall blowout risk by evaluating the associated impacts of each stage on blowout risk and identifying the barriers and systems that are intended to prevent a loss of well control. BORA will also identify alternatives for mitigating the consequences if an event should occur (Delmar Engineering 2011; see https://web-server-1.delmarus.com/Engineering/Joint%20Industry%20Projects/borajip.html).

Risk assessment considerations include well type, water depth, distance from shore, geologic characteristics of the formation, meteorological and oceanic conditions, geologic hazards, rig type, BOP design, mud program, and casing and cementing program. Several aspects of well-drilling execution considered include crew training and experience; number of barriers at each stage of operation; barrier verification; management system; real-time operations monitoring of geology and drilling fluid; and BOP inspection, testing, drills, and monitoring.

Source control and containment technology aspects considered include backup BOP activation capabilities, ROV support, containment equipment, collection system, spill response cost and resources, and novel or experimental plugging options.

Overall blowout risk will be evaluated by (a) quantifying the probability of blowout events and (b) quantifying the consequence of blowout events. The quantification of blowout risk will consider mitigation measures that may have measurable impacts during design, execution, and containment. Both historical and technical data, as well as expert input, will be used to evaluate the probability of threat at each phase of drilling, their potential consequences, and the effectiveness of barriers, controls, and mitigations. The model results will illustrate the range of blowout probability, along with the relative uncertainty in blowout occurrence, as well as the magnitude range of blowout consequence. BORA will also provide a blowout database and a Web-based Blowout Risk Assessment Tool. This tool can be updated as new information is received and analyzed to stimulate the ongoing assessment of drilling practices and well control procedures that are necessary for the continual improvement of drilling safety and pollution prevention.

International Association of Oil and Gas Producers. The International Association of Oil and Gas Producers (OGP) formed the Global Industry Response Group (GIRG) to ensure the lessons learned from the investigations of the DWH event and other similar incidents worldwide were applied globally. The GIRG formed three teams to address oil-spill prevention, containment, and response — the Well Engineering Design and Equipment/Operating Procedures Team, the Capping and Containment Team, and the Oil Spill Response Team (OGP 465 2011). The Well Engineering Design and Equipment/Operating Procedures Team focused on reducing oil-spill likelihood by improving drilling safety through enhancements in industry capabilities and practices in well engineering design and procedures; and well operations management, governance, and risk management standardization. The team presented six key recommendations in its *Deepwater Wells Report* (May 2011): (1) institute a three-level internal review process to ensure adherence to processes and procedures; (2) promote a human competency management system to ensure appropriate worker knowledge, experience, and training; (3) use nationally and internationally approved standards and practices as a basis for continual industry improvement; (4) implement a well management system (like SEMS) along with bridging document to improve overall technical and operational governance of well construction; (5) apply a minimum of two permanent, independent physical barriers when a well is capable of discharging to the environment; (6) create a new Wells Expert Committee (WEC) to communicate best practices, share industry lessons learned, advocate for harmonized standards, analyze incidents, and promote research and development (OGP 463 2011).

OGP WEC. The OGP WEC was founded shortly after the GIRG Well Engineering Design and Equipment/Operating Procedures Team publication of the *Deepwater Wells Report* (May 2011). Currently the WEC has established four taskforces to address (1) BOP reliability and technology development; (2) a database of well incidents; (3) human factors including training, competence, and behaviors; and (4) international standards (see http://www.ogp.org.uk/committees/wells).

DeepStar. DeepStar is a research and development consortium leveraging the financial and technical resources of the deepwater industry, academic/research institutions, and regulators to develop and execute deepwater technology projects. DeepStar is structured into committees, such as the Subsea Systems, Floating Systems, Flow Assurance, and Drilling Completions Committees, that execute technology development projects in order to gain acceptance of the technologies by industry and regulators and ultimately apply those technologies to deepwater assets (see http://www.deepstar.org).

International Association of Drilling Contractors Health, Safety, and Environmental Case Guidelines for Mobile Offshore drilling Units. The International Association of Drilling Contractors (IADC) Health, Safety, and Environmental (HSE) Case Guidelines (IADC 2010) provide a consistent methodology based on recognized global practices and standards for developing an integrated health, safety, and environmental management system for use in reducing risks associated with offshore and onshore drilling activities. The guidelines are gaining worldwide acceptance and exposure, which assists regulatory authorities' evaluation of drilling contractors' HSE management programs by providing assurance that the programs encompass best industry practices designed to minimize operating risks (http://www.iadc.org/hsecase/index.html).

The guidelines are intended to assist drilling contractors in achieving the following:

- Develop a HSE management system that addresses the scope of drilling operations and is aligned with international standards;

- Demonstrate to senior management and external stakeholders that their HSE management system's risk reducing measures meet established goals;

- Verify compliance with applicable regulatory and contractually agreed-upon HSE requirements; and

- Demonstrate compliance with the International Safety Management Code requirements of the International Maritime Organization.

International Association of Drilling Contractors WellCAP Accreditation Program. The IADC WellCAP is an accreditation program designed to ensure that well-control training institutions adhere to a core curriculum of well-control skills for drilling operations developed by industry and benchmarked according to recognized industry standards. The curriculum includes the following well-control skills:

- Causes of well kicks; well kick indicators and warning signals; increasing formation pressure indicators and their relationship to well control; and early detection and response.

- The ability to understand the types of pressure; perform various pressure-related calculations; perform well-control monitoring and procedures (e.g., shut-in and diverter use) during all stages of well-drilling operations;

understand gas (hydrocarbon, hydrogen sulfide, and carbon dioxide) characteristics and behavior; understand the types of drilling fluids and their proper use; understand methods to maintain constant bottom-hole pressure well control; understand well-control equipment and demonstrate proper usage; subsea well control; and government, industry, and company rules, orders, and policies.

Accreditation is achieved only after an extensive review of a provider's curriculum, testing practices, faculty, facilities, and administrative procedures to ensure suitable instruction resulting in an internationally recognized training certification of competent rig crews. Industry ensures continual improvement of the program through regular updating of curriculum guidelines.

Improving Containment.

International Association of Oil and Gas Producers. The objective of the OGP GIRG Capping and Containment Team is to decrease the time it takes to stop flow from an uncontrolled well by improving well-capping response readiness and studying the feasibility of a standardized global containment system. The primary conclusions of the team were presented the *Capping and Containment Report* (May 2011) recommending industry should (1) further develop capping and dispersant injection capability; (2) continue studying the feasibility of a global containment system; and (3) negotiate a Joint Development Agreement to execute these recommendations (OGP 464 2011).

OGP Subsea Well Response Project. The OGP Subsea Well Response Project (SWRP) was established on the recommendation of the OGP GIRG Capping and Containment Team (above). The SWRP is a consortium of nine major oil companies working to design a capping toolbox with a range of equipment to enable well shut-in, design hardware for the subsea injection of dispersant, and further assess the need for and feasibility and deployment options of a global containment system (see http://subseawellresponse.com/about-swrp and http://www.ogp.org.uk/global-insight/countering-major-incidents).

Improving Spill Response.

***Oil Spill Removal Organizations*.** The OSPR JITF Report (September 2010) contained recommendations for improving oil-spill response capabilities through expanding and optimizing the various oil-spill response options. Oil Spill Removal Organizations (OSROs) have dedicated significant time and resources to implementing those recommendations. The progress of each project under the seven recommendation categories developed by the OSPRS can be found in the OSPR JITF *Progress Report on Industry Recommendations to Improve Oil Spill Preparedness and Response* (OSR JITF 2011).

***Marine Spill Response Corp*.** An example of one OSRO's improvements is the Marine Spill Response Corp's (MSRC) Deep Blue program. This program has added additional dedicated spill response and recovery platforms, contracts with vessel operators to ensure ship readiness, and enhanced its oil-finding technology by adding infrared scanners and other technologies. The MSRC also expanded its capabilities for deploying chemical dispersants, has developed better oil-burning operations, and purchased more than 21,000 ft of boom. To allow for quicker deepwater response, it has also moved its Deep Blue Responder vessel to Port Fourchon, Louisiana (http://www.nola.com/news/gulf-oil-spill/index.ssf/2012/03/oil_spill_response_group_unvei.html and http://www.msrc.org/).

International Association of Oil and Gas Producers. The OGP is spearheading several initiatives, including the OGP GIRG Oil Spill Response Team (OSR Team) and Arctic Spill Response Technology Joint Industry Programme. The GIRG-OSR Team builds on the work described in the OSPR JITF Progress Report (2011), with broader applicability to international concerns. The goal of this team is to improve the effectiveness of both surface and subsurface oil-spill response preparedness and capability. The GIRG-OSR Team issued recommendations in the *Oil Spill Response Report* (May 2011) to further strengthen future oil-spill response protocols and technologies. The team recommended that industry form the Oil Spill Response JIP to execute the report recommendations. Many of the GIRG-OSR Team recommendations are reflective of those developed by the OSPR JITF, such as improving the understanding and application of dispersants; assessing and enhancing oil-spill response and risk/hazards assessment models, global oil spill response base capacity, oil-spill trajectory and subsea plume dispersion models, and documentation of crude oil types and their properties important for spill response; developing recommended practices/standard methodologies for response exercises, *in situ* burning, oil sensing and tracking, oil-spill response communication tools, and mobilizing, managing, and integrating military and volunteer responders (OGP 465 2011).

OGP Oil Spill Response Joint Industry Project. The OGP Oil Spill Response JIP was established based on the recommendation of the OGP GIRG-OSR Team and is comprised of OGP and International Petroleum Industry Environmental Conservation Association (IPIECA) member companies. The goal of the JIP is to manage and execute all 19 recommendations of the GIRG-OSR Team *Oil Spill Response Report* (May 2011) (see http://www.ogp.org.uk/global-insight/countering-major-incidents).

OGP Arctic Spill Response Technology Joint Industry Programme. The OGP established the Arctic Spill Response Technology JIP in January 2012. The JIP brings together industry experts to evaluate and advance oil-spill preparedness and response strategies and equipment in icy waters, and to increase understanding of potential impacts of oil on Arctic marine environment (OSPR JITF 2011; see http://www.sintef.no/jip-oil-in-ice). The JIP will undertake research projects in seven key areas, including (1) behavior of dispersed oil under ice and dispersant efficacy-testing in Arctic environments; (2) Arctic spill environmental impacts and their appropriate response; (3) trajectory modeling in ice; (4) oil-spill detection and monitoring in ice and under low visibility conditions; (5) mechanical recovery; (6) *in situ* burning in Arctic environments; and (7) experimental field releases (see http://www.ogp.org.uk/; http://www.sintef.no/jip-oil-in-ice).

American Petroleum Institute Arctic Oil Spill Task Group and the Joint Industry Programme on Oil Spill Recovery in Ice. The American Petroleum Institute Arctic Oil Spill Task Group and the JIP on Oil Spill Recovery in Ice jointly published the *Spill Response in the Arctic Offshore* Report on February 2, 2012. The JIP was created to develop international research programs to raise awareness of existing Arctic oil-spill response capabilities as well as to further enhance industry knowledge and capabilities of Arctic oil-spill response. The JIP report describes the fate and behavior of oil in Arctic conditions, and discusses the response options currently available for use by industry to respond to an oil spill in the Arctic including methods of monitoring, detection, tracking, *in situ* burning, physical dispersion, chemical dispersion, mechanical containment and recovery, and shoreline protection and cleanup. The report also identifies research projects that will be conducted to improve industry capabilities and coordination in the area of Arctic oil-spill response (API and JIP 2012).

Assessing Progress.

Oil Spill Commission Action Progress Report. The OSC Action, an outgrowth of the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, issued its progress report, *Assessing Progress: Implementing the Recommendations of the National Oil Spill Commission*, on April 27, 2012. The report evaluates the progress to improve the safety of offshore drilling and spill preparedness and response made by industry, the Department of the Interior, and other Federal agencies over the past two years since the DWH event. Overall the OSC assigned a grade of “B” to the Federal Government, a “C^{+}” to industry, and a “D” to Congress for their respective enhancements. The OSC Action report evaluated progress of the OSC recommendations in five categories: (1) safety and environmental protection, (2) spill response and containment, (3) impacts and restoration, (4) ensuring adequate resources, and (5) frontier areas — the Arctic. The OSC Action reported that the Federal Government and industry have made and continue to make significant improvements in the way offshore oil operations are developed, carried out, and overseen, as well as in the ability to contain and respond to offshore oil spills. The OSC Action also recognizes the progress in implementing its recommendations for Gulf of Mexico restoration and addressing Arctic concerns; however, believes additional work is needed these areas. In addition to the current work, the OSC Action report recommends continued improvements in all these areas and especially for Congress to enact legislation to support existing and future efforts and ensure adequate resources (OSCA 2012).

U.S. Government Accountability Office Progress Report. The U.S. Government Accountability Office (USGAO) was requested by Congress to examine (1) the industry’s improved capabilities for containing subsea wells (those on the ocean floor) in the Gulf of Mexico; (2) USDOI’s oversight of subsea well containment in the Gulf of Mexico; and (3) the potential to use similar subsea well-containment capabilities in other Federal waters, such as those along the Alaska coast. The USGAO reported its findings in February 2012 in its report *Interior Has Strengthened Its Oversight of Subsea Well Containment, but Should Improve Its Documentation* (GAO 2012). The USGAO report recognized the improvements industry has made to enhance its capabilities to respond to a subsea well blowout including the establishment of the collaborative containment companies, MWCC and HWCG (GAO 2012).

The report also acknowledges the USDOI’s improvements, including new requirements for industry resources to contain a subsea well blowout, plan reviews, guidance to operators outlining information that must be provided to demonstrate that operators can respond to a well blowout, and tests of an operator’s well-containment response capabilities in two unannounced spill drills. Given these improvements, the USGAO recommends that the USDOI document a time frame for incorporating well-containment response scenarios into unannounced spill drills in order to help ensure that operators can respond effectively to a subsea well blowout. In commenting on the draft report, the USDOI concurred with the USGAO's recommendation (GAO 2012).

4.3.4 Potential Effects to Human Health

4.3.4.1 National Environmental Policy Act

The National Environmental Policy Act and its related Federal guidelines (40 CFR 1508.8; 1978) have explicit language that requires the evaluation of both direct and indirect effects of the oil and gas industry on human health as well as the effects on low-income and minority populations (CEQ 1997). NEPA regulations instruct agencies to evaluate "the degree to which the proposed action affects public health or safety" (Berner 2011). Although these mandates exist, limited health information is currently included in Federal EISs. With the addition of the discussion of health issues in the planning stages, the impacts on human health can be considered beforehand, public and decision-maker awareness can be promoted, and prevention or mitigation can be built into the operations (Bhatia 2007; Niven and McLeod 2009). This would, in essence, change the process from reactionary to precautionary, thus attempting to remove or control health issues at the source (Niven and McLeod 2009).

4.3.4.2 Potential Impacts on the Human Environment

Offshore oil and gas activities have the potential to cause both adverse and beneficial impacts on human health. The exploration and development phases of oil and gas activities are beneficial because they require a large and diverse labor force to build the platforms, exploratory rigs, and various ships, boats, and barges necessary for working offshore (Luton and Cluck 2003). Increases in the labor force can promote the economy and development of infrastructure in these communities (Berner 2011).

Effects on the human environment can be both positive and negative, specifically with respect to psychological effects. The announcement of a leasing decision can affect humans in a positive way because it can boost the economy and bring much needed infrastructure development; possible negative effects could be related to additional stress and anxiety over oil spills, effects on human health, and impacts on the natural resources that communities use for a subsistence lifestyle (NRC 2003b; Anguilera et al. 2010). Negative impacts on the human environment vary based on whether they are the result of routine events or the result of the threat/event of an accidental oil spill.

4.3.4.3 Potential Impacts of Routine Operations

As discussed in Section 4.4.14, Environmental Justice, much of the Alaska Native population resides in the coastal areas of Alaska. Any new onshore and offshore infrastructure occurring between 2012 and 2017 could be located near these populations or near areas where subsistence hunting occurs. Any adverse environmental impacts on fish and mammal subsistence resources from installation of infrastructure and routine operations of these facilities could have disproportionately higher health or environmental impacts on Alaska Native populations. Mitigation measures, cooperative agreements between Native and industry groups, and government-to-government consultations are designed to limit the effects from routine events.

The North Slope Borough, Alaska, and the Alaska regional office of BOEM, through a Memorandum of Understanding, have evaluated the effects of the oil and gas industry on humans in the region. Appendix J of the *Beaufort and Chukchi Sea Planning Areas Oil and Gas Lease Sales 209, 212, 217, and 221 Draft Environmental Impact Statement* (MMS 2008b) presents a full evaluation of these effects and is hereby incorporated by reference in this PEIS (http://www.alaska.boemre.gov/ref/EIS%20EA/ArcticMultiSale_209/_DEIS.htm).

Public concerns regarding pollution of locally harvested fish and game, loss of traditional food sources and hunting grounds, and rapid social changes are examples of negative impacts on humans in Alaska. The harvesting of wildlife resources in the North Slope of Alaska contributes widely to the cultural, nutritional, and economic way of life of the residents living there (NRC 2003b). These impacts could affect both physical and mental health of Native tribal communities. Changes in the traditional way of life can lead to deteriorating physical well-being and mental health as well as increased domestic violence and substance abuse. North Slope tribal communities are concerned about the impacts of noise associated with routine operations on bowhead whale migration routes, as they depend on these whales for subsistence (NRC 2003b). If the whales migrate farther offshore, there are increased safety risks for the whalers themselves who must travel in more dangerous seas to hunt. Increased stress and anxiety from oil and gas development may contribute to the mental health issues of Alaskans (NRC 2003b).

The increased development has increased the smog and haze near some villages, which could be the cause for increased instances of asthma. Air quality is a major concern for the residents who live there (NRC 2003b). The impacts of the proposed action on air quality and related health concerns are discussed in Section 4.4.4. Increased rates of diabetes are likely the result of residents consuming higher concentrations of nonsubsistence foods such as shortening, lard, butter, and bacon, and consuming less fish and marine mammal products (NRC 2003b).

However, the increased revenue from the oil and gas industry can promote the economy and improve infrastructure of these more remote locations, resulting in beneficial impacts (Berner 2011). Alaska Natives have recognized that they have benefited by receiving monies to spend on public works and facilities, as well as better health care and counseling centers (NRC 2003b).

4.3.4.4 Potential Impacts of Accidental Spills

A number of studies conducted throughout the world have examined the effects of oil spills on the mental and physical health of exposed individuals and populations. These studies have identified a relatively common set of psychological and physiological effects incurred by spill response workers, fishermen, local communities, and others (Park and Holliday 1999; Janjua et al. 2006; Zock et al. 2007; Meo et al. 2008; Rodriguez-Trigo et al. 2010; also see reviews by Aguilera et al. [2010] and Goldstein et al. [2011]). Psychological effects may include increased rates of depression, anxiety, and post-traumatic stress. Physiological effects may include a variety of respiratory symptoms; irritation of the eyes and mucous membranes; and increased incidence of headaches, nausea, and dizziness. Similar effects may be expected in the event of an oil spill in the GOM and Alaska planning areas.

4.3.4.4.1 Gulf of Mexico. The impacts on human health as a result of oil spills can be broken down into several categories. Goldstein et al. (2011) list the categories as "those related to worker safety; toxicological effects in workers, visitors, and community members; mental health effects from social and economic disruption; and ecosystem effects that have consequences for human health." Initial concerns focus on the short-term toxicological effects to humans such as nausea, dizziness, eye irritation, headaches, and respiratory and dermal irritation, but more research is necessary to understand long-term effects (Janjua et al. 2006; Goldstein et al. 2011). Other immediate effects of particular concern are heat stroke and exhaustion and the inappropriate use of personal protective equipment by cleanup crews. Impacts on air quality include the emission of pollutants from the oil and the fire emissions that are hazardous and possibly fatal to humans at very high concentrations, as well as the dispersant mist resulting from the application of the chemical dispersants on the oil. The impacts of the proposed action on air quality are fully discussed in Section 4.4.4.

After an accidental release of oil into the environment, the more volatile, water-soluble, and degradable compounds will be weathered and degraded, leaving behind the heavier (higher molecular weight), less degradable, less toxic components. These heavier components will ultimately undergo weathering and degradation, but at much slower rates. These heavier components, when combined with sand on beaches, form tar balls, which can be encountered by beachgoers for some time. Humans walking along the beach may be exposed to these components via skin (dermal) contact (OSAT-2 2011). Beachgoers may also inhale petroleum hydrocarbons present as vapors or attached to airborne particles (OSAT-2 2011). Following the DWH event and subsequent cleanup, small surface residual balls (SSRBs) of tar remained on beaches following cleanup. These SSRBs are the oil residues left behind following cleanup by mechanical and/or manual means, and consist primarily of sand (up to 96%) mixed with and coating small amounts of residual oil (less than 13% of an SSRB) (OSAT-2 2011). A risk assessment examined both short-term (90 days of exposure in 1 year) and long-term (30-year exposure period) exposures to oil residues via skin contact, ingestion, and inhalation (OSAT-2 2011). Calculated potential cancer and non-cancer (physiological) health effects were below EPA acceptable health-based risk and hazard levels. It should be noted that oil seeps are extensive throughout the continental slope and naturally contribute hydrocarbons to the sediments and water column (Sassen et al. 1993; OSAT-2 2011).

In the case of the DWH event, elevated rates of post-traumatic stress disorder, depression, alcohol abuse, and conflicts between domestic partners were observed (Osofsky et al. 2011; Goldstein et al. 2011). A mental health assessment conducted in Louisiana following the DWH event identified increased symptoms of anxiety, depression, and post-traumatic stress (Osofsky et al. 2011). A large part of the GOM region's economy is based on the oil and gas industry and the harvesting of seafood. Restrictions placed on these industries due to an oil spill can increase the anxiety levels of humans and may contribute mental health issues (see studies cited in Goldstein et al. 2011).

Oil spills have the potential to impact certain groups of people more than others based on their current state of health. For example, GOM coast populations include communities that are still recovering from Hurricane Katrina, and among the 50 States, Louisiana ranks 44th to 49th (depending on the metric used, with 1st being the best) in the overall health of residents, rates of infant death, deaths from cancer, premature deaths, deaths from cardiovascular causes, high-school graduations, children living in poverty, health insurance coverage, and violent crime (Goldstein et al. 2011). As discussed in Section 4.4.14, there are areas in the GOM with environmental justice concerns. It is possible these low-income and minority populations could be affected to a greater extent than the general population because of their dietary reliance on wild coastal resources, their reliance on these resources for other subsistence purposes such as sharing and bartering, their limited flexibility in substituting wild resources with those purchased, and their likelihood of participating in cleanup efforts and other mitigating activities.

4.3.4.4.2 Arctic and Cook Inlet. The Native tribes of the North Slope have serious concerns about what would happen if there was an accidental oil spill in the Arctic region. An oil spill could have physical, psychological, social, economic, spiritual, and cultural impacts on the Native Alaskans. Major areas of concern are with impacts on subsistence resources (especially the bowhead whale), air quality, and oil spill cleanup. These concerns are related to how and if it would be cleaned up and how the International Whaling Commission would react if the spill greatly impacted the bowhead whale population (NRC 2003b). The impacts of the proposed action on air quality are discussed in Section 4.4.4. The North Slope Borough, Alaska, and the Alaska regional office of BOEM have, through a Memorandum of Understanding, evaluated the effects of the oil and gas industry on humans in the region. Appendix J of the *Beaufort and Chukchi Sea Planning Areas Oil and Gas Lease Sales 209, 212, 217, and 221 Draft Environmental Impact Statement* (MMS 2008b) presents a full evaluation of these effects.

Human populations in Arctic regions, especially indigenous populations, have been found to exhibit comparatively poorer health status than non-Arctic populations (AMAP 2009). While infant death rates are lower and population longevity has improved, the rates of several chronic diseases (such as cardiovascular disease and diabetes) have been increasing. These changes in health status are not uniform across Arctic populations, and are influenced by a number of determinants of health related to socioeconomic, dietary, and cultural influences. One factor relates to exposure of indigenous populations to contaminants, primarily through traditional food consumption (subsistence) (AMAP 2009). Persistent contaminants (organic chemicals and metals) moving through food chains and accumulating in food items have the potential to contribute to health impacts.

While oil spills in Alaska can affect human health the same ways as discussed for the GOM, the major concerns in Alaska involving the impacts on human health due to oil spills relate to the subsistence lifestyle of Native Alaskans. Humans can be affected through contact with the contaminants, such as through inhalation, skin contact, or intake of contaminated foods; through reduced availability of subsistence resources; through interference with subsistence harvest patterns; and stress due to fears of long-term implications of the spill (MMS 2007e as referenced in MMS 2008b; also see discussions presented in Section 4.4.12 of this Final PEIS).

As discussed in Section 4.4.14, there are areas in the Alaska region that are of environmental justice concern. Much of the Alaska Native population resides in the coastal areas of Alaska, and subsistence activities of Native communities could be affected by accidental oil spills, with the potential health effects of oil spill contamination of subsistence foods being the main concern. Mitigation measures, cooperative agreements between Native and industry groups, and government-to-government consultations are designed to limit the effects from oil spills.

4.3.4.5 Conclusion

Offshore oil and gas activities have the potential to affect the health status of human populations. Of particular concerns are adverse impacts that may occur as a consequence of accidental oil spills. Potential impacts on human health may affect both physiological and mental health of exposed individuals and populations. Mental health impacts may include an increased incidence of depression, anxiety, and post-traumatic stress. Physiological impacts may include a variety of respiratory symptoms, irritation of the eyes and mucous membranes, and an increased incidence of headaches, nausea, and dizziness. In Alaska, oil spills may affect not only the abundance of subsistence resources, but may lead to contaminant concentration in subsistence food items, thus contributing to reduced health status of affected populations.

Health effects are discussed throughout this PEIS, as appropriate. The State of Alaska is currently developing an approach to integrate health analysis into the EIS by way of a Health Impact Assessment (HIA) (Berner 2011). An HIA is a scientific method used to assess the potential effects of a policy on the health of a population and the distribution of those effects, and it brings together stakeholders to find a solution (Quigley et al. 2006; Berner 2011). The overall purpose of HIAs is “to inform and influence decision making on proposals and plans, so health protection and promotion are effectively integrated into them” (Quigley et al. 2006). This programmatic-level EIS acknowledges that there will be impacts on human health, both positive and negative, from the proposed action, but it is a broad-level document discussing the impacts over entire planning areas. It would be more appropriate to discuss impacts to site-specific populations at the lease sale level when a better understanding of who will be affected is clear.

4.3.5 Invasive Species

EO 13112, *Invasive Species*, defines invasive species as species that are non-native (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Invasive species can be plants, animals, or pathogens. Nationwide, invasive species are associated with environmental damages and losses totaling over $138 billion annually (Pimentel et al. 2000). More than 50,000 invasive species have been documented to date in the United States, and roughly 42% of threatened and endangered species in this country are considered at risk primarily because of invasive species (Pimentel et al. 2005). Effects of invasive species can be devastating on both habitat and native species and may (1) include a decrease in biological diversity of native ecosystems, (2) decrease the quality of important habitats for native fish and invertebrate species, (3) reduce habitats needed by threatened and endangered species, (4) increase direct and indirect competition with aquatic plants and animals, and (5) pose human health risks (http://www.invasivespeciesinfo.gov/whatis.shtml).

Oil and gas activities may play a part in the introduction of invasive species or may provide substrate and habitat encouraging the establishment of invasive species. Drillships and semisubmersibles are used and relocated throughout the world's oceans. Over time, fouling, encrusting, and boring organisms will attach to these devices. Unintentional introductions may occur when these drilling rigs are relocated to a new region such as the GOM. These same drillships and semisubmersibles may transport and release ballast water containing invasive plankton, larval invertebrates, or even fish, which may then become established due to the availability of acceptable habitat, plentiful food supply, and lack of predators.

Since 1998, there have been at least 16 documented cases of rigs being brought into the GOM from other parts of the world. Some rigs operating in the GOM were constructed or recently modified in Singapore, Taiwan, and Scotland. Newly built rigs undergoing their last year of construction stand in waters of surrounding shipyards. A year is sufficient time for fouling and encrusting organisms to colonize rig surfaces. One large semisubmersible was kept in Mobile Bay, Alabama, for 1 yr. Prior to being placed in Mobile Bay, it had spent 6 months drilling off the coast of Trinidad.

Oil and gas drilling rigs, platforms, and pipelines provide substrate and habitat for sessile organisms. Invasive mussels, barnacles, and corals are known to use rigs and platforms as attachment sites. Many marine organisms require hard surfaces to use as attachment sites for all or part of their natural history. Jellyfish have a polyp stage that requires hard substrate. Polyps settling on rigs in one location and then transported to another region can asexually reproduce. One polyp can produce up to 300 new jellyfish. Currently, there are thousands of oil and gas platforms in the GOM, each of which can provide a hectare or more of hard substrate that can support algae, mollusks, and other sessile invertebrates (Atchison et al. 2008). No-activity-zone natural reefs provide 104.5 km^2 (40.3 mi^2) of hard substrate, which could be used for settlement sites.

Above-water platform structures may also encourage the colonization of new habitat by invasive species. Many migratory bird species use the platform structures as stopover spots while crossing the GOM (Russell 2005). Ongoing research funded by BOEM is studying the interactions between migrating birds and oil and gas structures off the Louisiana coast.

A number of invasive species have been recorded from the OCS planning areas considered for oil and gas leasing in the proposed action. In the GOM, invasive species reported since the mid-1900s include the brown mussel (*Perna perna*), the Australian spotted jellyfish (*Phyllorhiza punctata*), the pink jellyfish (*Drymonema dalmatina*), two species of hydroids (*Cordylophora caspia* and *Garveia franciscana*), a sea anemone (*Diadumene lineata*), a polychaete worm (*Hydroides elegans* and *Ficopomatus enigmaticus*), the Atlantic copepod (*Centropages typicus*), four barnacle species (*Balanus amphitrite*, *B. reticulatus*, *B. trigonus*, and *Tetraclita stalactifera stalactifera*), and four species of isopod (*Sphaeroma walkeri*, *S. terebrans*, *Limnoria* spp., and *Ligia exotica*). Some of these species are native to other parts of the world (e.g., the brown mussel is native to Africa and South America), while other species are native to North American marine habitats but not to the GOM (e.g., the Atlantic copepod *Centropages typicus*). Suggested avenues of initial introduction of these various species include discharge of ballast water, dumping of ballast rock, or attachment to vessel surfaces.

Although invasive species are a worldwide problem, Alaska has far fewer invasive species compared to the rest of the nation (Fay 2002). Relatively few aquatic invasive species have been introduced and become established in Alaska compared to other States. This is, in part, due to Alaska's plant and animal transportation laws, geographic isolation, northern climate, small human population, and relatively few concentrated disturbed habitat areas (Fay 2002). However, a non-native amphipod and a colonial tunicate have been found in Alaskan waters. Potential introduction pathways include the movement of large ships and ballast water from the United States west coast and Asia, and the relocation of previously used docks and pier timbers (ADFG 2012). While invasive species impacts, to date, are low, potential threats must be monitored because a significant portion of Alaska's economy, including sport and commercial fishing, depends upon the pristine and natural quality of its aquatic ecosystems. Climate change may also affect the ability of marine invasives to become established (Invasive Species Advisory Committee 2010). For example, changes in water temperature or precipitation regimes (and associated runoff into coastal waters) may make areas more favorable for an invasive species to become established or spread.

Exploratory drilling of Federal leases offshore of Alaska requires bringing rigs and/or vessels to Alaska. Such rigs or vessels may come from the GOM, the West Coast, or foreign waters and be contaminated with species alien to Alaska. Such species may be attached to the hull structure (e.g., sponges and barnacles), hitch a ride on the vessel (e.g., rats, insects, crustaceans, and mollusks), or be transported via ballast water (e.g., crustaceans and mollusks). Once brought to Alaska, alien species contaminating a rig or vessel may subsequently disperse into Alaska's ecosystems.

Although introduction of invasive species to Alaskan waters could occur through the import and placement of offshore oil/gas structures, historically the threat has not been considered significant because of the very low level of offshore drilling in Alaskan waters. The Alaska Aquatic Nuisance Species Management Plan (Fay 2002) considers activities other than oil/gas structures major pathways for the introduction of aquatic alien species, including aquaculture; aquarium trade; biological control; boats, ships, and aircraft; channels, canals, and locks; live bait; nursery industry; scientific research institutions, schools, and public aquariums; recreational fisheries enhancement; restaurants; and seafood retail and processing. However, the potential for introduction of invasive species may increase with increased drilling, together with potential climate-related changes in environmental baseline conditions (such as water quality and currents).

Vessels, including those used by the oil/gas industry, do pose more potential for introducing invasive species than oil/gas structures. For example, Hines and Ruiz (2000) reported finding 13 species of crustaceans and 1 species of fish arriving at Port Valdez in the ballast water of oil tankers voyaging from San Francisco Bay or Long Beach, California. The issue of invasive species and ballast water is managed by the USCG under the National Invasive Species Act of 1996. The USCG has promulgated regulations (33 CFR Part 151) to make compliance with ballast water guidelines mandatory. Therefore, oil- or gas-related vessels are required to abide by these requirements in order to reduce the potential for introduction of invasive species.

4.4 ENVIRONMENTAL IMPACTS OF ALTERNATIVE 1 – PROPOSED ACTION

4.4.1 Exploration and Development Scenario

4.4.1.1 Gulf of Mexico

Oil and gas leasing and development have been occurring in the GOM for over 50 years. There are a total of 29,097 lease blocks (each approximately 23 km^2 [3 mi × 3 mi]) and a total of 3,280 active platforms in the Western, Central, and Eastern GOM OCS Planning Areas. Predictable patterns of activity have become established for the planning areas, and these were used to estimate future activity within the GOM OCS Region Planning Areas that could occur under this scenario (Table 4.4.1-1). This scenario of future development and activity was generated using best professional judgment for the purpose of analysis only and does not constitute official forecasts or policy recommendations.

In general, the major activity types under a given lease can include exploration, development, and production (see Table 4.4.1-1). The onset and timing of different activity types that may result from a lease sale in the Program will vary within and between Planning Areas over the 40- to 50-year life of the Program. For example, relatively more exploration drilling is expected to occur in the first 5–10 years of the Program, whereas relatively more development drilling and production will occur later in the Program. The types of activities included in the scenario in Table 4.4.1-1 may occur anywhere within the GOM planning areas included in the proposed action (Figure 4.4.1-1). Figure 4.4.1-2 shows the anticipated onset and timing of exploration and development drilling, as well as oil and gas production associated with the 12 lease sales potentially held under the Program. Although the actual levels of OCS activity will fluctuate with market supply and demand for oil and gas, similar temporal trends are expected. The peak in exploration drilling is expected to occur between 5 and 10 years after the Program is initially approved. Shallow-water exploration drilling generally occurs before deepwater drilling. Development drilling and platform construction are expected to lag behind

TABLE 4.4.1-1 Proposed Action (Alternative 1) – Exploration and Development Scenario for the GOM

Scenario Element	Gulf of Mexico
Number of sales	12
Years of activity	40–50
Potentially available oil (Bbbl)[a]	2.7–5.4
Potentially available natural gas (tcf)	12–24
Platforms	200–450
FPSOs[b]	0–2
No. of exploration and delineation wells	1,000–2,100
No. of development and production wells	1,300–2,600
Miles of new pipeline	2,400–7,500
Vessel trips/week	300–600
Helicopter trips/week	2,000–5,500
New pipeline landfalls	0–<12
New pipe yards	4–6
New natural gas processing facilities	0–12
Platforms removed with explosives	150–275
Drill Muds/Well (tons)	
Exploration and delineation wells	1,000
Development and production wells	1,000
Drill Cuttings/Well (tons)	
Exploration and delineation wells	1,200
Development and production wells	1,200
Produced Water/Well/yr (tbbl)[c]	
Oil well	130 (highly variable)
Natural gas well	35 (highly variable)
Bottom Area Disturbed (ha)[d]	
Platforms	150–2,500
Pipeline	2,000–11,500

[a] Bbbl = billion barrels.

[b] Floating production, storage, and offloading systems.

[c] Based on 1.04 bbl produced water/bbl of oil, and 86 bbl produced water/1 million cf gas (Clark and Veil 2009); tbbl = thousand barrels.

[d] Assumes 0.67 ha (1.6 ac) per platform and 0.8–1.6 ha (2.0–4.0 ac) per mile of pipeline.

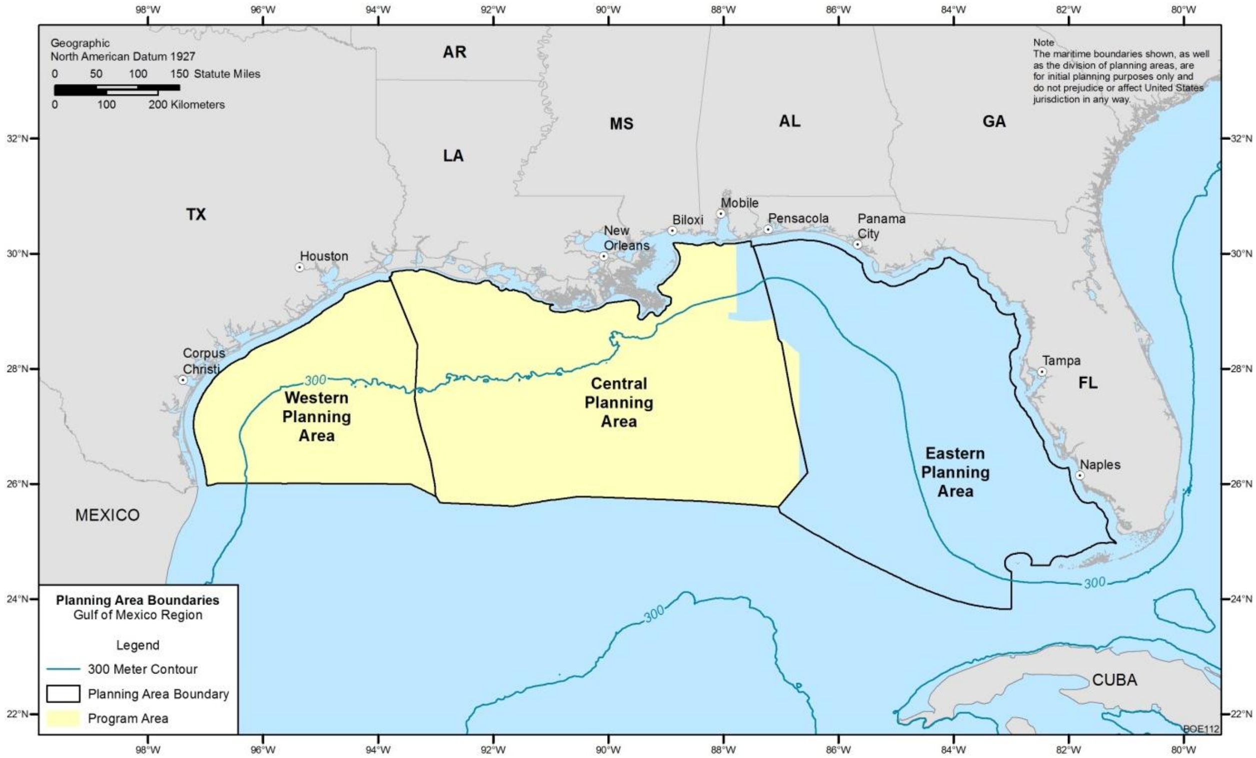

FIGURE 4.4.1-1 Gulf of Mexico Planning Areas Where Leasing for Oil and Gas Development May Occur under the 2012-2017 OCS Leasing Program

exploration drilling by several years. A secondary peak in development drilling associated with more costly deepwater and ultra-deepwater development operations is expected to occur approximately 15–20 years into the Program. Peak production is expected to occur after 2030. It is also notable that these types of temporal trends have been occurring related to all approved OCS oil and gas programs since 1980. In the analysis of potential environmental impacts associated with the leasing program, additional assumptions are used to identify potential oil and gas development activity levels to more specific marine and coastal areas under consideration in a particular analysis. The GOM OCS may be divided into continental shelf and slope regions, and this distinction is important to both the occurrence of oil and gas within the GOM hydrocarbon basin and to ecosystem characteristics and processes within the GOM Large Marine Ecosystem. Assumed levels of oil and gas infrastructure and production that would occur on the continental slope and shelf are shown in Table 4.4.1-2. This information suggests that while the amounts of well drilling and gas production will be approximately the same on the shelf as on slope (51% versus 49%, respectively), most new platforms will be installed in shallow water (in depths <200 m [<660 ft]) on the continental shelf. In contrast, most oil production (93%) will occur in deeper water (at depths >200 m [>660 ft]) on the continental slope. Consistent with this scenario, deepwater wells are expected to have a comparatively greater worst-case discharge.

This assumed difference by depth of infrastructure development and oil and gas production suggests similar differences in the resources that could be affected by normal exploration and development (E&D) activities on the OCS. For example, 87% of all new

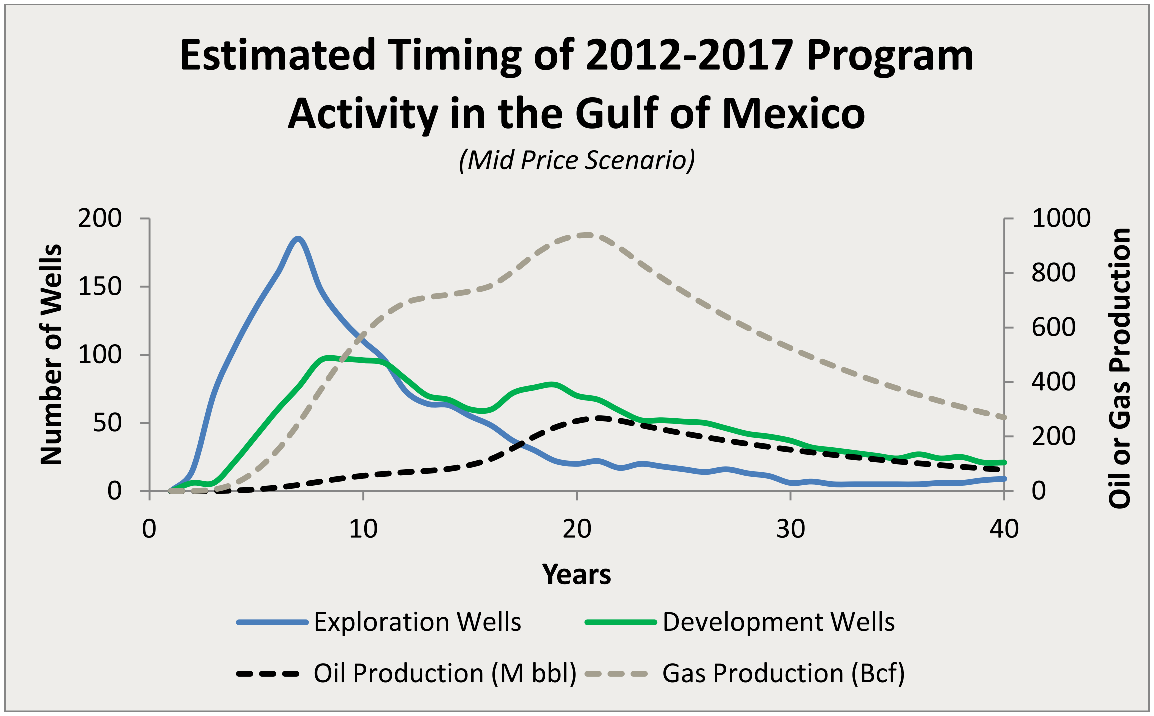

FIGURE 4.4.1-2 Estimated Timing of Exploration, Development, and Production from Gulf of Mexico Lease Sales during the 2012-2017 OCS Leasing Program

TABLE 4.4.1-2 Depth Distribution of New Infrastructure and Expected Natural Gas and Oil Production on the GOM OCS

			% of New Wells		% of New Platforms		% of New Gas Production		% of New Oil Production	
OCS Depth Zone (m)	OCS Area	OCS Sub-area	OCS Area	OCS Sub-area	OCS Area	OCS Sub-area	OCS Area	OCS Sub-area	OCS Area	OCS Sub-area
0–60	Shelf	Inner	52	37	95	87	51	37	7	5
60–200		Outer		15		8		14		2
200–800	Slope	Upper	48	12	5	2	49	7	93	12
800–1,600		Mid		20		2		22		44
1,600–2,400				-[a]		-		-		-
>2,400		Lower		16		1		20		37

[a] No wells, platforms, or production are expected for this depth range.

platform development is assumed to occur in waters of the inner continental shelf at depths of 60 m (about 200 ft) or less (Table 4.4.1-2). Thus, resources occurring in these shallower areas may be expected to be more likely to encounter, and be affected by, normal well development and operation than would resources restricted to deeper areas of the OCS.

4.4.1.2 Alaska – Cook Inlet

The Cook Inlet has had oil and gas operations in State waters since the late 1950s and currently possesses a well-established oil and gas infrastructure. There has been no oil and gas activity in the Cook Inlet Planning Area. A single sale in Cook Inlet is included in the proposed action as a special interest sale, meaning that the planning process for the sale will not start until industry expresses an interest in holding the sale. The most recent OCS lease sale in Cook Inlet was in 2004 when no leases were purchased. The most recent sale in which OCS leases were purchased occurred in 1997 when two leases were purchased. Appraisal activity for an offshore prospect (Cosmopolitan) leased in this sale was conducted from an onshore location.

Table 4.4.1-3 summarizes the assumed levels of exploration and development that could occur under the proposed action (Alternative 1). Oil and gas development that could occur in the Cook Inlet OCS Planning Area under the proposed action is expected to use both new and existing infrastructure. Exploration drilling would employ fixed rigs (such as jack-up and mobile gravity-base rigs) in water depths up to 150 ft (46 m) and floating rigs (semisubmersible rigs, drill ships, or barges) in deeper water areas. Production wells will most likely use fixed platforms with subsea well tie-backs to supplement on-platform wells. New subsea pipelines would connect offshore installations to existing onshore facilities. Oil and gas would be carried by new onshore pipelines over relatively short distances to existing oil refineries in Nikishi and natural gas transmission facilities in the Kenai area, respectively. Relative timing of exploration and development drilling, platform construction, and oil and gas production is generally comparable to that in the GOM.

4.4.1.3 Alaska – Arctic

In contrast to oil and gas development in the GOM OCS, and with the exception of a single production site (Northstar) that has an actual surface location in Alaskan State waters, there has been no development activity from a structure in Arctic OCS areas. Since 1979, ten lease sales have been held in the Beaufort Sea Planning Area and three in the Chukchi Sea Planning Area (http://www.boem.gov/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Leasing_and_Plans/Leasing/Alaska%20Region%20Lease%20Sales%20To%20Date.pdf). The 2008 Lease Sale 193 for the Chukchi Sea Planning Area (MMS 2007b) is of note because of the high industry interest expressed through the acquisition of 487 leases and the more than $2.6 billion received by the government in high bids. No activity has resulted from this lease sale because of litigation that remains unresolved at the time this PEIS is being written. The scenario put forth for the Arctic in the 2012–2017 Program in Table 4.4.1-4, however, assumes that the exploration and development activities anticipated as a result of Sale 193 will have occurred prior to the beginning of the development and production activities listed in the

TABLE 4.4.1-3 Proposed Action (Alternative 1) – Exploration and Development Scenario for Cook Inlet

Scenario Element	Cook Inlet
Number of sales	1
Years of activity	40
Oil production (Bbbl)[a]	0.1–0.2
Natural gas production (tcf)[a]	0–0.7
Platforms	1–3
No. of exploration and delineation wells	4–12
No. of development and production wells	42–114
Miles of new offshore pipeline	25–150
Miles of new onshore pipeline[b]	50–105
Vessel trips/week	1–3
Helicopter trips/week	1–3
New pipeline landfalls	0–1
New shore bases	0
New processing facilities	0
New waste disposal facilities	0
Platforms removed with explosives	0
Drill Fluids/Well (bbl)	
Exploration and delineation wells	500 – discharged at well site
Development and production wells	All treated and disposed of in the well
Drill Cuttings (dry rock)/Well (tons)	
Exploration and delineation wells	600 – discharged at well site
Development and production wells	All treated and disposed in the well
Bottom Area Disturbed (ha)	
Platforms (1.5 ha/platform)	1.5–4.5
Pipeline (1.4 ha/mile)	35–210
Surface Area Disturbed (ha)	
Pipeline (7.3 ha/mile)	365–770

[a] Bbbl = billion barrels; tcf = trillion cubic feet.

[b] New onshore pipelines would deliver oil to existing refineries in Nikiski and natural gas to transmission facilities in the Kenai area.

TABLE 4.4.1-4 Proposed Action (Alternative 1) – Exploration and Development Scenario for Arctic Alaska

Scenario Element	Beaufort Sea	Chukchi Sea
Number of sales	1	1
Years of activity	50	50
Oil production (Bbbl)[a]	0.2–0.4	0.5–2.1
Natural gas production (tcf)[b]	0–2.2	0–8.0
Platforms	1–4	1–5
No. of exploration wells	6–16	6–20
No. of production wells	40–120	60–280
No. of subsea production wells	10	18–82
Miles of new offshore pipeline	30–155	25–250
Miles of new onshore pipeline	10–80	0
Vessel trips/week	1–12	1–15
Helicopter trips/week	1–12	1–15
New pipeline landfalls	0	0
New shore bases	0	0
Drill Fluids/Well (bbl)		
Exploration and delineation wells	500 – discharged at well site	500 – discharged at well site
Development and production wells	All treated and disposed of in the well.	All treated and disposed of in the well.
Drill Cuttings (dry rock)/Well (tons)		
Exploration and delineation wells	600 – discharged at well site	600 – discharged at well site
Development and production wells	All treated and disposed in the well.	All treated and disposed in the well.
Bottom Area Disturbed		
Platforms (1.5 ha/platform)	1.5–6.0	1.5–7.5
Pipeline (1.4 ha/mile)	42–217	35–350
Surface Soil Disturbed		
Pipeline[c]	73–584	0

[a] Bbbl = billion barrels.

[b] Assumes that a natural gas pipeline from the North Slope will be operating by 2020 and have capacity for new supplies in 2030–2035; tcf = trillion cubic feet.

[c] Assumes 46 m (150 ft) wide construction ROW; 7.3 ha (18 ac)/mi.

table. In particular, the scenario was developed using the assumptions that the discovery and development of a 1-Bbbl oil field has already occurred, a pipeline has been installed from the OCS production area in the Chukchi Sea to Point Belcher near Wainwright, Alaska, and support base facilities have been constructed there as well. As a result of these assumptions, the scenario in Table 4.4.1-4 includes no new pipeline landfalls or support bases, since these would have already been constructed in support of OCS operations resulting from Lease Sale 193 (BOEMRE 2011j). In addition, oil discoveries less than 1 Bbbl were assumed not to be economically feasible in the Program, because an initial larger field needed to justify the construction of a pipeline to shore and coastal service facilities. It is assumed that development as a result of lease sales under the Proposed Action Alternative would utilize existing infrastructure, and that fields smaller than 1.0 Bbbl could be produced.

The PEIS assumes that the most probable locations for oil and gas activities in the Arctic OCS will be in the areas that have been already leased in recent sales (Figure 4.4.1-3). While activities within the entire Chukchi and Beaufort Sea Planning Areas are considered in the analyses that follow, it is assumed that these areas in Figure 4.4.1-3 reflect industry's current assessment of the best hydrocarbon prospects through its large investments in acquiring the leases. It is reasonable to assume that industry will continue to explore and develop these areas before moving into other areas currently considered less promising. Based on historical information and recent industry trends, BOEM anticipates that new exploration drilling as a result of the proposed lease sales under this Program will not begin in the Arctic until 2018, and that most drilling will occur within 7 years. Most development drilling and platform construction associated with the single Chukchi or Beaufort lease sale is not expected to occur until after 2025.

In the Beaufort Sea Planning Area, exploration is assumed to use artificial gravel islands or extended-reach drilling in shallow waters (<6 m [20 ft]), mobile platforms in mid-depths (6–18 m [20–60 ft]), and drill ships in deeper areas of the shelf. Because of severe winter ice pack conditions, it is assumed that development would be limited to the shelf and to depths less than 91 m (300 ft) and platform installation would occur only in the summer (open water) season. Production operations will use gravity-base platforms or gravel islands in shallow water (<12 m [40 ft]) and larger gravity-base platforms in deeper waters (up to 91 m [300 ft]). Oil produced at the platforms will be delivered via trenched subsea pipelines to existing onshore facilities.

In the Chukchi Sea Planning Area, with its greater water depths (>30 m [100 ft]) and more remote location, exploration drilling is expected to employ drill ships. As in the Beaufort Sea, concerns regarding severe winter ice conditions will also limit exploration and development to the shelf and depths <91 m (300 ft) and only in the summer (open water) season. Production operations will use large gravity-base structures with trenched subsea pipelines to transport the oil to landfalls.

In both areas, elevated onshore pipelines will convey the oil from the landfall facilities to production facilities at Prudhoe Bay for ultimate entry to the Trans-Alaska Pipeline System (TAPS). Natural gas development and production are not expected to begin until around 2035 in the Arctic. Gas pipelines would need to be installed before gas production could begin. Once

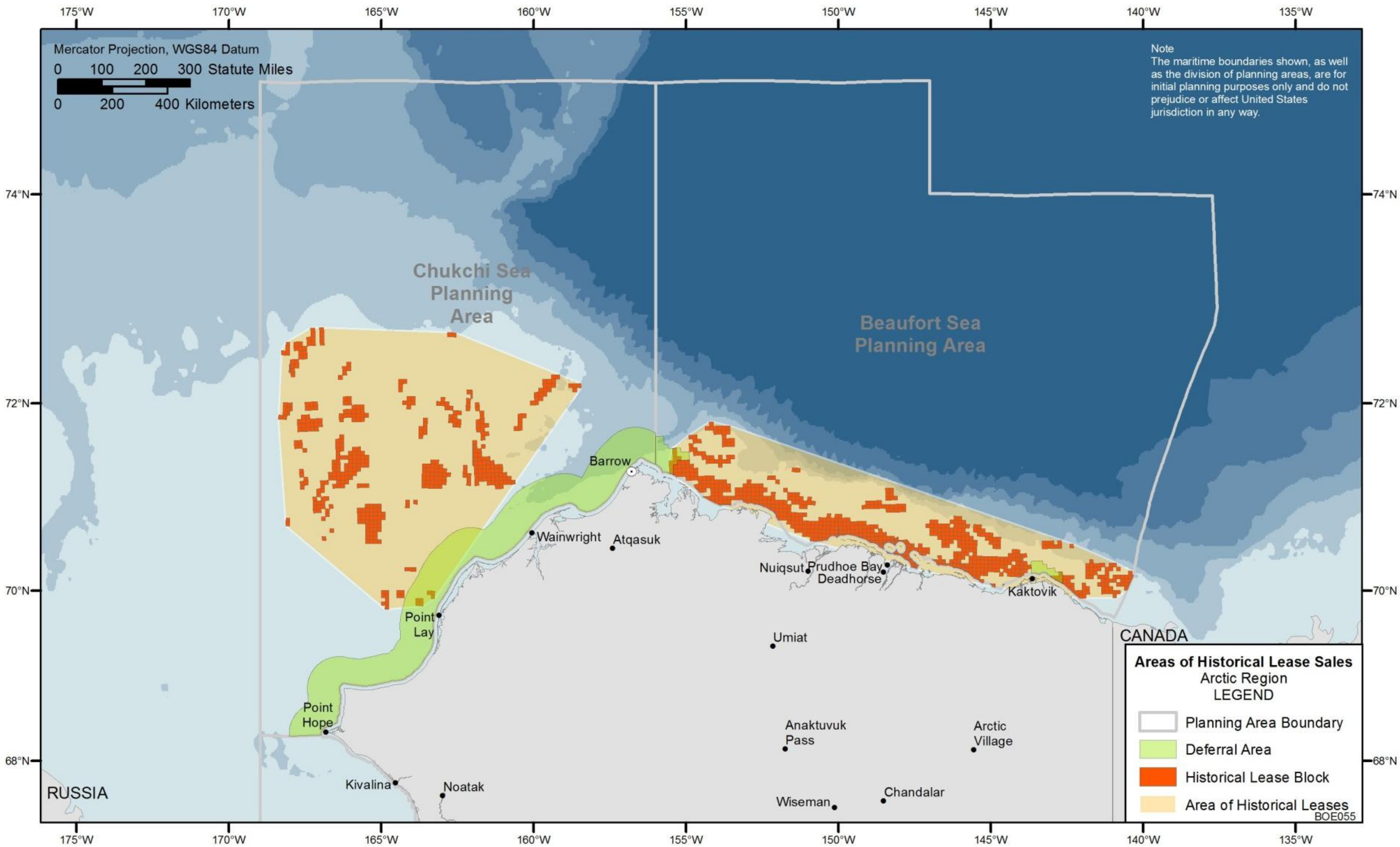

FIGURE 4.4.1-3 Areas of Historical Lease Sales in the Beaufort and Chukchi Seas OCS Planning Areas

produced, gas would be transported by new subsea and overland pipelines that would be constructed through the same corridor as the existing offshore oil pipeline. This offshore pipeline would be trenched into the seafloor as a protective measure against ice damage. A second new pipeline would be required to transport gas from shore to a main transportation hub near Prudhoe Bay, on the assumption that a natural gas pipeline connecting the North Slope with the lower 48 States will be in place and operational by 2020. Natural gas from the Chukchi and Beaufort Seas may be transported by new and existing aboveground pipelines for entry into such a pipeline (assuming capacity is available in the 2030–2035 time frame).

4.4.2 Accidental Spill Scenario

Oil spills are unplanned accidental events. Depending on the phase of O&G development and the location, magnitude, and duration of a spill, natural resources that may be affected include marine mammals, marine and coastal birds, sea turtles, fish, benthic and pelagic invertebrates, water quality, marine and coastal habitats, and areas of special concern (such as marine parks and protected areas). Spills may also affect a variety of socioeconomic conditions such as local employment, commercial and recreational fisheries, tourism, and subsistence. For this PEIS, assumptions have been made about the occurrence and location of small and large oil spills associated with the Program.

The source and number of assumed small and large accidental spills are based on the volume of anticipated oil production in each area, the assumed mode of transportation (pipeline and/or tanker), and the spill rates for large spills. It is also assumed that these spills would occur with uniform frequency over the life of the proposed action. Platform spills are assumed to occur in areas proposed for lease consideration. Pipeline spills are assumed to occur between the proposed lease areas and existing infrastructure. Tanker and barge spills are assumed to occur along the tanker and barge routes from the lease areas to shore facilities.

As discussed in Section 4.3.3, loss of well control, a type of platform spill, has the potential to result in the largest volume across oil spills. Between 1971 and 2010, more than 41,500 exploratory and development/production operation wells were drilled on the OCS, and almost 16 billion bbl (Bbbl) of oil was produced. During the period of 1971 to 2010, there were 253 well control incidents during exploratory and development/production operations on the OCS. These incidents were associated with exploratory and development drilling, completion, workover, and production operations. Of these well control incidents, 52 resulted in crude, condensate, diesel, or drilling mud releases ranging from <1 bbl to 450 bbl. The loss of well control, explosion, and fire on the DWH mobile offshore drilling unit (MODU) resulted in the release of an estimated 4.9 million bbl of crude oil until the well was capped on July 15, 2010.

Spills from tankers carrying oil produced in the Beaufort and Chukchi Sea Planning Areas are assumed to occur outside of those planning areas. It is assumed that oil produced in the Beaufort and Chukchi Sea Planning Areas would be delivered by offshore and onshore pipe to TAPS, with subsequent delivery to the Valdez terminal facilities followed by tanker transport to West Coast ports. Some tankering could also occur in the GOM to transport oil from FPSO facilities expected to operate in areas of the GOM distant from existing pipelines.

4.4.2.1 Expected Accidental Events – Spill Size Assumptions

Spill size will vary greatly depending on the amount of oil released over a period of time as a result of a single accidental event. For this PEIS, hypothetical spill sizes were developed using OCS and U.S. historical spill databases. Table 4.4.2-1 presents the spill assumptions for the GOM, the Beaufort and Chukchi Seas, and Cook Inlet. The sizes of the assumed spills for each spill type (platform, pipeline, tanker, or barge) are approximately equal to the median spill sizes of historical spills for each spill type. Two categories of spill sizes are considered: small and large.

4.4.2.1.1 Small Spills. Analysis of historical data from the GOM, Pacific, and Alaska OCS regions shows that small spills occur most frequently (Anderson et al. 2012; MMS 2007c, 2008a). Examination of these data also shows that most offshore oil spills have been <1 bbl in size, and these small spills accounted for approximately 95% of all OCS spills but less than 5% of the total volume of oil spills on the OCS (Anderson et al. 2012; Anderson and LaBelle 2000). Most of the total volume of OCS oil spilled (95%) has been from spills ≥10 bbl. On the basis of the historical OCS spill data, for this PEIS small spills are considered to be <1,000 bbl in volume (Table 4.4.2-1). Small spills are further divided into two groups: spills <50 bbl and spills ≥50 bbl but <1,000 bbl (Table 4.4.2-1).

4.4.2.1.2 Large Spills. The spill-size assumptions used in this PEIS for expected large spills are based on the reported spills from exploration and production in the GOM and Pacific OCS and what is anticipated as likely to occur (Anderson et al. 2012; MMS 2007c, 2008a; Anderson and LaBelle 2000); there have been no large oil spills in the Alaska OCS region. For this PEIS, a large spill is considered to be ≥1,000 bbl. Between 1964 and 1999, there were 11 platform spills and 16 pipeline spills ≥1,000 bbl on the OCS (Anderson and LaBelle 2000). Between 2000 and 2010, there were 2 platform spills and 4 pipeline spills ≥1,000 bbl (Anderson et al. 2012). The median sizes of these large spills from pipelines and platforms for 1964–2010 are 4,550 and 7,000 bbl, respectively (Anderson et al. 2012). The median sizes of these large spills from pipelines and platforms for 1996–2010 are 1,700 and 5,100 bbl, respectively (Anderson et al. 2012). From 1971 to 2010, the DWH event in 2010 was the only loss of well control incident on the OCS that resulted in a spill volume ≥1,000 bbl. The scenario for a low-probability CDE is discussed separately below.

4.4.2.1.3 Expected Accidental Events – Spill Number Assumptions. The number of spills assumed to occur during the years of activity of the proposed action is estimated by multiplying the oil spill rate for each of the spill size groups by the projected oil production as a result of the proposed action. Details on the methodology for estimating spill rates (and thus mean spill number) can be found in Anderson et al. (2012). As shown in Table 4.4.2-1, most spills assumed to occur during the duration of the proposed action would be in the small-volume category (<1,000 bbl). As the spill size increases, the occurrence rate decreases, so the number of estimated spills decreases. Estimates of the number of large spills for the Beaufort Sea and Chukchi Sea Planning Areas were also derived from fault-tree modeled rates and compared to

TABLE 4.4.2-1 Oil Spill Assumptions for the Proposed Action (Alternative 1)

		Number of Spill Events[a]		
		Gulf of Mexico Region	Arctic Region	South Alaska Region
Scenario Elements	Assumed Spill Volume	Western, Central, and Eastern Planning Areas	Beaufort and Chukchi Planning Areas	Cook Inlet
Oil Production (Bbbl)[b]		2.7–5.4	0.7–2.5	0.1–0.2
Large (bbl)	≥1,000			
pipeline	1,700[c]	2–5	1–2	1 spill from either
platform	5,100[d]	1–2	1	
tanker	3,100	1		
Small (bbl)[e]	≥50 to <1,000	35–70	10–35	1–3
	≥1 bbl to <50	200–400	50–190	7–15

[a] The assumed number of spills are estimated using the 1996–2010 spill rates found in Anderson et al. (2012). The ≥1,000 bbl spill rate for pipelines is 0.88 spills/Bbbl. The ≥1,000 bbl spill rate for platforms is 0.25 spills/Bbbl. The ≥1,000 bbl spill rate for tankers is 0.34 spills/Bbbl in U.S. waters and 0.46 spills/Bbbl for Arctic North Slope tankers (1989 to 2008). The ≥50 to <1,000 bbl spill rate for pipelines and platforms combined is 12.88 spills/Bbbl. The ≥1 to <50 bbl spill rate for pipelines and platforms combined is 74.75 spills/Bbbl. For the Alaska OCS region, the 1996–2010 spill rates were compared to fault-tree rates in Bercha Group Inc. (2006, 2008a,b, 2011). The greater number of spills from Anderson et al. (2012) is represented here. Note that spill volumes for spills ≥10,000 bbl are not reported for the 1996–2010 period because there were no such pipeline spills and only one platform spill (i.e., the DWH event). For the 1996–2010 period, Anderson et al. (2012) reports an assumed ≥10,000 bbl spill rate of 0.18 spills/Bbbl for pipelines and 0.13 spills/Bbbl for platforms.

[b] Bbbl = billion barrels.

[c] During the last 15 years (1996–2010), 7 oil spills ≥1,000 bbl occurred from U.S. OCS pipelines. The median spill size was 1,720 bbl. The maximum spill size between 1996 and 2010 from U.S. OCS pipelines was 8,212 bbl.

[d] During the last 15 years (1996–2010), 2 oil spills ≥1,000 bbl occurred from U.S. OCS platforms. During Hurricane Rita, one platform and two jack-up rigs were destroyed, and a combined total of 5,066 bbl was spilled. The median spill size, when not accounting for a decreasing trend in the rate of platform spills, over 1964–2010, is 7,000 bbl.

[e] The number of spills <1000 bbl is estimated using the total spill rate for both pipeline and platform spills.

the rates from Anderson et al. (2012) (Bercha Group, Inc. 2011). In all cases, the Anderson et al. (2012) estimates were the more conservative estimates and were used in lieu of specific fault-tree models which are considered at the lease sale stage.

4.4.2.2 An Unexpected Accidental Event and Spill – Catastrophic Discharge Event

As discussed in Section 4.3.3, a CDE is a low probability, very large volume spill that if one were to occur it would have the potential for severe environmental consequences. Although CDEs are unexpected, such spills may result from OCS exploration, development, and production operations involving facilities, tankers, and pipelines. The CDE size assumptions below are derived assuming a loss of well control event as explained in Section 4.3.3.

Catastrophic Discharge Event – Spill Size and Number Assumptions. The CDE estimate is intended to provide a scenario for a low-probability event with the potential for catastrophic consequences. Past oil spills that may be relevant include the *Exxon Valdez* oil spill (262,000 bbl) (non-OCS program related) in Prince William Sound in south central Alaska, the Ixtoc oil spill (3,500,000 bbl) (non-OCS program related) in the western GOM, and the DWH event (4,900,000 bbl) in the northern GOM (McNutt et al. 2011). For this PEIS, CDE estimates were developed for each program area, taking into account considerations such as water depth, weather conditions (such as ice cover), and the potential availability of response equipment for drilling relief wells. The spill size assumptions for such highly unlikely and unexpected events are presented in Table 4.4.2-2. The likelihood of occurrence of such events is discussed in more detail in Section 4.3.3.

For the GOM planning areas, the CDE volumes range from 900,000 to 7,200,000 bbl, depending on the depth at which the loss of well control occurs (Table 4.4.2-2). For the Cook Inlet Planning Area, the CDE volume estimates range from 75,000 to 125,000 bbl, depending on the availability of a rig to drill a relief well. For the Chukchi Sea and Beaufort Sea Planning Areas, the CDE volume estimates range from 1,400,000 to 2,100,000 bbl and 1,700,000 to 3,900,000 bbl, respectively.

4.4.3 Potential Impacts on Water Quality

4.4.3.1 Gulf of Mexico

This section analyzes impacts on GOM coastal and marine waters. Coastal waters, as defined here, include the bays and estuaries along the coast and State waters extending out to the inward boundary of the territorial seas. Marine waters extend from this boundary out to the Exclusive Economic Zone, or approximately 322 km (200 mi) from the coast.

Table 4.1.1-1 details impacting factors associated with oil and gas activities and the development phase in which they can occur. The following factors affecting water quality have been identified: disturbance of bottom sediments, wastes and disposal, vessel traffic, and

TABLE 4.4.2-2 Catastrophic Discharge Event Assumptions[a]

Program Area	Volume (million bbl)	Duration (days)	Factors Affecting Duration
Gulf of Mexico	0.9–7.2	30–90	Water depth and drill depth determines timing of relief well
Arctic			
Chukchi Sea	1.4–2.2	40–75	Type of drill rig used and rig availability to drill relief well during open water season
Beaufort Sea	1.7–3.9	60–300	Type of drill rig, timing of drilling relative to ice conditions, and rig availability to drill relief well
Cook Inlet	0.075–0.125	50–80	Availability of rig to drill relief well

[a] The GOM OCS Region has estimated the discharge rate and duration for a catastrophic spill event for both shallow and deep water (in part) based on information gathered from shallow water and deepwater well tests and flow rates validated by the Ixtoc (1979) and the DWH (2010) oil spills. The Alaska OCS Region has estimated a very large oil-spill scenario based on a reasonable, maximum flow rate for each OCS planning area, taking into consideration geologic conditions and well log data. The Alaska OCS Region modeled the flow of fluids from a representative reservoir into the well and flow up through the borehole based on formation thickness, porosity, and permeability; oil saturation, viscosity, and gas content; and reservoir pressure and temperature. The number of days until a hypothetical blowout and discharge from a well could be contained was also estimated. Different assumptions about the type of drilling rig, timing of drilling, nature of ice conditions, and relief well operations underlie the CDE scenarios in the Chukchi Sea and Beaufort Sea; therefore, the scenarios are not directly comparable. The time period required to drill a relief well and kill the well in the Chukchi Sea is explained in detail in BOEMRE (2011j). The relief well is drilled and killed within the open water season. Over half of the 75-day estimate includes transport of relief well rig to the site and drilling of the actual relief well. The greater range in spill duration in the Beaufort reflects different assumptions about the drilling rig and timing of drilling relative to seasonal ice conditions. The scenario range incorporates both open- and late open-water season and winter blowout scenarios (the late open-water season may delay the relief well drilling until the following open-water season). These are discharge volumes and do not account for decreases in volume from bridging, containment, or response operations. Note that under BOEM and BSEE regulations, exploration and development plans and oil spill response plans must incorporate a separate worst-case discharge calculation derived from individual well parameters and characteristics.

accidental spills. The water quality stressor activities associated with oil and gas development are shown in Table 4.4.3-1.

Discharges to waters of the GOM are regulated by National Pollution Discharge Elimination System (NPDES) OCS General Permit No. GMG290000 until Sept. 30, 2012, for the western GOM (off of Texas and Louisiana) and NPDES OCS General Permit No. GMG460000 until March 31, 2015, for the eastern GOM, including the Mobile and Viosca Knoll lease blocks in the Central Planning Area. Permits issued under Section 402 of the Clean Water Act for offshore activities must comply with any applicable water quality standards and/or Federal water quality criteria, as well as with Section 403 of the Clean Water Act. Water quality standards consist of the following: designated uses of the water body, water quality criteria to protect those uses and determine whether they are being attained, and anti-degradation policies to help protect high quality water bodies. Discharges from offshore activities near State water boundaries must comply with all applicable State water quality standards.

Section 403 of the Clean Water Act requires that NPDES permits for discharges to the territorial seas, the contiguous zone, and the ocean be issued in compliance with the U.S. Environmental Protection Agency's (USEPA's) regulations for preventing unreasonable degradation of the receiving waters. Prior to permit issuance, ocean discharges must be evaluated against USEPA's published criteria for determination of unreasonable degradation. Unreasonable degradation, as defined in the NPDES regulations (40 CFR 125.121[e]), encompasses the following:

1. Significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities.

2. Threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms.

3. Loss of aesthetic, recreational, scientific, or economic values that is unreasonable in relation to the benefit derived from the discharge.

Common impacts on water quality in both coastal and marine areas include impacts from vessel traffic, well drilling, and operational discharges. During drilling, drilling muds are circulated down a hollow drill pipe, through the drill bit, and up the annulus between the drill pipe and the borehole. Drilling muds are used for the lubrication and cooling of the drill bit and pipe. The muds also remove the cuttings that come from the bottom of the oil well and help prevent loss of well control by acting as a sealant. The drilling muds carry drill cuttings (i.e., crushed rock produced by the drill bit) to the surface. The drilling muds are then processed on the platform to remove the cuttings and recycled back down the well. The separated cuttings are, in most cases, discharged to the ocean. There are three classes of drilling muds used in the industry: water-based muds (WBMs), oil-based muds (OBMs), and synthetic-based muds (SBMs) (Neff et al. 2000). The WBMs used in most offshore drilling operations in U.S. waters consist of fresh- or saltwater, barite, clay, caustic soda, lignite, lignosulfonates, and/or water-soluble polymers. The OBMs use mineral oil or diesel oil as the base fluid rather than fresh- or

TABLE 4.4.3-1 Water Quality Impact Matrix

	Water Quality			
Stressor and O&G Activity	Coastal Water	Shelf Water	Deepwater	Marine Water
Vessel Traffic Exploration, Construction, Operation, Decommissioning	X	X	X	X
Well Drilling: Exploration, Development	X	X	X	X
Pipelines: Trenching, Landfalls, Construction	X	X		X
Chemical Releases: Drilling, Normal Operational Discharges, Sanitary Wastes	X	X	X	X
Platforms: Anchoring, Mooring, Removal	X	X	X	X
Onshore Construction	X			
Oil Spills	X	X	X	X

saltwater. They offer several technical advantages over WBMs for difficult drilling operations; however, because of their persistence and adverse environmental effects, OBMs and associated cuttings have been banned from ocean discharges in U.S. waters and must be transported to shore for disposal (Neff et al. 2000). The SBMs are a family of products developed in the 1990s to provide drilling performance similar to that of oil-based fluids, but with improved biodegradation characteristics and decreased ecotoxicity (Neff et al. 2000). The types that would be used most frequently would be those that meet the requirements of the NPDES permit. The SBM-wetted cuttings are permitted for ocean discharge, while the spent fluid is transported to shore for reuse or disposal (Neff 2010).

Discharges of drilling muds and cuttings during normal operations are regulated by NPDES general permits issued by USEPA. In areas where disposal of drilling muds and/or cuttings at sea are permitted under an NPDES general permit and BOEM and BSEE regulations, their environmental effects are localized because of settling, mixing, and dilution (Montagna and Harper 1996; Neff et al. 2000; Continental Shelf Associates 2004c). The majority of cuttings are found within 250 m (820 ft) of a drilling site (Continental Shelf Associates 2004c). Constituents of SBM cuttings have been found in an approximately 1 ha (2.5 ac) area surrounding a drilling rig at concentrations that may cause harm to wildlife (Neff et al. 2000).

Produced water is water that is brought to the surface from an oil-bearing formation during oil and gas extraction. It is the largest individual discharge produced by normal operations. Small amounts of oil are routinely discharged in produced water during OCS operations. The USEPA has set an effluent limitation of 29 mg/L for the oil content of produced waters (MMS 2007c). Produced water may contain specialty chemicals added to the well for process purposes (e.g., biocides and corrosion inhibitors) and chemicals added during treatment of the produced water before its release to the environment (e.g., water clarifiers). Produced water can have elevated concentrations of several constituents, including salts, petroleum hydrocarbons, some metals, and naturally occurring radioactive material (NORM). Petroleum hydrocarbons in produced water discharges are a major environmental concern. The most abundant hydrocarbons in produced water are benzene, toluene, ethylbenzene, and xylenes

(BTEX) and low-molecular-weight saturated hydrocarbons. The BTEX compounds rapidly evaporate into the atmosphere, leaving behind less volatile, heavier compounds (weathering) (NRC 2003b). Polycyclic aromatic hydrocarbons (PAHs) are heavier hydrocarbons in produced water and are a concern because of the toxicity of some PAHs and their persistence in the marine environment (Rabalais et al. 1991).

The NORM waste in produced water includes the radium isotopes Ra-226 and Ra-228 and is a concern because it is radioactive. However, in produced water discharges, radium coprecipitates with barium sulfate and is not available for uptake by organisms (Neff 2002).

Generally, the amount of produced water is low when production begins but increases over time near the end of the field life. In a nearly depleted field, production may be as high as 95% water and 5% fossil fuels (Rabalais et al. 1991). The National Research Council (2003a) estimated that the total amount of produced water being released into GOM waters was 660 million bbl/yr in the 1990s. Between 1996 and 2005, the annual volume of produced water varied between 432 million bbl/yr and 686 million bbl/yr, with an average discharge of 596 million bbl/yr (MMS 2007c).

Before being discharged into the ocean, produced water is typically treated and must meet NPDES requirements regarding discharge rate, contaminant concentration, and toxicity, thereby reducing the potential for contamination. However, the discharge of produced water into the sea may degrade water and sediment quality in the immediate vicinity of the discharge point because of its potential constituents. Studies have shown contaminated sediments exist in areas up to 1,000 m (3,280 ft) from a produced water discharge point, indicating water quality in that zone has been affected by produced water discharges (Rabalais et al. 1991). Because discharge points are typically much farther apart than 1,000 m (3,280 ft), no interactions that would measurably affect water quality are expected between them, and background concentrations are expected to exist away from the immediate discharge location. Two recent studies have shown that produced water discharges do not make a significant contribution to the hypoxic conditions that are seen in the GOM (Veil et al. 2005; Bierman et al. 2007).

Normal operations for the proposed action would also involve the use of vessels with associated impacts. Compliance with NPDES permits and USCG regulations would prevent or minimize most impacts on the environment caused by ship traffic.

The placement of drilling units and platforms would disturb bottom sediments and produce turbidity in the water. This impact would be unavoidable; however, these impacts would be temporary and water quality would return to normal (e.g., background concentrations of suspended solids) within minutes to hours without mitigation because of mixing, settling, and dilution.

4.4.3.1.1 Impacts of Routine Operations.

Coastal Waters. Routine activities potentially affecting coastal water quality include pipeline landfalls, well completion activities, platform construction, and operation discharges.

The estimated exploration and development scenario for the GOM for the proposed action is presented in Table 4.4.1-1 and estimated depth distribution of the activities in Table 4.4.1-2.

Construction and installation of exploratory and development wells (up to 100 and 600, respectively), platforms (up to 450), and offshore pipelines (up to 12,000 km [7,500 mi]) would affect water quality and disturb habitats (see Table 4.4.1-1). Such activities would disturb bottom sediments and increase the turbidity of the water in the area of construction. Trenching operations to bury pipelines would produce turbidity (i.e., increased suspended solids) in the coastal waters along pipeline corridors. The disturbance of bottom sediments caused by these operations would be unavoidable. However, these impacts would be temporary, and water quality would return to normal (i.e., background concentrations) without mitigation, once these activities were completed because of settling and mixing.

Construction of new onshore support facilities (up to 11 pipeline landfalls, 6 pipe yards, and 12 processing facilities) could affect the quality of nearshore and fresh waters in the GOM Planning Areas. During land site preparation, vegetation is typically cleared from the area, compacting the topsoil, because of the constant movement of heavy machinery. This compaction would reduce the water retention properties of the soil and increase erosion and surface runoff from the site. Water quality would be degraded by increases in site runoff of particulate matter, heavy metals, petroleum products, and chemicals to local streams, estuaries, and bays. Proper siting of facilities and requirements associated with NPDES construction permits should largely mitigate these impacts.

The OCS service and construction vessel traffic to and from platform sites within the planning area (up to 600 vessel trips per week) would also affect water quality through the permitted release of operational wastes. Routine vessel-associated discharges that could affect coastal water quality include sanitary wastes and bilge water. Bilge water discharges from support vessels could contain petroleum and metals from machinery. Bilge water and sanitary discharges to larger coastal water channels would produce local and temporary effects because of the large volume of water available to dilute the discharges and the presence of currents that would promote mixing. However, in confined portions of some channels, there might be insufficient water volume or currents for mixing and dilution. In such regions, water quality could be degraded. Compliance with applicable NPDES permits and USCG regulations would prevent or minimize most impacts on receiving waters. Discharges in coastal areas are regulated by State-issued or Federal NPDES permits specifically for coastal areas.

Produced water discharges were banned in coastal waters of the GOM in the late 1990s, and reinjection of produced water is practiced in coastal areas to avoid discharges (NRC 2003b; Wilson 2007).

Marine Waters. Marine waters can be divided into continental shelf waters and deep waters. Continental shelf waters are defined as those waters that lie outside of the coastal waters and have a depth less than 305 m (1,000 ft). Deep waters are located in regions that are equal to or deeper than 305 m (1,000 ft).

Routine operations that could affect water quality include anchoring, mooring, drilling and well completion activities, well testing and cleanup operations, flaring/burning, facility installation and operations, support service activities, decommissioning, and site clearance. Construction and installation of exploratory and development wells (up to 1,200), platforms (up to 450), and offshore pipelines (up to 12,000 km [7,500 mi]) would affect water quality and disturb habitats (see Table 4.4.1-1).

As with coastal areas, OCS vessel traffic to and from platform sites within the planning area (up to 600 vessel trips per week) would also affect water quality through the permitted release of operational wastes (such as bilge water). Because of the relatively small volumes that would be discharged, these waste materials would be quickly diluted and dispersed, and any impacts on water quality would be highly localized and temporary. Compliance with applicable NPDES permits and USCG regulations would prevent or minimize most impacts on receiving waters.

Sanitary and domestic waste and deck drainage would occur from platforms, drilling vessels, and service vessels as part of normal operations and could contribute to water quality degradation. However, sanitary and domestic wastes would be routinely processed through onsite waste treatment facilities before being discharged overboard, and deck drainage would be treated onsite to remove oil and then discharged. Sand and sludge recovered from the treatment processes would be containerized and shipped to shore for disposal. Impacts on water quality from such discharges would require no mitigation because of the treated nature of the wastes, the small quantities of discharges involved, and the mixing and dilution of the wastes with large volumes of water.

Discharges associated with drilling and production are discussed in Section 4.4.3.1. Normal operations for the proposed action would also involve the use of vessels with associated impacts, such as those discussed for related impacts on coastal areas. Compliance with NPDES permits and USCG regulations would prevent or minimize most impacts on the environment.

The placement of drilling units and platforms would disturb bottom sediments and produce turbidity in the water. Pipeline trenching, required in water depths less than 61 m (200 ft), would also produce turbidity along pipeline corridors. This impact would be unavoidable; however, these impacts would be temporary, and water quality would return to normal (e.g., background concentrations of suspended solids) within minutes to hours without mitigation because of mixing, settling, and dilution.

As discussed in Section 3.4.1.2, hypoxic conditions exist on the Louisiana-Texas shelf. The size of the hypoxic zone varies from year to year. The hypoxic zone attained a maximum measured extent in 2002, when it encompassed about 22,000 km^2 (8,494 mi^2). Normal operations from oil and gas production in the GOM could affect the extent and severity of the hypoxic zone through discharges and accidental releases. Very preliminary calculations reveal that ammonium and oil and grease contained in produced water are a small percentage of that contributed by the Mississippi River to the hypoxic zone (Rabalais 2005). A study that monitored oxygen-demanding substances and nutrients in the produced water discharges from

50 platforms found that produced water discharges contributed less than 1% of the oxygen-demanding substances to the hypoxic zone (Veil et al. 2005).

For the proposed action, the compositions and volumes of discharges would be expected to be about the same as those observed historically, and compliance with existing NPDES permits would minimize impacts on receiving waters (e.g., through limitations on concentrations of toxic constituents). Water quality likely would recover without mitigation when discharges ceased because of dilution and dispersion.

Although deepwater operations and practices are similar to those used in shallower environments, there are some significant differences. Three of these are seafloor discharges from pre-riser and riserless drilling operations, discharge of cuttings wetted with SBFs, and more extensive and frequent use of chemical products to enhance oil and gas throughput because of the temperatures and pressures present at the seafloor, including their use within pipelines to facilitate the transport of large quantities of methanol and other chemicals to and from the shore.

Floating production facilities are used in deepwater rather than conventional, bottom-founded (i.e., fixed) platforms. These deepwater facilities include floating production semisubmersibles, tension leg platforms, and spars (Harbinson and Knight 2002). Often these facilities are surface hubs for several subsea systems. Therefore, in deep water, there will be far fewer and more widely spaced surface facilities than on the shelf, but these facilities will have increased discharges of produced waters over time due to the larger volume being processed.

In order to enhance the throughput of oil and gas in deep water, more extensive and frequent use of some chemical products is anticipated because of the temperatures and pressures encountered at the seafloor. Chemicals most likely to be present in deepwater operations and drilling include monoethylene glycol, methanol, corrosion inhibitors, and biocides (Grieb et al. 2008). The toxicity of these substances varies, but the impact on water quality would be temporary and localized (within feet of a release), due to the small quantities in which they would likely be released and the amount of dilution and mixing that would occur in a subsea environment (Grieb et al. 2008).

Deepwater activities could incrementally increase support activities and the expansion, construction, or modification of onshore support bases due to the deeper draft of these support vessels. The impacts resulting from this growth would be common to all OCS support facilities (point-source waste discharges, runoff, dredging, and vessel discharges) and not specific to deepwater activities. Short-term degradation of water quality might increase at a few support base locations that would be expected to grow as a consequence of deepwater activities (including Corpus Christi, Galveston, and Port Fourchon).

4.4.3.1.2 Impacts of Expected Accidental Events and Spills.

Coastal Waters. Accidental releases could affect the quality of coastal water in the GOM. The magnitude and severity of impacts would depend on spill location and size, type of product spilled, weather conditions, and the water quality and environmental conditions at the time of the spill.

Under the proposed action, the number and types of spills assumed to occur in the GOM Planning Area include up to seven large spills (i.e., ≥1,000 bbl), up to five spills at a volume of 1,700 bbl from pipelines, up to two spills at a volume of 5,000 bbl from platforms, and up to one spill at a volume of 3,100 bbl from a tanker. Between 35 and 70 small spills with volumes between 50 and 999 bbl are assumed to occur, as well as between 200 and 400 very small spills with volumes between 1 and 50 bbl (Table 4.4.2-1).

Weathering processes that transform the oil, such as volatilization, emulsification, dissolution, chemical oxidation, photo-oxidation, and microbial oxidation, may reduce impacts of oil spills in the GOM Planning Areas on coastal water quality (NRC 2003b; NOAA 2005). Dissolution, which is a small component of weathering, can be important to biological communities because the most soluble fractions are often the most toxic (Shen and Yapa 1988). Because oil is generally less dense than water, it would tend to float on the sea surface. Lighter oil fractions such as BTEX would readily evaporate from the surface and, therefore, would not be a continuing source of potential water contamination. Following a spill, light crude oils can lose as much as 75% of their initial volume to evaporation as the lighter components (e.g., BTEX) change from the liquid to the gas phase; medium-weight crude oils can lose as much as 40% (NRC 2003b).

If a large spill occurred in enclosed coastal waters or was driven by winds, tides, and currents into an enclosed coastal area, water quality would be adversely affected. These impacts could be increased if they occurred in areas with degraded water quality, such as areas continuing to be affected by the DWH. Similarly, if a large tanker spill were to happen near port, adverse impacts on coastal waters could occur. In such a low-energy environment (i.e., an environment in which there is limited wave and current activity), the oil would not be easily dispersed, and weathering could be slower than it would be in the open sea. Effects on water quality could persist if oil reached coastal wetlands and was deposited in fine sediments, becoming a long-term source of pollution because of remobilization. In such locations, spill cleanup might be necessary for the recovery of the affected areas. Potential impacts from spill response and cleanup activities are discussed below. As a result of the DWH event, residual oil was still being removed from shorelines as of March 2012 (ERMA 2012a, b). However, supratidal buried oil, small surface residue balls, and submerged oil mats are three types of residual oil from the DWH spill in the nearshore zone that were identified as being more damaging to completely remove from coastal habitats than to let them remain and naturally attenuate (OSAT-2 2011). The OSAT-2 (2011) concluded that the residual oil had a relatively minor impact on resources compared with the potential negative impact to those resources that could be sustained through cleanup activities. Oiled shorelines might also be washed with warm or cold water, depending on the shore's location.

Small oil spills (<1,000 bbl) or very small oil spills (<50 bbl) would produce small but measurable impacts on water quality. Assuming that all small and very small spills would not occur at the same time and place, water quality would rapidly recover without mitigation because of mixing, dilution, and weathering. However, impacts could be increased if they occurred in areas with degraded water quality and/or areas continuing to be affected by the DWH event, the extent of which could change over the duration of the Program.

Marine Waters. Accidental releases could affect the quality of marine waters in the GOM Planning Areas. The number and types of spills assumed to occur in the GOM Planning Areas are the same as those discussed above for coastal waters. The magnitude of these impacts and the rate of recovery would depend on the location and size of the spill, the type of product spilled, weather conditions, and environmental conditions at the time of the spill. Failures of production-related piping, seals, and connections have been identified as key risks for releases that may affect water quality in deepwater environments, with loss of well control presenting the highest risk of environmental impacts (Grieb et al. 2008). Because of the depths of some deepwater drilling operations, servicing any leak identified during subsea drilling and production operations would be more difficult and require remotely operated vehicles for depths greater than 610 m (2,000 ft) (Grieb et al. 2008). Each piping connection presents a potential for leakage due to human error, corrosion, or erosion (Grieb et al. 2008). In general, oil spilled below the surface rises rapidly as droplets that coalesce to form a slick. Standard response procedures for a spill could then be used.

Because deepwater operations can be located far from shore, tankers could be used to shuttle crude oil to shore stations. This transport of oil from operations in deep water has the potential to produce spills that could affect coastal waters within a very short time if the spill occurred near the port. It is expected that such spills could release approximately 3,100 bbl of oil. Such a release could retain a large volume of oil in the slick at the time it contacted land.

If it is assumed that all small (<1,000 bbl) and very small (<50 bbl) spills would not occur at the same time and place, water quality would rapidly recover without mitigation because of mixing, dilution, and weathering.

Spill Response and Cleanup. Spill response and cleanup activities in coastal and marine water could include, depending on location, use of chemical dispersants, *in situ* burning, use of vessels and skimmers, and beach cleaning and booming (BOEMRE 2011j).

Dispersants are combinations of surfactants and solvents that work to break surface oil into smaller droplets that then disperse on the surface and into the water column. Many factors affect the behavior, efficacy, and toxicity of a particular dispersant, including water temperature, surface salinity, wave and wind energy, light regime, water depth, type of oil, concentration of dispersant, how the dispersant is applied (constant or intermittent spikes), and exposure time to organisms. Dispersants are used to degrade an oil spill more quickly through increasing surface area and to curtail oil slicks from reaching shorelines (Word et al. 2008). As oil breaks into smaller droplets, it can distribute vertically in the water column. If oil droplets adhere to sediment, the oil can be transported to the seafloor and interstitial water in the sediment. In shallow nearshore waters, wind, wave, and current action would more likely mix the dispersant-oil mixture into the water column and down to the seafloor environment. Chemically dispersed oil is thought to be more toxic to water column organisms than physically dispersed oil, but the difference is not clear-cut, and generally the toxicity is within the same order of magnitude (NRC 2005b).

In situ burning is used to reduce an oil spill more quickly and to curtail oil slicks from reaching shorelines. *In situ* burning could increase the surface water temperature in the immediate area and produce residues. The uppermost layer of water (upper millimeter or less) that interfaces with the air is referred to as the microlayer. Important chemical, physical, and biological processes take place in this layer, and it serves as habitat for many sensitive life stages and microorganisms (GESAMP 1995). Disturbance to this layer through temperature elevation could cause negative effects on biological, chemical, and physical processes.

Residues from *in situ* burning can float or sink depending on the temperature and age of the residue. Floating residue can be collected; however, residues that sink could expose the benthic waters and sediment to oil components as the residue degrades on the seafloor.

The NOAA Office of Response and Restoration states, “Overall, these impacts [from open water *in situ* burning] would be expected to be much less severe than those resulting from exposure to a large, uncontained oil spill” (NOAA 2011d).

Oiled shorelines might be washed with warm or cold water, depending on the shore’s location. Oil dispersants and surface washing agents used to clean up a spill could also be a source of impacts to water quality for coastal areas in the event of a spill (EIC and NCSE 2010; CRRC 2010). Beach cleaning and booming activities could result in effects from suspended sediment in waters and resettlement of sediments elsewhere, possible resuspension of hydrocarbons, and runoff of treatment-laden waters that could affect nearshore temperature and nutrient concentrations (BOEMRE 2011j).

4.4.3.1.3 Impacts of an Unexpected Catastrophic Discharge Event. A CDE is considered to be an unexpected, low-probability event unlikely to occur during routine operations (see Section 4.4.2.2. For the GOM Planning Areas, a CDE is assumed to have a volume of 0.9-7.2 million bbl and last from 30 to 90 days (Table 4.4.2-2). A catastrophic discharge event in either coastal or marine water could present sustained degradation of water quality from hydrocarbon contamination in exceedance of State and Federal water and sediment quality criteria. These effects could be significant depending upon the duration and area impacted by the spill. Additional effects on water quality would occur from response and cleanup vessels, *in situ* burning of oil, dispersant use, discharges and seafloor disturbance from relief well drilling, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring.

A CDE occurring below the seafloor, outside the wellbore, would have the potential to resuspend sediments and move large quantities of bottom sediments. Some sediment could travel at rates of up to 2.1 km/day (1.3 mi/day), depending on sediment size and bottom currents (Hamilton 1990). Sediments could also be destabilized to the point of mass movement at depth. Large-scale sediment resuspension could potentially release heavy metals into the water column, changing its water chemistry (Caetano et al. 2003). Sediments also have the potential to become contaminated with oil components, because oil components may adsorb onto marine detritus that could be deposited on the seafloor.

A CDE at depth would introduce large quantities of hydrocarbons into the water column, with dispersed (chemically or mechanically) and suspended oil droplets potentially creating a plume at depth. A CDE would also cause large patches of sheen and/or oil on the water surface. Mitigation efforts, such as burning, could also introduce hydrocarbons into the water column. Introduction of chemicals, such as the PAHs present in crude oil, into the water column via the spill or cleanup efforts could have acutely toxic and chronic sublethal effects on the marine environment; however, the effects are poorly understood, and more research is needed. Dissolved oxygen levels would be a concern due to the release of a carbon source into the water column. Data collected in the area of the DWH event indicated that dissolved oxygen levels decreased by about 20% below long-term average values for the GOM, but the levels were not considered hypoxic (NOAA 2010d).

A CDE could also include release of natural gas into the water column. Methane and other natural gas constituents are carbon sources, and their introduction into the marine environment could reduce the dissolved oxygen levels due to microbial degradation of the methane, potentially creating hypoxic or “dead” zones. However, evidence from the DWH event indicates that natural gas released from the well was rapidly broken down by bacterial action with little oxygen drawdown (Camilli et al. 2010; Kessler et al. 2011).

Response efforts would decrease the amount of oil remaining in GOM waters, but it is assumed that natural processes would aid the degradation of the oil and gas released during a CDE. Natural processes will physically, chemically, and biologically aid the degradation of oil (NRC 2003b). The physical processes involved in degradation of oil include evaporation, emulsification, and dissolution; the primary chemical and biological degradation processes include photo-oxidation and biodegradation (NRC 2003b).

Impacts to water quality from the DWH event may be relevant to a future CDE and are discussed in more detail in Section 3.4.1.4.

4.4.3.1.4 Impact Conclusions.

Routine Operations. Overall coastal and marine water quality impacts due to routine operations and operational discharges under the proposed action would be unavoidable. Compliance with NPDES permit requirements would reduce or prevent most impacts on receiving waters caused by discharges from normal operations. Water quality would recover when discharges ceased because of dilution, settling, and mixing. Impacts on water quality from routine operations associated with the Program are expected to be minor to moderate.

Expected Accidental Events and Spills. Expected accidental oil spills could reduce water quality, and these impacts would be unavoidable. The magnitude of the impacts would depend on the specific location affected and the nature and magnitude of the activity/accident. Small spills would be expected to result in minor, short-term impacts on coastal and marine water quality. A large spill in coastal waters could result in longer term impacts on water quality, but cleanup efforts would reduce the likelihood of long-term impairment. A large spill in marine waters would be expected to have temporary impacts on water quality; however, cleanup efforts and evaporation, dilution, and dispersion would minimize the long-term impacts. Impacts on water quality from large accidental spills associated with the Program are expected to be minor to major, depending on the location, timing, magnitude of the event, and the effectiveness of containment and cleanup activities.

An Unexpected Catastrophic Discharge Event. In the unlikely event of a low-probability CDE, impacts to water quality would be moderate to major. A CDE could present sustained degradation of water quality from hydrocarbon contamination in exceedance of State and Federal water and sediment quality criteria. Impacts from a CDE would depend on the spill size and composition, weather conditions, and the location of the spill, as well as the effectiveness of response actions.

4.4.3.2 Alaska – Cook Inlet

This section analyzes impacts on coastal and marine waters in the Cook Inlet Planning Area. Coastal waters, as defined here, include the bays and estuaries along the coast and State waters extending out to the inward boundary of the territorial seas. Marine waters extend from this boundary out to a water depth of 200 m (656 ft).

Section 4.1.1 details impacting factors for activities associated with oil and gas activities and the development phases in which they can occur. The following factors affecting water quality have been identified: disturbance of bottom sediments, wastes and disposal, vessel traffic, and accidental spills. The water quality stressor activities associated with oil and gas are shown in Table 4.4.3-1. Note that no onshore construction or pipeline landfalls are anticipated for the Cook Inlet Planning Area for the lease sales during 2012-2017 period.

Discharges to waters of Cook Inlet are regulated by NPDES OCS General Permit No. AKG-31-5000 until July 2, 2012. USEPA is scheduled to transfer the NPDES General Permit program over to the Alaska Department of Environmental Conservation (ADEC) by the end of October, 2012 (ADEC 2012a). Permits issued under Section 402 of the Clean Water Act for offshore activities must comply with any applicable water quality standards and/or Federal water quality criteria, as well as with Section 403 of the Clean Water Act. Water quality standards consist of the following: designated uses of the water body, water quality criteria to protect those uses and determine whether they are being attained, and anti-degradation policies to help protect high quality water bodies. Discharges from offshore activities near State water boundaries must comply with all applicable State water quality standards.

Section 403 of the Clean Water Act requires that NPDES permits for discharges to the territorial seas, the contiguous zone, and the ocean be issued in compliance with USEPA's regulations for preventing unreasonable degradation of the receiving waters. Prior to permit issuance, ocean discharges must be evaluated against USEPA's published criteria for determination of unreasonable degradation. Unreasonable degradation, as defined in the NPDES regulations (40 CFR 125.121[e]), encompasses the following:

1. Significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities.

2. Threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms.

3. Loss of aesthetic, recreational, scientific, or economic values that is unreasonable in relation to the benefit derived from the discharge.

Specific water quality effects information related to NPDES regulated discharges in the Cook Inlet planning area is provided by USEPA (Tetra Tech 2006).

Common impacts on water quality in both coastal and marine areas include those from vessel traffic, well drilling, and operational discharges. The types of impacts expected are the same as those discussed above in Section 4.4.3.1.

4.4.3.2.1 Impacts of Routine Operations.

Coastal Waters. Routine activities potentially affecting coastal water quality include pipeline landfalls, well completion activities, platform construction, and operational discharges. The estimated exploration and development scenario for Cook Inlet is presented in Table 4.4.1-3.

Construction and installation of exploratory and development wells (up to 12 and 114, respectively), platforms (up to 3), and offshore pipelines (up to 240 km [150 mi]) would affect water quality and disturb habitats (see Table 4.4.1-3). Trenching operations to bury pipelines would produce turbidity (i.e., increased suspended solids) in the coastal waters along pipeline corridors. Increased water turbidity would also result from placing drilling units and platforms. The disturbance of bottom sediments caused by these operations would be unavoidable. However, these impacts would be temporary, and water quality would return to normal (i.e., background concentrations) without mitigation, once these activities were completed, because of settling and mixing.

Construction of new onshore pipelines (up to 169 km [105 mi]) would also impact coastal water quality in the Cook Inlet Planning Area. Proper siting of facilities and requirements associated with NPDES construction permits would largely mitigate these impacts. The impacts on water quality would range from negligible to minor, depending on site location and construction and mitigation activities.

Increased turbidity from construction and installation activities would occur in the immediate area of the activity. Contaminants introduced into Cook Inlet waters by these activities would be diluted and dispersed by complex currents associated with the tides (diurnal tidal variations at the upper end of the Cook Inlet at Anchorage can be 9 m [30 ft]), estuarine circulation, wind-driven waves, and Coriolis forces (MMS 2003a; Royal Society of Canada 2004). Seawater enters the Lower Cook Inlet from the Gulf of Alaska at the Kennedy

Entrance south of the Kenai Peninsula, and fresh water enters the inlet from numerous streams along the east, north, and west shorelines; major freshwater inputs include the Susitna and Kenai Rivers. Seawater circulates northward in Cook Inlet along its eastern boundary, mixes with fresh water in the northern end, and flows southward along the western boundary. Water exits the lower Cook Inlet through Shelikof Strait and discharges into the Gulf of Alaska (MMS 2002a). Surface currents in Cook Inlet can exceed 5 knots (5.7 mph), and bottom currents can reach 1.5 knots (1.7 mph) (Royal Society of Canada 2004). Approximately 90% of waterborne contaminants would be flushed from the lower Cook Inlet within about 10 months (MMS 2003a). Contaminants flushed from Cook Inlet would pass through Shelikov Strait and enter the Gulf of Alaska. Because of dilution, settling, and flushing, impacts from these activities would be local and temporary.

In addition to affecting the turbidity of coastal waters in the Cook Inlet, construction activities would produce waste materials. The majority of wastes generated during construction and developmental drilling would consist of drill cuttings and spent muds (MMS 2002a). Drilling muds and cuttings generated when installing exploration and delineation wells would be discharged at the well site. The volume of drilling fluids and cuttings vary depending upon the well characteristics, but, in general, fluids average approximately 500 bbl/well, and drill cuttings would comprise the equivalent of approximately 600 tons/well of dry rock. Thus, under the proposed action, up to 6,000 bbl of drilling fluids and up to 7,200 tons of drill cuttings could be disposed of in the waters of the Cook Inlet Planning Area. All drilling muds and cuttings associated with development and production wells would be treated and reinjected into the well. Discharge of drilling muds and cuttings would increase turbidity in the vicinity of the well. The discharge would contain trace metal and hydrocarbon constituents that would be suspended in the water column and subsequently deposited on the seafloor. These drilling discharges must comply with NPDES permit requirements regarding the discharge amount, rate, and toxicity, which would greatly reduce the impact to water quality.

During drilling, drilling muds are circulated down a hollow drill pipe, through the drill bit, and up the annulus between the drill pipe and the borehole. Drilling muds are used for the lubrication and cooling of the drill bit and pipe. The muds also remove the cuttings that come from the bottom of the oil well and help prevent loss of well control by acting as a sealant. The drilling muds carry drill cuttings (i.e., crushed rock produced by the drill bit) to the surface. The drilling muds are then processed on the platform to remove the cuttings and recycled back down the well. The separated cuttings are, in most cases, discharged into the ocean. As discussed in Section 4.4.3.1, three classes of drilling muds are used in the industry: WBMs, OBMs, and SBMs (Neff et al. 2000). The WBMs used in most offshore drilling operations in U.S. waters consist of fresh- or saltwater, barite, clay, caustic soda, lignite, lignosulfonates, and/or water-soluble polymers. The OBMs use mineral oil or diesel oil as the base fluid rather than fresh- or saltwater. They offer several technical advantages over WBMs for difficult drilling operations; however, because of their persistence and adverse environmental effects, OBMs and associated cuttings have been banned from ocean discharges in U.S. waters and must be transported to shore for disposal (Neff et al. 2000). The SBMs are a family of products developed in the 1990s to provide drilling performance similar to that of oil-based fluids, but with improved biodegradation characteristics and decreased ecotoxicity (Neff et al. 2000). The types that would be used most frequently would be those that meet the requirements of the NPDES permit. The

SBM-wetted cuttings are permitted for ocean discharge, while the spent fluid is transported to shore for reuse or disposal (Neff 2010).

Discharges of drilling muds and cuttings during normal operations are regulated by NPDES general permits issued by USEPA. In areas where disposal of drilling muds and/or cuttings at sea is permitted under an NPDES general permit and BOEM and BSEE regulations, the environmental effects of such disposal are localized because of settling, mixing, and dilution (Montagna and Harper 1996; Neff et al. 2000; Continental Shelf Associates 2004c). The majority of cuttings are found within 250 m (820 ft) of a drilling site (Continental Shelf Associates 2004c). Constituents of SBF cuttings have been found in an approximately 1-ha (2.5-acre) area surrounding a drilling rig at concentrations that may cause harm to wildlife (Neff et al. 2000).

Because all produced water would be discharged down hole, there would be no impacts on water quality from these operational discharges. Domestic wastewater would also be generated by these activities. This material would be injected into a disposal well. Solid wastes, including scrap metal, would be hauled offsite for disposal at an approved facility.

The OCS service and construction vessel traffic to and from platform sites within the planning area (up to nine vessel trips per week) would also affect quality through the permitted release of operational wastes. Routine vessel-associated discharges that could affect coastal water quality include sanitary wastes and bilge water. Bilge water discharges from support vessels could contain petroleum and metals from machinery. Bilge water and sanitary discharges to larger coastal water channels would produce local and temporary effects because of the large volume of water available to dilute the discharges and the presence of currents that would promote mixing. However, in confined portions of some channels, there might be insufficient water volume or currents for mixing and dilution. In such regions, water quality could be degraded. Compliance with applicable NPDES permits and USCG regulations would prevent or minimize most impacts on receiving waters. Discharges in coastal areas are regulated by State-issued or Federal NPDES permits specifically for coastal areas.

The National Research Council (2003b) estimated that the total amount of produced water being released into Cook Inlet waters was 45.7 million bbl/yr in the 1990s. Produced water can contain hydrocarbons, salts, and metals at levels toxic to marine organisms. Before being discharged into the ocean, produced water is typically treated and must meet NPDES requirements regarding discharge rate, contaminant concentration, and toxicity, thereby reducing the potential for sediment contamination. However, under the current NPDES permits, new facilities would not be allowed to discharge produced water into Cook Inlet. Under the proposed action, it is anticipated that all produced waters would be treated and reinjected into the well. Therefore, no impacts on water quality are expected to result from produced water.

Marine Waters. Routine operations that could affect marine water quality in the Cook Inlet Planning Area include anchoring, mooring, drilling and well completion activities, well testing and cleanup operations, flaring/burning, facility installation and operations, support service activities, decommissioning, and site clearance. These activities would disturb the seafloor and increase the suspended sediment load in the water column. Offshore pipelines in

Alaska are normally placed in a dredged trench in waters less than about 60 m (197 ft) deep. Dredged material from the trenches can be used to cover the pipeline. As these operations are reversed and structures removed, increased turbidity would reoccur. In general, plumes from these activities extend a few hundred meters to a few kilometers down current, but the length of the plume would depend on rate and duration of discharge, sediment grain size, current regime, source type, water column turbulence, and season. The direction of plume movement would be influenced by the general circulation pattern in the planning area and local ambient conditions. Suspended sediments in the plumes are expected to have toxicity ranges that are generally described as nontoxic to slightly toxic (National Academy of Sciences 1983). Overall, it is anticipated that the impacts on water quality from routine operations would be localized and temporary. As with coastal water impacts, dilution, settling, and rapid flushing would minimize any long-lasting impacts on water quality.

Adverse water quality impacts would also be produced by routine discharges of domestic waste (e.g., wash water, sewage, and galley wastes) and deck drainage (platform and deck washings, and gutters and drains, including drip pans and work areas). Domestic waste would increase suspended solids in the receiving water, thereby increasing turbidity and biological oxygen demand. Sanitary and domestic wastes are monitored in accordance with the NPDES permit. Established effluent limitations and guidelines published in 40 CFR Part 435, and operator compliance should minimize impacts on ambient water quality. Such impacts would be local and temporary.

The principal discharges of concern during drilling would be muds and cuttings. Drilling muds and cuttings generated when installing exploration and delineation wells would be discharged at the well site. All drilling muds and cuttings associated with development and production wells would be treated and reinjected into the well. See the discussion above for coastal waters for further information on potential impacts of discharging drilling muds and cuttings.

During operations, all produced water would be reinjected into the well in the Cook Inlet Planning Area, there produced water generated from activities associated with the proposed action would have no impacts on marine water quality.

As with coastal waters, OCS vessels traveling to and from platform sites within the planning area (up to three vessel trips per week per platform) could affect local water quality as a result of operational discharge of waste fluids. Because of dilution, settling, and flushing, water quality impacts from such discharges would be localized and temporary.

4.4.3.2.2 Impacts of Expected Accidental Events and Spills.

Coastal Waters. Accidental releases could affect the quality of coastal water in the Cook Inlet. The magnitude and severity of impacts would depend on the spill location and size, type of product spilled, weather conditions, and the water quality and environmental conditions at the time of the spill.

Under the proposed action, the number and types of spills assumed to occur in the Cook Inlet Planning Area include up to one large spill (i.e., ≥1,000 bbl) from either a platform (5,100 bbl) or a pipeline (1,700 bbl), up to three small spills with volumes between 50 and 999 bbl; and up to 15 very small spills with volumes between 1 and 50 bbl (Table 4.4.2-1). For conservative analysis (i.e., one in which impacts would be greater than those that would actually occur), all the spills are assumed to occur in Cook Inlet coastal waters. Such spills would adversely affect water quality. A spill in isolated coastal waters, in shallow waters under thick ice, or in rapidly freezing ice could cause sustained degradation of water quality to levels that are above State or Federal criteria for hydrocarbon contamination. Concentrations could exceed the chronic criterion of 0.015 ppm total hydrocarbons, but this exceedance would probably occur over a relatively small area. Persistent small spills in such areas could result in local chronic contamination. In most cases, spills would be rapidly diluted. In some cases, however, water quality could be degraded to a greater extent.

Weathering processes that transform the oil, such as volatilization, emulsification, dissolution, chemical oxidation, photo-oxidation, and microbial oxidation, may reduce impacts of oil spills on coastal water quality in the Cook Inlet Planning Area (NRC 2003b; NOAA 2005). Dissolution, which is a small component of weathering, can be important to biological communities because the most soluble fractions are often the most toxic (Shen and Yapa 1988). Because oil is generally less dense than water, it would tend to float on the sea surface. Lighter oil fractions such as BTEX would readily evaporate from the surface and, therefore, would not be a continuing source of potential water contamination. Following a spill, light crude oils can lose as much as 75% of their initial volume to evaporation as the lighter components (e.g., BTEX) change from liquid to gas phase; medium-weight crude oils can lose as much as 40% (NRC 2003b).

Spills would tend to move in directions consistent with established circulation patterns for the planning area (i.e., northward along the Kenai Peninsula and southward along the Alaska Peninsula). Actual flow paths would be affected by winds, tides, ice cover, temperature, and cleanup activities.

If a large spill were to happen near port, there could be adverse effects on coastal waters. In such a low-energy environment (i.e., an environment in which there is limited wave and current activity), the oil would not be easily dispersed, and weathering could be slower than it would be in the open sea. Effects on water quality could persist if oil reached coastal wetlands and was deposited in fine sediments, becoming a long-term source of pollution because of remobilization. In such locations, spill cleanup might be necessary for the recovery of the affected areas. Potential impacts to water quality from spill cleanup activities are discussed below.

Assuming that all small sized (<1,000 bbl) and very small (<50 bbl) spills would not occur at the same time and place, water quality would rapidly recover without mitigation because of mixing, dilution, and weathering.

Under Arctic conditions (i.e., cold water and cold air temperatures), weathering processes, such as volatilization, would also be much slower than in warmer climates

(MMS 2008b); under calm conditions and cold temperatures in restricted waters, vertical mixing and dissolution would be reduced (MMS 2008b). If the spill were to occur on ice or under ice, oil would be trapped and essentially remain unchanged until breakup occurred and the ice began to melt. The volatile compounds from such a spill would be more likely to freeze into the ice within hours to days rather than dissolve or disperse into the water below the ice. A hydrocarbon plume in the water column underneath the ice could persist with concentrations that exceed background levels in Cook Inlet, as discussed in Section 3.4.2, for a distance greater than that in the open sea (MMS 2008b). Impacts on coastal waters from a large spill would depend on the season, type, and composition of the spill, weather conditions, and size of the spill.

Marine Waters. Accidental hydrocarbon releases in the marine environment can occur at the surface from tankers or platforms or at the seafloor from the wellhead or pipelines. The number of potential spills estimated for Cook Inlet marine waters are conservatively assumed to be the same as those discussed above for coastal waters. In general, oil spilled below the surface rises rapidly as droplets that coalesce to form a slick. Standard response procedures for a spill could then be used. In open marine waters, evaporation, advection, and dispersion generally reduce the effects of toxic oil fractions and their degradation products to below State and Federal criteria for hydrocarbon contamination. Sustained degradation of water quality to levels exceeding the chronic criterion of 0.015 ppm total hydrocarbon contamination is unlikely. However, levels could exceed this standard over several thousand square kilometers for a short period of time (about 30 days), depending on the size, location, and season of the spill. Marine spills would tend to move in directions consistent with established circulation patterns for the planning area (i.e., northward along the Kenai Peninsula and southward along the Alaska Peninsula). Actual flow paths would be affected by winds, tides, ice cover, temperature, and cleanup activities. The persistence of oil slicks would generally last less than 1 year. Large oil spills assumed under this alternative would become more likely as the volume of assumed oil production increases. Water quality would eventually recover, but recovery time could be decreased by oil-spill cleanup activities.

Spill Response and Cleanup. Spill response and cleanup activities in both coastal and marine waters could include, depending on location, use of chemical dispersants, *in situ* burning, use of vessels and skimmers, drilling of a relief well, and beach cleaning and booming (BOEMRE 2011j). Potential impacts to water quality from each of these spill response and cleanup activities are discussed above in Section 4.4.3.1.2. However, clean up of large spills in the open sea off of south central Alaska could be hindered by several factors. There could be limited access to oil slicks contained between ice floes during a large part of the year. There could also be reduced oil flow into recovery devices because of increased viscosity and precipitation of wax crystals, as well as decreased oil adhesion to the recovery unit material and a high percentage of free water in the recovered product due to mixing of the oil slick with slush ice and snow (MMS 2008b). In winter, icebreakers could affect the movement of spilled oil that may be trapped beneath or in the ice (BOEMRE 2011j).

If an oil spill occurred in winter, *in situ* burning would be limited by the lack of open water to collect oil and open water in which to burn it. If burning could occur in winter on a limited scale, sea ice would melt in the immediate vicinity of the burn.

4.4.3.2.3 Impacts of an Unexpected Catastrophic Discharge Event. A CDE is considered an unexpected, low-probability event unlikely to occur during routine operations (Section 4.4.2.2). For the Cook Inlet Planning Area, a low-probability CDE is assumed to have a volume of 75,000-125,000 bbl and a duration of 50–80 days (Table 4.4.2-2). A catastrophic discharge event in coastal or marine water could present sustained degradation of water quality from hydrocarbon contamination in exceedance of State and Federal water and sediment quality criteria. These effects could be significant depending upon the duration and area impacted by the spill. Additional effects on water quality could occur from response and cleanup vessels, *in situ* burning of oil, dispersant use, discharges and seafloor disturbance from relief well drilling, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring. Impacts from the spill would again depend on the spill size and composition, weather conditions, and the location of the spill.

Broken ice occurs in the northern and western portions of lower Cook Inlet during fall and winter. If an open water spill were to occur at this time, the ice would contain the oil somewhat and reduce spreading. However, oil cleanup is also more difficult in broken ice conditions. Oil from spills occurring in the winter may be trapped under ice, resulting in localized degradation of water and/or sediment quality.

Impacts to water quality from the DWH event are discussed in Section 3.4.1.4. However, differences between the GOM and the Cook Inlet Planning Area in terms of seasonality, weather and wind patterns, sea ice, and surface water temperatures make extrapolations from the DWH event and a CDE in the Cook Inlet Planning Area problematic.

4.4.3.2.4 Impact Conclusions.

Routine Operations. Overall coastal and marine water quality impacts due to routine operations and operational discharges under the proposed action would be unavoidable. Compliance with NPDES permit requirements would reduce or prevent most impacts on receiving waters caused by discharges from normal operations. Water quality would recover when discharges ceased because of dilution, settling, and mixing. Impacts on water quality from routine operations associated with the Program are expected to be minor to moderate.

Expected Accidental Events and Spills. Expected accidental oil spills could reduce water quality, and these impacts would be unavoidable. In the presence of cold temperatures and ice, cleanup activities could be more difficult. The magnitude of the impacts would depend on the specific location affected and the nature and magnitude of the activity/accident. Small spills would be expected to result in minor, short-term impacts on coastal and marine water quality. A large spill in coastal waters could result in longer term impacts on water quality, but cleanup efforts would reduce the likelihood of long-term impairment. A large spill in marine waters would be expected to have temporary impacts on water quality; however, cleanup efforts and evaporation, dilution, and dispersion would minimize the long-term impacts. Impacts on water quality from large accidental spills associated with the Program are expected to be minor to major, depending on the location, timing, magnitude of the event, and effectiveness of spill response activities.

An Unexpected Catastrophic Discharge Event. In the unlikely event of a low-probability CDE, impacts to water quality would be moderate to major. A catastrophic discharge event could present sustained degradation of water quality from hydrocarbon contamination in exceedance of State and Federal water and sediment quality criteria. These effects could be significant depending upon the duration and area impacted by the spill. Impacts from the event would depend on the spill size and composition, weather conditions, the location of the spill, and the effectiveness of containment and cleanup responses.

4.4.3.3 Alaska – Arctic

This section analyzes impacts on coastal and marine waters in the Arctic region. Coastal waters, as defined here, include the bays and estuaries along the coast and State waters extending out to the inward boundary of the territorial seas. Marine waters extend from this boundary out to a water depth of 200 m (656 ft).

Table 4.1.1-1 details impacting factors associated with oil and gas activities and the development phase in which they can occur. The following factors affecting water quality have been identified: disturbance of bottom sediments, wastes and disposal, vessel traffic, and accidental spills. The water quality stressor activities associated with oil and gas development are shown in Table 4.4.3-1.

The 2006 Arctic NPDES General Permit for wastewater discharges from Arctic oil and gas exploration (No. AKG-33-0000) expired on June 26, 2011. USEPA reissued separate NPDES exploration general permits for the Beaufort Sea and the Chukchi Sea in January 2012 for public review. USEPA plans to reissue the final permits by October 2012. When exploration General Permits for the Beaufort and Chukchi Seas are reissued, operators will be required to apply for coverage under the reissued permits. Public comments on the proposed Arctic oil and gas exploration permits were collected through March 30, 2012. USEPA Region 10 will post updates to the following Web site as they become available: http://yosemite.epa.gov/r10/water.nsf/npdes+permits/arctic-gp.

Permits issued under Section 402 of the Clean Water Act for offshore activities must comply with any applicable water quality standards and/or Federal water quality criteria, as well as with Section 403 of the Clean Water Act. Water quality standards consist of the following: designated uses of the water body, water quality criteria to protect those uses and determine whether they are being attained, and anti-degradation policies to help protect high quality water bodies. Discharges from offshore activities near State water boundaries must comply with all applicable State water quality standards.

Section 403 of the Clean Water Act requires that NPDES permits for discharges to the territorial seas, the contiguous zone, and the ocean be issued in compliance with USEPA's regulations for preventing unreasonable degradation of the receiving waters. Prior to permit issuance, ocean discharges must be evaluated against USEPA's published criteria for determination of unreasonable degradation. Unreasonable degradation, as defined in the NPDES regulations (40 CFR 125.121[e]), encompasses the following:

1. Significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities.

2. Threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms.

3. Loss of aesthetic, recreational, scientific, or economic value that is unreasonable in relation to the benefit derived from the discharge.

Specific water quality effects information related to NPDES regulated discharges in the Beaufort Sea and Chukchi Sea Planning Areas is provided in draft form by USEPA (USEPA 2012a; USEPA 2012b).

Common impacts on water quality in both coastal and marine areas include those from vessel traffic, well drilling, and operational discharges. The types of impacts expected are the same as those discussed above in Section 4.4.3.1.

4.4.3.3.1 Impacts of Routine Operations.

Coastal Waters. Construction and installation of exploratory wells (up to 16 in the Beaufort Sea Planning Area and up to 20 in the Chukchi Sea Planning Area), development wells (up to 120 in the Beaufort Sea Planning Area and up to 280 in the Chukchi Sea Planning Area), subsea production wells (up to 10 in the Beaufort Sea Planning Area and up to 82 in the Chukchi Sea Planning Area), platforms (up to 4 in the Beaufort Sea Planning Area and up to 5 in the Chukchi Sea Planning Area), and offshore pipelines (up to 249 km [155 mi] in the Beaufort Sea Planning Area and up to 402 km [250 mi] in the Chukchi) would affect water quality. Such activities would disturb bottom sediments and increase the turbidity of the water in the area of the construction. Because pipelines in shallow waters are buried using a trenching method, installation would initially release sediment to the water column. Moderate impacts on water quality (i.e., turbidity) from such construction and installation activities would occur in the immediate area of the activity. These impacts would be local and short term as settling and mixing occurred.

Drilling muds and cuttings generated when installing exploration and delineation wells would be discharged at the well site. All drilling muds and cuttings associated with development and production wells would be treated and reinjected into the well or hauled offsite for disposal. For exploration wells, the volume of drilling fluids and cutting vary depending upon the well characteristics, but, in general, fluids average approximately 500 bbl/well and drill cuttings would comprise the equivalent of approximately 600 tons/well of dry rock. Thus, under the proposed action, up to 8,000 bbl of drilling fluids and up to 9,600 tons of drill cuttings could be disposed of in the waters of the Beaufort Sea Planning Area and up to 10,000 bbl of drilling fluids and up to 12,000 tons of drill cuttings could be disposed of in the waters of the Chukchi Sea Planning Area. Discharge of drilling muds and cuttings would increase turbidity in the vicinity of the well. The discharge would contain trace metal and hydrocarbon constituents that would be suspended in the water column and subsequently deposited on the sea floor. These drilling discharges must comply with NPDES permit requirements regarding the discharge amount, rate, and toxicity, which would greatly reduce the impact to water quality. USEPA has signaled its intent to eliminate the authorization to discharge non-aqueous drilling fluids and associated drill cuttings, allowing only WBMs and cuttings to be discharged except during active bowhead whaling activities in the Beaufort Sea, unless the Agency authorizes such discharge after review of the operator's evaluation of the feasibility of drilling facility storage capacity and land-based disposal alternatives.

Because of climatic conditions in the Arctic region, there would be a number of additional operations specific to the Arctic (e.g., constructing and maintaining ice roads [MMS 2002c] and ice islands). In addition to affecting the turbidity of coastal waters in the Arctic region, construction activities would also produce waste materials. Contaminants would also be released to the coastal waters during every ice breakup from fluids entrained in ice roads and ice islands (Skolnik and Holleyman 2005). Entrained contaminants from vehicle exhaust, grease, antifreeze, oil, and other vehicle-related fluids would pass directly into the sea at each breakup (MMS 2002c). These discharges are not expected to be major; however, they would occur throughout the life of a development area.

Construction of new onshore pipelines (up to 129 km [80 mi] in the Beaufort Sea Planning Area and none in the Chukchi Sea Planning Area) would also affect coastal water quality in the Arctic region. Proper siting of facilities and requirements associated with construction permits would largely mitigate these impacts. The impacts on water quality would range from negligible to minor, depending on site location and construction and mitigation activities.

The OCS service and construction vessel traffic to and from platform sites within the planning area (up to 12 vessel trips per week in the Beaufort Sea Planning Area and up to 15 vessel trips per week in the Chukchi Sea Planning Area) would also affect water quality through the permitted release of operational wastes. Compliance with applicable NPDES permits and USCG regulations would prevent or minimize most impacts on receiving waters.

Marine Waters. Routine operations that could affect marine water quality in the Arctic region include anchoring, mooring, drilling and well completion activities, well testing and cleanup operations, flaring/burning, facility installation and operations, support service activities, decommissioning, and site clearance. Activities such as dredging trenches for pipelines and constructing artificial islands would disturb the seafloor and increase the suspended sediment load in the water column. These suspended sediments have toxicity ranges that are generally described as nontoxic to slightly toxic (National Academy of Sciences 1983). Turbidity and plumes containing sediments would depend on the season, sediment grain size, the rate and duration of discharge within the disturbed areas, and the currents present. This additional suspended sediment load would be temporary, and impacts on water quality would be localized.

The majority of wastes generated during construction and development would consist of drill cuttings and spent muds (MMS 2002c). Drilling muds and cuttings generated when installing exploration and delineation wells would be discharged at the well site. All drilling muds and cuttings associated with development and production wells would be treated and reinjected into the well. Some waste also would be generated during operations from well-workover rigs. Domestic wastewater and produced waters generated by these activities would also be injected into the disposal well. Solid wastes, including scrap metal, would be hauled offsite for disposal at an approved facility. Impacts on water quality from these activities would be negligible.

Turbidity on a smaller scale would also result from retrieving anchors used to control the movement of vessels while dredging and setting pipes or placing platforms. These types of disturbances would not occur if drillships, which use dynamic positioning rather than anchors, were used, a standard procedure in Chukchi Sea exploration.

The OCS service and construction vessel traffic to and from platform sites within the planning area (up to 12 vessel trips per week in the Beaufort Sea Planning Area and up to 15 vessel trips per week in the Chukchi Sea Planning Area) would also affect water quality through the permitted release of operational wastes. Compliance with applicable NPDES permits and USCG regulations would prevent or minimize most impacts on receiving waters.

4.4.3.3.2 Impacts of Expected Accidental Events and Spills.

Coastal Waters. Accidental releases could affect the quality of coastal water in the Arctic region. The magnitude and severity of impacts would depend on the location of the spill, spill size, type of product spilled, weather conditions, and the water quality and environmental conditions at the time of the spill. Under the proposed action, the number and types of spills assumed to occur in the Arctic region include up to three large spills (i.e., ≥1,000 bbl): up to two spills at a volume of 1,700 bbl from pipelines and up to one spill at a volume of 5,000 bbl from a platform. Between 10 and 35 small spills with volumes between 50 and 999 bbl are assumed to occur and between 50 and 190 very small spills with volumes between 1 and 50 bbl (Table 4.4.2-1).

If a large spill were to occur in enclosed coastal waters or were driven by winds, tides, and currents into a semi-enclosed coastal area, water quality would be adversely affected. With limited wave and current activity in coastal waters, the oil would not be easily dispersed, and weathering could be slower than in the open sea (see discussion in Section 4.4.3.1.2). Under Arctic conditions (i.e., cold water and cold air temperatures), weathering processes, such as volatilization, would also be much slower than in warmer climates (MMS 2008b); under calm conditions and cold temperatures in restricted waters, vertical mixing and dissolution would be reduced (MMS 2008b). If the spill were to occur on ice or under ice, oil would be trapped and essentially remain unchanged until breakup occurred and the ice began to melt. The volatile compounds from such a spill would be more likely to freeze into the ice within hours to days rather than dissolve or disperse into the water below the ice. A hydrocarbon plume in the water column underneath the ice could persist with concentrations that exceed background levels of hydrocarbons in the Arctic, as discussed in Section 3.4.3, for a distance greater than that in the open sea (MMS 2008b). Spills in first-year ice would melt out in late spring or early summer. Spills in multi-year ice would melt out later in the summer or in subsequent summers. Spills released from the ice would be relatively unweathered and would have the characteristics of fresh oil. Impacts on coastal waters from a large spill would depend on the season, type and composition of the spill, weather conditions, and size of the spill.

Effects on water quality could persist even longer if oil were to reach coastal wetlands and be deposited in fine sediments, becoming a long-term source of pollution because of remobilization. In such locations, spill cleanup could be necessary for recovery of the affected areas. Shoreline cleanup operations could involve crews working with sorbents, hand tools, and heavy equipment. The magnitude and severity of impacts from such spills would depend on the nature of the coastal area associated with the spill, the spill size and composition, and the water quality and condition of resources affected by the spill.

Cleanup of large spills in the open sea could be hindered by several factors. There could be limited access to oil slicks contained between ice floes during a large part of the year. There could also be reduced oil flow into recovery devices because of increased viscosity and precipitation of wax crystals, as well as decreased oil adhesion to the recovery unit material and a high percentage of free water in the recovered product due to mixing of the oil slick with slush ice and snow (MMS 2008b). Impacts from the spill would again depend on the spill size and composition, weather conditions, and the location of the spill.

Based on the assumption that all small (<1,000 bbl) and very small (<50 bbl) spills do not occur at the same time and place, water quality would rapidly recover without mitigation, due to mixing, dilution, and weathering.

Marine Waters. Under Arctic conditions (i.e., cold water and air temperatures), weathering processes would be much slower than in warmer climates (MMS 2008b). Seasonality and the specific spill location would cause variability in effects (e.g., summer versus winter in the Beaufort and Chukchi Seas). If a spill were to occur, oil would be trapped and essentially remain unchanged until breakup occurred and the ice began to melt. The volatile compounds from such a spill would be more likely to freeze into the ice within hours to days rather than dissolve or disperse into the water below the ice. A hydrocarbon plume in the water column underneath the ice could persist with concentrations that are above background levels for a distance that would be five times greater than that in the open sea (MMS 2008b).

If it is assumed that all small (<1,000 bbl) and very small spills (<50 bbl) would not occur at the same time and place, water quality would rapidly recover without mitigation because of mixing, dilution, and weathering.

Spill Response and Cleanup. Spill response and cleanup activities in both coastal and marine waters could include, depending on location, use of chemical dispersants, *in situ* burning, use of vessels and skimmers, drilling of a relief well, and beach cleaning and booming (BOEMRE 2011j). Potential impacts to water quality from each of these spill response and cleanup activities are discussed above in Section 4.4.3.1.2. However, cleanup of large spills in the open sea within the Beaufort and Chukchi Seas could be hindered by several factors. There could be limited access to oil slicks contained between ice floes during a large part of the year. There could also be reduced oil flow into recovery devices because of increased viscosity and precipitation of wax crystals, as well as decreased oil adhesion to the recovery unit material and a high percentage of free water in the recovered product due to mixing of the oil slick with slush ice and snow (MMS 2008b). In winter, icebreakers could affect the movement of spilled oil that may be trapped beneath or in the ice (BOEMRE 2011j).

If an oil spill occurred in winter, *in situ* burning would be limited by the lack of open water to collect oil and open water in which to burn it. If burning could occur in winter on a limited scale, sea ice would melt in the immediate vicinity of the burn.

4.4.3.3.3 Impacts of an Unexpected Catastrophic Discharge Event. For the Chukchi Sea Planning Area, a low-probability CDE is assumed to have a volume of 1.4–2.2 million bbl and a duration of 40-75 days (Table 4.4.2-2). For the Beaufort Sea Planning Area, a CDE is assumed to have a volume of 1.7-3.9 million bbl with a duration of 60-300 days (Table 4.4.2-2). A CDE in coastal or marine waters in either planning area could present sustained degradation of water quality from hydrocarbon contamination in exceedance of State and Federal water and sediment quality criteria. These effects could be significant depending upon the duration and area impacted by the spill. Additional effects on water quality could occur from response and cleanup vessels, *in situ* burning of oil, dispersant use, discharges and seafloor disturbance from relief well drilling, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring. Impacts from the event would again depend on the spill size and composition, weather conditions, and the location of the spill. Impacts to water quality from the DWH event are discussed in Section 3.4.1.4. However, differences between the GOM and the Beaufort and Chukchi Seas in terms of seasonality, weather and wind patterns, sea ice, and surface water temperatures make extrapolations from the DWH event and a CDE in the Beaufort or Chukchi Seas problematic.

Decomposition and weathering processes for oil are much slower in cold waters than in temperate regions. In marine waters, advection and dispersion would reduce the effects of a release of toxic oil fractions or their toxic degradation products, including products resulting from photo-oxidation. Isolated or coastal waters under thick ice or a fresh spill in rapidly freezing ice, however, would not be exposed to advection and dispersion. Spills released from the ice would be relatively unweathered and would have the characteristics of fresh oil. Before the oil was released from the ice, the contaminated ice could drift for hundreds of kilometers. If oil contacted a shoreline, mixed into the shoreline, and then dispersed, elevated concentrations of hydrocarbons could occur in the water and sediments offshore of the oiled shoreline.

4.4.3.3.4 Impact Conclusions.

Routine Operations. Overall coastal and marine water quality impacts due to routine operations and operational discharges under the proposed action would be unavoidable. Compliance with NPDES permit requirements would reduce or prevent most impacts on receiving waters caused by discharges from normal operations. Water quality would recover when discharges ceased because of dilution, settling, and mixing. Impacts on water quality from routine operations associated with the Program are expected to be minor to moderate.

Expected Accidental Events and Spills. Expected accidental oil spills could reduce water quality, and these impacts would be unavoidable. In the presence of cold temperatures and ice, cleanup activities could be more difficult. The magnitude of the impacts would depend on the specific location affected and the nature and magnitude of the activity/accident. Small spills would be expected to result in minor and short-term impacts on coastal and marine water quality. A large spill in coastal waters could result in longer term impacts on water quality, but cleanup efforts would reduce the likelihood of long-term impairment. A large spill in marine waters would be expected to have temporary impacts on water quality; however, cleanup efforts and evaporation, dilution, and dispersion would minimize the long-term impacts. Impacts on water quality from expected large accidental spills associated with the Program are expected to be minor to major, depending on the location, timing, magnitude of the event, and the effectiveness of containment and cleanup activities.

An Unexpected Catastrophic Discharge Event. In the unlikely event of a low-probability CDE, impacts to water quality would be moderate to major, depending on the location, timing, and magnitude of the event. A catastrophic discharge event could present sustained degradation of water quality from hydrocarbon contamination in exceedance of State and Federal water and sediment quality criteria. These effects could be significant depending upon the duration and area impacted by the spill. Impacts from the event would depend on the spill size and composition, weather conditions, the location of the spill, and the effectiveness of spill containment and cleanup activities.

4.4.4 Potential Impacts on Air Quality

4.4.4.1 Gulf of Mexico

In the GOM west of 87.5° W longitude, OCS air emissions are regulated by BOEM according to 30 CFR 250.302-304. BOEM reviews projected air emissions information from an operator submitting a plan for exploration or development activities. If the projected annual emissions exceed a certain threshold, which is determined by the distance from shore, the operator needs to perform a modeling analysis to assess air quality impacts on onshore areas. If the modeled concentrations exceed defined significance levels in an attainment area, which is an area that meets the National Ambient Air Quality Standards (NAAQS), best available control technology would be required on the facility. If the affected area is classified nonattainment, further emission reductions or offsets may be required. Projected contributions to onshore pollutant concentrations are also subject to the same limits that the USEPA applies to the onshore areas under its Prevention of Significant Deterioration (PSD) program (MMS 2007d).

Facilities located east of 87.5° W longitude would be under the USEPA jurisdiction, which regulates air emissions as prescribed in 40 CFR Part 55. For facilities located within 40 km (25 mi) of a State's seaward boundary, the regulations are the same as would be applicable if the emission source were located in the corresponding onshore area and would include State and local requirements for emission controls, emission limitations, offsets, permitting, testing, and monitoring. For facilities located beyond 40 km (25 mi) of a State's seaward boundary, the basic Federal air quality regulations apply, which include the USEPA emission standards for new sources, the PSD regulations, and Title V permits. PSD applies to sources that, depending on the source type, could potentially emit more than either 100 tpy or 250 tpy of a criteria pollutant or precursor. Title V applies to sources that could potentially emit more than 100 tpy of any regulated pollutant other than greenhouse gases (GHGs). In 75 FR 31514, the USEPA promulgated the Greenhouse Gas Tailoring Rule, bringing emissions of GHGs under the PSD and Title V requirements. New source GHG thresholds for PSD are 75,000 tpy CO_2e for sources already subject to PSD for another pollutant and 100,000 tpy CO_2e for other new sources.[16] For Title V, the thresholds are 100,000 tpy CO_2e and 100 tpy based on mass. Which threshold applies to a particular source, how the potential emissions are calculated, and what controls are required if the applicable threshold is exceeded are all issues determined in discussions with regulators during the air permit application and approval process (MMS 2007d).

The USEPA has established NAAQS for six criteria pollutants — nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter (PM; PM_{10}, PM with an aerodynamic diameter of 10 μm or less; and $PM_{2.5}$, PM with an aerodynamic diameter of 2.5 μm or less), carbon monoxide (CO), lead (Pb), and ozone (O_3) — because of their potential adverse effects on human health and welfare. The health and environmental effects of air pollutants have been summarized by the USEPA (USEPA 2011a). Ambient levels of criteria pollutants except Pb can contribute to respiratory illnesses, especially in persons with asthma, children, and the elderly, and PM and CO can also aggravate cardiovascular diseases.

Ozone Formation. O_3 in the atmosphere is formed by photochemical reactions involving primarily nitrogen oxides (NO_x) and volatile organic compounds (VOCs). It is formed most readily in the summer season, with high temperatures, lower wind speeds, intense solar radiation, and an absence of precipitation; high O_3 episodes are typically associated with slow-moving, high-pressure systems characterized by light winds and a shallow boundary layer (NRC 1992). O_3 can irritate the respiratory system, reduce lung function, and aggravate asthma. Repeated exposure to O_3 pollution for several months may cause permanent lung damage. Children, adults who are active outdoors, and people with respiratory problems are the most at risk from high O_3. High levels of O_3 are also accompanied by a mix of organic radicals, which also causes adverse health effects. O_3 interferes with the ability of plants to produce and store food, which makes them more susceptible to disease, insects, other pollutants, competition, and harsh weather. It may also cause damage to the leaves of trees and other plants, thereby affecting the health and appearance of vegetation in cities, National Parks, and recreation areas. O_3 may reduce forest growth and crop yields, potentially affecting species diversity in ecosystems (USEPA 2011a).

Acid Deposition and Visibility. Gaseous pollutants undergo various chemical reactions in the atmosphere to form small particles, which remain airborne for extended periods of time. NO_x compounds react with ammonia and moisture to form ammonium nitrate particles, which

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[16] There is an additional requirement that the source's GHG emissions also meet the 100/250 tpy non-GHG threshold based on mass (total GHG emissions without considering the global warming potential of individual gases).

contribute to $PM_{2.5}$ concentrations. SO_2 combines with moisture to form tiny sulfate particles, which may also contribute to adverse health effects. In addition, gaseous NO_x and SO_2 can dissolve into cloud water. These acidic chemicals eventually return to the ground in either wet (e.g., rain, snow) or dry (e.g., gases, particles) forms, commonly referred to as acid deposition or acid rain (USEPA 2011b). Dry deposition is equally as important as wet deposition. The deposition often takes place hundreds of kilometers from the source. Acid deposition can damage forests and crops, change the makeup of soil, and may, in some cases, make lakes and streams acidic and unsuitable for fish. Deposition of nitrogen from NO_x emissions also contributes to nitrogen load in water bodies, especially estuaries and near-coastal ecosystems. Acid deposition accelerates the decay of building materials and paints, including irreplaceable monuments, statues, sculptures, and other cultural resources. Particulate matter, including sulfate and nitrate particles and organic aerosols that form part of photochemical smog, reduces atmospheric visibility in areas including National Parks, Monuments, and Wilderness Areas (USEPA 2011b).

In general, the most important source of visibility degradation is from $PM_{2.5}$ in the 0.1 to 1 μm size range, which covers the range of visible light (0.4–0.7 μm) (Malm 1999). These particles are directly emitted into the atmosphere through fuel burning. However, other sources arise through chemical transformation of NO_2, SO_2, and VOCs into nitrates, sulfates, and carbonaceous particles. Existing visibility in the eastern United States, including the GOM States, is impaired due to $PM_{2.5}$ containing primarily sulfates and carbonaceous material. High relative humidity (over 70%) can play an important factor in visibility impairment, especially in the GOM coastal areas, where relative humidity is higher than 70% throughout the year. These particles are generally hygroscopic, and thus the absorption of water by the particulate matter makes them grow to a size that enhances their ability to scatter light and hence aggravates visibility reduction. Over the open waters of the GOM, a study of visibility from platforms off Louisiana revealed that significant reductions in Louisiana coastal and offshore visibility are almost entirely due to transient natural occurrences of fog (Hsu and Blanchard 2005). Episodes of haze are short-lived and affect visibility much less. Offshore haze can result from plume drift generated from coastal sources (MMS 2007d).

4.4.4.1.1 Impacts of Routine Operations. Under the proposed action, construction and operation of up to 2,100 exploration and delineation wells, up to 2,600 development and production wells, up to 12,100 km (7,500 mi) of new pipeline, up to 12 new pipeline landfalls, up to 6 new pipe yards, and up to 12 new natural gas processing facilities, and the removal of up to 275 platforms with explosives will result in emissions that could affect air quality in the GOM. These activities would generate emissions from stationary sources at the drilling/well sites and from support vessels and aircraft over the 40- to 50-year period of the Program (Table 4.4.1-1). There could be up to 600 vessel trips/wk and 5,500 helicopter trips/wk under the proposed action.

Emissions. The type and relative amounts of air pollutants generated by offshore operations vary according to the phase of activity. There are three principal phases of oil and gas activities operations: exploration, development, and production. Activities affecting air quality include seismic surveys, drilling activities, platform construction and emplacement, pipeline

TABLE 4.4.4-1 Estimated 40-Year Total Air Emissions from OCS Activities in the Gulf of Mexico Planning Areas, Proposed 2012-2017 Leasing Program

	Emissions (10^3 tons)					
Activity	NO_x	SO_x	PM_{10}	$PM_{2.5}$	CO	VOC
Development/production wells	314.17–604.52[a]	0.27–0.51	4.88–9.36	4.82–9.25	58.23–111.57	6.22–11.93
Drilling exploration/delineation wells	320.81–610.61	0.27–0.52	4.97–9.44	4.91–9.33	59.32–112.51	6.34–12.04
Helicopters	1.82–3.34	0.45–0.82	0.35–0.65	0.35–0.65	22.24–40.91	4.39–9.08
Oil tanker/barge cruising/idling – Lower 48 States	0.00–5.6	0.00–0.73	0.00–0.11	0.00–0.11	0.00–0.57	0.00–4.83
Pipe-laying vessels	32.56–94.99	5.53–16.13	1.23–3.58	1.23–3.58	6.76–19.71	1.23–3.58
Platform construction	7.31–13.17	1.05–1.88	0.17–0.31	0.17–0.31	0.95–1.71	0.17–0.31
Platform production	122.54–225.34	1.68–3.08	1.12–2.07	1.10–2.03	134.83–247.94	109.69–201.71
Platform removal	7.31–13.17	1.05–1.88	0.17–0.31	0.17–0.31	0.95–1.71	0.17–0.31
Support vessels	220.59–405.64	29.72–54.66	3.82–7.03	3.82–7.03	21.01–38.64	3.82–7.03
Survey vessels	3.99–7.4	0.48–0.89	0.06–0.11	0.06–0.11	0.33–0.62	0.06–0.11
Total	1,031.11–1,983.79	40.49–81.11	16.78–32.97	16.64–32.71	304.63–575.9	132.25–250.22

[a] The range of values reflects the low and high end of the exploration and development scenarios for the Program.

Sources: Industrial Economics, Inc. et al. 2012; Wolvovsky 2012.

laying and burial operations, platform operations, flaring, fugitive emissions, support vessel and helicopter operations, and evaporation of VOCs during transfers and spills. Principal emissions of concern are the criteria pollutants and their precursors: NO_x, sulfur oxides (SO_x),[17] PM_{10} and $PM_{2.5}$, CO, and VOC. Releases of toxic chemicals could be a concern around oil spills and *in situ* burning and especially during accidental releases of hydrogen sulfide (H_2S) at platforms.

Wilson et al. (2010) provided a comprehensive emission inventory of oil and gas activities in the GOM for the year 2008, showing that support vessels and platforms rank first and second, respectively, as NO_x emitters with natural gas engines being the largest source on platforms. Support vessels are the largest SO_x emitters, while the drilling rigs also emit large amounts of SO_x. Albeit small, the primary SO_x sources on platforms are diesel engines used in drilling. The largest sources of PM_{10} are support vessels, drilling rigs, and production platforms. VOCs come mostly from production platforms, where the primary sources are cold vents, followed by fugitive sources. Fugitive sources include oil and gas processing, pump and compressor seals, valves, connectors, and storage tanks. Natural gas engines on platforms account a considerable portion of CO emissions (Wilson et al. 2010).

The 40-year total air emissions from the proposed action were estimated using the most recently available exploration and development scenario for 2012-2017, as shown in Table 4.4.4-1. These emissions were estimated by BOEM (Wolvovsky 2012) using emission factors from the Offshore Environmental Cost Model (Industrial Economics, Inc. et al. 2011).

In terms of absolute amounts, the largest emissions would be NO_x followed by CO, with lesser amounts of VOC, SO_x, PM_{10}, and $PM_{2.5}$ in order of descending emissions. Under both the high and low scenarios, drilling and delineation wells would be the largest source of NO_x, PM_{10}, and $PM_{2.5}$ (helicopters are comparable for PM_{10} and $PM_{2.5}$), support vessels would be the largest source of SO_x, and platform production would be the largest source of CO and VOCs. Emissions from the Program would initially be lower in the first few years as exploratory wells were drilled and platforms started producing oil and gas. During the last half of the Program, emissions would decrease as production decreased and some platforms were removed (MMS 2007d).

It is estimated that about 10% of the crude oil produced in deep water in the GOM would be transported to shore via tanker, while in shallow waters about 1% of production would be transported by barge. The transport of crude oil would result in VOC emissions from loading operations and breathing losses during transit. VOC emissions would also occur during unloading and ballasting in port. There would also be emissions of NO_x, SO_2, and PM_{10} from the ships' engines (MMS 2007d).

Impacts on Criteria Pollutants Other Than Ozone. BOEM performed a cumulative air quality modeling analysis of platform emissions in a portion of the GOM in 1992 (MMS 1997b). The area modeled included most of the coastline of Louisiana and extended

[17] Sulfur dioxide (SO_2) belongs to the family of sulfur oxides (SO_x). For emissions, SO_2 accounts for most of SO_x, and thus these are used interchangeably.

eastward to include coastal Mississippi and Alabama. Facility emissions were obtained from the emissions inventory used in the GOM air quality study (MMS 1995a). The emission values were multiplied by a factor of 1.4 to account for growth. The modeled onshore annual average NO_2 concentrations were generally somewhat greater than 1 microgram per cubic meter ($\mu g/m^3$). The highest values appeared in the Mississippi River Delta region, where a maximum concentration of 6 $\mu g/m^3$ was calculated, which is 6% of the national standard for NO_2. The highest predicted annual, maximum 24-hr, and maximum 3-hr average SO_2 concentrations were 1.1, 13, and 98 $\mu g/m^3$, respectively. These values are 1, 4, and 7% of the NAAQS for the respective averaging periods. Modeling was not performed for PM_{10} or $PM_{2.5}$, but the concentrations would be lower because of lower emission rates. The projected emissions for the proposed action would be lower than the emissions used in the modeling and scattered further offshore; thus, the impacts would be correspondingly lower. Existing concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ in the GOM coast States are well within the NAAQS, so emissions from the proposed action would not result in any exceedance of the NAAQS.

The highest predicted NO_2 and SO_2 concentrations in the 1992 emissions modeling were well within the maximum allowable PSD Class II increments for those pollutants. Any concentrations resulting from the emissions associated with the proposed action should also be within the PSD Class II increments.

The maximum allowable increase for the annual average NO_2 concentration in the Class I Breton National Wilderness Area (NWA) is 2.5 $\mu g/m^3$. The highest predicted annual average NO_2 concentration in Breton from the year 1992 emission sources was 3.6 $\mu g/m^3$, which exceeds the Class I increment and indicates that the question of increment consumption at Breton NWA could be of concern (MMS 1997b, 2007d).

The highest predicted SO_2 concentrations in Breton NWA were 0.3, 4.5, and 9.7 $\mu g/m^3$ for the annual, maximum 24-hr average, and maximum 3-hr average concentrations, respectively. The maximum allowable concentration increases for PSD Class I areas are 2.0, 5.0, and 25 $\mu g/m^3$, respectively. Based on this result, SO_2 concentrations from the proposed action would be within the Class I maximum allowable increases (MMS 1997b, 2007d).

Comparing Impacts to PSD Increments

Several points should be considered when air quality impacts are compared to PSD increments. First, the PSD program applies to individual sources, not programs. Emissions from an individual source such as a platform or set of platforms could differ from the emissions being modeled in a particular study. Second, increment tracking is a cumulative process that sets a maximum allowable increase above a baseline concentration. It is unlikely that a permitting agency would permit a single source to consume all of the increment. Last, PSD applies only to major sources, generally sources with the potential to emit more than 250 tons/yr, except for the 100 tons/yr threshold for 28 source categories. OCS oil and gas production activities are subject to a 250 tons/yr threshold. Regardless of the *actual* emissions, a source's *potential* emissions could exceed the 250 tons/yr threshold. Determining potential emissions and available PSD increment allowances requires consultation with the cognizant regulators.

Because of continuing concern about the combined impact of offshore and onshore emission sources on the PSD Class I increments in Breton NWA, BOEMRE has collected an emission inventory for OCS facilities located within 100 km (62 mi) of the Breton Class I area.

A modeling study (2000–2001) to the baseline years (1977 for SO_2 and 1988 for NO_2) revealed that none of the allowable SO_2 or NO_2 increments had been fully consumed (Wheeler et al. 2008). The maximum annual, 24-hr, and 3-hr SO_2 increments consumed with the Breton NWA were –1.07, 1.18, and 1.80 μg/m^3, respectively. A decrease in annual SO_2 concentration resulted from a general decrease in SO_2 emissions from onshore and offshore sources since 1977. The maximum allowable concentration increases for PSD Class I areas are 2.0, 5.0, and 25 μg/m^3, respectively. The maximum annual NO_2 increment consumed within the Breton NWA was 0.10 μg/m^3, for which the maximum allowable NO_2 increment is 2.5 μg/m^3. In addition, BOEM consults with the U.S. Fish and Wildlife Service (USFWS), the Federal land manager of the Breton NWA area, for plans within 100 km (62 mi) of Breton that exceed a certain emission threshold. The use of low-sulfur fuel is a requirement (MMS 2007d).

No modeling has been performed for CO. In OCS waters, CO emission sources less than about 7,000 tons/year would not have any significant effect on onshore air quality and are exempt from air quality review under BOEM air quality regulations (MMS 2007d). This is based on air quality modeling that was performed to support the BOEM air quality rules. As shown in Table 4.4.4-1, CO emissions from the proposed action are higher than 7,000 tons/year. However, CO emissions are comparable to NO_2 and SO_2 emissions, and their associated impacts are well within the NAAQS discussed above. In addition, CO standards (40,000 and 10,000 μg/m^3 for 1- and 8-hr averages, respectively) are more than one order of magnitude higher than those for NO_2 and SO_2. Therefore, no significant impacts from CO associated with the proposed action would be anticipated.

Impacts on Ozone. As discussed in MMS (2007d), the impacts from OCS activities on O_3 were evaluated in the GOM air quality study (MMS 1995a). The study focused on the O_3 nonattainment areas in southeast Texas and the Baton Rouge, Louisiana, areas. It was determined through modeling that OCS sources contributed little to onshore O_3 concentrations in either of these areas. At locations where the model predicted 1-hr average O_3 levels above 120 parts per billion (ppb), which was then the NAAQS, the OCS emissions contributed less than 2 ppb to the total concentrations. These contributions occurred in only a small geographic area during any particular episode. At locations where the model predicted O_3 levels were much less than 120 ppb, the highest OCS contributions were about 6–8 ppb. When the modeling was performed after doubling the OCS emissions, the highest OCS contributions at locations where the predicted O_3 levels exceeded the standard was 2–4 ppb.

Again, as noted in MMS (2007d), more recent O_3 modeling was performed using a preliminary GOM-wide emissions inventory for the year 2000 to examine the O_3 impacts with respect to the 1997 8-hr O_3 standard of 80 ppb (effective May 27, 2008, the 8-hr O_3 standard was lowered to 75 ppb). One modeling study focused on the coastal areas of Louisiana extending eastward to Florida (Haney et al. 2004). This study showed that the impacts of OCS emissions on onshore O_3 levels were very small, with the maximum contribution of 1 ppb or less at locations where the standard was exceeded. The other modeling effort dealt with O_3 levels in southeast Texas (Yarwood et al. 2004). The results of this study indicated a maximum contribution of 0.2 ppb or less to areas exceeding the standard.

Due to the complex, nonlinear nature of the photochemical production of ozone in the atmosphere, changing emissions of ozone precursors by a given percentage may not produce a corresponding percentage change in O_3 concentrations. However, the projected emissions from the proposed action would be smaller than the emissions used in the models to ensure that contributions to O_3 levels from actions associated with the proposed action would be smaller than the figures above.

Impacts on Visibility. The application of the VISCREEN visibility screening model (USEPA 1992) to individual OCS facilities has shown that the emissions are not large enough to significantly impair visibility. It is not known to what extent aggregate OCS sources contribute to visibility reductions. However, the individual emission sources from the proposed action are relatively small and scattered over a large area, and it is not expected that they would have a measurable impact on acid deposition or visibility (MMS 2007d).

Greenhouse Gas Emissions and Climate Change. Estimates were made of the 40-year total GHG emissions of CO_2, CH_4, and N_2O for all projected OCS oil and gas Program activities (Wolvovsky 2012). Emission estimates for the various activities were largely based on emission factors from the Offshore Environmental Cost Model (Industrial Economics, Inc. et al. 2011). Air emissions resulting from the Program were estimated by considering the exploration and development scenarios presented in Table 4.4.4-1. Emissions are given in terms of teragrams (Tg) of CO_2e, where one Tg is 10^{12} g (10^6 metric tons). This measure takes into account a global warming potential (GWP) factor, which accounts for the relative effectiveness of a gas to contribute to global warming with respect to the same amount CO_2. In these calculations, CH_4 is given a GWP of 21, while N_2O is given a GWP of 310.

Table 4.4.4-2 lists the 40-year total calculated emissions of CO_2, CH_4, and N_2O from activities associated with the Program and compares them with current (2009) U.S. GHG emissions from all sources (USEPA 2011l). The projected CO_2 emissions from the Program are about 0.025-0.049 % of all current CO_2 emissions in the United States. The Program CH_4 emissions are about 0.054-0.101% of the current CH_4 emissions in the United States, which is slightly higher than CO_2. The projected N_2O emissions from the Program are about 0.004-0.008% of all current N_2O emissions in the United States. If CO_2, CH_4, and N_2O emissions are combined, the Program emissions are about 0.027–0.046% and 0.027–0.045% of the nationwide total of three GHG emissions and of all GHG emissions, respectively. The estimated total global GHG emissions in 2005 were approximately 38,726 Tg CO_2e (74 FR 66539). The estimated Program GHG emissions are about 0.0046%–0.0078% of the total global GHG emissions.

As noted in Section 3.3, GHG emissions are one of the causes of climate change. Climate change is a global phenomenon and predicting climate change impacts requires consideration of large scale or even worldwide GHG emissions, not just emissions at a local level. Climate change predictive capability (modeling) lacks the ability to estimate the impact of GHGs from a particular source or sources such as oil and gas activities associated with the Program. What their impact, if any, would be is determined not only by the emissions from the oil and gas activities themselves, but also by the GHG emissions of other sources throughout the world and whether these other emissions are expected to increase or decrease. In addition, since

TABLE 4.4.4-2 Projected Greenhouse Gas Emissions from Oil and Gas Activities in the Gulf of Mexico Planning Areas, 2012-2017 Leasing Program[a]

Pollutant	2012-2017 Program[b] (Tg CO_2e)	2012-2017 GOM (Tg CO_2e)[c]	Total 2009 U.S. Emissions from All Sources (Tg CO_2e)	2012-2017 GOM as Percentage of Total 2009 U.S. Emissions
CO_2	58.30–117.27	55.72–106.79	5,505.2	0.025–0.049
CH_4	15.4–29.67	15–27.6	686.3	0.054–0.101
N_2O	0.47–0.95	0.47–0.91	295.6	0.004–0.008
$CO_2 + CH_4 + N_2O$	74.18–147.89	71.18–120.5	6,487.1	0.027–0.046
All GHGs[d]	74.18–147.89	71.18–120.5	6,633.2	0.027–0.045

a Emissions in the table represent 40-year totals, except the third column, which presents total 2009 U.S. emissions.

b Sum of the GHGs from GOM, Cook Inlet, and the Beaufort Sea and Chukchi Sea Planning Areas in this table and Tables 4.4.4-4 and 4.4.4-6.

c One Tg is equal to 10^{12} g, or 10^6 metric tons. The CO_2e for a gas is derived by multiplying the mass of the gas by the associated GWP, which accounts for the relative effectiveness of a gas to contribute to global warming with respect to the same amount CO_2. In these calculations, CH_4 is given a GWP of 21, while N_2O is given a GWP of 310.

d Total U.S. GHG emissions also include hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride emissions. Estimates of emissions from the Program were not made for these compounds, but they are assumed to be very small.

Sources: Industrial Economics, Inc. et al. 2012; USEPA 2011l; Wolvovsky 2012.

some GHG gases, such as CO_2, may persist in the atmosphere for up to a century, the potential impacts of any source may extend well beyond the active lifetime of the source or program. This said, given the small percentage contributions of oil and gas activities in the GOM to global GHG emissions, the potential impact on climate change would probably be small. Section 3.3 provides some baseline considerations for climate change and Section 4.4.3 and Sections 4.4.6 through 4.4-15 discuss potential impacts to specific impact areas.

4.4.4.1.2 Impacts of Expected Accidental Events and Spills. Under the proposed action, the number and types of spills assumed to occur in the GOM include up to eight large spills (≥1,000 bbl) from both pipeline and platforms including one tanker spill and between 235 and 470 small spills (<1,000 bbl) over the 40- to 50-year period of the Program (Table 4.4.2-1). Evaporation of oil from these spills and emissions from spill response and cleanup activities including *in situ* burning, if used, have the potential to affect air quality in the GOM.

Spills and *In Situ* Burning. Evaporation of small accidental oil spills would cause small, localized increases in VOCs. Most of the emissions would occur within a few hours of the spill and would decrease after that period. Large spills would result in emissions over a large area and a longer period of time. The impacts at a given location would depend on the size, location, and duration of the spill and meteorological conditions such as wind speed and direction. Hanna and Drivas (1993) modeled the emissions of various hydrocarbon compounds from a large spill. A number of these compounds, including BTEX and hexane, are classified by the USEPA as hazardous air pollutants. The results showed that these compounds evaporate almost completely within a few hours after the spill occurs. Ambient concentrations peak within the first several hours after the spill starts and are reduced by two orders of magnitude after about 12 hr. The heavier compounds take longer to evaporate and may not peak until about 24 hr after spill occurrence. Total ambient VOC concentrations are high in the immediate vicinity of an oil spill, but concentrations are much reduced after the first day (MMS 2007d). Spreading of the spilled oil and action by winds, waves, and currents would further disperse VOC concentrations to extremely low levels over a relatively larger area. Concentrations of criteria pollutants would remain well within NAAQS (MMS 2008b). Over time, air quality would return to pre-spill conditions.

Diesel fuel oil could be spilled either in transit or from accidents involving vehicles, vessels, or equipment. A diesel spill would evaporate faster than a crude oil spill. Ambient hydrocarbon concentrations would be higher than those of a crude oil spill but would persist for a shorter time. Also, because any such spill probably would be smaller than some potential crude oil spills, any air quality effects from a diesel spill likely would be lower than those for other spills (MMS 2008b).

In situ burning of spilled crude or diesel would generate a plume of black smoke and emissions of NO_2, SO_2, CO, PM_{10}, and $PM_{2.5}$ that would temporarily affect air quality, but the effects would be small. Fingas et al. (1995, 2011) describe the results of a monitoring program of a burn experiment at sea. The program involved extensive ambient measurements during two experiments in which approximately 300 bbl of crude oil was burned. During the burn, CO, SO_2, and NO_2 were measured only at background levels and were frequently below detection levels. Ambient levels of VOCs were high within about 100 m (328 ft) of the fire, but were significantly lower than those associated with a nonburning spill. Polyaromatic hydrocarbons (PAHs) were largely burned by the fire and were lower in soot than in the oil. Particulates at sea level were of concern only up to 150 m (492 ft) downwind. Measured concentrations of PAHs were low. It appeared that a major portion of these compounds was consumed in the burn. Effects of *in situ* burning for spilled diesel fuel would be similar to those associated with a crude oil spill (MMS 2008b).

A major component of the pollution from a fire would be soot. Soot would cling to plants near the fire but would tend to clump and wash off vegetation in subsequent rains. Potential contamination of shoreline and onshore vegetation would be limited, however, because oil and gas activities under the proposed action would be at least 15 km (9.3 mi) offshore, with the exception of any oil- or gas-transport pipelines (MMS 2008b).

Smoke from burning crude oil would contain PAHs. Benzo(a)pyrene, which often is used as an indicator of the presence of carcinogenic varieties of PAHs, is present in crude oil smoke in very small amounts, but in quantities approximately three times larger than in unburned oil (Evans 1988). Investigators have found that, overall, the oily residue in smoke plumes from crude oil is mutagenic, although not highly so. McGrattan et al. (1995) modeled smoke plumes associated with *in situ* burning. Modeling has shown that the surface concentrations of particulate matter do not exceed the health criterion of 150 μg/m^3 beyond about 5 km (3 mi) downwind of an *in situ* burn. This result appears to be supported by field experiments conducted off Newfoundland and in Alaska (MMS 2007d). This is quite conservative, as this health standard is based on a 24-hr average concentration rather than a 1-hr average concentration. After the burn, air quality would rapidly return to pre-burn conditions.

Hydrogen Sulfide. An accidental release of H_2S in the atmosphere could present a serious hazard to platform workers and persons in close proximity to a platform. H_2S concentrations of 20 ppm, the OSHA ceiling level that must not be exceeded during any part of the workday, cause irritation to exposed persons within minutes and concentrations of 500 ppm are deadly. All OCS operators involved in production of sour gas or oil that could result in atmospheric H_2S concentrations above 20 ppm are required to file an H_2S Contingency Plan with BOEM. The plan contains measures to prevent serious injury or death to personnel. Under a worst-case scenario of an accidental release at a very large facility with a throughput of 100 million cubic feet of gas per day with high H_2S concentration levels (on the order of 20,000 ppm), near-calm wind, and stable atmospheric conditions, the H_2S levels are predicted to be 500 ppm at about 1 km (0.6 mi) from the facility and 20 ppm at several kilometers from the source (MMS 2001c). Most "sour gas" facilities have H_2S concentrations below 500 ppm, which would result in H_2S levels of 20 ppm that are confined to an area within the dimensions of a typical platform (MMS 2007d).

In the case of an aquatic H_2S release, the gas is soluble in water, so a small gas leak would result in almost complete dissolution into the water column. Larger leaks would result in less dissolution and could result in release into the atmosphere if the surrounding waters reach saturation. Because the oxidation of H_2S in water takes place slowly, there should not be any appreciable zones of hypoxia. H_2S levels can have adverse impacts on mammals, birds, and fish (MMS 2001c).

4.4.4.1.3 Impacts of an Unexpected Catastrophic Discharge Event. For the purposes of analysis, a low-probability CDE event in the GOM is assumed to range in size from 900,000 and 7,200,000 bbl, and have a duration of 30–90 days (Table 4.4.2-2). Evaporation of oil from these spills and emissions from spill response and cleanup activities including *in situ* burning, if used, have the potential to result in minor to moderate impacts to air quality in the GOM.

A CDE in the GOM could emit regulated pollutants into the atmosphere. This may affect air quality impacts during some phases of the event. The greatest impacts on air quality conditions would occur during the initial explosion of gas and oil and during the spill response and cleanup. Impacts could continue for days during the initial event and could continue for months during spill response and cleanup. Therefore, while the impacts could be large during these two phases, overall, the emissions from a CDE would be temporary and, over time, air quality in the GOM would return to pre-event conditions (BOEMRE 2011j).

In a CDE, oil may be burned to prevent it from entering sensitive habitats. During an *in situ* burn, the conditions exist (i.e., incomplete hydrocarbon combustion and the presence of chlorides in seawater) such that dioxins and furans could potentially form. (Dioxins and furans are a family of extremely persistent chlorinated compounds that magnify in the food chain, and dioxins are a group of potentially cancer-causing chemicals.) A total of 410 controlled burns (corresponding to about 5% of the total leaked oil) were conducted during the DWH event (Lubchenco 2010). Measurements of dioxins and furans during the DWH event *in situ* burning were made and their emission factors were derived (Aurell and Gullett 2010). These measurements were taken in the plume at locations to which the public and workers would not generally have access. The estimated levels of dioxins and furans produced by the *in situ* burns were similar to those from residential woodstove fires and slightly lower than those from forest fires, according to USEPA researchers (Schaum et al. 2010), and thus, concerns about bioaccumulation in seafood were alleviated. The reports found that while small amounts of dioxins were created by the burns, workers, onshore residents, and residents consuming fish would all have lifetime incremental cancer risks less than 6×10^{-8}, well below USEPA's target risk level of 10^{-4} to 10^{-6}.

Although there are relatively few studies on air quality impacts to human health following oil spills, some lessons can be learned from the 1991 Kuwaiti oil field. In the Kuwaiti event, 600 oil wells were set on fire. These burnings produced a composite smoke plume of gaseous constituents (e.g., NO_X, SO_X, CO_2, etc.), acid aerosols, VOCs, metal compounds, PAHs, and particulate matter. Petruccelli et al. (1999) found that soldiers' reported eye and upper respiratory tract irritation, shortness of breath, cough, rashes, and fatigue were associated with proximity to the Kuwaiti oil fires and that the incidence of symptoms generally decreased after the soldiers left Kuwait. Military personnel deployed to the Persian Gulf War have reported a variety of symptoms attributed to their exposures, including asthma and bronchitis, but Lange et al. (2002) and Thorn et al. (2002) did not find that exposures to oil fire smoke caused respiratory symptoms among veterans. Smith et al. (2002) found that, despite some limitations in the study, the data they analyzed did not indicate that Gulf War veterans have an increased risk of postwar morbidity from exposure to Kuwaiti oil well-fire smoke. However, there may well be differences in exposure and pollutants emitted between the widespread, uncontrolled Kuwaiti oil field fires over land and the DWH event fires involving controlled burns over water.

There would be some residual air quality impacts after the well is capped or "killed." As most of the oil would have been burned, evaporated, or weathered over time, air quality would return to pre-oil spill conditions. While impacts on air quality are expected to be localized and temporary, adverse effects that may occur from the exposure of humans and wildlife to air pollutants could have long-term consequences (BOEMRE 2011a).

4.4.4.1.4 Impact Conclusions.

Routine Operations. Routine operations in the GOM would result in levels of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ well within the NAAQS at onshore locations. The incremental concentrations of NO_2, SO_2, and PM_{10} would be well within the maximum allowable PSD increments. No significant impacts from CO would be anticipated. Emissions estimates for all activities (OCS and non-OCS) show that OCS activities would contribute less than 2% of the total O_3 in areas with levels at times above the standard levels. It would not be expected that emissions from the proposed action would have a measurable impact on acid deposition or visibility. Given the small percentage contributions of routine Program operations to global GHG emissions, their potential impact on climate change would be small. Therefore, impacts to air quality from routine operations associated with the Program in the GOM are expected to be minor.

Expected Accidental Events and Spills. Spill impacts at a given location would depend on the size, location, and duration of the spill and meteorological conditions such as wind speed and direction. Evaporation of small accidental oil spills would cause small localized increases in VOCs. Most of the emissions would occur within a few hours of the spill and would decrease thereafter. Large spills (≥1,000 gal) would result in VOC increases over a larger area and a longer period of time. Most of the VOCs considered hazardous by USEPA are reduced by 99% within 12 hr after a spill. Heavier compounds take longer to evaporate, and therefore air concentrations may not peak until 24 hr after the spill. VOC concentrations in the immediate vicinity of the spill could be high during the first day but concentrations of criteria pollutants would remain within the NAAQS. Over time, air quality would return to pre-spill conditions. Therefore, impacts from small spills would be minor. Impacts from large spills could be moderate in the immediate vicinity of the spill for a short time after the spill, but would be minor after about 12 hr. Air quality impacts from a small or large diesel spill would be less than from an oil spill, and thus would be minor.

In situ burning of spilled crude or diesel would generate emissions of NO_2, SO_2, CO, PM_{10}, and $PM_{2.5}$. In general, particulates would not exceed 150 $\mu g/m^3$ beyond about 5 km (3 mi) downwind of an *in situ* burn. After the burn, air quality would return to pre-burn conditions. Thus, the air quality impacts of *in situ* burns of small spills (<1,000 bbl) would be minor. Air quality impacts of *in situ* burns of large spills could be moderate, but would rapidly return to minor after the burn ceased.

An accidental release of H_2S to the atmosphere could present a serious hazard to platform workers and persons close to the platform. OCS operators involved with sour gas production must have an H_2S Contingency Plan containing measures to prevent serious injury or death to workers. Most sour gas facilities have H_2S concentrations that would result in H_2S levels above the OSHA ceiling level within the dimensions of a typical platform. With the Contingency Plan mitigating impacts, accidental releases of H_2S would cause minor to moderate air impacts.

An Unexpected Catastrophic Discharge Event. In the event of an unexpected CDE, the greatest impacts on air quality would occur during the initial explosion of gas and oil and during the spill response and cleanup. Impacts could continue for days during the initial event and for months during the spill response and cleanup. Despite the length of time that could be involved, emissions from a CDE would be temporary and, over time, air quality in the GOM would return to pre-event conditions.

If *in situ* burning is used during the response to a CDE, carcinogenic dioxins and furans could be formed. These chemicals can bioaccumulate in the food chain. Studies performed during the DWH event indicated that levels of these chemicals were about the same as levels from residential wood stoves and forest fires, so that bioaccumulation is not expected to be a problem. Although dioxins were created during DWH burns, reports found that workers, onshore residents, and residents consuming fish had incremental lifetime cancer risks well below USEPA's target risk level. Although there may be differences between exposure and pollutants emitted between the uncontrolled Kuwaiti oil field fires over land and the controlled DWH burns over water, one study concluded that symptoms reported by soldiers and associated with proximity to the Kuwaiti fires decrease after leaving Kuwait. Other studies concluded that exposure to oil fire smoke did not cause respiratory symptoms among veterans and that there was no increase in morbidity from exposure to smoke from Kuwaiti oil well fires.

There would be some residual air quality impacts after the well was capped. Over time, air quality would return to pre-event conditions. While impacts on air quality are expected to be temporary, adverse effects may occur from the exposure of humans and wildlife to air pollutants that could have long-term consequences.

Overall, the air quality impacts of an unexpected CDE, including *in situ* burning, in the GOM could be moderate during the initial release and during the spill response and cleanup, but would become minor after the well was capped.

4.4.4.2 Alaska – Cook Inlet

The OCS facilities located off the coast of Alaska within the Cook Inlet would be under the jurisdiction of the USEPA, which regulates air emissions as prescribed in 40 CFR Part 55. For facilities located within 40 km (25 mi) of a State's seaward boundary, the regulations are the same as would be applicable if the emission source were located in the corresponding onshore area, and would include State and local requirements for emission controls, emission limitations, offsets, permitting, monitoring, testing, and reporting. For facilities located more than 40 km (25 mi) from a State's seaward boundary, the USEPA air quality regulations apply, for new sources, PSD regulations, and Title V permits. PSD applies to sources that could potentially emit more than either 100 tpy or 250 tons per year (tpy) of a criteria pollutant or precursor. Title V applies to sources that could potentially emit more than 100 tpy of any regulated non-GHG pollutant. In 75 FR 31514, the USEPA promulgated the Greenhouse Gas Tailoring Rule, bringing emissions of GHGs under the PSD and Title V requirements. New source GHG thresholds for PSD are 75,000 tpy CO_2e for sources already subject to PSD for another pollutant and 100,000 tpy CO_2e for other new sources.[18] For Title V, the thresholds are 100,000 tpy CO_2e and 100 tpy on a mass basis. Which threshold applies to a particular source, how the potential emissions are calculated, and what controls are required if the applicable threshold is exceeded are all issues determined in discussions with regulators during the air permit application and approval process.

18 There is an additional requirement that the source's GHG emissions also meet the 100/250 tpy non-GHG threshold based on mass (total GHG emissions without considering the global warming potential of individual gases).

The USEPA has established NAAQS for six criteria pollutants — NO_2, SO_2, PM_{10} and $PM_{2.5}$, CO, Pb, and O_3 — because of their potential adverse effects on human health and welfare. The health and environmental effects of air pollutants have been summarized by the USEPA (USEPA 2011a). Ambient levels of criteria pollutants other than Pb can contribute to respiratory illnesses, especially in persons with asthma, children, and the elderly, and PM and CO can also aggravate cardiovascular diseases.

Ozone Formation. O_3 in the atmosphere is formed by photochemical reactions involving primarily NO_x and VOCs. It is formed most readily in the summer season, with high temperatures, lower wind speeds, intense solar radiation, and an absence of precipitation; high-O_3 episodes are typically associated with slow-moving, high-pressure systems characterized by light winds and shallow boundary layers (NRC 1992). Conditions in Alaska are seldom favorable for significant O_3 formation, primarily due to low ambient temperature and lack of sufficient emissions of VOC to initiate the chemical reaction that forms ozone in the presence of sunlight. At Kodiak, for example, the highest monthly mean daily maximum of 61.0°F occurs in August, when the highest temperature is 86°F (NCDC 2011a). However, measurements taken at several locations have found moderate levels of ozone in Alaska, about 34% and 54% of the 1-hr (revoked in 2005) and 8-hr NAAQS, based on data from Wainwright and Point Lay for 2009 and 2010 and about 61% and 67% of the NAAQS for data taken at five locations on the North Slope for various periods between 1999 and 2007 (USEPA 2010d, 2011s).

Acid Deposition and Visibility. Gaseous pollutants undergo various chemical reactions in the atmosphere to form small particles, which remain airborne for extended periods of time. NO_x compounds react with ammonia and moisture to form ammonium nitrate particles, which contribute to $PM_{2.5}$ concentrations. SO_2 combines with moisture to form tiny sulfate particles, which may also contribute to adverse health effects. In addition, gaseous NO_x and SO_2 can dissolve into tiny suspended water droplets that form clouds. These acidic chemicals eventually return to the ground in either wet (e.g., rain, snow) or dry (e.g., gases, particles) forms, commonly referred to as acid deposition or acid rain (USEPA 2011b). Dry deposition and wet deposition are equally important. The deposition often takes place hundreds of miles from the source. Acid deposition can damage forests and crops, change the makeup of soil, and in some cases may make lakes and streams acidic and unsuitable for fish. Deposition of nitrogen from NO_x emissions also contributes to nitrogen load in water bodies, especially estuaries and near-coastal ecosystems. Acid deposition accelerates the decay of building materials and paints, including those of irreplaceable monuments, statues, sculptures, and other cultural resources. Particulate matter, including sulfate and nitrate particles and organic aerosols that form part of photochemical smog, reduces atmospheric visibility. Atmospheric pollutants adversely affect visibility in many national parks and monuments, as well as wilderness areas (USEPA 2011b).

The most important source of visibility degradation is from $PM_{2.5}$ in the 0.1- to 1-μm size range, which covers the range of visible light (0.4–0.7 μm) (Malm 1999). These particles are directly emitted into the atmosphere through fuel burning. However, other sources arise through the chemical transformation of NO_2, SO_2, and VOCs into nitrates, sulfates, and carbonaceous particles. Existing visibility in Alaska is generally good because of the absence of large emission sources.

4.4.4.2.1 Impacts of Routine Operations. The Cook Inlet OCS experiences open-water conditions throughout the year, except in small northern portions of the planning area from January to March (MMS 2003a).

Under the proposed action, construction and operation of up to 12 exploration and delineation wells, up to 114 development and production wells, up to 241 km (150 mi) of new offshore pipeline, up to 169 km (105 mi) of new onshore pipeline, and up to 1 new pipeline landfall would be required before adverse air quality impacts would occur in Cook Inlet. These activities would generate emissions from stationary sources at the drilling/well sites and from support vessels and aircraft over the 40-year period of the Program (Table 4.4.1-3). There could be up to 3 vessel trips/week and 3 helicopter trips/week under the proposed action.

Emissions. The type and relative amounts of air pollutants generated by offshore operations vary according to the phase of activity. There are three principal phases of OCS operations: exploration, development, and production. Activities affecting air quality include seismic surveys; drilling activities; platform construction and emplacement; pipeline laying and burial operations; platform operations; flaring; fugitive emissions; support vessel and helicopter operations; and evaporation of VOCs during transfers and spills. Principal emissions of concern are the criteria pollutants and their precursors: NO_x, SO_2, PM_{10}, and $PM_{2.5}$, CO, and VOCs.

Releases of toxic chemicals could be a concern around oil spills and *in situ* burning and especially during accidental releases of H_2S at platforms. Other sources of pollutants related to OCS operations are accidents such as losses of well control and oil spills. Spill emissions consist primarily of VOCs, while fires and *in situ* burning produce criteria pollutants along with hazardous air pollutants.

The 50-year total air emissions from the proposed action in the Cook Inlet were estimated using the most recent available exploration and development scenarios for 2012–2017, as shown in Table 4.4.4-3. These emissions were estimated by BOEM (Wolvovsky 2012), using emission factors from the Offshore Environmental Cost Model (Industrial Economics, Inc. et al. 2011).

Oil and gas activity emissions from the Program for the Cook Inlet are relatively small in comparison to those other planning areas. In terms of absolute amount, the main emissions would be NO_x followed by CO and VOCs, with lesser amounts of SO_x, PM_{10} and $PM_{2.5}$ in order of descending emissions. Emissions from the Program would initially be lower in the first few years as exploratory wells were drilled and platforms started producing oil and gas. During the last half of the 50-yr Program, emissions would decrease as production decreased and some platforms were removed (MMS 2007d).

Impacts on Criteria Pollutants Other Than Ozone. Air quality modeling for NO_2, SO_2, and PM_{10} were conducted for a lease sale in the Cook Inlet Planning Area (MMS 2003a). Potential air quality impacts were estimated by using the Offshore and Coastal Dispersion model for both exploratory drilling and a production facility. Potential emission sources were placed so as to maximize potential air quality impacts on the Tuxedni Wilderness Area (WA), which is a PSD Class I area in the Cook Inlet. The highest predicted NO_2 concentration in the Tuxedni WA was 0.27 $\mu g/m^3$, about 11% of PSD Class I maximum allowable increment of 2.5 $\mu g/m^3$. For

TABLE 4.4.4-3 Estimated 50-year Total Air Emissions from OCS Activities in the Cook Inlet Planning Area, Proposed 2012-2017 Leasing Program

	Emissions (10^3 tons)					
Activity	NO_x	SO_x	PM_{10}	$PM_{2.5}$	CO	VOC
Development/production wells	0.80–2.18[a]	0.16–0.44	0.06–0.15	0.06–0.15	0.14–0.39	0.00–0.01
Drilling exploration/delineation wells	0.08–0.23	0.02–0.05	0.01–0.02	0.01–0.02	0.01–0.04	0.00–0.00
Helicopters	0.01–0.04	0.00–0.01	0.00–0.01	0.00–0.01	0.16–0.52	0.03–0.10
Pipe-laying vessels	0.33–1.99	0.06–0.34	0.01–0.08	0.01–0.08	0.07–0.41	0.01–0.08
Platform construction	0.01–0.02	0.00–0.00	0.00–0.00	0.00–0.00	0.00–0.00	0.00–0.00
Platform production	0.90–2.87	0.01–0.04	0.01–0.03	0.01–0.03	0.99–3.16	0.81–2.57
Platform removal	0.01–0.02	0.00–0.00	0.00–0.00	0.00–0.00	0.00–0.00	0.00–0.00
Support vessels	1.63–5.16	0.22–0.7	0.03–0.09	0.03–0.09	0.15–0.49	0.03–0.09
Survey vessels	0.02–0.06	0.00–0.01	0.00–0.00	0.00–0.00	0.00–0.01	0.00–0.00
Total	3.79–12.57	0.47–1.58	0.11–0.37	0.11–0.37	1.54–5.76	0.89–2.85

[a] The range of values reflects the low and high end of the exploration and development scenarios for the Program.

Sources: Industrial Economics, Inc. et al. 2012; Wolvovsky 2012.

SO_2, the highest predicted annual average, maximum 24-hr, and maximum 3-hr average concentrations in the Tuxedni WA were 0.02, 0.58, and 2.7 μg/m^3, respectively, for which PSD Class I incremental limits are 2, 5, and 25 μg/m^3. For PM_{10}, the highest annual average and 24-hr average concentrations in Tuxedni WA were predicted to be 0.02 and 0.51 μg/m^3, for which PSD Class I incremental limits are 4 and 8 μg/m^3. The highest onshore pollutant concentrations were lower than or comparable to those in the Tuxedni WA and thus less than the NAAQS and the PSD Class II incremental limits.

Comparing Impacts to PSD Increments

Several points should be considered when air quality impacts are compared to PSD increments. First, the PSD program applies to individual sources, not programs. Emissions from an individual source such as a platform or set of platforms could differ from the emissions being modeled in a particular study. Second, increment tracking is a cumulative process that sets a maximum allowable increase above a baseline concentration. It is unlikely that a permitting agency would permit a single source to consume the entire increment. Last, PSD applies only to major sources, generally sources with the potential to emit more than 250 tons/yr, except the 100 tons/yr threshold for 28 source categories. OCS oil and gas production activities are subject to a 250 tons/yr threshold. Regardless of the *actual* emissions, a source's potential emissions could exceed the 250 tons/yr threshold. Determining *potential* emissions and available PSD increment allowances require consultation with the cognizant regulators.

If applicable under the PSD or Title V regulations, each project in the Program would apply the best available control technology according to USEPA and State regulations, and pollutant concentrations would have to meet the PSD incremental limits. Existing pollutant concentrations in the Cook Inlet are well within the NAAQS (MMS 2003a). The small additional concentrations from the Program would not be expected to result in levels that equal or exceed the NAAQS.

Impacts on Ozone. As noted above, although ozone does form in Alaska, conditions are seldom favorable for significant O_3 formation because of the low ambient temperature and the lack of sufficient emissions of VOC to initiate the chemical reaction with NO_x and sunshine required to form ozone. Thus a significant increase in O_3 concentrations onshore is not likely to result from oil and gas activities associated with the proposed action. OCS activities would also be relatively small and separated from each other, diminishing the combined effects from these activities and greatly increasing atmospheric dispersion of pollutants before they reach shore. The proposed activities would not be expected to cause any exceedances of the O_3 standard (MMS 2008b).

Impacts on Visibility. A number of visibility screening runs were performed using the VISCREEN model to evaluate potential effects of oil and gas activities on visibility in the Tuxedni WA (MMS 2003a). For an exploration project located 12 km (7.5 mi) distant from the Tuxedni WA, the model results exceed the screening criteria when the wind blows directly from the facility to the Tuxedni WA, under the worst-case meteorological conditions with a wind speed of 1 m/s (2.2 mph) and stable atmosphere. If the screening criteria are exceeded, it indicates the possibility that a plume generated by the emissions would be visible by an observer within Tuxedni WA. However, it does not provide a measure of any general visibility effects in the area, such as regional haze. It is estimated that this scenario would occur less than 1% of the time. For distances larger than 50 km (31 mi), the screening criteria were not exceeded. Under average meteorological conditions, it is estimated that a plume would not be visible.

Given that oil and gas sources are relatively small and would be scattered over a large area, it is not expected that they would have a measureable impact on visibility. However, a more refined analysis might be needed during the permitting process to more precisely evaluate any effects of oil and gas activities on visibility.

Greenhouse Gas Emissions and Climate Change. Estimates were made of the 50-year total GHG emissions of CO_2, CH_4, and N_2O for all projected activities associated with the Program (Wolvovsky 2012). Emission estimates for the various activities were largely based on emission factors from the Offshore Environmental Cost Model (Industrial Economics, Inc. et al. 2011). Air emissions resulting from the Program were estimated by considering the exploration and development scenarios presented in Table 4.4.1-3. Emissions are given in terms of (Tg) of CO_2e, where 1 Tg is 10^{12} g (10^6 metric tons). This measure takes into account a Global Warming Potential (GWP) factor that accounts for the relative effectiveness of a gas to contribute to global warming with respect to the same amount of CO_2. In these calculations, CH_4 is given a GWP of 21, while N_2O is given a GWP of 310.

Table 4.4.4-4 lists the total calculated emissions (25-year totals for the low scenario and 30-year totals for the high scenario) of CO_2, CH_4, and N_2O from activities associated with the Program and compares them with current (2009) U.S. GHG emissions from all sources (USEPA 2011l). The projected CO_2 emissions from the Program are about 0.00038–0.00095% of all current CO_2 emissions in the United States. The Program CH_4 and N_2O emissions are up to about 0.00170% and 0.00011%, respectively, of their current respective emissions in the United States. If CO_2, CH_4, and N_2O emissions are combined, the Program emissions are about 0.00039–0.00099% of the nationwide total of these three GHG emissions and about 0.00038%–0.00097% of the nationwide emissions of all GHGs. The estimated total global GHG emissions in 2005 were approximately 38,726 Tg CO_2e (74 FR 66539). The estimated Program GHG emissions are about 0.000065–0.00017% of the total global GHG emissions.

As noted in Section 3.3, GHG emissions are one of the causes of climate change. Climate change is a global phenomenon and predicting climate change impacts requires consideration of large-scale or even worldwide GHG emissions, not just emissions at a local level. Climate change predictive capability (modeling) lacks the ability to estimate the impact of GHGs from a particular source or sources such as oil and gas activities associated with the Program. What their impact, if any, would be is determined not only by the emissions from the oil and gas activities themselves, but also by the GHG emissions of other sources throughout the world and whether these other emissions are expected to increase or decrease. In addition, since some GHG gases, such as CO_2, may persist in the atmosphere for up to a century, the potential impacts of any source may extend well beyond the active lifetime of the source or program. This said, given the small percentage contributions of oil and gas activities in Cook Inlet to global GHG emissions, the potential impact on climate change would probably be small. Section 3.3 provides some baseline considerations for climate change and Section 4.4.3 and Sections 4.4.6 through 4.4-15 discuss potential impacts on specific impact areas.

TABLE 4.4.4-4 Projected Greenhouse Gas Emissions from Oil and Gas Activities in the Cook Inlet Planning Area, 2012-2017 Leasing Program[a]

Pollutant	2012-2017 Program[b] (Tg CO_2e)	2012-2017 Cook Inlet (Tg CO_2e)[c]	Total 2009 U.S. Emissions from All Sources (Tg CO_2e)	2012-2017 Cook Inlet as Percentage of Total 2009 U.S. Emissions
CO_2	58.3–117.27	0.52–1.57	5,505.2	0.00038–0.00095
CH_4	15.4–29.67	0.11–0.35	686.3	0.00064–0.00170
N_2O	0.47–0.95	0.005–0.010	295.6	0.00007–0.00011
$CO_2 + CH_4 + N_2O$	74.18–147.89	0.63–1.93	6,487.1	0.00039–0.00099
All GHGs[d]	74.18–147.89	0.63–1.93	6,633.2	0.00038–0.00097

[a] Emissions in the table represent 25-year totals for the low scenario and 30-year totals for the high scenario, except the third column, which presents total 2009 U.S. emissions.

[b] Sum of the GHGs from Cook Inlet, GOM, and the Beaufort Sea and Chukchi Sea Planning Areas in this table and Tables 4.4.4-2 and 4.4.4-6.

[c] One Tg is equal to 10^{12} g, or 10^6 metric tons. The CO_2e for a gas is derived by multiplying the mass of the gas by the associated GWP, which accounts for the relative effectiveness of a gas to contribute to global warming with respect to the same amount CO_2. In these calculations, CH_4 is given a GWP of 21, while N_2O is given a GWP of 310.

[d] Total U.S. GHG emissions also include hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride emissions. Estimates of emissions from the Program were not made for these compounds, but they are assumed to be very small.

Sources: Industrial Economics, Inc. et al. 2012; USEPA 2011l; Wolvovsky 2012.

4.4.4.2.2 Impacts of Expected Accidental Events and Spills. Under the proposed action, the number and types of spills assumed to occur in Cook Inlet include up to one large spill (≥1,000 bbl) from either a pipeline or platform and between 8 and 18 small spills (<1,000 bbl) over the 40-year period of the Program (Table 4.4.2-1). Evaporation of oil from these spills and emissions from spill response and cleanup activities including *in situ* burning, if used, have the potential to affect air quality in Cook Inlet.

Spills and In Situ Burning. Small accidental oil spills would cause small, localized increases in concentrations of VOCs because of evaporation of the surface oil. Most of the emissions would occur within a few hours of the spill and would decrease rapidly after that period. Large spills would exhibit similar behavior but would affect a somewhat larger area and cause elevated pollutant concentrations that would persist for a longer period of time. The impacts at a given location would depend on the size, location, and duration of the spill and meteorological conditions such as wind speed and direction. Hanna and Drivas (1993) modeled the emissions of various hydrocarbon compounds from a large spill. A number of these compounds, including BTEX and hexane, are classified by the USEPA as hazardous air pollutants. Many of these contaminants may be carcinogenic to humans and/or animals. The results showed that these compounds evaporate almost completely within a few hours after the spill occurs. Ambient concentrations peak within the first several hours after the spills starts and are reduced by two orders of magnitude after about 12 hr. The heavier compounds take longer to evaporate and may not peak until about 24 hr after spill occurrence. Total ambient VOC concentrations are high in the immediate vicinity of an oil spill, but concentrations are much reduced after the first day (MMS 2007d). Spreading of the spilled oil and action by winds, waves, and currents would further disperse VOC concentrations to extremely low levels over a relatively larger area. Concentrations of criteria pollutants would remain well within NAAQS (MMS 2008b). Over time, air quality would return to pre-spill conditions. There is no information about any possible effect from the inhalation of air contaminants by subsistence animals, but this effect would be expected to be much less than any contamination by contact with hazardous compounds in the water. These effects on subsistence are described in Section IV.B.3.k of MMS (2007d).

In situ burning is a potential technique for cleanup and disposal of spilled oil. *In situ* burning of a spill results in emissions of NO_2, SO_2, CO, and PM_{10} and generates a plume of black smoke. Fingas et al. (1995, 2011) describes the results of a monitoring program of a burn experiment at sea. The program involved extensive ambient measurements during two experiments in which approximately 300 bbl of crude oil was burned. It found that during the burn, CO, SO_2, and NO_2 were measured only at background levels and were frequently below detection levels. Ambient levels of VOCs were high within about 100 m (328 ft) of the fire but much lower than those associated with a nonburning spill. PAHs were largely burned by the fire and were lower in the soot than in the oil. Particulates at sea level were of concern only up to 150 m (492 ft) downwind. Measured concentrations of PAHs were low. It appeared that a major portion of these compounds was consumed in the burn. Effects of *in situ* burning for spilled diesel fuel would be similar to those associated with a crude oil spill (MMS 2008b). The appearance of a black plume from *in situ* burning around a subsistence hunting area could have an adverse effect on subsistence hunting practices because of the creation of a perception that wildlife has been contaminated. Subsistence hunters may avoid areas where such incidents have occurred.

A major component of the pollution from a fire would be soot. Soot would cling to plants near the fire but would tend to clump and wash off vegetation in subsequent rains. Potential contamination of shoreline and onshore vegetation would be limited, because oil and gas activities under the proposed action would be at least 15 km (9.3 mi) offshore, with the exception of any oil- or gas-transport pipelines (MMS 2008b).

Smoke from burning crude oil would contain PAHs. Benzo(a)pyrene, which often is used as an indicator of the presence of carcinogenic varieties of PAHs, is present in crude oil smoke in very small amounts, but in quantities approximately three times larger than in unburned oil (Evans 1988). Investigators have found that, overall, the oily residue in smoke plumes from crude oil is mutagenic, although not highly so. McGrattan et al. (1995) modeled smoke plumes associated with *in situ* burning. The results showed that the surface concentrations of particulate matter did not exceed the health criterion of 150 $\mu g/m^3$ beyond about 5 km (3 mi) downwind of an *in situ* burn. This appears to be supported by field experiments conducted off Newfoundland and in Alaska (MMS 2007d). This should be considered conservative because this health standard is based on a 24-hr average concentration rather than a 1-hr average concentration.

After the burn, air quality would rapidly return to pre-burn conditions.

Air quality impacts from accidental oil spills in open water during the proposed action would be similar to those described above. However, albeit limited to a small northern area and short duration (January to March), a spill in Cook Inlet during broken ice or melting ice conditions could result in more concentrated emissions over a smaller area than would be the case under open-water conditions because the ice would act to reduce spreading of the oil compared to the spreading of a spill in open water. An oil spill on solid sea ice would spread relatively slowly compared to a spill in open water. The more volatile components of the oil would evaporate rather rapidly, but the heavier compounds would linger on the surface. The effects on air quality would result in more concentrated emissions over a smaller area than would be the case for a spill in open water.

Hydrogen Sulfide. An accidental release of H_2S at a platform and its associated impacts on platform workers and persons in close proximity to a platform are discussed in detail in Section 4.4.4.1. Potential impacts at or around the platform would be similar in the Cook Inlet.

4.4.4.2.3 Impacts of an Unexpected Catastrophic Discharge Event. In the Cook Inlet Planning Area, an unexpected low-probability CDE is assumed to range in size from 75,000 and 125,000 bbl, with a duration of 50–80 days (Table 4.4.2-2). Evaporation of oil from these spills and emissions from spill response and cleanup activities including *in situ* burning, if used, have the potential to result in minor to moderate impacts to air quality in Cook Inlet.

A CDE in South Central Alaska could emit regulated pollutants into the atmosphere. This may cause air quality impacts during some phases of the event. The greatest impacts on air quality conditions would occur during the initial explosion of gas and oil and during the spill response and cleanup, particularly if the event occurs during the winter. Impacts could continue for days during the initial event and could continue for months during spill response and clean up. Therefore, while the impacts may be large during these two phases, overall, the emissions from a CDE would be temporary and, over time, air quality in south central Alaska would return to pre-event conditions (BOEMRE 2011j).

The air impacts of any *in situ* burning associated with a CDE in Cook Inlet would be similar to those open-water impacts discussed in Section 4.4.4.1. Potential impacts from a large spill on the ice are discussed in the "Spills and *In Situ* Burning" subsection above.

There would be some residual air quality impacts after the well is capped or "killed." As most of the oil would have been burned, evaporated, or weathered over time, air quality would return to pre-oil spill conditions. While impacts on air quality are expected to be localized and temporary, adverse effects that may occur from the exposure of humans and wildlife to air pollutants could have long-term consequences (BOEMRE 2011a).

4.4.4.2.4 Impact Conclusions.

Routine Operations. Routine operations in Cook Inlet would result in levels of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ within the NAAQS at onshore locations. Modeling conducted for NO_2, SO_2, and PM_{10} for a lease sale in Cook Inlet showed concentrations below the Class I PSD increments in the Tuxedni WA and below the NAAQS and PSD Class II increments at onshore locations. The small additional concentrations from the Program would not be expected to exceed the NAAQS. Conditions are seldom favorable for significant O_3 formation in Alaska, and the proposed activities would not be expected to cause exceedances of the O_3 standard. Given that oil and gas sources are relatively small and scattered over a large area, it is not expected that they would have a measurable impact on visibility. Given the small percentage contributions of routine Program operations to global GHG emissions, their potential impact on climate change would be small. Therefore, impacts to air quality from routine operations associated with the Program in Cook Inlet are expected to be minor.

Expected Accidental Events and Spills. Spill impacts at a given location would depend on the size, location, and duration of the spill and meteorological conditions such as wind speed and direction. Evaporation of small accidental oil spills would cause small localized increases in VOCs. Most of the emissions would occur within a few hours of the spill and would decrease thereafter. Large spills ($\geq$1,000 gal) would result in VOC increases over a larger area and a longer period of time. Most of the VOCs considered hazardous by USEPA are reduced by 99% within 12 hr after a spill. Heavier compounds take longer to evaporate, and therefore air concentrations may not peak until 24 hr after the spill. VOC concentrations in the immediate vicinity of the spill could be high during the first day, but concentrations of criteria pollutants would remain within the NAAQS. Over time, air quality would return to pre-spill conditions. Therefore, impacts from small spills would be minor. Impacts from large spills could be moderate in the immediate vicinity of the spill for a short time after the spill but would be minor after about 12 hr.

In situ burning of spilled crude or diesel would generate emissions of NO_2, SO_2, CO, PM_{10}, and $PM_{2.5}$. In general, particulates would not exceed the 150 $\mu g/m^3$ beyond about 5 km (3 mi) downwind of an *in situ* burn. After the burn, air quality would return to pre-burn conditions. Thus, the air quality impacts of *in situ* burns of small spills (<1,000 bbl) would be minor. Air quality impacts of *in situ* burns of large spills could be moderate, but would rapidly return to minor after the burn ceased.

An accidental release of H_2S to the atmosphere could present a serious hazard to platform workers and persons close to the platform. OCS operators involved with sour gas production must have an H_2S Contingency Plan containing measures to prevent serious injury or death to workers. Most sour gas facilities have H_2S concentrations that would result in H_2S levels above the OSHA ceiling level within the dimensions of a typical platform. With the Contingency Plan mitigating impacts, accidental releases of H_2S would cause minor to moderate air impacts.

An Unexpected Catastrophic Discharge Event. In the event of an unexpected CDE, the greatest impacts on air quality would occur during the initial release and during the spill response and cleanup. Impacts could continue for days during the initial event and for months during the spill response and cleanup. Despite the length of time that could be involved, emissions from a CDE would be temporary and, over time, air quality in Cook Inlet would return to pre-event conditions.

If *in situ* burning is used during the response to a CDE, carcinogenic dioxins and furans could be formed. These chemicals can bioaccumulate in the food chain. Studies performed during the DWH event indicated that levels of these chemicals were about the same as levels from residential wood stoves and forest fires so that bioaccumulation is not expected to be a problem. Although dioxins were created during DWH burns, reports found that workers, onshore residents, and residents consuming fish had incremental lifetime cancer risks well below USEPA's target risk level. Although there may be differences between exposure and pollutants emitted between the uncontrolled Kuwaiti oil field fires over land and the controlled DWH burns over water, one study concluded that symptoms reported by soldiers and associated with proximity to the Kuwaiti fires decreased after leaving Kuwait. Other studies concluded that exposure to oil fire smoke did not cause respiratory symptoms among veterans and that there was no increase in morbidity from exposure to smoke from Kuwaiti oil well fires.

There would be some residual air quality impacts after the well was capped. Over time, air quality would return to pre-event conditions. While impacts on air quality are expected to be temporary, adverse effects may occur from the exposure of humans and wildlife to air pollutants that could have long-term consequences.

Overall, the air quality impacts of an unexpected CDE, including *in situ* burning, in Cook Inlet could be moderate during the initial explosion of gas and oil and during the spill response and cleanup but would become minor after the well was capped.

4.4.4.3 Alaska – Arctic

With the exception of icebreakers, which are a major emission source in the Arctic that is not present in the GOM, general air emission sources and potential impacts on ambient air quality associated with OCS oil and gas activities are covered in detail in Section 4.4.4.1 for the GOM. Air quality impacts for both the Beaufort and the Chukchi Seas are similar and are discussed together. Differences are noted where appropriate.

With the enactment of the Clean Air Act Amendments of 1990 (CAA), control of air emissions from rigs, drillships, and platforms on the Arctic OCS was the responsibility of the USEPA (CAA Section 328). Amendments to CAA Section 328 were enacted on December 23, 2011, through the Consolidated Appropriations Act, 2012 (Pub. L. 112-74. December 23, 2011. Amendment to Section 430 Section 10101 of the Omnibus Budget Reconciliation Act of 1993 [30 USC 28f], Section 432, Air Emissions from Outer Continental Shelf Activities). The signing of Pub. L. 112-74 transferred authority from the USEPA to the Department of Interior (USDOI) for air emissions on the Beaufort Sea and Chukchi Sea OCS adjacent to the North Slope Borough of Alaska. The new jurisdiction is authorized under Section 5(a)(8) of the OCS Lands Act (OCSLA) and is regulated pursuant to the USDOI Pollution Prevention and Control rule at 30 CFR Part 550 Subpart C (USDOI Air Quality Regulatory Program). The Arctic OCS is defined to include the Beaufort Sea and Chukchi Sea OCS Planning Areas that are adjacent to the North Slope Borough of Alaska. The other Alaska OCS Planning Areas, including the Cook Inlet, remain under USEPA jurisdiction and emissions are regulated pursuant to 40 CFR Part 55.

All Federal actions on the Alaska OCS, including the Arctic OCS, proposed to occur within 4.8 km (3 mi) of shore remain subject to air quality regulations of the Alaska Department of Environmental Conservation (ADEC) and may require State air quality permits. For proposed exploration plans (EPs) or development or production plans (DPPs) located more than 4.8 km (3 mi) offshore on the Arctic OCS, emissions are regulated by the BOEM Alaska Region (AOCSR) under the USDOI Air Quality Regulatory Program. Under the program, the AOCSR does not issue air quality permits, as was required under USEPA rules; rather, the AOCSR Office of the Environment conducts an analytical evaluation of the air quality analysis contained in any EP or DPP proposed for the Arctic OCS for compliance with program. Emissions projected for a facility proposed for an EP or DPP that exceed exemption thresholds calculated under 30 CFR 550.303(d) would be required to conduct an air quality impact analysis (dispersion analysis) for comparison to the USEPA Significance Levels (SLs)[40 CFR 51.165(b)(2)]. Should the air quality analysis show that pollutant concentrations would exceed one or more of the SLs, the application of Best Available Control Technology (BACT) would be required. If the action proposes a permanent facility, for instance a DPP, additional analysis would be required to demonstrate whether the application of BACT would result in compliance with the USEPA Maximum Allowable Increases (MAIs) [40 CFR 52.2(c)]. Additional controls are required until the MAIs are met. The air quality analysis contained in a proposed EP or DPP must demonstrate compliance with the USDOI Air Quality Regulatory Program before the EP or DPP could be approved by the AOCSR Office of Leasing and Plans. Any required application of BACT or other emission controls would be enforced by the AOCSR Bureau of Safety and Environmental Enforcement (BSEE).

Emissions of greenhouse gases (GHGs) also occur as a result of the operation of engines aboard marine vessels and other vehicles and equipment proposed for the Alaska OCS. For the Arctic OCS, GHG emissions are no longer reported within the USEPA Title V or Prevention of Significant Deterioration (PSD) air quality permitting process. Rather, depending on the type of oil and gas activity, the operator is independently responsible for reporting projected emissions of GHG to the USEPA as specified in the 40 CFR Part 98 Subparts A, C, and W. No function of the USDOI Air Quality Regulatory Program provides for the reporting of GHG.

Likewise, under the program, there is no requirement to report or obtain a permit for hazardous air pollutants (HAPs) pursuant to Section 112 of the Clean Air Act. Therefore, it is the responsibility of the project proponent to independently consult with the Federal and State EPA authorities regarding requirements to report HAPs.

The USEPA has established NAAQS for six criteria pollutants — NO_2, SO_2, PM_{10} and $PM_{2.5}$, CO, Pb, and O_3 — because of their potential adverse effects on human health and welfare. The health and environmental effects of air pollutants have been summarized by the USEPA (USEPA 2011a). Ambient levels of criteria pollutants other than Pb can contribute to respiratory illnesses, especially in persons with asthma, children, and the elderly, and PM and CO can also aggravate cardiovascular diseases.

Ozone Formation. O_3 in the atmosphere is formed by photochemical reactions involving primarily NO_x and VOCs. It is formed most readily in the summer season, with high temperatures, lower wind speeds, intense solar radiation, and an absence of precipitation; high-O_3 episodes are typically associated with slow-moving, high-pressure systems characterized by light winds and shallow boundary layers (NRC 1992). Conditions in Alaska are seldom favorable for significant O_3 formation, primarily due to low ambient temperature. At Barrow, for example, the highest monthly mean daily maximum of 45.9°F occurs in July, when the highest temperature is 79°F (NCDC 2011b). However, measurements taken at several locations have found moderate levels of ozone in Alaska, about 34% and 54% of the 1-hr (revoked in 2005) and 8-hr NAAQS based on data from Wainwright and Point Lay for 2009 and 2010, and about 61% and 67% of the NAAQS for data taken at five locations on the North Slope for various periods between 1999 and 2007 (USEPA 2010d, 2011s).

Acid Deposition and Visibility. Gaseous pollutants undergo various chemical reactions in the atmosphere to form small particles, which remain airborne for extended periods of time. NO_x compounds react with ammonia and moisture to form ammonium nitrate particles, which contribute to $PM_{2.5}$ concentrations. SO_2 combines with moisture to form tiny sulfate particles, which may also contribute to adverse health effects. In addition, gaseous NO_x and SO_2 can dissolve into cloud water. These acidic chemicals eventually return to the ground in either wet (e.g., rain, snow) or dry (e.g., gases, particles) forms, commonly referred to as acid deposition or acid rain (USEPA 2011b). Dry deposition is just as important as wet deposition. The deposition often takes place hundreds of miles from the source. Acid deposition can damage forests and crops, change the makeup of soil, and in some cases may make lakes and streams acidic and unsuitable for fish. Deposition of nitrogen from NO_x emissions also contributes to nitrogen load in water bodies, especially estuaries and near-coastal ecosystems. Acid deposition accelerates the decay of building materials and paints, including those of irreplaceable monuments, statues, sculptures, and other cultural resources. Particulate matter, including sulfate and nitrate particles and organic aerosols that form part of photochemical smog, reduces atmospheric visibility. Atmospheric pollutants adversely affect visibility in many of national parks and monuments, and in wilderness areas (USEPA 2011b).

The most important cause of visibility degradation is from $PM_{2.5}$ in the 0.1- to 1-μm size range, which covers the range of visible light (0.4–0.7 μm) (Malm 1999). These particles are directly emitted into the atmosphere through fuel burning. However, other sources arise through chemical transformation of NO_2, SO_2, and VOCs into nitrates, sulfates, and carbonaceous particles. Existing visibility in Alaska is generally good because of the absence of large emission sources. However, the phenomenon of Arctic haze, which occurs in Arctic Alaska during the winter and spring, is caused primarily by long-range transport of pollutants from industrial Eurasia (Rahn 1982).

Arctic Haze. Arctic haze causes a reduction in visibility and often appears in distinct bands at different heights. The haze is seasonal, appearing first in late fall around November, and peaking in the spring. The haze originates from anthropogenic sources outside the Arctic. The most severe episodes occur when stable high pressure systems produce clear, calm weather and can reduce visibility (~30.6 km [~19 mi]) in spite of the otherwise clear weather. Coal burning appears to be the principle source of haze particles. Haze particles consists of sulfate (up to 90%), soot, and sometimes dust, most of which originate in Eurasia and are picked up by the Arctic air mass that moves northward over the North Pole in winter. The cold, dry air in the polar regions allows particles to remain airborne for weeks, thus permitting the contaminants to spread over the Arctic and into North America. Arctic haze reduces visibility, but the levels of sulfur compounds in haze are lower than those found in heavily polluted cities (AMAP 1997).

4.4.4.3.1 Impacts of Routine Operations. OCS operations in the Arctic Ocean are unique in a number of ways because of the sea ice that is present much of the year. In waters 5–10 m (16–33 ft) deep, exploratory wells may be drilled from an ice or gravel island (MMS 2003e). Construction of an ice island would need to take place in winter (November–January), and material and personnel would be carried to the site by vehicles operating on an ice road. In water 10–20 m (33–66 ft) deep, movable platforms attached to the seafloor may be used for exploration. Drilling operations from these platforms are usually conducted during open-water season from July through October. Ice islands are not projected for the Chukchi Sea, because activities there would not occur close to shore. In deeper waters, drillships or floating platforms would be used, and drilling would be limited less than 4 months during the summer. Material and supplies would be ferried using barges or supply boats. In addition, icebreakers would operate in the vicinity of the drilling rig and vessels to control incursions of sea ice. Because of the Arctic conditions, the pace of development is slower as activities are limited to certain rather narrow time frames. Air emission rates tend to be higher because activities are more concentrated and additional vessels such as icebreakers may be needed. In shallow waters, production may take place from gravel islands, while in deeper waters production facilities would be installed on large gravity-base platforms. As in the case of exploration, a gravel island would be constructed during winter. The modules for production facilities would be installed during the ice-free period using barges, tugboats, and supply vessels (MMS 2007d).

Under the proposed action, construction and operation of up to 36 exploration wells, up to 400 production wells, up to 92 subsea wells, up to 652 km (405 mi) of new offshore pipeline, and up to 129 km (80 mi) of new onshore pipeline would be required before adverse air quality impacts would occur in Arctic Alaska. These activities would generate emissions from stationary sources at the drilling/well sites and from support vessels and aircraft over the 50-year period of the Program (Table 4.4.1-4). There could be up to 27 vessel trips/wk and 27 helicopter trips/wk under the proposed action.

Emissions. The type and relative amounts of air pollutants generated by offshore operations vary according to the phase of activity. There are three principal phases of OCS operations: exploration, development, and production. Activities affecting air quality include seismic surveys; drilling activities; platform construction and emplacement; pipeline laying and burial operations; platform operations; flaring; fugitive emissions; support vessel and helicopter operations; and evaporation of VOCs during transfers and spills.

Releases of toxic chemicals could be a concern around spills and during *in situ* burning and especially during accidental releases of H_2S at platforms. Other sources of pollutants related to OCS operations are accidents such as losses of well control and oil spills. Spill emissions consist primarily of VOCs, while fires and *in situ* burning produce criteria pollutants along with hazardous air pollutants.

The 50-year air emissions from the proposed action for the Beaufort Sea and the Chukchi Sea were estimated by using the most recent available exploration and development scenarios for 2012–2017 as shown in Table 4.4.4-5; pipe-laying vessels, platform construction, and platform removal activities include emissions from icebreakers. These emissions were estimated by BOEM (Wolvovsky 2012), using emission factors from the Offshore Environmental Cost Model (Industrial Economics, Inc. et al. 2011).

In terms of absolute amount, the largest emissions would be NO_x, followed by CO, with lesser amounts of SO_x, VOCs, PM_{10}, and $PM_{2.5}$. Under the low scenario, the largest source of NO_x is the drilling of exploration and delineation wells; under the high scenario, the largest NO_x source is support vessels. Under both scenarios, the drilling of exploration and delineation wells is the largest source of SO_x, PM_{10}, and $PM_{2.5}$. Oil tankers cruising, loading, and unloading in Alaska are projected to be the largest source of CO and VOC emissions associated with oil and gas activities in the Arctic. However, much of the tanker emissions would be at some distance from the lease areas. For sources located in or near the lease areas, platform production would be the largest source of CO and VOC emissions. Emissions from the Program would initially be lower in the first few years as exploratory wells were drilled and platforms started producing oil and gas. During the last half of the Program, emissions would decrease as production decreased and some platforms were removed (MMS 2007d).

Impacts on Criteria Pollutants Other Than Ozone. Air quality modeling using the Offshore and Coastal Dispersion Model (OCD) has been performed in past studies to assess impacts from planned lease sales in the Beaufort Sea (MMS 1996a). The highest predicted onshore annual average NO_2 concentrations were in the range of 0.5–1.5 $\mu g/m^3$, which is well below the PSD Class II maximum allowable increment of 25 $\mu g/m^3$. Concentrations of SO_2 and PM_{10} were not modeled; however, when the results are scaled according to the respective emission rates, the levels would be below the PSD Class II maximum allowable increments.

An examination of the air quality modeling analysis performed for the Northstar facility and proposed Liberty development project in the Beaufort Sea provides a measure of the expected impacts over water near an OCS production facility on a gravel island in the Beaufort Sea. The highest predicted concentrations for NO_2, SO_2, and PM_{10} for the Northstar and Liberty projects occurred within 200 m (656 ft) of the facility boundary and were close to but still lower than PSD Class II maximum allowable increments (MMS 2002c). The highest onshore concentrations were considerably lower. The combined facility concentrations for Liberty plus background were well within NAAQS (between 2 and 30% of the standards).

Results of OCD modeling for development from a proposed lease sale in the Chukchi Sea indicated that the highest annual average NO_2 concentration was 1.29 $\mu g/m^3$, which is about 5% of PSD Class II maximum allowable increment of 25 $\mu g/m^3$ (MMS 1991). No modeling was performed for SO_2 and PM_{10}, but concentrations should be well within the PSD Class II increments considering that NO_x emissions are an order of magnitude higher than SO_2 and PM_{10} emissions.

TABLE 4.4.4-5 Estimated 50-Year Total Air Emissions from OCS Activities in the Arctic (Beaufort and Chukchi Seas) Planning Area, Proposed 2012-2017 Leasing Program

	Emissions[a] (10^3 tons)					
Activity	NO_x	SO_x	PM_{10}	$PM_{2.5}$	CO	VOC
Development/Production Wells	2.44–9.4[b]	0.5–1.92	0.17–0.64	0.17–0.64	0.01–0.05	0.44–1.67
Drilling Exploration/Delineation Wells	5.93–17.79	1.54–4.61	0.27–0.80	0.24–0.73	0.00–0.01	0.26–0.77
Helicopters	0.04–0.21	0.01–0.05	0.01–0.04	0.01–0.04	0.43–2.56	0.09–0.5
Pipe-laying Vessels	0.73–5.37	0.12–0.91	0.03–0.2	0.03–0.2	0.15–1.11	0.03–0.2
Platform Construction	1.85–8.33	0.43–1.96	0.07–0.33	0.07–0.3	0.06–0.26	0.06–0.29
Platform Production	2.39–14.07	0.03–0.19	0.02–0.13	0.02–0.13	2.63–15.5	2.14–12.61
Platform Removal	1.85–8.33	0.43–1.96	0.07–0.33	0.07–0.3	0.06–0.26	0.06–0.29
Support Vessels	4.3–25.34	0.58–3.41	0.07–0.44	0.07–0.44	0.41–2.41	0.07–0.44
Survey Vessels	0.05–0.32	0.01–0.04	0.00–0.00	0.00–0.00	0.00–0.03	0.00–0.00
Total	19.49–89.16	3.65–15.04	0.71–2.92	0.68–2.8	3.77–22.2	3.15–16.79

[a] Activity in the Beaufort and Chukchi Seas will be confined to the ice-free portions of the year and emissions will occur predominantly during this period.

[b] The range of values reflects the low and high end of the exploration and development scenarios for the Program.

Source: Industrial Economics, Inc. et al. 2012; Wolvovsky 2012.

Results of PSD permit modeling for Beaufort Sea exploration drilling by Shell's Frontier Discoverer drillship and its Associated Fleet, including icebreakers, were below the PSD Class II increments and below the NAAQS levels (USEPA 2010d). Similar modeling for Beaufort Sea and Chukchi Sea exploration drilling by the *Noble Discoverer* drillship indicated no violations of Alaska SAAQS or NAAQS, including the 1-hr NO_2 and SO_2 standards beyond 500 m (1,640 ft) of the drillship and at all onshore locations. The analysis included the formation of secondary $PM_{2.5}$ (USEPA 2011s).

These activities in the Arctic Alaska are not anticipated to affect Class I areas in Alaska, which are several hundred miles away.

The major onshore source of industrial emissions in the Arctic Alaska, the Prudhoe Bay-Kuparuk-Endicott oil-production complex, was the subject of monitoring programs during 1986–1987 and from 1990 through 1996. Five monitoring sites were selected; three were considered subject to maximum air pollutant concentrations, and two were considered more representative of the air quality of the general Prudhoe Bay area. All the values meet Federal and State ambient air quality standards. These results indicate that ambient pollutant concentrations from oil and gas activities, even for sites subject to maximum concentrations, are likely to meet the ambient air quality standards (MMS 2008b).

The Program would result in a rather slow rate of development involving a small number of facilities that would be spread over a wide area. Each project would apply the best available control technology according to USEPA and State regulations, and pollutant concentrations would have to meet the PSD incremental limits. Existing pollutant concentrations in coastal Alaska are well within the NAAQS. The small additional concentrations from the Program would result in levels that are still well within the NAAQS.

Impacts on Ozone. As noted above, although ozone does form in Alaska, conditions are seldom favorable for significant O_3 formation. Precursor NO_x and VOC emissions are relatively small, and a significant increase in O_3 concentrations onshore is not likely to result from oil and gas activity scenarios associated with the proposed action. Although sunshine is present in the Beaufort Sea program area most of each day during summer, temperatures remain relatively low. The highest 8-hr average ozone concentrations would be well below the NAAQS of 0.075 ppm. Because the projected O_3 precursor emissions from any of the proposed activities are considerably lower than the existing emissions from the Prudhoe Bay-Kuparuk-Endicott complex, the proposed activities would not be expected to cause any violations of the O_3 standard (MMS 2008b).

Impacts on Visibility. For the proposed Liberty Project in the Beaufort Sea, British Petroleum (Exploration) Alaska (BPXA) ran the VISCREEN model, which calculates the potential impact of a plume of specified emissions for specific transport and dispersion conditions (MMS 2002c). It found noticeable effects on a limited number of days, ones that had the most restrictive meteorological conditions, but no effects at all during average meteorological conditions. This model tends to overestimate impacts, and it is not known to what extent OCS sources contribute to the predicted visibility reductions. The OCS sources are relatively small and would be scattered over a large area. It is not expected that they would have a measureable impact on visibility. Overall, the impacts from the proposed action would be expected to be small or negligible (MMS 2007d).

Greenhouse Gas Emissions and Climate Change. Estimates were made of the 50-year total GHG emissions of CO_2, CH_4, and N_2O for all projected activities associated with the Program (Wolvovsky 2012). Emission estimates for the various activities were largely based on emission factors from the Offshore Environmental Cost Model (Industrial Economics, Inc. et al. 2011). Air emissions resulting from the Program were estimated by considering the exploration and development scenarios presented in Table 4.4.1-4. Emissions are given in terms of (Tg) of CO_2e, where 1 Tg is 10^{12} g (10^6 metric tons). This measure takes into account a GWP factor, which accounts for the relative effectiveness of a gas to contribute to global warming with respect to the same amount CO_2. In these calculations, CH_4 is given a GWP of 21, while N_2O is given a GWP of 310.

Table 4.4.4-6 lists the total calculated emissions (30-year totals for the low scenario and 43-year totals for the high scenario) of CO_2, CH_4, and N_2O from activities associated with the Program and compares them with current (2009) U.S. GHG emissions from all sources (USEPA 2011l). The projected CO_2 emissions from the Program are about 0.0012–0.0038% of all current CO_2 emissions in the United States. The projected CH_4 and N_2O emissions from the Program are up to about 0.0058% and 0.0002%, respectively, of all their current respective emissions in the United States. If CO_2, CH_4, and N_2O emissions are combined, the Program emissions are about 0.0012–0.0038% and 0.0012–0.0037% of the nationwide total of three GHG emissions and of all GHG emissions, respectively. The estimated total global GHG emissions in 2005 were approximately 38,726 Tg CO_2e (74 FR 66539). The estimated Program GHG emissions are about 0.00020–0.00064% of the total global GHG emissions.

As noted in Section 3.3, GHG emissions are one of the causes of climate change. Climate change is a global phenomenon and predicting climate change impacts requires consideration of large scale or even worldwide GHG emissions, not just emissions at a local level. Climate change predictive capability (modeling) lacks the ability to estimate the impact of GHGs from a particular source or sources such as oil and gas activities associated with the Program. What their impact, if any, would be is determined not only by the emissions from the oil and gas activities themselves, but also by the GHG emissions of other sources throughout the world and whether these other emissions are expected to increase or decrease. In addition, since some GHG gases, such as CO_2, may persist in the atmosphere for up to a century, the potential impacts of any source may extend well beyond the active lifetime of the source or program. This said, given the small percentage contributions of oil and gas activities in Arctic region to global GHG emissions, the potential impact on climate change would probably be small. Section 3.3 provides some baseline considerations for climate change and Section 4.4.3 and Sections 4.4.6 through 4.4-15 discuss potential impacts to specific impact areas.

4.4.4.3.2 Impacts of Expected Accidental Events and Spills. Under the proposed action, the number and types of spills assumed to occur in Arctic Alaska include up to 3 large spills (≥1,000 bbl) from pipelines or platforms and between 60 and 225 small spills (<1,000 bbl) over the 50-year period of the Program (Table 4.4.2-1). Evaporation of oil from these spills and

TABLE 4.4.4-6 Projected Greenhouse Gas Emissions from Oil and Gas Activities in the Arctic (Beaufort and Chukchi Seas) Planning Area, 2012-2017 Leasing Program[a]

Pollutant	2012-2017 Program[b] (Tg CO_2e)	2012-2017 Beaufort and Chukchi Seas (Tg CO_2e)[c]	Total 2009 U.S. Emissions from All Sources (Tg CO_2e)	2012-2017 Beaufort and Chukchi Seas as Percentage of Total 2009 U.S. Emissions
CO_2	58.3–117.27	2.06–8.91	5,505.2	0.0012–0.0038
CH_4	15.4–29.67	0.29–1.72	686.3	0.0014–0.0058
N_2O	0.47–0.95	0.01–0.03	295.6	0.0001–0.0002
$CO_2 + CH_4 + N_2O$	74.18–147.89	2.36–10.66	6,487.1	0.0012–0.0038
All GHGs[d]	74.18–147.89	2.36–10.66	6,633.2	0.0012–0.0037

[a] Emissions in the table represent 30-year totals for the low scenario and 43-year totals for the high scenario, except the third column, which presents total 2009 U.S. emissions.

[b] Sum of the GHGs from Beaufort and Chukchi Seas, GOM, and the Cook Inlet Planning Areas in this table and Tables 4.4.4-2 and 4.4.4-4.

[c] One Tg is equal to 10^{12} g or 10^6 metric tons. The CO_2e for a gas is derived by multiplying the mass of the gas by the associated GWP, which accounts for the relative effectiveness of a gas to contribute to global warming with respect to the same amount CO_2. In these calculations, CH_4 is given a GWP of 21, while N2O is given a GWP of 310.

[d] Total U.S. GHG emissions also include hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride emissions. Estimates of emissions from the Program were not made for these compounds, but they are assumed to be very small.

Sources: Industrial Economics, Inc. et al. 2012; USEPA 2011l; Wolvovsky 2012.

emissions from spill response and cleanup activities including *in situ* burning, if used, have the potential to affect air quality in the Arctic Alaska.

Spills and In Situ Burning. Small accidental oil spills would cause small, localized increases in concentrations of VOCs because of evaporation of the spill. Most of the emissions would occur within a few hours of the spill and would decrease rapidly after that period. Large spills would exhibit similar behavior but would affect a somewhat larger area and cause elevated pollutant concentrations to persist somewhat longer. The impacts at a given location would depend on the size, location, and duration of the spill and meteorological conditions such as wind speed and direction. Hanna and Drivas (1993) modeled the emissions of various hydrocarbon compounds from a large spill. A number of these compounds, including BTEX and hexane, are classified by the USEPA as hazardous air pollutants. Many of these contaminants may be carcinogenic to humans and/or animals. The results showed that these compounds evaporate rapidly within a few hours after the spill occurs. Ambient concentrations peak within the first several hours after the spills starts and are reduced by two orders of magnitude after about 12 hr. The heavier compounds take longer to evaporate and may not peak until about 24 hr after spill occurrence. Total ambient VOC concentrations are high in the immediate vicinity of an oil spill, but concentrations are much reduced after the first day (MMS 2007d). Spreading of the spilled oil and action by winds, waves, and currents would further disperse VOC concentrations to extremely low levels over a relatively larger area. Concentrations of criteria pollutants would remain well within NAAQS (MMS 2008b). Over time, air quality would return to pre-spill conditions. There is no information about any possible effect from the inhalation of air contaminants by subsistence animals, but this effect would be expected to be much less than any contamination by contact with hazardous compounds in the water. These effects on subsistence are described in Section IV.B.3.k of MMS (2007d).

In situ burning is a potential technique for cleanup and disposal of spilled oil. *In situ* burning of a spill results in emissions of NO_2, SO_2, CO, and PM_{10} and generates a plume of black smoke. Fingas et al. (1995, 2011) describes the results of a monitoring program of a burn experiment at sea. The program involved extensive ambient measurements during two experiments in which approximately 300 bbl of crude oil was burned. It found that during the burn, CO, SO_2, and NO_2 were measured only at background levels and were frequently below detection levels. Ambient levels of VOCs were high within about 100 m (328 ft) of the fire, but were much lower than those associated with a nonburning spill. PAHs were largely burned by the fire and were lower in the soot than in the oil. Particulates at sea level were of concern only up to 150 m (492 ft) downwind. Measured concentrations of PAHs were low. It appeared that a major portion of these compounds was consumed in the burn. The appearance of a black plume from *in situ* burning around a subsistence hunting area could have an adverse effect on subsistence hunting practices because of the creation of a perception that wildlife has been contaminated. Subsistence hunters may avoid areas where such incidents have occurred.

A major component of the pollution from a fire would be soot. Soot would cling to plants near the fire but would tend to clump and wash off vegetation in subsequent rains. Potential contamination of shoreline and onshore vegetation would be limited, because oil and gas activities under the proposed action would be at least 15 km (9.3 mi) offshore, with the exception of any oil- or gas-transport pipelines (MMS 2008b).

Smoke from burning crude oil would contain PAHs. Benzo(a)pyrene, which often is used as an indicator of the presence of carcinogenic varieties of PAHs, is present in crude oil smoke in very small amounts, but in quantities approximately three times larger than in unburned oil (Evans 1988). Investigators have found that, overall, the oily residue in smoke plumes from crude oil is mutagenic, although not highly so. McGrattan et al. (1995) modeled smoke plumes associated with *in situ* burning. The results showed that the surface concentrations of particulate matter did not exceed the health criterion of 150 $\mu g/m^3$ beyond about 5 km (3 mi) downwind of an *in situ* burn. This appears to be supported by field experiments conducted off Newfoundland and in Alaska (MMS 2007d). This is quite conservative as this health standard is based on a 24-hr average concentration rather than a 1-hr average concentration. After the burn, air quality would return to pre-burn conditions.

Air quality impacts from accidental oil spills in open water during the proposed action would be similar to those described above. However, a spill in the Arctic during broken ice or melting ice conditions could result in more concentrated emissions over a smaller area than would be the case under open-water conditions because the ice would act to reduce spreading of the oil compared to the spreading of a spill in open water. The sea-surface spreading of an oil spill on solid sea ice would be relatively slow compared to a spill in open water. The more volatile components of the oil would evaporate rather rapidly, but the heavier compounds would linger on the surface. The effects on air quality would result in more concentrated emissions over a smaller area than would be the case for a spill in open water.

Hydrogen Sulfide. An accidental release of H_2S at a platform and its associated impacts on platform workers and persons in close proximity to a platform are discussed in detail in Section 4.4.4.1 for the GOM. Potential impacts at or around the platform would be similar in Arctic Alaska.

4.4.4.3.3 Impacts of an Unexpected Catastrophic Discharge Event. In the Arctic, an unexpected, low-probability CDE event is assumed to range in size from 1,700,000 and 3,900,000 bbl with a duration of 60–300 days in the Beaufort Planning Area, and from 1,400,000 and 2,100,000 bbl with a duration of 40–75 days in the Chukchi Planning Area (Table 4.4.2-2). Evaporation of oil from these spills and emissions from spill response and cleanup activities including *in situ* burning, if used, have the potential to result in minor to moderate impacts to air quality in Arctic Alaska.

A CDE in Arctic Alaska could emit regulated pollutants into the atmosphere. This may impact air quality during some phases of the event. The greatest impacts on air quality conditions would occur during the initial explosion of gas and oil and during spill response and clean up, particularly if the event occurs during the winter. Impacts could continue for days during the initial event and could continue for months during spill response and clean up. Therefore, while the impacts may be large during these two phases, overall, the emissions from a CDE would be temporary and, over time, air quality in Arctic Alaska would return to pre-event conditions (BOEMRE 2011j).

There would be some residual air quality impacts after the well is capped or "killed." As most of the oil would have been burned, evaporated, or weathered over time, air quality would return to pre-oil spill conditions. While impacts on air quality are expected to be localized and temporary, adverse effects that may occur from the exposure of humans and wildlife to air pollutants could have long-term consequences (BOEMRE 2011a).

The air impacts of any *in situ* burning associated with a CDE in the Arctic would be similar to impacts discussed in Section 4.4.4.1. Potential impacts from a large spill on ice are discussed in the "Spills and *In Situ* Burning" subsection above.

4.4.4.3.4 Impact Conclusions.

Routine Operations. Routine Program operations in Arctic Alaska would result in levels of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ well within the NAAQS at onshore locations. Existing pollutant concentrations in coastal Alaska are well within the NAAQS, and the small additional concentrations from the Program would result in levels that are still well within the NAAQS. Conditions are seldom favorable for significant O_3 formation in Alaska, and the proposed activities would not be expected to cause any violations of the O_3 standard. In addition, routine operations are not expected to have a measurable impact on visibility. Given the small percentage contributions of routine Program operations to global GHG emissions, their potential impact on climate change would be small. Therefore, impacts to air quality from routine operations associated with the Program in Arctic Alaska are expected to be minor.

Expected Accidental Events and Spills. Spill impacts at a given location would depend on the size, location, and duration of the spill and meteorological conditions such as wind speed and direction. Evaporation of small accidental oil spills would cause small localized increases in VOCs. Large spills (≥1,000 gal) would result in VOC increases over a larger area and a longer period of time. Most of the VOCs considered hazardous by USEPA are reduced by 99% within 12 hr after a spill. Heavier compounds take longer to evaporate, and therefore air concentrations may not peak until 24 hr after the spill. VOC concentrations in the immediate vicinity of the spill could be high during the first day but concentrations of criteria pollutants would remain within the NAAQS. Over time, air quality would return to pre-spill conditions. Therefore, impacts from small spills would be minor. Impacts from large spills could be moderate in the immediate vicinity of the spill for a short time after the spill but would be minor after about 12 hr.

In situ burning of spilled crude or diesel would generate emissions of NO_2, SO_2, CO, PM_{10}, and $PM_{2.5}$. In general, particulates would not exceed the 150 $\mu g/m^3$ beyond about 5 km (3 mi) downwind of an *in situ* burn. After the burn, air quality would return to pre-burn conditions. Thus, the air quality impacts of *in situ* burns of small spills (<1,000 bbl) would be minor. Air quality impacts of *in situ* burns of large spills could be moderate, but would rapidly return to minor after the burn ceased.

An accidental release of H_2S to the atmosphere could present a serious hazard to platform workers and persons close to the platform. OCS operators involved with sour gas production must have an H_2S Contingency Plan containing measures to prevent serious injury or death to workers. Most sour gas facilities have H_2S concentrations that would result in H_2S levels above the OSHA ceiling level within the dimensions of a typical platform. With the Contingency Plan mitigating impacts, accidental releases of H_2S would cause minor to moderate air impacts.

Spills on ice could result in more concentrated emissions over a smaller area than would be the case for spills in open water, as discussed above. The impacts for small spills would still be minor, and impacts from large spills could be moderate in the immediate vicinity of the spill for a short time after the spill but would be minor after some time, probably exceeding 12 hr.

An Unexpected Catastrophic Discharge Event. During an unexpected CDE, the greatest impacts on air quality would occur during the initial explosion of gas and oil and during the spill response and cleanup. Impacts could continue for days during the initial event and for months during the spill response and cleanup. Despite the length of time that could be involved, emissions from a CDE would be temporary and, over time, air quality in Arctic Alaska would return to pre-event conditions.

If *in situ* burning is used during the response to a CDE, carcinogenic dioxins and furans could be formed. These chemicals can bioaccumulate in the food chain. Studies performed during the DWH event indicated that levels of these chemicals were about the same as levels from residential wood stoves and forest fires, so that bioaccumulation is not expected to be a problem. Although dioxins were created during DWH burns, reports found that workers, onshore residents, and residents consuming fish had incremental lifetime cancer risks well below USEPA's target risk level. Although there may be differences between exposure and pollutants emitted between the uncontrolled Kuwaiti oil field fires over land and the controlled DWH burns over water, one study has concluded that symptoms reported by soldiers and associated with proximity to the Kuwaiti fires decreases after leaving Kuwait. Other studies concluded that exposure to oil fire smoke did not cause respiratory symptoms among veterans and that there was no increase in morbidity from exposure to smoke from Kuwaiti oil well fires.

There would be some residual air quality impacts after the well was capped. Over time, air quality would return to pre-event conditions. While impacts on air quality are expected to be temporary, adverse effects may occur from the exposure of humans and wildlife to air pollutants that could have long-term consequences.

Overall, the air quality impacts of an unexpected CDE, including *in situ* burning, in Arctic Alaska could be moderate during the initial explosion of gas and oil and during the spill response and cleanup but would become minor after the well was capped.

4.4.5 Potential Impacts on the Acoustic Environment

This section identifies impact producing factors and potentially impacted resources (such as marine mammals). Details on impacted resources (such as marine mammals and sea turtles) are provided in the specific resource sections of Chapter 4.

BOEM has screened seismic, deep-tow sonar, electromagnetic survey, geological and geological sampling, remote sensing, and marine magnetic survey activities for potential impacts on marine mammals; sea turtles; fishes; commercial, personal, and recreational fisheries; coastal and marine birds; benthic communities; cultural resources; subsistence uses of natural resources; military uses; and recreational and commercial diving in the GOM (BOEMRE 2010b), but did not cover other routine operations such as construction, drilling, explosives, and support vessels and aircraft. The study reviewed EAs, EISs, and relevant literature pertinent to OCS activities and identified resources such as marine mammals for impact analysis. A preliminary screening using resource-specific significance criteria based on accepted threshold levels was conducted to identify those G&G seismic survey activities and resources with potential for non-negligible impacts. Various technologies were evaluated for each type of activity, and impacts from airgun noise, sonar noise, vessel traffic, towed streamers, and aircraft traffic were considered. Only seismic surveys were determined to have potential adverse impacts on marine mammals, sea turtles, fishes, and commercial and recreational fisheries. The other survey activities screened were determined to have negligible or no measurable acoustic impacts. These results should also be relevant to the Arctic region and south central Alaska and include potential for impacts to personal-use and subsistence fisheries and taking of marine mammals.

Table 4.4.1-1 details impact producing factors for routine activities associated with oil and gas activities and the project phases in which they can occur. Noise associated with offshore OCS oil and gas activities results from exploration activities, construction of onshore and offshore facilities and pipelines involving activities such as pile driving, trenching, earth moving, and building, the operation of fixed structures such as offshore platforms and drilling rigs, maintenance, aircraft and service-vessel traffic including icebreakers, and platform removal, and results in changed ambient noise conditions during those activities.

During exploration, noise is generated by operating airgun arrays, drilling, and support vessels and aircraft. During the development phase, noise is generated by drilling, ship and aircraft traffic, pipeline trenching, platform and other offshore construction, and onshore construction. During production operations, noise is generated by maintenance activities, ship and aircraft traffic, and various production activities and associated equipment such as pumps. During production, airgun–supported deep penetration 4D seismic operations that incorporate changes in reservoirs over time, if used, will also cause noise. Workover rigs also conduct drilling activity during the production phase, albeit with lesser noise levels than original drilling. Decommissioning noise is generated by explosive and nonexplosive structure removal, and supporting ship and aircraft traffic.

Noise generated from these activities can be transmitted through both air and water and may be extended or transient, and pulsed or constant. Offshore drilling and production involves various activities that produce a composite underwater noise field. As described in Section 3.6, the intensity level and frequency of the noise emissions are highly variable, both between and among the various industry sources. Noise from proposed OCS activities may affect resources. Whether a sound is or is not detected by marine organisms will depend both on the acoustic properties of the source (spectral characteristics, intensity, and transmission patterns) and sensitivity of the hearing system in the marine organism. Anthropogenic noise can cause physical damage to or death of an exposed animal; intense levels can damage hearing, and, if particularly loud or novel, may induce disruptive behavior and cause stress-related responses, such as endocrine responses (MMS 2006a, 2008a).

Accidental events with the potential for affecting ambient noise conditions include oil spills involving transport and support vessels and tankers, loss of well control, and spill response activities. Oils spills can occur both offshore and at coastal facilities and have occurred in coastal waters at shoreline storage, processing, or transport facilities.

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellhead or wellbore are referred to as loss of well control. Loss of well control can occur during exploratory drilling, development drilling, production, completion, or workover operations. In the event of a loss of well control, the eruption of gases and fluids may generate significant pressure waves and noise. During a loss of well control, the pressure waves and noise generated by the eruption of gases and fluids might be significant enough to harass or injure marine mammals, depending on the proximity of the animal to the site of the loss of well control (MMS 2006a).

Accident response and support activities, including support aircraft and vessels, involved in mitigating loss of well control and spills affect ambient noise conditions. For smaller spills, response actions (and associated changes in ambient noise) in open water would be expected to be localized and of relatively short duration. In the event of a large spill or a catastrophic spill event covering a greater ocean area and contacting the shore or moving into coastal and inland wetlands, longer term response activities including seismic surveys, skimmers, and other mechanical equipment, would affect ambient noise conditions over a wider area and for a longer time than would response activities for small spills. The nature, magnitude, and duration of noise-related impacts depends on the magnitude, frequency, location, and date of accidents, characteristics of spilled oil, spill-response capabilities and timing, and various meteorological and hydrological factors (MMS 2006a, 2007d). For spills, accident response and cleanup activities, including intentional hazing, would be the primary sources of acoustic impacts.

4.4.5.1 Gulf of Mexico

Impacts of Routine Operations. Routine activities that affect ambient noise conditions in some portions of the GOM include seismic surveys, drilling noise, ship and aircraft noise, offshore and onshore construction, operational activities, and decommissioning (see Section 3.6.1 for details on the noise levels and frequencies associated with routine operational activities).

Under the proposed action, seismic surveys would be conducted to identify locations for up to 2,100 exploration wells (Table 4.4.1-1). Noise from these seismic surveys and the associated survey and support vessels would affect the acoustic environment. Airgun noise can be detected up to 100 km (62 mi) from the source, so, under appropriate conditions (see Section 3.6.1.4.4), the affected area can be extensive, but the greatest changes to ambient noise levels would occur at locations closer to the airgun. Effects could include behavioral and physical effects on marine mammals and sea turtles. Impacts of seismic surveys on marine mammals and sea turtles are presented in Sections 4.4.7.1 and 4.4.7.4, respectively. In addition to the noise, the high-pressure pulse and associated particle motion in the near field is a concern for fish. Potential impacts on fish are discussed in Section 4.4.7.3. Commercial and recreational fishing could be affected if behavioral changes in target species (MMS 2007d) occur as a result of exposure to seismic surveys (see Section 4.4.11). These impacts would continue for the duration of the survey, and the affected area would move along with the survey and support vessels. Because these activities would be short term, potential impacts on ecological resources would be short-term.

Under the proposed action, construction and installation of exploration and delineation wells (up to 2,100), development and production wells (up to 2,600), platforms (up to 450), FPSOs (up to 2), and offshore pipelines (up to 12,000 km [7,500 mi]) will result in increases in noise levels in the vicinity of these construction activities. With the exception of pipeline trenching, construction and installation activities would generate noise from stationary noise sources at the drilling/well sites and from support vessels and aircraft.

Noise from pile driving, construction of offshore platforms and pipelines and noise from the associated support vessels and aircraft would cause noise that would disturb marine mammals (Section 4.4.7.1) and sea turtles (Section 4.4.7.4) in the vicinity of the construction activity and may cause fish to leave the construction area (see Section 4.4.7.3). Pipeline trenching and onshore construction could cause behavioral effects in birds, especially if the noises occur near nesting colonies during nesting periods (see Section 4.4.7.2). Marine species in nearby waters could also be affected. These effects would persist for the duration of the activity, could persist for weeks after the end of the activity, and would be strongest at the construction site or along the line of the trenching activity or routes of the vessels or aircraft. Multiple construction projects in the same vicinity could have increased noise impacts.

Additional noise-related impacts could be caused by dredging operations. Noise from dredging generally reaches background levels within 25 km (16 mi), but can extend even farther and thus can affect a fairly wide area.

Under the proposed action, drilling noise during exploration and production would be relatively constant for the duration of the drilling. Drilling noise generally would be less than ambient background levels beyond 30 km (19 mi) from the drill site (see Section 3.6.1.4) and would be strongest near the well. Noise levels would increase if several wells were located in proximity to one another. The principal noise concern in the GOM is the potential to affect marine mammals, sea turtles, and fish (see Sections 4.4.7.1, 4.4.7.4, and 4.4.7.3, respectively).

In addition to drilling noise, machinery on platforms also generates noise during operation. Such noise could be continuous or transient and variable in intensity, depending on the nature and role of the machinery. Underwater noise would be relatively low intensity because the noise sources are on decks well above the surface of the water and because of the small surface area of the legs in contact with the water, but it could affect marine mammals (see Section 3.6.1.4.3).

Under the proposed action, vessel traffic (up to 600 trips per week for up to 45 platforms) and helicopter traffic (up to 5,500 trips per week) will result in increases in noise levels along the traffic routes and at the platforms during construction and operation. Sound generated by these activities will be transient at any one location, may be variable in intensity (MMS 2006a), and may affect marine mammals, sea turtles, and birds (see discussions in Section 4.4.7). Noise from vessel traffic generally reaches background levels within 10 km (6 mi) of the source, but may be detectable at very large distances in deep water. Flights over land would also affect terrestrial mammals (see Section 4.4.7.1). How far sounds travel from vessels is highly variable, depending on environmental conditions and the type of vessel. However, noise would be transient along the traffic path but would recur as long as trips continue. Frequent overflights could produce longer term consequences (MMS 2007d, 2008a).

Noise from decommissioning could result from dismantlement of above-platform structures and the use of underwater explosive or mechanical means to collapse or sever the platform. Marine mammals, sea turtles, and fish could be affected by the noise and shock wave, especially that associated with the use of explosives (see Sections 4.4.6 and 4.4.7). Nonexplosive impacts from dismantling activities and support vessels and aircraft would continue for the duration of the activity and be localized around the facility being decommissioned. Noise and the pressure pulse from explosive detonation would be short term, but the pressure pulse could cause serious impacts on nearby marine mammals (MMS 2007d, 2008a) (also see Section 4.4.7.1). Explosive detonation impacts would be strongest near the detonation site.

Impacts of Expected Accidental Events and Spills. Under the proposed action, the number and types of spills assumed to occur in the GOM Planning Area include up to 7 large spills (≥1,000 bbl) from both pipeline and platforms, and as many as 470 small spills (<1,000 bbl) and up to one tanker spill of up to 3,100 bbl (Table 4.4.2-1). Noise from emergency and spill-response activities and support vessels and aircraft has the potential to disturb marine mammals, sea turtles, fish, and birds. For small spills, noise generated from response actions in open water would be expected to be localized and of relatively short duration. In the event of a large spill covering a greater ocean area and contacting the shore or moving into coastal and inland wetlands, longer term response activities, including seismic surveys, skimmers, and other mechanical equipment, over a wider area would be required and associated noise would occur over a wider area. Noise from response equipment and support vessels and aircraft could disturb marine mammals, sea turtles, fish, and birds in the vicinity of the response action, temporarily for small spills and for longer periods for large spills (see the biota-specific discussion in Section 4.4.7). Noise along the trajectories of support vessels and aircraft would be transient and localized along the trajectory but would recur for the duration of the spill response. Response activities for onshore spills or offshore spills that reached the land would have similar impacts but would also affect terrestrial species (MMS 2006a, 2007d). The pressure wave and noise generated from an incident involving a loss of well control could affect marine mammals and could be large enough to harass or injure them if they were close enough to the site of the event (MMS 2006a).

Impacts of an Unexpected Catastrophic Discharge Event. For the purposes of analysis, a CDE in the GOM is assumed to range in size from 900,000 to 7,200,000 bbl (Table 4.4.2-2). Sources of noise and impacts would be similar to, but probably larger than, those above for expected events. Accident response and support activities, including support aircraft and vessel activity, have the potential to cause noise impacts. These impacts would occur both at the site of the response activity and along the trajectories of support vessels and aircraft and would affect marine mammals, sea turtles, fish, and birds. Noise along support vessel and aircraft routes would be transient and localized along the route but would recur for the duration of the response. The ensonified area would depend on the size of the CDE and the extent of the response area. The impacts could cover large area, as was the case for the DWH event, and be more sustained over a longer time depending on the volume, location, duration, and weather conditions during the CDE and the response and cleanup activities. Impacts could continue for days during the initial event and for months during spill response and cleanup.

Impact Conclusions.

Routine Operations. Noise impacts under the proposed action would be unavoidable. Routine activities that affect ambient noise conditions in the GOM include seismic surveys, drilling, ship and aircraft traffic, onshore and offshore construction, operational activities, and decommissioning. Noise would affect marine mammals, sea turtles, fish, and birds. Terrestrial mammals would be affected by noise produced during onshore construction and aircraft overflights. The magnitude of the impact would vary with the type of resource affected, the timing of the noise-generating activity, the distance over which the noise is detectable, and the spatial relationship between the noise-generating activity and the affected resource. Short-term transient noises would generally have different impacts than continuous, long-term noise. Seismic survey noise would be short-term. Drilling noise would continue for the duration of the activity and could be detectable over a fairly wide area. Ship and aircraft traffic would produce transient noise along the routes followed. Construction activities would tend to be limited to the vicinity of the activity except for dredging and pile driving, which can be detected over fairly wide areas. Operational noises would be low-level and localized but would continue over the lifetime of the activity. Impacts on ambient noise levels from these activities are expected to be minor.

Decommissioning activities would be similar to construction activities and would be expected to have minor impacts on ambient noise levels except for the use of explosives. If used, explosive noise would be short-term but the pressure pulse could cause serious impacts to nearby marine mammals. Impacts from use of explosives could thus be minor to moderate.

Expected Accidental Events and Spills. Seismic surveys, skimmers, mechanical equipment, and support vessels and aircraft are among the noise sources associated with cleanup and response activities. Noise from these sources would persist for the duration of the response activities. At the conclusion of the activities, ambient noise would return to pre-spill levels. Noise from response activities could affect terrestrial and marine mammals, sea turtles, fish, and birds. Noise from responses to small spills would be short-term and localized except for the transient noise along the trajectories of support vessels and aircraft. Noise from response activities for large spills would probably take place over a longer time and cover a greater area, generally producing greater impacts than noise from response activities for small spills. Noise impacts from response activities for small and large spills are expected to be minor. If the event involves a major loss of well control, the associated pressure wave could harass or injure nearby marine mammals. Thus, the impacts could be minor to moderate.

An Unexpected Catastrophic Discharge Event. Seismic surveys, skimmers, mechanical equipment, and support vessels and aircraft are among the noise sources associated with response and cleanup activities for an unexpected CDE. Noise from these response activities could continue for days during the initial event and for months during spill response and cleanup. When these activities cease, ambient noise would return to pre-spill levels. Noise from response activities could affect terrestrial and marine mammals, sea turtles, fish, and birds. Noise would be transient along the trajectories of support vessels and aircraft but would persist for the possibly extended duration of cleanup and response activities. If the event involves a major loss of well control, the associated pressure wave could harass or injure nearby marine mammals. Noise impacts from response activities for an unexpected CDE are expected to be minor to moderate.

4.4.5.2 Alaska – Cook Inlet

The impact producing factors for noise that may be expected for the Cook Inlet Planning Area under the proposed action include seismic surveys, ship and aircraft traffic, drilling and trenching, offshore construction, and production operations. There would be no onshore new construction involving pipeline landfalls, shore bases, processing facilities, or waste facilities and no platform removals in the Cook Inlet Planning Area under the proposed action (see Table 4.4.1-3).

Impacts of Routine Operations. Routine activities that could potentially cause changes in ambient noise levels in Cook Inlet include seismic surveys, drilling noise, ship and aircraft noise, offshore construction, and operational activities. See Section 3.6.1.4 for details on the noise levels and frequencies associated with routine operational activities.

Under the proposed action, seismic surveys would be conducted to identify locations for up to 12 exploration and delineation wells (Table 4.4.1-3). Airgun noise can be detected up to 100 km (62 mi) from the source and beyond under appropriate conditions (see Section 3.6.1.4.4), so the affected area can be extensive, although changes in ambient noise levels would be greatest at locations closest to the airgun. Noise from these seismic surveys and the associated survey and support vessels would alter the acoustic environment and affect ecological resources in the planning area. Effects could include physical and behavioral changes in marine mammals and fish and disturbance of birds. See Section 4.4.7 for discussions of noise impacts on ecological resources of the planning area. Targeted species for commercial, personal-use, subsistence, and recreational fishing could also be affected (MMS 2007d). These impacts would continue for the duration of the survey, and the affected area would move along with the survey and support vessels.

Noise from construction of as many as 3 offshore platforms, up to 114 development and production wells, 241 km (150 mi) of offshore pipeline, and 169 km (105 mi) of onshore pipeline, as well as noise from the associated support vessels and aircraft, could disturb marine mammals (see Section 4.4.7.1) as well as birds (see Section 4.4.7.2) in the vicinity of the construction activity. Construction activity may cause fish to leave the construction area (see Section 4.4.7.3). These effects would persist for the duration of the activity and could persist for weeks after the end of the activity and would be strongest at the construction site or along the line of any required offshore trenching activity. Multiple construction projects occurring simultaneously in the same vicinity or over multiple years would have increased noise impacts. Any effects would persist for the duration of the construction and be strongest near the construction site.

Under the proposed action, pile driving drilling noise during exploration, development, and production would be relatively constant for the duration of the drilling. Drilling noise generally would be less than ambient background levels beyond 30 km (19 mi) from the drill site (see Section 3.6.1.4.3) and would be strongest near the well. Noise levels would increase if several wells were operating simultaneously in close proximity to one another. The noise could have impacts on mammals, fish, and birds in Cook Inlet as discussed in Section 4.4.7. Noise and vessel traffic associated with oil and gas activities in offshore areas adjacent to boundaries of the

Lake Clark National Park and Preserve, the Katmai National Park and Preserve, and State wildlife refuges and ranges bordering Cook Inlet could temporarily disturb some wildlife and negatively affect recreational values for park users (Section 4.4.12) (MMS 2007d).

In addition to drilling noise, machinery on platforms generates noise during operation. Such noise could be continuous or transient and variable in intensity depending on the nature and the role of the machinery. Underwater noise would be relatively weak because of the small surface area in contact with the water, but it could affect marine mammals (MMS 2006a). Because there would be no more than three platforms developed as a result of leasing under the Proposed Action Alternative, noise impacts from platform operation are anticipated to localized.

Under the proposed action, vessel traffic (up to three trips per week) and helicopter traffic (up to three trips per week) will result in increases in noise levels along the traffic routes and at platforms during construction and operation. Sound generated by these activities is transient and variable in intensity; it may affect mammals, fish, and birds, as discussed in Section 4.4.7. Noise from vessel traffic generally reaches background levels within 10 km (6 mi) of the source, but may be detectable at very great distances in deep water. Flights over land would also affect terrestrial mammals (see Section 4.4.7.1). The noise would be transient along the traffic path but would recur as long as trips continue. Frequent overflights could produce longer term consequences (MMS 2007d, 2008a).

Although Cook Inlet is generally more than 90% ice free and the Federal waters of Cook Inlet are not seasonally icebound, any icebreaker activity may increase as a result of the proposed action and could result in increased disturbance of marine mammals. Icebreakers operate in support of exploration including seismic survey, construction, and operation activities. Icebreakers do not operate during the open-water season. Icebreaking vessels produce louder, but also more variable, sounds than those associated with other vessels of similar power and size. Icebreaker noise can be substantial out to at least 5 km (3 mi) and may be detectable from more than 50 km (31 mi) away. Icebreaker noise would add to the impacts discussed above for the particular activity they were supporting, but any increases would not occur during the open-water season. Impacts would be transient along the path of the icebreaker and would be strongest near the path.

There is currently no subsistence whaling in Cook inlet, but there is some potential for noise-induced alterations in marine mammal behavior. Local residents have consistently indicated that whales and other marine mammals are very sensitive to noise and that they have been disturbed from their normal patterns of behavior by past seismic and drilling activities (Section 4.4.13). Lease stipulations have minimized such problems in the recent past, so noise and disturbance effects are expected to be effectively mitigated (MMS 2006a). See Sections 4.4.10.2.1 and 4.4.13.2.1 for discussions of noise impacts on land use and subsistence harvests, respectively.

Impacts of Expected Accidental Events and Spills. Under the proposed action, the number and types of spills assumed to occur in the Cook Inlet Planning Area include up to one large spill (≥1,000 bbl) from either a pipeline or a platform and as many as 18 small (<1,000 bbl) spills (Table 4.4.2-1). Noise from emergency and spill-response activities and support vessels and aircraft has the potential to disturb marine mammals, fish, and birds. For small spills, noise generated from response actions in open water would be expected to be localized and of relatively short duration. In the event of a large spill covering a greater ocean area and contacting the shore or moving into coastal and inland wetlands, longer term response activities over a wider area would be required and associated noise would occur over a wider area. Noise from response equipment and activities including seismic surveys, skimmers, and other mechanical equipment and support vessels and aircraft could affect marine mammals, fish, and birds in the vicinity of the response action, temporarily for small spills and for longer periods for large spills (see biota-specific discussions in Section 4.4.7). Noise along the routes of support vessels and aircraft would be transient and localized along the route but would recur for the duration of the response. Response activities for onshore spills or offshore spills that reached coastal areas would have similar acoustic impacts on nearby marine mammals and birds and would also affect terrestrial species (MMS 2006a, 2007d). The pressure wave and noise generated from an incident involving a loss of well control could affect marine mammals and could be large enough to harass or injure them if they were close enough to the site of the event (MMS 2006a).

Impacts of an Unexpected Catastrophic Discharge Event. An unexpected CDE in the Cook Inlet Planning Area is assumed to range in size from 75,000 to 125,000 bbl (Table 4.4.2-2). Sources of noise and impacts would be similar to, but probably larger than, those above for expected events. Accident response and support activities, including support aircraft and vessel activities, have the potential to cause noise impacts. These impacts would occur both at the site of the response activity and along the trajectories of support vessels and aircraft and would affect marine mammals, fish, and birds. Noise along support vessel and aircraft routes would be transient and localized along the route but would recur for the duration of the response. The ensonified area would depend on the size of the CDE and the extent of the response area. The impacts could cover a large area, as was the case for the DWH event, and be more sustained over a longer time depending on the volume, location, duration, and weather conditions during the CDE and the response and cleanup activities. Impacts could continue for days during the initial event and for months during spill response and cleanup.

Impact Conclusions.

Routine Operations. Noise impacts under the proposed action would be unavoidable. Routine activities that affect ambient noise conditions in Cook Inlet include seismic surveys, drilling, ship and aircraft traffic, icebreakers, onshore and offshore construction, operational activities, and decommissioning. Noise would affect marine mammals, fish, and birds. Terrestrial mammals would be affected by onshore construction and aircraft overflights. The magnitude of the impact would vary with the type of resource affected, the timing of the noise-generating activity, the distance over which the noise is detectable, and the spatial relationship between the noise-generating activity and the affected resource. Short-term transient noises would generally have different impacts than continuous, long-term noise. Seismic survey noise would be short-term. Drilling noise would continue for the duration of the activity and could be detectable over a fairly wide area. Ship and aircraft traffic would produce transient noise along the routes followed. Noise from icebreakers, if used, would be seasonal, louder and more variable than noise for other vessels, and detectable over a fairly wide area. Construction activities would tend to be limited to the vicinity of the activity, except for dredging and pile driving, which can be detected over fairly wide areas. Operational noises would be low-level and localized but would continue over the lifetime of the activity. Impacts on ambient noise levels from these activities are expected to be minor.

Decommissioning activities would be similar to construction activities and would be expected to have minor impacts on ambient noise levels except for the use of explosives. If used, explosive noise would be short–term but the pressure pulse could cause serious impacts to nearby marine mammals. Impacts from use of explosives could thus be minor to moderate.

Expected Accidental Events and Spills. Seismic surveys, skimmers, mechanical equipment, and support vessels and aircraft are among the noise sources associated with cleanup and response activities. Noise from these sources would persist for the duration of the response activities. At the conclusion of the activities, ambient noise would return to pre-spill levels. Noise from response activities could affect terrestrial and marine mammals, fish, and birds. Noise from responses to small spills would be short-term and localized except for the transient noise along the trajectories of support vessels and aircraft. Noise from response activities for large spills would probably take place over a longer time and cover a greater area, generally producing greater impacts than noise from response activities for small spills. Noise impacts from response activities for small and large spills are expected to be minor. If the event involves a major loss of well control, the associated pressure wave could harass or injure nearby marine mammals. Thus, the impacts could be minor to moderate.

An Unexpected Catastrophic Discharge Event. Seismic surveys, skimmers, mechanical equipment, and support vessels and aircraft are among the noise sources associated with response and cleanup activities for an unexpected CDE. Noise from these response activities could continue for days during the initial event and for months during spill response and cleanup. When these activities cease, ambient noise would return to pre-spill levels. Noise from response activities could affect terrestrial and marine mammals, fish, and birds. Noise would be transient along the trajectories of support vessels and aircraft but would persist for the possibly extended duration of cleanup and response activities. If the event involves a major loss of well control, the associated pressure wave could harass or injure nearby marine mammals. Noise impacts from response activities for an unexpected CDE are expected to be minor to moderate.

4.4.5.3 Alaska – Arctic

The impact-producing factors for noise that may be expected in Arctic Alaska under the proposed action include seismic surveys, ship and aircraft traffic, drilling and trenching, offshore construction, construction of onshore pipeline, and production operations. There would be no onshore construction involving pipeline landfalls or shore bases and no platform removals in Arctic Alaska under the proposed action (see Table 4.4.1-4).

Impacts of Routine Operations. Routine activities that will affect ambient noise conditions in the Beaufort Sea and Chukchi Sea Planning Areas include seismic surveys, drilling noise, ship and aircraft noise, icebreaker noise, offshore construction, onshore pipeline construction, and operational activities. See Section 3.6.1.4 for details on the noise levels and frequencies associated with routine operational activities.

Under the proposed action, seismic surveys would be conducted to identify locations for up to 36 exploration wells (16 in the Beaufort Sea Planning area and 20 in the Chukchi Sea Planning Area). Airgun noise can be detected up to 100 km (62 mi) from the source and beyond under appropriate conditions (see Section 3.6.1.4.4), so the affected area can be extensive, although changes in ambient noise levels would be greatest at locations closest to the airgun. Noise from these seismic surveys and the associated survey and support vessels would alter the acoustic environment and affect ecological resources in the planning area. Effects would include physical and behavioral changes and disturbance in marine mammals and fish. Marine and coastal birds could also be affected. See Section 4.4.7 for discussions of noise impacts on ecological resources of the two planning areas. The potential for affecting ecological resources would continue for the duration of the survey activities.

Under the proposed action, construction and installation of exploratory and production wells (up to 36 and 400, respectively), platforms (up to 9), onshore pipelines (up to 129 km [80 mi]), offshore pipelines (up to 652 km [405 mi]), and subsea wells (up to 92 [up to 10 in the Beaufort Sea Planning Area and up to 81 in the Chukchi Sea Planning Area]) will result in increases in noise levels in the vicinity of these construction activities. With the exception of pipeline trenching, construction and installation activities would generate noise from stationary noise sources at the drilling/well sites and from support vessels and aircraft.

Noise from pile driving, construction of offshore platforms and pipelines, support vessel and aircraft traffic, and gravel placement activities could disturb normal behaviors in marine mammals, birds, and fish in the vicinity of the construction activities (see Section 4.4.7). These effects would persist for the duration of the activity and would be strongest at the construction site(s) or along the line of any required trenching activity. Multiple construction projects occurring simultaneously in the same vicinity or over multiple years would have increased noise impacts.

Construction of up to 129 km (80 mi) of onshore pipeline on areas adjacent to the Beaufort Sea would cause noise that would disturb terrestrial mammals (see Section 4.4.7.1). Impacts would depend on the season and proximity to critical habitat and would persist for the duration of the construction activity. Affected areas would move as the active construction area progressed along the pipeline route. Marine mammals, birds, and fish in nearby waters could be affected. Given that there would be no new pipeline landfalls and no new shore bases constructed, little or no additional onshore construction is anticipated under the proposed action, any noise-related impacts would be limited to relatively few terrestrial mammals and birds. Any effects would persist for the duration of the construction and be strongest near the construction site. Additional noise-related impacts could be caused by gravel excavation activities.

Under the proposed action, drilling noise would be relatively constant during exploration phase drilling and during development and production phase drilling. Drilling noise generally would be less than ambient background levels beyond 30 km (19 mi) from the drill site (see Section 3.6.1.4.3) and strongest near the well. Noise levels would increase if several wells were located in close proximity to one another. The drilling noise could affect marine mammals, birds, and fish (see the biota-specific discussion in Section 4.4.7).

In addition to drilling noise, machinery on platforms generates noise during operation. Such noise could be continuous or transient and variable in intensity depending on the nature and the role of the machinery. Underwater noise would be relatively weak because of the small surface area in contact with the water, but it could affect marine mammals (MMS 2006a).

Under the proposed action, vessel traffic (up to 27 trips per week) and helicopter traffic (up to 27 trips per week) will result in increases in noise levels along the traffic routes and at the platforms during construction and operation. Vessel traffic in Arctic Alaska occurs primarily in the summer (MMS 2007d). Sound generated by these activities is transient and variable in intensity and may affect terrestrial and marine mammals, marine and coastal birds, and fish, as discussed in Section 4.4.7. Noise from vessel traffic generally reaches background levels within 10 km (6 mi) of the source, but may be detectable at very large distances in deep water. Flights over land would also affect terrestrial mammals (see Section 4.4.7.1). The noise would be transient along the traffic path but would recur as long as trips continue. Frequent overflights could produce longer term consequences (MMS 2007d, 2008a).

Icebreaker activity in the Beaufort Sea and Chukchi Sea areas could increase under the proposed action if needed to support exploration, construction, and operation activities. In addition to icebreaking activities when there is ice cover, icebreakers also engage in ice management activities during the summer. Icebreakers do not operate during the open-water season. Icebreaking vessels produce louder, but also more variable, sounds than those associated with other vessels of similar power and size. Icebreaker noise can be substantial out to at least 5 km (3 mi) and may be detectable from more than 50 km (31 mi) away (see Section 3.6). Icebreaker noise would add to the impacts discussed above for the particular activity they were supporting. Impacts would be transient along the path of the icebreaker and would be strongest near the path.

Noise during staging activities for exploration, development, and production would likely occur in areas with existing infrastructure, such as Deadhorse, and cause little direct impact on local native communities. Noise from vessel and aircraft traffic, seismic surveys, and icebreakers could also disturb marine mammals, birds, and fish and thus potentially affect subsistence harvests and resources. Lease stipulations have minimized such problems in the recent past, so noise and disturbance effects are expected to be effectively mitigated (MMS 2008b).

Impacts of Expected Accidental Events and Spills. Under the proposed action, the number and types of spills assumed to occur in the Arctic region include up to 3 large spills (≥1,000 bbl) from pipelines and platforms and between 60 and 225 small (<1,000 bbl) spills over the 50-yr period of the Program (Table 4.4.2-1). Noise from emergency and spill-response activities and support vessels and aircraft has the potential to disturb marine mammals, fish, and birds. For small spills, noise generated from response actions in open water would be expected to be localized and of relatively short duration. In the event of large spills covering a greater ocean area and contacting the shore or moving into coastal and inland wetlands, longer term response activities over a wider area would be required and the associated noise would occur over a wider area. Noise from response equipment and activities including seismic surveys, skimmers, and other mechanical equipment and support vessels and aircraft could disturb marine mammals, birds, and fish, as well as invertebrate prey species in the vicinity of the response action; the impact would be temporary for small spills and of longer duration for large spills (see biota-specific discussions in Section 4.4.7). Noise along the routes of support vessels and aircraft would be transient and localized but would recur for the duration of the spill response. Response activities for onshore spills or offshore spills that reached the land could have similar impacts but would also affect terrestrial species (MMS 2006a, 2007d). The pressure wave and noise generated from an incident involving a loss of well control could affect marine mammals and could be large enough to harass or injure them if they were close enough to the site of the event (MMS 2006a).

Impacts of an Unexpected Catastrophic Discharge Event. In the Arctic planning areas, an unexpected CDE is assumed to range in size between 1,700,000 and 3,900,000 bbl in the Beaufort Planning Area, and between 400,000 and 2,100,000 bbl in the Chukchi Planning Area (Table 4.4.2-2). Sources of noise and impacts would be similar to, but probably larger than, those above for expected events. Accident response and support activities, including support aircraft and vessel activities, have the potential to cause noise impacts. These impacts would occur both at the site of the response activity and along the trajectories of support vessels and aircraft and would affect marine mammals, fish, and birds. Noise along support vessel and aircraft routes would be transient and localized along the route but would recur for the duration of the response. The ensonified area would depend on the size of the CDE and the extent of the response area. The impacts could cover a large area, as was the case for the DWH event, and be more sustained over a longer time depending on the volume, location, duration, and weather conditions during the CDE and the response and cleanup activities. Impacts could continue for days during the initial event and for months during spill response and cleanup.

Impact Conclusions.

Routine Operations. Noise impacts under the proposed action would be unavoidable. Routine activities that affect ambient noise conditions in Arctic Alaska include seismic surveys, drilling, ship and aircraft traffic, icebreakers, onshore and offshore construction, operational activities, and decommissioning. Noise would affect marine mammals, fish, and birds. Terrestrial mammals would be affected by onshore construction and aircraft overflights. The magnitude of the impact would vary with the type of resource affected, the timing of the noise-generating activity, the distance over which the noise is detectable, and the spatial relationship between the noise-generating activity and the affected resource. Short-term transient noises would generally have different impacts than continuous, long-term noise. Seismic survey noise would be short-term. Drilling noise would continue for the duration of the activity and could be detectable over a fairly wide area. Ship and aircraft traffic would produce transient noise along the routes followed. Noise from icebreakers would be seasonal, louder and more variable than noise for other vessels, and detectable over a fairly wide area. Construction activities would tend to be limited to the vicinity of the activity, except for dredging and pile driving, which can be detected over fairly wide areas. Operational noises would be low-level and localized but would continue over the lifetime of the activity. Impacts on ambient noise levels from these activities are expected to be minor.

Decommissioning activities would be similar to construction activities and would be expected to have minor impacts on ambient noise levels except for the use of explosives. If used, explosive noise would be short-term but the pressure pulse could cause serious impacts to nearby marine mammals. Impacts from use of explosives could thus be minor to moderate.

Expected Accidental Events and Spills. Seismic surveys, skimmers, mechanical equipment, support vessels and aircraft, and icebeakers, if used, are among the noise sources associated with cleanup and response activities. Noise from these sources would persist for the duration of the response activities. At the conclusion of the activities, ambient noise would return to pre-spill levels. Noise from response activities could affect terrestrial and marine mammals, fish, and birds. Noise from responses to small spills would be short-term and localized except for the transient noise along the trajectories of support vessels and aircraft. Noise from response activities for large spills would probably take place over a longer time and cover a greater area, generally producing greater impacts than noise from response activities for small spills. Noise impacts from response activities for small and large spills are expected to be minor. If the event involves a major loss of well control, the associated pressure wave could harass or injure nearby marine mammals. Thus, the impacts could be minor to moderate.

An Unexpected Catastrophic Discharge Event. Seismic surveys, skimmers, mechanical equipment, support vessels and aircraft, and icebreakers, if used, are among the noise sources associated with response and cleanup activities for an unexpected CDE. Noise from these response activities could continue for days during the initial event and for months during spill response and cleanup. When these activities cease, ambient noise would return to pre-spill levels. Noise from response activities could affect terrestrial and marine mammals, fish, and birds. Noise would be transient along the trajectories of support vessels and aircraft but would persist for the possibly extended duration of cleanup and response activities. If the event involves a major loss of well control, the associated pressure wave could harass or injure nearby marine mammals. Noise impacts from response activities for an unexpected CDE are expected to be minor to moderate.

4.4.6 Potential Impacts on Marine and Coastal Habitats

4.4.6.1 Coastal and Estuarine Habitats

4.4.6.1.1 Gulf of Mexico (GOM). Coastal and estuarine habitats could be directly or indirectly affected by a number of factors associated with oil and gas activities (Table 4.4.6-1). These factors include vessel traffic, maintenance dredging of navigational canals, construction and operation of onshore facilities, installation and maintenance of pipelines, expansion of ports and docks, and operation of offshore oil and gas facilities. The potential for impacts would be largely influenced by site-specific factors, such as the habitat types and distribution in the

TABLE 4.4.6-1 Impacting Factors for Coastal and Estuarine Habitats in the Gulf of Mexico

	Habitat Type		
Oil and Gas Impacting Factors[a]	Barrier Landforms	Wetlands	Seagrasses
Vessel traffic (all phases)	X	X	X
Navigation channel maintenance dredging (operations)	X	X	X
Pipeline emplacement (construction)	X	X	X
Construction of onshore facilities (construction)		X	X
Expansion of onshore facilities (construction)	X	X	X
Use of existing facilities (operations)	X	X	X
Expansion of ports and docks (construction)	X	X	X
Disposal of OCS-related wastes (all phases)		X	X
Accidental spills (all phases)	X	X	X

[a] X = Potential impacts on the resource attributable to the impacting factor.

vicinity of oil and gas activities. Many of the activities associated with oil and gas, such as platform construction, would occur in offshore waters, with minimal impacts on coastal habitats other than for potential accidents.

Impacts of Routine Operations.

Barrier Landforms. The potential effects on coastal barrier islands, beaches, and dunes from routine operations would primarily be associated with indirect effects from maintenance dredging and vessel traffic. Impacts of pipeline landfalls and use or expansion of coastal facilities could also occur.

Maintenance dredging of navigation channels in barrier inlets and bar channels can remove sediments from the longshore sediment drift. Maintained channels intercept and capture sediments, and dredged materials are often discharged to ocean dump sites. Dredging may contribute to the reduction of sediment deposition and affect the stability of downdrift barrier landforms (MMS 2007c). Reductions in sediment supply could subsequently contribute to small local losses of adjacent downdrift barrier beach habitat, with impacts over a broader area where the sediment supply is low, such as along the Louisiana coastal barrier islands in the Central Planning Area (CPA). However, dredged sediments are used in beach restoration projects where feasible (MMS 2008a). The installation of erosion control structures, such as jetties, for OCS-related facilities built near barrier shorelines may also accumulate sediments and induce erosion of downdrift areas (MMS 2007c). Although it is not considered likely, there is a possibility that, in some locations, dredging may result in the resuspension and transport of sediments that may contain residual oil from the DWH event.

Service vessel traffic to exploration and production wells could contribute to erosion of barrier beaches. Approximately 300 to 600 vessel trips per week would occur in the GOM under the proposed action. Waves generated by service vessels can erode unprotected shorelines and areas that currently experience barrier beach losses from ongoing shoreline degradation, particularly the coastal areas of Louisiana; vessel traffic can contribute to the accelerated erosion of sediments along beaches through increased wave activity. Erosion from vessel activity along unarmored navigation channels has resulted in channel widening in the Western Planning Area (WPA) and CPA and land loss in some areas. However, restoration and stabilization of channel margins have been effective in minimizing channel widening. Wave activity could be minimized by maintaining reduced vessel speeds in the vicinity of barrier islands.

The proposed action would include approximately less than 12 new pipeline landfalls in the GOM region. Impacts on barrier landforms would likely be avoided during pipeline construction by the use of modern construction techniques, such as directional (trenchless) boring, under barrier islands and beaches (MMS 2008a). These construction methods avoid or minimize impacts on the barrier systems (Wicker et al. 1989). If nonintrusive techniques were not used, impacts on beach and dune communities from ground-disturbing activities during pipeline construction could occur, with the potential for accelerated beach erosion and island breaching. The presence of pipelines, even after decommissioning, in some areas of the GOM may potentially result in the reduction or elimination of suitable sediment sources used for beach renourishment and restoration projects, because of the necessity of pipeline avoidance. Loss of sediment sources could potentially restrict restoration activities in some areas. In addition, at restoration sites, pipeline safety buffers can reduce the number and extent of areas available for restoration, and pipeline surveys divert funds that would otherwise be available for such restoration. However, as noted above, fewer than 12 new pipeline landfalls would be constructed under the proposed action. Pipeline disturbance widths are generally small with modern placement methods, and the rights-of-way should be less than 200 m (218 yd) in width. Operators are interested in protecting pipelines from coastal erosion, so a synergy could be developed with coastal restoration projects. Because of demand for OCS material for coastal restoration, BOEM is trying to cluster pipelines and to keep pipelines away from known marine mineral resources (BOEM 2012a; USDOI 2009).

Up to 12 new natural gas processing facilities and 4 to 6 new pipe yards would be constructed. No new facilities would be expected to be constructed on barrier beaches or associated dunes; however, impacts on other coastal upland habitats would likely occur. Habitat losses would be minimized if facilities were located in previously disturbed areas. Expansion of existing facilities located on barrier beaches or dunes would result in losses of those habitats. The continued use of facilities that have become located in the barrier beach and dune zone because of ongoing shoreline recession may result in accelerated erosion of those habitats.

Wetlands. The potential effects on wetlands from routine operations would primarily be associated with direct impacts from pipeline emplacement and maintenance and navigation channel maintenance dredging, as well as indirect impacts from decreased water quality (such as from disposal of OCS-related wastes), altered hydrology, and vessel traffic. Impacts from ground-disturbing activities during construction or expansion of support facilities, such as processing facilities and pipeline yards, could also occur.

The construction of pipelines through coastal wetlands could result in direct losses of marsh habitat, depending on avoidance of wetlands in pipeline route selection and the emplacement technique used. The use of directional boring under wetlands during pipeline construction would likely avoid or minimize impacts on wetlands. Trenching for pipeline emplacement would result in direct impacts on marsh habitat from excavation. Long-term reduction in vegetation productivity above and adjacent to the pipeline, including areas backfilled, would likely occur, with potential losses of wetland habitat, depending on factors such as the success of backfilling, time of year, and duration of construction (Turner et al. 1994; MMS 2007c).

Maintenance dredging of navigation channels would contribute to increased flushing and draining of interior marsh areas by tides and storms, which could result in shifts in species composition, habitat deterioration, erosion, and wetland loss (LCWCRTF 1998, 2003). Channels alter the hydrology of coastal marshes by affecting the amount, timing, and pathways of water flow (Day et al. 2000a). Hydrologic alterations can result in changes in salinity and inundation, causing a dieback of marsh vegetation and a subsequent loss of substrate and conversion to open water (LCWCRTF 2001; Day et al. 2000a). Saltwater intrusion into brackish and freshwater wetlands further inland could result in mortality of salt-intolerant species and loss of some wetland types such as cypress swamp, or transition of wetland types such as freshwater marsh to brackish and saltmarsh or open water (MMS 2007c). The deposition of dredged material onto adjacent disposal banks could potentially result in a small localized contribution to ongoing impacts of disposal banks, such as preventing the effective draining of some adjacent areas, resulting in higher water levels or more prolonged tidal inundation, or restricting the movement of water, along with sediments and nutrients, into other marsh areas (Day et al. 2000a). Impacts on marsh habitats from navigation channels would be expected to be mitigated by the beneficial use of dredged material (MMS 2008a), through the application of dredged material onto marsh surfaces to increase substrate elevations for marsh restoration or creation. Small areas of marsh would likely be lost during dredging by the occasional inadvertent deposition of dredged material, as well as created by material deposition into shallow water (MMS 2007c).

Service vessel traffic to exploration and production wells would contribute to erosion of marsh habitat. Wetland losses would likely occur along unarmored navigation channels because of the widening that would result from the continued erosion of adjacent marsh substrates due to waves generated by vessel traffic (LCWCRTF 2003). Erosion from vessel activity along navigation channels has resulted in channel widening in the WPA and CPA and land loss in some areas. However, restoration and stabilization of channel margins have been effective in minimizing channel widening. Erosion of wetlands would not occur along armored channels, which are frequently used by OCS-related vessel traffic.

The construction or expansion of facilities near the coastline, including the potential expansion of port facilities, could potentially result in the direct loss of wetlands from the placement of fill material during building construction, as well as the construction of pipelines, access roads, and transmission corridors. However, construction in wetlands is discouraged by State and Federal permitting agencies. Section 404 of the Clean Water Act regulates the discharge of dredge or fill material into U.S. waters, including wetlands. Impacts on jurisdictional wetlands (those under the regulatory jurisdiction of the CWA, Section 404) would require permitting from USACE. In addition, Executive Order 11990, "Protection of Wetlands" (42 FR 26961, May 24, 1977), requires all Federal agencies to minimize the destruction, loss, or degradation of wetlands, both jurisdictional and nonjurisdictional, and to preserve and enhance the natural and beneficial values of wetlands. Indirect impacts of construction could include habitat fragmentation, altered hydrology from changes in surface drainage patterns or isolation of wetland areas from water sources, conversion to upland communities or open water, sedimentation and turbidity, and introduction of contaminants in stormwater runoff. Resulting changes in affected wetlands could include a reduction in biodiversity and the establishment and predominance of invasive plant species. Impacts on wetlands from construction could be minimized by maintaining buffers around wetlands and by using best management practices for erosion and sedimentation control. As noted above, construction in wetlands is managed and regulated by the appropriate State agencies and the USACE. It is assumed that standard mitigation measures would be applied to any construction project associated with the Program.

Impacts on wetlands near constructed facilities might also result from other factors, such as disposal of wastes at upland disposal sites, which could introduce contaminants into wetlands. Contaminants from land storage or disposal sites might migrate into groundwater or could be present in stormwater runoff that could flow into wetlands. Contaminants might also be released to surface water in service vessel discharges, which might affect wetlands. State requirements would be enforced to prevent and address potential occurrences. Impacts on wetlands would be minimized by implementing water quality practices.

Seagrasses. The potential effects on seagrass communities from routine operations would primarily be associated with effects from vessel traffic, pipeline emplacement, and maintenance dredging. Impacts from use or expansion of coastal facilities could also occur.

Coastal seagrass communities might be damaged by vessel traffic outside established traffic routes, which could result in long-term scars on seagrass beds (MMS 2003d). The recovery rate would be greater for larger scars and low-density vegetation. Seagrass communities might also be affected by trenching for pipeline installation, which could bury adjacent seagrasses and deposit lighter sediments onto leaves of more distant seagrasses. Turbidity from pipeline emplacement, maintenance dredging of navigation canals, or vessel traffic might adversely affect seagrass communities by decreasing seagrass cover and productivity, and changing species composition, as a result of reduced light levels (MMS 2007c). It is assumed that the USACE and State agency requirements regarding the mitigation of turbidity impacts on submerged vegetation from pipeline emplacement and maintenance dredging of navigation channels would be followed. Salinity changes resulting from dredging can also result in changes in species composition of seagrass communities. Because activities associated with the Program would be located adjacent to coastlines with substantial seagrass resources in the U.S. GOM, the Program would be expected to have potential effects on the overall condition of seagrass communities in the GOM. Localized impacts on small areas of seagrass could occur in coastal areas west of Florida including the extensive, deepwater seagrass resources of the west Florida shelf.

Impacts of Expected Accidental Events and Spills. The potential effects on coastal and estuarine habitats from accidents would primarily be associated with impacts from spills of oil and other petroleum hydrocarbons, such as fuel oil or diesel fuel, and subsequent cleanup efforts. Large (≥1,000 bbl) and small (<1,000 bbl) oil spills could occur as a result of tanker and barge spills, pipeline spills, or platform spills. This analysis assumes 2–5 pipeline spills of 1,700 bbl, 1–2 platform spills of 5,100 bbl, 1 tanker spill of 3,100 bbl, 35–70 small spills (>50–1,000 bbl), and 200–400 small spills up to 50 bbl. Spills from vessels should be minimized by compliance with USCG requirements for spill prevention and control. Section 4.4.2 provides details of spill assumptions. Oil or other spilled materials might be transported to barrier landforms and wetland habitats by currents or tides. The amount of oil deposited on coastal habitats would depend on various factors, such as spill volume, distance from shoreline, ambient conditions, degree of weathering, and effectiveness of response actions. Large spills would potentially result in heavy or widespread deposits of oil. The majority of spills would be less than 50 bbl and would likely result in light, mostly localized oiling, or would fail to reach a shoreline. Small spills >50 to <1,000 bbl, while not likely to result in widespread shoreline oiling, could be expected to result in moderate deposits.

Beaches could be affected by oil spills, and the direct mortality of biota could result. Spilled oil that reaches barrier beaches might be restricted to beach surfaces, or it could penetrate into subsurface layers. Permeable substrates, generally associated with larger sand grain sizes, and holes created by infauna could increase oil penetration, especially that of light oils and petroleum products (NOAA 2000). Oil may become buried under sediments by wave action. Although beach and foredune areas are often sparsely vegetated, impacts on vegetation might occur if oil was carried to higher elevations by storm waves and tides. Oiled beach sediments could weaken dune and other beach vegetation, resulting in accelerated erosion. Because of the changes in barrier beach and dune profiles as a result of hurricanes, such as Katrina and Rita, habitat between the shoreline and beach ridge may be more vulnerable to impacts of spills (MMS 2008a).

Impacts on coastal marsh vegetation from oil spills could range from a short-term reduction in photosynthesis to extensive mortality and subsequent loss of marsh habitat as a result of substrate erosion and conversion to open water (Hoff 1995; Proffitt 1998). Small spills less than 50 bbl would likely result in short-term impacts, while large spills could incur both short-term and long-term impacts depending on habitat type and location and the effectiveness of spill containment and cleanup activities.

Vegetation that dies back could recover, even following the death of all existing leaves. Long-term impacts could include reduced stem density, biomass, and growth (Proffitt 1998). Mangroves might decrease canopy cover or die over a period of weeks to months (Hensel et al. 2002; Hayes et al. 1992). Other effects of spills could include a change in plant community composition or the displacement of sensitive species by more tolerant species. In locations where soil microbial communities were affected, effects might be long term, and wetland recovery might be slowed. The degree of impacts on wetlands from spills are related to the oil type and degree of weathering, amount of oil, duration of exposure, season, plant species, percentage of plant surface oiled, substrate type, and oil penetration (Hayes et al. 1992; Hoff 1995; Proffitt 1998; Hensel et al. 2002). Higher mortality and poorer recovery of vegetation generally result from spills of lighter petroleum products (such as diesel fuel), heavy deposits of oil, spills during the active growing period of a plant species, contact with sensitive plant species (especially those located in coastal fresh marsh), completely oiled plants, and deep penetration of oil and accumulation in substrates. Most spills in deepwater areas would require an extended period of time to reach a shoreline or marsh and would undergo natural degradation and dispersion, which, in addition to expected containment actions, would reduce potential impacts. A large spill in shallow water, for example, a tanker spill of 3,100 bbl, could result in relatively unweathered oil reaching extensive areas of coastal wetlands and subsequent loss of marsh habitat. Because of the changes in barrier island profiles as a result of hurricanes Katrina, Rita, and Ivan, there is a greater potential for oil spill impacts on coastal marshes (MMS 2008a).

Impacts on seagrass communities would generally be short term, resulting from contact with oil dispersed in the water column, from reduced light and oxygen levels due to the sustained presence of an oil slick in protected areas, or from reduced populations of epiphyte grazers (MMS 2007c). Recovery would generally occur in about 1 yr. Long-term losses of seagrass habitat would not be expected to occur from a spill unless unusually low tides result in direct contact of seagrass leaf surfaces with an oil slick.

Although any residual oil that might remain on barrier beaches following cleanup could be largely removed in highly exposed locations through wave action, oil could remain in the shallow subsurface for extended periods of time. In some locations, oil might become buried by new sand deposition (NOAA 2000). Natural degradation and persistence of oil on beaches are influenced by the type of oil spilled, the amount present, sand grain size, the degree of penetration into the subsurface, the exposure to the weathering action of waves, and sand movement onto and off the shore. Spilled oil might be entirely absent from affected beaches within a year or less, or it might persist for many years (Dahlin et al. 1994; Hayes et al. 1992; Petrae 1995; Irvine 2000). On sheltered beaches, heavy oiling left for long periods could form an asphalt pavement relatively resistant to weathering (Hayes et al. 1992). Spilled oil remaining in wetlands after cleanup degrades naturally by weathering processes and biodegradation caused by microbial communities in the soil. Full recovery of coastal wetlands might occur in less than 1 yr or might require more than 5 yr, depending on site and spill characteristics (Hoff 1995). Oil might degrade very slowly in saturated soils under mangroves; more than 30 yr could be required for mangroves to recover (Hensel et al. 2002). Oil could remain in some coastal substrates for decades, even if it was cleaned from the surface. Heavy deposits of oil in sheltered areas or in the supratidal zone could form asphalt pavements resistant to degradation (Hoff 1995).

Spill cleanup operations might adversely affect barrier beaches and dunes if large volumes of contaminated substrates were removed. Such removal could affect beach stability, resulting in accelerated shoreline erosion, especially in areas of sand deficit, such as along the Louisiana coastline in the CPA. However, sand removal is generally minimized during spill cleanup (MMS 2007c). Foot traffic during cleanup might mix surface oil into the subsurface, where it might persist for a longer time. Spill cleanup actions might damage coastal wetlands through trampling of vegetation, incorporation of oil deeper into substrates, increased erosion, and inadvertent removal of plants or sediments, all of which could have long-term effects (Hoff 1995; Proffitt 1998; NOAA 2000). These actions could result in plant mortality and delay or prevent recovery. In locations where spill cleanup would include the excavation and removal of contaminated soils and biota, increased erosion and lowered substrate elevation could result in marsh loss by conversion to open water, unless new sediments were applied. Effective low-impact cleanup actions could include bioremediation, low-pressure flushing, or use of chemical cleaners (Mendelssohn and Lin 2003; Hoff 1995; Proffitt 1998).

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE with an assumed volume of 0.9–7.2 million bbl and duration of 30–90 days (Table 4.4.2-2). The amount of oil deposited on coastal habitats would depend on various factors, such as spill volume, distance from shoreline, ambient conditions, degree of weathering, and effectiveness of response actions. Although oiling in most areas on barrier islands and beaches is expected to be light, a CDE would potentially result in heavy or widespread deposits of oil and would have a greater likelihood for extensive areas of shoreline affected and heavy deposits of oil in multiple locations. For example, the DWH event, which released 4.9 million bbl of oil, affected more than 1,046 km (650 mi) of the GOM coastal habitat, from the Mississippi River Delta to the Florida panhandle. More than 209 km (130 mi) of coastal habitat were moderately to heavily oiled, including a substantial number of Louisiana beaches (see Section 3.7.1.1.5).

An extended-duration CDE could potentially impact over 1,600 km (1,000 mi) of shoreline. Because of the length of shoreline that could potentially be oiled and the sensitivity of GOM coastal habitats, a high-volume, extended-duration CDE could cause extensive habitat degradation. Loss of vegetation could lead to loss of marsh habitat as a result of substrate erosion and conversion to open water.

While storms may remove oil from shores and strong winds would accelerate the process of dispersal and weathering, storm surges may carry oil into the coastline and inland as far as the surge reaches. Hurricanes have degraded many coastal beaches, marshes, and barrier islands in the GOM, making them more susceptible to a CDE. The toxicity of oil reaching beaches and coastal wetlands from a deepwater CDE should be greatly reduced due to weathering and response activities, thereby minimizing the chances of irreversible damage to the impacted areas. A CDE in shallower waters near shore may have greater impacts because of a shorter period of weathering and dispersion prior to shoreline contact. A spill from a CDE could oil a few to several hundreds of acres of wetlands depending on the depth of inland penetration (Burdeau and Collins 2010). Effects would vary from moderate to heavy oiling. In most cases, the beach face would receive most of the oil; however, in areas where the marsh is immediately adjacent to the beach face or embayments, or in the case of small to severe storms, marshes would also be oiled. Light oiling in wetlands may cause diebacks for one growing season or less, depending on the oil concentration and the season during which contact occurs. However, depending on its duration and magnitude, a CDE could result in high concentrations of oil that would cause long-term effects to wetland vegetation, including some plant mortality and loss of land.

Impact Conclusions.

Routine Operations. Routine Program activities in the GOM would result in minor to moderate localized impacts. Although routine operations in the GOM could have impacts on coastal barrier beaches and dunes, primarily as a result of pipeline construction, maintenance dredging of inlets and channels, and vessel traffic, modern methods of pipeline construction could result in minimal beach erosion. Studies have shown few effects of pipeline landfalls and navigation channels on barrier beach stability.

Routine operations in the GOM could have direct impacts on wetlands as a result of direct losses of habitat from construction activities, pipeline landfalls, and channel dredging, and indirect impacts as a result of altered hydrology caused by channel dredging. Construction impacts, while unavoidable, would be mitigated by State and Federal regulations governing construction in wetland areas.

Expected Accidental Events and Spills. Impacts of a spill on coastal habitats in the GOM could range from negligible to minor for small spills 50 bbl or less, negligible to moderate for small spills >50 to <1,000 bbl, and moderate to major for large spills (≥1,000 bbl), if recovery from the effects of a spill does not occur and exposure results in habitat loss. Spills of oil or other materials could potentially affect both the surface and subsurface of beach and dune substrates in the GOM. Oiled beach sediments could weaken dune and other beach vegetation, resulting in accelerated erosion. Impacts on coastal marsh vegetation from oil spills could range from a short-term reduction in photosynthesis to extensive mortality and subsequent loss of marsh habitat as a result of substrate erosion and conversion to open water. Cleanup operations themselves could also affect wetlands. The effects of spills will depend on the specific habitat affected; the size, location, duration, and timing of the spill; and on the effectiveness of spill containment and cleanup activities. Small spills would likely result in short-term minor impacts, while large spills could incur both short-term and long-term moderate to major impacts, depending on habitat type and location and effectiveness of spill containment and cleanup activities.

An Unexpected Catastrophic Discharge Event. A CDE with an assumed volume of 0.9–7.2 million bbl in the GOM would be associated with a loss of well control. Oil might be transported from offshore areas to coastal wetlands by currents or tides. The amount of oil deposited on coastal habitats would depend on various factors, such as spill volume, distance from shoreline, ambient conditions, degree of weathering, and effectiveness of response actions. A CDE would potentially result in heavy or widespread deposits of oil and would have a greater likelihood for extensive areas of shoreline being affected and heavy deposits of oil in multiple locations. The degree of effects and length of recovery depend on a number of factors such as the type of oil, extent of biota exposure, substrate type, degree of sediment contamination, time of year, temperature, and species sensitivity. Impacts of a CDE on coastal habitats in the GOM could range from moderate to major.

4.4.6.1.2 Alaska Region – Cook Inlet.

Impacts of Routine Operations. The potential effects on coastal habitats from routine operations would primarily be associated with direct impacts from ground-disturbing activities during pipeline construction as well as indirect impacts from service vessels and the operation of existing facilities (see Table 4.4.6-2).

TABLE 4.4.6-2 Impacting Factors for Coastal and Estuarine Habitats in the Alaska Region – Cook Inlet

	Habitat Type		
Oil and Gas Impacting Factors[a]	Cook Inlet Coastal Habitats	Arctic Barrier Landforms	Arctic Wetlands
Vessel traffic (all phases)	X	X	X
Construction of onshore pipelines (construction)	X		X
Use of existing facilities (operations)	X		X
Disposal of OCS-related wastes (all phases)	X		X
Accidental spills (all phases)	X	X	X

[a] X = Potential impacts on the resource attributable to the impacting factor.

Up to one new pipeline landfall would be constructed in the Cook Inlet Planning Area. Pipeline installation would include trench excavation through intertidal and shallow subtidal areas. Installation could directly disturb tidal marshes, beaches, rocky shores, or other coastal habitats, depending on the location of the landfall. A few acres of habitat would likely be altered at each landfall site, and some intertidal and shallow subtidal organisms would be displaced (MMS 2003b). Intertidal and shallow subtidal vegetation could be indirectly impacted by excavation for pipeline installation. Areas adjacent to the trench may be covered by excavated sediments, and organisms could be affected by sedimentation and turbidity associated with the disturbance of bottom sediments during trench excavation and backfilling. Impacts could be reduced by implementing measures to restrict the dispersal of sediments.

Approximately 80–169 km (50–105 mi) of new onshore pipeline would be constructed. Pipelines would deliver oil to existing refineries in Nikiski and natural gas to transmission facilities in the Kenai area, both on the eastern side of Cook Inlet. Indirect effects could include habitat fragmentation, reduced infiltration and increased surface runoff from soil compaction on the construction site, altered hydrology including increased or reduced inundation or saturation of substrates, sedimentation and turbidity, deposition of fugitive dust, and introduction of contaminants in stormwater runoff. Impacts to local streams could affect coastal wetlands. Impacts could result in changes in plant community structure, reduction in plant biodiversity, and the establishment and dominance of invasive plant species. However, activities that may potentially impact wetlands are regulated by State agencies and the USACE. Standard mitigation measures would be applied to any construction project associated with these activities. For example, construction-related impacts could be minimized by maintaining buffers around wetlands and implementing best management practices for erosion and sediment control. Although wetlands along the pipeline route could be affected by construction, impacts could be reduced if pipelines were located in existing utility or transportation system rights-of-way, when possible, and if natural drainage patterns were maintained. Section 404 of the Clean Water Act regulates the discharge of dredge or fill material into U.S. waters, including wetlands. Impacts on jurisdictional wetlands (those under the regulatory jurisdiction of the CWA, Section 404) would require permitting from USACE. In addition, Executive Order 11990, "Protection of

Wetlands" (42 FR 26961, May 24, 1977), requires all Federal agencies to minimize the destruction, loss, or degradation of wetlands, both jurisdictional and nonjurisdictional, and to preserve and enhance the natural and beneficial values of wetlands. Indirect impacts to coastal habitats from sedimentation originating along the pipeline route could be reduced by minimizing crossings of anadromous fish streams and consolidating pipeline crossings with other utility and road crossings.

Construction of a pipeline gravel service road, haul road, and access roads would replace habitat with unvegetated surfaces or result in altered habitat having few species in common with nearby undisturbed habitats. Habitat may also be disturbed by the establishment of work camps. Resulting changes in affected wetlands could include a reduction in biodiversity, replacement of one wetland type for another (such as by dewatering or ponding), conversion to upland communities, or conversion of vegetated wetlands to open water.

No new shore bases, processing facilities, or waste disposal facilities would be constructed. Existing shore bases, gas processing facilities, and waste disposal facilities would be used for all new oil and gas activities in the planning area. Operation of existing facilities could have local indirect effects on wetland vegetation from exhaust emissions or atmospheric releases from processing facilities. Contaminants could be introduced into wetlands from the use of existing waste storage or disposal sites, if contaminants migrate into groundwater or enter stormwater that flows into wetlands. Service vessels would make one to three trips per week for each of the one to three new platforms in the planning area. Discharges from service vessels that support drilling platforms may contain materials that adversely affect coastal wetlands or other intertidal or shallow subtidal habitats. Wetland impacts could be avoided or minimized by implementing practices that eliminate or minimize impacts on water quality.

Impacts of Expected Accidental Events and Spills. The potential impacts on coastal habitats from accidents would primarily be associated with impacts from spills of oil or other petroleum hydrocarbons, such as fuel oil or diesel fuel, and the methods used for spill cleanup. Large (≥1,000 bbl) and small (<1,000 bbl) oil spills could occur as a result of pipeline spills or platform spills. This analysis assumes 1 large spill of 1,700 bbl from a pipeline or 5,100 bbl from a platform, as well as 1–3 small spills >50to <1,000 bbl, and 7–15 small spills up to 50 bbl. Currents and tides within Cook Inlet could transport oil or other materials to coastal habitats. The Cook Inlet Planning Area is unlike any other OCS Planning Area in that it is almost entirely surrounded by coastal habitat. Therefore, there is a very high likelihood that spills in the planning area would make contact with coastal habitats. Because of the patterns of Cook Inlet surface currents, habitats along the western shoreline of the inlet and along Shelikof Strait would have the greatest likelihood of contact from spills within the planning area, while the eastern shoreline would have a lower potential for contamination from spills (MMS 2003a). Extensive winter ice can develop along the western shores of Cook Inlet, and epibiota are seasonally removed by ice scour. Along the Shelikof Strait mainland, intertidal communities are affected by glacier ice melt and are subject to turbidity and freshwater stresses (McCammon et al. 2002).

Intertidal habitats would be highly vulnerable to spills that reach the coastline, and repeated influxes of oil may contaminate intertidal surfaces with each subsequent tidal cycle. Because of the wide tidal range (more than 9 m [30 ft] in some portions of upper Cook Inlet, north of the planning area), extensive areas of shoreline habitat may be affected by a spill, especially soft bottom habitats (sands and muds), which typically have a relatively flat topography. Shallow subtidal habitats could be affected by oil that slumps from intertidal areas and accumulates below the low-tide line.

Vulnerable intertidal habitats sensitive to disturbance from oil spills extend around most of lower Cook Inlet (MMS 2003a). Highly sensitive shoreline habitats include marshes, sheltered tidal flats, and sheltered rocky shores (NOAA 1994). The vulnerability of intertidal habitats is generally rated as highest for vegetated wetlands and semipermeable substrates, such as mud, that are sheltered from wave energy and strong tidal currents. Oil contacting these habitats is less likely to be removed by waves. Cleanup activities are very difficult to conduct on soft mud substrates, such as on tidal flats (NOAA 1994, 2000).

Direct mortality of biota could result from spilled oil contacting intertidal habitats. Oil readily adheres to marsh vegetation (NOAA 1994, 2000; Hayse et al. 1992), and effects may range from a short-term reduction in photosynthesis to extensive vegetation injury or mortality. Many invertebrates are sensitive to oil exposure. Studies of the *Exxon Valdez* oil spill provide valuable information on oil spill effects and recovery. Following the *Exxon Valdez* oil spill, the abundance of many species of algae and invertebrates were reduced at affected sites (NOAA 1997b; Peterson 2000; *Exxon Valdez* Oil Spill Trustee Council 2003). In particular, the abundance and reproductive potential of *Fucus gardneri*, a common and important brown alga species, was reduced in oiled areas and remained unstable at some locations for extended periods (*Exxon Valdez* Oil Spill Trustee Council 2003, 2010a). Although adult *Fucus* appear to have some resistance to oil toxicity, earlier life stages appear to be much more sensitive (NOAA 1998). In shallow subtidal habitats, impacts were less severe, although kelp, eelgrass, and many invertebrates were adversely affected (Peterson 2000).

Spilled oil that contacts intertidal habitats can cause changes in community structure and dynamics. Toxic compounds in oil can selectively remove the more sensitive organisms, such as echinoderms and some crustaceans, while organic enrichment from oil can stimulate the growth and abundance of opportunistic infaunal invertebrates, such as some polychaetes and oligochaetes (McCammon et al. 2002). Some opportunistic species, such as species of barnacle, oligochaetes, and filamentous brown algae, colonized affected shorelines following the *Exxon Valdez* oil spill and cleanup (Peterson 2000; *Exxon Valdez* Oil Spill Trustee Council 2003). Indirect effects also included the spread of *Fucus gardneri* onto lower shoreline areas in some regions, which inhibited the return of red algae (Peterson 2000). The reduction of predators or herbivores can also result in changes in lower trophic levels for extended periods. The adverse effects of oil on intertidal organisms, such as macroalgae, clams, and mussels, can last for more than a decade (MMS 2003e; *Exxon Valdez* Oil Spill Trustee Council 2003).

Extended periods of time may be required for intertidal communities to fully recover from an oil spill. The degree of effects and length of recovery depend on a number of factors such as the type of oil, extent of biota exposure, substrate type, degree of sediment contamination, time of year, and species sensitivity (NOAA 1998; Hayse et al. 1992; Hoff 1995). Both large and small spills could result in long-term and short-term impacts, depending on the habitats affected, the duration and size of the spill, and on the effectiveness of spill containment and cleanup activities. Recovery would likely be considerably longer for large spills with extensive biota exposure and sediment contamination than for small spills, particularly those less than 50 bbl. Although the most acutely toxic components of crude oil are rapidly lost through weathering, the more persistent components have been associated with long-term pathologies such as carcinogenicity (NOAA 1997b). Full recovery of wetlands including invertebrate communities may require more than 10 years (Hoff 1995). Studies indicate that full recolonization of sheltered rocky shorelines in Cook Inlet may require 5–10 years (Highsmith et al. 2001). Although studies in Prince William Sound indicate that some organisms can recover quickly, recovery in some intertidal and shallow subtidal habitats takes more than a decade (Peterson 2000; *Exxon Valdez* Oil Spill Trustee Council 2003). More than 20 years after the *Exxon Valdez* oil spill, intertidal communities were considered to be recovering, but had not yet fully recovered from the effects of the spill (*Exxon Valdez* Oil Spill Trustee Council 2010a).

Spilled oil may penetrate into subsurface layers or may remain on the surface. Oil can remain in intertidal sediments and organisms for more than a decade and may remain a long-term source of exposure (NOAA 1997; MMS 2003e; Short et al. 2004; *Exxon Valdez* Oil Spill Trustee Council 2003). Lingering oil, in some areas only slightly weathered, persists in intertidal beach substrates at a number of locations more than 20 years after the *Exxon Valdez* oil spill (*Exxon Valdez* Oil Spill Trustee Council 2009b, 2010a, b). Coarse-grained sand beaches are more conducive to subsurface penetration than fine-grained sands (NOAA 2000), and subsequent deposition of sand may bury oil deposits. Natural removal of subsurface oil from gravel beaches is greatly reduced by surface armoring of boulders, as observed in Prince William Sound (NOAA 1997b). Although oil is not likely to adhere to the surface of mudflats, oil may be deposited if concentrations are high; penetration of the surface is unlikely except for entering burrows or crevices (NOAA 2000).

Cleanup activities may also adversely affect intertidal habitats and biota, as occurred following the *Exxon Valdez* oil spill (NOAA 1997b; McCammon et al. 2002; *Exxon Valdez* Oil Spill Trustee Council 2003). The removal of organisms from affected surfaces and washing out of fine particles from substrates likely inhibited and slowed the recovery of intertidal communities in some areas. Trampling of vegetation and other biota during cleanup activities as well as working oil deeper into sediments from foot traffic and equipment can also delay recovery from oil spills. Extensive vessel traffic during cleanup operations may increase turbidity and adversely affect organisms, such as eelgrass, in shallow subtidal communities (*Exxon Valdez* Oil Spill Trustee Council 2003).

Impacts of an Unexpected Catastrophic Discharge Event. For the Cook Inlet Planning Area, the PEIS analyzes an unexpected CDE with an assumed volume of 75,000–125,000 bbl and duration of 50–80 days (Table 4.4.2-2). Currents and tides within Cook Inlet could transport oil, and there is a very high likelihood that spills in the planning area would make contact with coastal habitats. A CDE would potentially result in heavy or widespread deposits of oil and would have a greater likelihood for extensive areas of shoreline affected and heavy deposits of oil in multiple locations. A spill under ice or in rapidly freezing or broken ice would be more difficult to clean up, and weathering would occur much more slowly. Under these conditions, oil could be transported considerable distances and contact coastal habitats during spring breakup. The degree of effects and length of recovery depend on a number of factors such as the type of oil, extent of biota exposure, substrate type, degree of sediment contamination, time of year, and species sensitivity.

Approximately 257,000 bbl of oil were spilled during the *Exxon Valdez* oil spill, considerably larger than the CDE considered here. That spill affected approximately 2,100 km (1,300 mi) of coastline, with 300 km (200 mi) heavily or moderately oiled. More than 20 years after the *Exxon Valdez* oil spill, intertidal communities were considered to be recovering, but had not yet fully recovered from the effects of the spill (*Exxon Valdez* Oil Spill Trustee Council 2010a). While a CDE would not be expected to result in the extent of shoreline oiling that occurred following the *Exxon Valdez* oil spill, contamination of coastal habitats would likely result in long-term impacts to biotic community structure and function in sensitive intertidal habitats; such habitats could take decades to recover.

Impact Conclusions.

Routine Operations. Routine Program activities in Cook Inlet would result in minor to moderate localized impacts. Routine operations in Cook Inlet could affect coastal habitats as a result of vessel traffic, as well as infrastructure maintenance and repair activities. Direct loss of habitat could occur as a result of damaging habitats during maintenance. Direct losses would be minimized through existing Federal and State environmental review and permitting procedures that would attempt to mitigate impacts through appropriate requirements. Secondary impacts on wetlands could occur from water and air quality degradation.

Expected Accidental Events and Spills. Impacts of a spill on coastal habitats could range from negligible to minor for small spills 50 bbl or less, negligible to moderate for small spills 50 to <1,000 bbl, and moderate to major for large spills (≥1,000 bbl) if recovery from the effects of a spill does not occur and exposure results in habitat loss. Because the Cook Inlet Planning Area is almost entirely surrounded by coastal habitat, it is likely that a large spill would contact these habitats. Habitats along the western shoreline have the greatest likelihood of contact based on surface currents in the inlet. Effects of a large spill may range from a short-term reduction in photosynthesis to extensive vegetation injury or mortality. Large spills could result in changes in community structure and direct loss of habitat. The effects of accidental oil spills will depend on habitats affected; the size, location, duration, and timing of the spill; and on the effectiveness of spill containment and cleanup activities.

An Unexpected Catastrophic Discharge Event. An unexpected 75,000–125,000 bbl CDE in Cook Inlet would be associated with a loss of well control or pipeline break. Oil or other spilled materials might be transported from offshore areas to coastal wetlands by currents or tides. The amount of oil deposited on coastal habitats would depend on various factors, such as spill volume, distance from shoreline, ambient conditions, degree of weathering, and effectiveness of response actions. A catastrophic discharge event would potentially result in heavy or widespread deposits of oil and would have a greater likelihood for extensive areas of shoreline being affected and heavy deposits of oil in multiple locations. The degree of effects and length of recovery depend on a number of factors such as the type of oil, extent of biota exposure, substrate type, degree of sediment contamination, time of year, temperature, and species sensitivity. Impacts to coastal habitats from a CDE would range from moderate, if recovery of habitats occurs, to major, if recovery does not occur and exposure results in habitat loss.

4.4.6.1.3 Alaska – Arctic.

Impacts of Routine Operations.

Coastal Barrier Beaches. The potential effects on coastal barrier beaches from routine operations would primarily be associated with direct impacts from ground-disturbing activities during pipeline construction and indirect effects from vessel traffic.

No new pipeline landfalls would be constructed in the Arctic region. However, 16–129 km (10–80 mi) of new onshore pipeline would be constructed for the Beaufort Sea, connecting to existing infrastructure on the Arctic Coastal Plain (ACP). Pipeline construction may affect sand beaches and dunes on the margins of lakes and rivers on the ACP, and erosion of sand beaches and dunes adjacent to pipelines could be promoted. Stabilization of dune margins could be difficult, and establishment of vegetation cover might be slow, possibly resulting in prolonged losses of dune habitat near pipeline routes.

No new shore bases, processing facilities, or waste disposal facilities would be constructed in the Arctic region. Existing shore bases, gas processing facilities, and waste disposal facilities would be used for all new oil and gas activities in the region. Operation of existing facilities could have local indirect effects on vegetation from exhaust emissions or atmospheric releases from processing facilities.

Arctic coastal habitats are exposed to strong wave and sea ice action, and the shoreline is generally unstable and prone to erosion (MMS 2002c; Viereck et al. 1992; Macdonald 1977). Service vessel traffic to exploration and production wells and barge traffic in support of shore bases could contribute to erosion along barrier beaches. Under the proposed action, up to three vessel trips per week would be made to each of the up to five new platforms along the Chukchi Sea and up to four along the Beaufort Sea. Increases in wave activity from vessel traffic could contribute to the removal of sediments along barrier beaches. Wave activity could be minimized by maintaining reduced vessel speeds in the vicinity of barrier islands.

Wetlands. The potential effects on wetlands from routine operations would primarily be associated with direct impacts from ground-disturbing activities during construction of pipelines and roads, as well as the indirect impacts from decreased water and air quality, altered hydrology, and facility maintenance. Wetland losses could result in the localized reduction or loss of wetland functions, such as fish and wildlife habitat, attenuation of flooding and shoreline erosion, and removal of substances that reduce water quality. Avoidance of wetlands during route selection for pipelines or roads might be difficult on the ACP because of the high density of wetlands. Activities that would potentially affect wetlands are regulated by State agencies and USACE. Section 404 of the Clean Water Act regulates the discharge of dredge or fill material into U.S. waters, including wetlands. Impacts on jurisdictional wetlands (those under the regulatory jurisdiction of the CWA, Section 404) would require permitting from USACE. In addition, Executive Order 11990, "Protection of Wetlands" (42 FR 26961, May 24, 1977), requires all Federal agencies to minimize the destruction, loss, or degradation of wetlands, both jurisdictional and nonjurisdictional, and to preserve and enhance the natural and beneficial values of wetlands. Standard measures would help mitigate construction-related impacts.

Although no new pipeline landfalls would be constructed in the Arctic region, 16–129 km (10–80 mi) of pipeline would be constructed onshore to transport oil from the Beaufort Sea to existing North Slope pipelines. With a 46-m (150-ft) wide construction ROW, approximately 73–584 ha (180–1,443 ac) of land would be disturbed. A number of wetland types, including wet or moist tundra habitat, lakes, ponds, or marshes (including those occurring within lakes and ponds), could be affected by pipeline construction. Construction of a pipeline gravel workpad (service roadway), haul road, and access roads would replace wetland habitat with unvegetated surfaces or result in upland habitat having few species in common with nearby undisturbed habitats. Because of the high density of wetlands on the coastal plain, wetland habitat expected to constitute a large proportion of the disturbed area would likely be lost, as occurred during the construction of the TAPS (Pamplin 1979; BLM 2002). Construction of buried pipeline segments would affect similar amounts of wetland habitat as a workpad. However, construction of aboveground pipeline segments without a workpad would result in the loss of only small areas of wetland habitat at the locations of the vertical support members. Wetland areas may also be disturbed by the establishment of work camps. Additional impacts of construction could include altered hydrology from changes in surface drainage patterns or isolation of wetland areas from water sources, such as from blocking natural surface flows. Changes in the moisture regime, natural drainage patterns, or snow-drift patterns in adjacent areas would likely result in thermokarst, with resulting changes in the species composition of plant communities (NRC 2003a). Wetland impacts associated with degraded water quality could include sedimentation and turbidity and introduction of contaminants in stormwater runoff. Resulting changes in affected wetlands could include a reduction in biodiversity, replacement of one wetland type for another (such as by dewatering or ponding), conversion to upland communities, or conversion of vegetated wetlands to open water. Wetlands adjacent to a gravel workpad would be indirectly affected by deposition of airborne dust. Additional wetland habitat may be lost through thermokarst associated with new impoundments and heavy dust accumulations (BLM 2002).

Deposition of fugitive dust can affect plant communities and alter wetland characteristics, primarily by reducing canopy cover and altering species composition (Auerbach et al. 1997; Everett 1980; Walker and Everett 1987). Impacts may include reduced growth and density of vegetation and changes in community composition to more tolerant species. Reductions in plant cover can reduce the insulation of the ground surface, leading to thawing of the underlying ice-rich permafrost (NRC 2003a). Nonvascular species, primarily mosses and lichens, are highly sensitive. The reduction or loss of sphagnum mosses, which are important components of many plant communities on the ACP, can occur in acidic tundra habitat, especially within 10 m (33 ft) of a road (Walker et al. 1987a), potentially contributing to thermokarst. Deposition of dust on snowdrifts along roads promotes earlier melting. Roads and construction/excavation equipment can also provide a means for the introduction and spread of non-native plants and noxious weeds.

The construction of access roads and transmission corridors would likely result in the direct loss of wetlands from the placement of fill material during construction. Additional wetland habitat could be disturbed by other forms of infrastructure such as employee camps, airstrips, and power stations. The construction of these facilities could eliminate wetland habitat within the immediate footprints of the facilities. While this wetland loss would be long term, the areas disturbed represent an extremely small portion of habitat that occurs on the ACP adjacent to the Arctic region. Impacts on wetlands from construction could be minimized by maintaining buffers around lakes and ponds and by using best management practices for erosion and sedimentation control.

The impacts of road construction on the North Slope are often reduced by the restriction of construction activities to the winter months when the ground is frozen and the use of ice roads rather than gravel roads. Although ice roads avoid the loss of habitat associated with gravel roads, they may affect some vegetation communities. Effects may result from delayed melting in spring, damage to plants, plant mortality, and removal of dead material from the canopy (Walker et al. 1987a). Tundra communities generally recover from such effects, however, within several years (MMS 2002c, 2003e). Drier communities, elevated microsites, and tussock tundra are more affected (Pullman et al. 2003), while moist or wet meadow communities are little affected (MMS 2007h).

Large amounts of gravel may be required for permanent road construction. On the North Slope, gravel is often extracted from the floodplains of large rivers (Pamplin 1979; BLM 2002). The excavation of gravel from these material sites and the creation of stockpile areas may affect wetland communities on river floodplains. Wetland areas may be modified by gravel excavation and other mining operations that alter stream channels. Revegetation of the affected area is expected to be relatively rapid, within a few years.

Additional factors, such as reduced air quality, might also affect wetlands because of activities associated with pipeline or platform construction. Exhaust emissions, such as from construction equipment or pump stations, or fugitive dust generated from exposed soils or roadways could have adverse effects on nearby wetland communities.

Existing shore bases, gas processing facilities, and waste disposal facilities would be used for all new oil and gas activities in the region. Operation of existing facilities could have local indirect effects on vegetation from exhaust emissions or atmospheric releases from processing facilities. Contaminants could be introduced into wetlands from the use of existing land storage or disposal sites, if contaminants migrate into groundwater or enter stormwater that flows into wetlands. Contaminants might also be released to surface waters in service vessel discharges, and might subsequently affect wetlands. Impacts on wetlands could be minimized by the implementation of air and water quality practices.

Impacts of Expected Accidental Events and Spills.

Coastal Barrier Beaches. The potential effects on coastal barrier beaches and dunes from accidents would primarily be associated with impacts from spills of oil and other petroleum hydrocarbons, such as fuel oil or diesel fuel, and subsequent cleanup efforts. Large (≥1,000 bbl) and small (<1,000 bbl) oil spills could occur as a result of pipeline spills or platform spills. This analysis assumes 1–2 large spills of 1,700 bbl from a pipeline, 1 large spill of 5,100 bbl from a platform, as well as 10–35 small spills >50 to <1,000 bbl and 50–190 small spills up to 50 bbl. Oil or other spilled materials might be transported to barrier island beaches, coastal beaches, or lagoon beaches by currents or tides. Contamination of beaches from platform spills, pipeline spills, or vessel spills could occur. Because platforms in the Chukchi Sea would be at least 40 km (25 mi) from the coastline, platform spills there would have a lower potential for contacting beaches and dunes than spills nearer the coast in the Beaufort Sea, and the point of contact may be a greater distance down the coastline due to longshore currents. Greater weathering of the lighter, more acutely toxic components of crude oil may therefore also occur prior to contact with the coastline. Beach habitat could be affected by oil spills, and the direct mortality of biota could result. Although beach and foredune areas are often sparsely vegetated, impacts on vegetation might occur if oil were carried to higher elevations by storm waves and tides.

Spilled oil that becomes stranded on beaches might occur only on the surface, or it could penetrate into subsurface layers. Permeable substrates, generally associated with larger sand grain sizes, and holes created by infauna could increase oil penetration, especially that of light oils and petroleum products. Penetration into coarse-grained sand beaches may be up to 25 cm (0.8 ft) (NOAA 1994, 2000). Light oils may penetrate peat shores; however, peat resists penetration by heavy oils (NOAA 2000).

Although any residual oil that could remain following cleanup might be largely removed in highly exposed locations through wave action, oil could remain in the shallow subsurface for extended periods of time. In some locations, oil might become buried by new sand or gravel deposition. Natural degradation and persistence of oil on beaches are influenced by the type of oil spilled, amount present, sand grain size, degree of penetration into the subsurface, exposure to weathering action of waves, and sand movement onto and off shore. Although petroleum-degrading microbial communities are present, biodegradation along Arctic coastlines would likely be slow (Prince et al. 2002; Braddock et al. 2003; Braddock et al. 2004) and is limited to only a few months per year. Spilled oil might persist for many years, with continued effects on infauna and potential recovery of infaunal communities. On sheltered beaches, heavy oiling left for long periods could form an asphalt pavement relatively resistant to weathering (Hayes et al. 1992). Lagoon shorelines include low-energy beaches where spilled oil would likely persist for many years. Spilled oil may persist for extended periods on peat shores; however, if cleaned up, it would be expected to persist for less than a decade (Owens and Michel 2003).

Spill cleanup operations might adversely affect beaches and dunes, if the removal of contaminated substrates affects beach stability and results in accelerated shoreline erosion. Vehicular and foot traffic during cleanup could mix surface oil into the subsurface, where it would likely persist for a longer time. Manual cleanup rather than use of heavy equipment would minimize the amount of substrate removed.

Wetlands. The potential effects on wetlands from accidents would primarily be associated with impacts from spills of oil and other petroleum hydrocarbons, such as fuel oil or diesel fuel, and subsequent cleanup efforts. Oil or other spilled materials might be transported from offshore areas to coastal wetlands by currents or tides, and may result from spills involving platforms, pipelines, or service vessels. Because platforms in the Chukchi Sea would be at least 40 km (25 mi) from the coastline, platform spills there would have a lower potential for contacting coastal wetlands than spills nearer the coast in the Beaufort Sea, and the point of contact may be a greater distance down the coastline due to longshore currents. Greater weathering of the lighter, more acutely toxic components of crude oil may therefore also occur prior to contact with the coastline. The potential for impacts on marshes, estuaries, and low-lying tundra would depend on wind and wave conditions, because the rates of abrasion and dispersal of stranded oil by littoral processes are generally low, due to the small tidal range along the Arctic coast. Oil may be deposited at higher elevations of marshes, tundra, and river deltas by spring tides or storm surges and would be expected to persist for long periods due to the low rates of dispersion and degradation.

Freshwater wetlands on the ACP could be affected by spills from onshore pipelines. Oil spilled on the ACP could potentially flow into a nearby stream. Vegetation along the path of the spill would be injured or killed, including wetland vegetation along the stream. Oil reaching the Arctic coastline may persist for extended periods of time and slow or reduce vegetation recovery. Wetlands in river deltas and estuaries could be affected by oil spilled in upstream areas.

Impacts on wetlands from oil spills could result in extensive injury or mortality of vegetation and invertebrates in or on the substrate. Other effects of spills could include a change in plant community composition or the displacement of sensitive species by more tolerant species. Impacts on soil microbial communities might result in long-term wetland effects, and wetland recovery would likely be slowed. Various factors influence the extent of impacts on wetlands. Impacts would depend on site-specific factors at the location and time of the spill. The degree of impacts is related to the oil type and degree of weathering, the quantity of the spill (lightly or heavily oiled substrates), duration of exposure, season, plant species, percentage of plant surface oiled, substrate type, soil moisture level, and oil penetration into the soil (Hayes et al. 1992; Hoff 1995; NOAA 1994). Higher mortality and poorer recovery of vegetation generally result from spills of lighter petroleum products (such as diesel fuel), heavy deposits of oil, spills during the growing season, contact with sensitive plant species, completely oiled plants, and deep penetration of oil and accumulation in substrates. Oil that reaches the root system would result in high levels of mortality. Vegetation regrowth and recovery are generally better where oil spills occur in flooded areas or on saturated soils, than on unsaturated soils (BLM 2002). Coastal wetlands in sheltered areas, such as bays and lagoons, which are not exposed to strong water circulation or wave activity, would be expected to retain oil longer with longer-lasting effects on biota (Culbertson et al. 2008).

Oil spills on ice or snow in winter would likely be easily cleaned up with little oil remaining; however, spills during other times may be difficult to clean up, and considerable amounts of oil may remain. Following cleanup, the spilled oil remaining degrades naturally by weathering and biodegradation by soil microbial communities. However, biodegradation would likely be slow due to generally cool temperatures and a short growing season. Full recovery of wetlands, including invertebrate communities, might require more than 10 years depending on site and spill characteristics (Hoff 1995; Culbertson et al. 2008). Oil could remain in some wetland substrates for decades, even if it was cleaned from the surface. Heavy deposits of oil in sheltered areas of coastal wetlands or in the supratidal zone could form asphalt pavements resistant to degradation (Hoff 1995; Culbertson et al. 2008).

Spill cleanup actions might damage wetlands through trampling of vegetation, incorporation of oil deeper into substrates, increased erosion, and inadvertent removal of plants or sediments, all of which could have long-term effects (NOAA 1994, 2000; Hoff 1995). These actions could result in plant mortality and delay or prevent recovery. Complete recovery of coastal wetlands disturbed by cleanup activities could take several decades. Effective low-impact cleanup actions could include bioremediation, low-pressure flushing, or use of chemical cleaners.

The NOAA Environmental Sensitivity Index (ESI) shoreline classification system classifies coastal habitats on a scale of 1 to 10, according to habitat sensitivity to spilled oil, oil-spill retention, and difficulty of cleanup (NOAA 1994). Habitats with high ESI values are given a higher priority for protection. The ESI shoreline classification for the Beaufort and Chukchi Sea coasts includes habitats with high values, such as inundated lowland tundra or salt/brackish-water marshes, both ranked 10 (MMS 2002d, Owens and Michel 2003).

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE in the Beaufort Sea with a volume of 1.7–3.9 million bbl and duration of 60–300 days, and in the Chukchi Sea with a volume of 1.4–2.2 million bbl and a duration of 40–75 days. A CDE would potentially result in heavy or widespread deposits of oil and would have a greater likelihood of affecting extensive areas of shoreline and leaving heavy deposits of oil in multiple locations. Oil or other spilled materials might be transported from offshore areas to barrier island beaches, coastal beaches, or lagoon beaches or to coastal wetlands by currents or tides, even from a discharge in the Chukchi Sea; however, the point of contact may be a greater distance down the coastline due to longshore currents. Greater weathering of the lighter, more acutely toxic components of crude oil may therefore also occur prior to contact with the coastline. However, if a CDE were to occur late in the open-water season, oil could continue to be released after the end of the season. The liquid hydrocarbons may freeze into the sea ice and remain over winter without any extensive amount of weathering. Un-weathered oil could subsequently be transported to non-spill-zone areas in the Chukchi and Beaufort Seas and be released in the spring (BOEMRE 2011).

The Arctic shoreline is characterized by small tides and moderate winds of the region, generally creating a low potential for spilled oil to reach beyond the intertidal zone (BOEMRE 2011). However, seasonal storm events could force oil into upper shoreline areas and inside delta areas (Reimnitz and Maurer 1979). Tundra and marsh areas would then be affected. Long-term effects, impacting populations for more than two years, are possible for coastal areas due to the severity of a CDE. In 1970, Reimnitz and Maurer (1979) observed the effects of tidal surges from a major storm event that inundated low-lying tundra and delta regions on the Beaufort Sea shoreline, leaving debris lines from flotsam as far as 5,000 m (16,500 ft) inland. A storm of equal or greater magnitude could force weathered oil far inward and leave residue over wide areas of tundra and river shores.

Natural degradation and the persistence of oil on beaches are influenced by the amount of oil present, sand grain size, degree of penetration into the subsurface, exposure to weathering action of waves, and sand movement onto and off shore. Spilled oil might persist on some beaches for many years, with continued effects on infaunal communities. The potential for impacts on marshes, estuaries, and low-lying tundra would depend on wind and wave conditions. The degree of impacts is related to the degree of weathering, whether substrates are lightly or heavily oiled, duration of exposure, season, plant species, percentage of plant surface oiled, substrate type, soil moisture level, and oil penetration into the soil and root systems. Oil contamination could persist for 10 years or more, during which time the oil in the sediments could be slowly released back into the environment as a result of erosion or exposure of oiled sediments and soils (BOEMRE 2011). Full recovery of wetlands, including invertebrate communities, may require more than 10 years depending on site and spill characteristics (Culbertson et al. 2008).

Impact Conclusions.

Routine Operations. Routine Program activities in the Arctic would result in minor to moderate localized impacts. Routine operations in the Arctic could affect coastal habitats as a result of pipeline construction, gravel mining on floodplains (for pipeline workpads and offshore islands), vessel traffic, and infrastructure maintenance and repair activities. These activities could result in direct loss of habitat by replacing habitat with infrastructure and by damaging habitats during maintenance. These direct losses would be minimized through existing Federal and State environmental review and permitting procedures that would attempt to mitigate impacts through appropriate siting and construction requirements. Secondary impacts on wetlands could occur from water and air quality degradation, ice roads, fugitive dust, and altered drainage caused by pipelines and roads.

Expected Accidental Events and Spills. Impacts of a spill on coastal habitats could range from negligible to minor for small spills 50 bbl or less, negligible to moderate for small spills 50 to <1,000 bbl, and moderate to major for large spills (≥1,000 bbl), if recovery from the effects of a spill does not occur and exposure results in habitat loss. Oil or other spilled materials might be transported to barrier island beaches, coastal beaches, or lagoon beaches by currents or tides. Beach habitat could be affected by oil spills, and the direct mortality of biota could result. Spilled oil that becomes stranded on beaches could penetrate into subsurface layers. Impacts on vegetation behind beaches might occur if oil were carried to higher elevations by storm waves and tides. Freshwater wetlands on the ACP could be affected by spills from onshore pipelines. Impacts on wetlands from oil spills could result in extensive injury or mortality of vegetation and invertebrates in or on the substrate. Spills could result in changes in community structure and direct loss of habitat. Vegetation regrowth and recovery are generally better where oil spills occur in flooded areas or on saturated soils, than on unsaturated soils.

An Unexpected Catastrophic Discharge Event. An unexpected 1.7–3.9 million bbl CDE in the Beaufort Sea or a 1.4–2.1 million bbl CDE in the Chukchi Sea would be associated with a loss of well control. Oil or other spilled materials might be transported from offshore areas to coastal wetlands by currents or tides. The amount of oil deposited on coastal habitats would depend on various factors, such as spill volume, distance from shoreline, ambient conditions, degree of weathering, and effectiveness of response actions. A CDE would potentially result in heavy or widespread deposits of oil and would have a greater likelihood for extensive areas of shoreline being affected and heavy deposits of oil in multiple locations. The degree of effects and length of recovery depend on a number of factors such as the type of oil, extent of biota exposure, substrate type, degree of sediment contamination, time of year, temperature, and species sensitivity. Impacts to coastal habitats from a CDE would range from moderate, if recovery of habitats occurs, to major, if recovery does not occur and exposure results in habitat loss.

4.4.6.2 Marine Benthic Habitats

4.4.6.2.1 Gulf of Mexico.

Soft Sediments.

Impacts of Routine Operations.

Exploration and Site Development. Impacting factors for the exploration and site development phase are shown in Table 4.4.6-3. The vast majority of marine benthic habitat affected by the Program would be soft sediments. Drilling wells would temporarily reduce habitat quality by generating temporary turbidity and sedimentation for some distance around the disturbed area. It is estimated that 1,000 to 2,100 exploration and delineation wells and 1,300 to 2,600 development and production wells will be drilled in the WPA and CPA. Drilling can occur from fixed platforms, floating platforms, or drillships. The installation of floating or fixed platforms would disturb soft sediment habitat where the legs or mooring structures (anchors and chains) encountered the seabed and where subsea equipment (such as reentry collars and blowout preventers) was installed. Chronic local bottom disturbance would result from subsequent movements of anchors and mooring lines associated with floating production platforms and support vessels. The actual area of seafloor affected by anchoring operations would depend upon water depth, currents, size of the vessels and anchors, and length of anchor chain. The amount of bottom affected by anchored structures would increase with water depth because of the use of larger anchors and longer anchor chains. Anchor scars were detected in a radial pattern up to 3 km (2 mi) from a well located on the GOM continental slope (Continental Shelf Associates, Inc. 2006). Drilling vessels would use either anchors or dynamic positioning to maintain station. Drilling vessels using dynamic positioning systems rather than anchors would not generate mooring impacts on the seafloor. Exploratory well platforms can be fixed or floating.

Under the proposed action, it is estimated that 200 to 450 new production platforms will be constructed, which is expected to disturb 150 to 2,500 ha (370 to 6,178 ac) of seafloor. Ninety-five percent of these new platforms will be located in water depths less than 200 m (656 ft). In deep water, floating platforms (including those associated with a FPSO system) requiring mooring structures will typically be used, while platforms in more shallow water would

TABLE 4.4.6-3 Impacting Factors by Phase and Potential Effects on Marine Benthic Habitat in the CPA and WPA of the GOM

Disturbance	Potential Effects[a]
Exploration and Site Development	
Seismic surveys	Noise; localized anchoring disturbance
Anchoring and mooring of platforms, drillships, and seismic survey vessels	Sediment scour; temporary turbidity and sedimentation; localized alteration in sediment grain size and biogeochemical functions
Drilling and production platform placement	Noise; temporary sediment resuspension and turbidity; loss of natural habitat creation of artificial reef
Drilling	Noise; small habitat loss; local alteration of sediment characteristics; temporary turbidity and sedimentation in surrounding areas
Miscellaneous discharges (deck washing; sanitary waste; vessel releases of bilge and ballast water)	Sediment contamination
Solid wastes	Sediment contamination
Discharge of drilling muds/cuttings	Sediment and water column contamination; alteration in sediment granulometry and biogeochemical functions
Pipeline trenching and placement	Noise; long-term loss and degradation of existing benthic habitat; temporary sediment resuspension and turbidity; substrate for growth
Production	
Scour from anchors and the movement of pipelines and mooring structures	Chronic, long-term disturbance of bottom sediments; turbidity
Platform production	Noise; loss of natural habitat creation of artificial reef
Produced water discharge	Sediment contamination
Miscellaneous discharges	Sediment contamination
Solid wastes and debris	Sediment contamination
Decommissioning	
Miscellaneous discharge	Sediment contamination
Solid wastes and debris	Sediment contamination
Platform removal	Explosive noise; temporary turbidity and disturbance of bottom sediments

[a] Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

likely have legs and not require mooring. Impacts from fixed and floating production platforms would be similar to those described above for the exploration phase.

Under the proposed action, it is estimated that 3,862 to 12,070 km (2,400 to 7,500 mi) of new pipeline would be placed in the CPA and WPA, resulting in disturbance to 2,000 to 11,500 ha (4,942 to 28,417 ac) of seafloor. Up to two FPSO systems could potentially be used in deep water, which would reduce the need for pipelines. In water depths less than 60 m (197 ft), pipelines must be buried; benthic organisms within the trenched corridor could be killed or injured and organisms to either side of the pipeline could be buried by sediments. Pipelines placed on the sediment surface would replace the existing soft sediments with man-made substrate that sessile invertebrates may colonize over time. Vessel anchoring during pipeline placement would also disturb soft sediment. Anchor and mooring impacts from pipeline placement vessels would be eliminated if dynamic positioning systems rather than anchors were used during pipeline placement. The recovery period for soft sediment benthic habitat disturbed by pipeline placement would depend on factors such as water depth, sediment type, and community composition. Disturbed sediments with a greater proportion of sand to mud may fill in with fine silty material, which would alter grain size and potentially inhibit the colonization by species that existed prior to the disturbance.

During the exploration and development phase, drill cuttings and drilling muds (including synthetic drilling fluids adhering to the cuttings) could contaminate and alter the grain size of sediments immediately around the wellhead and below the discharge area. Drilling wastes are regulated by the USEPA under NPDES permits and can be discharged into the ocean only if they meet USEPA toxicity and discharge rate requirements. These requirements greatly reduce the potential for sediment contamination. Drill cuttings and muds rapidly reach the sediment surface. Therefore, the discharged drilling muds and cuttings could be deposited in highly concentrated thick layers if deposited in shallow water or near the sediment surface. In the case of near-surface discharge in deep water, drilling muds would spread out in a thin veneer over a wide area. Settled muds could cause smothering of organisms, changes in sediment characteristics and biogeochemical functions, and the loss of food resources in the immediate area. The biodegradable synthetic drilling fluids attached to the drilling waste may deplete oxygen (Trannum et al. 2010) and therefore may create local sediment anoxia.

Studies at multiple sites on the Louisiana continental shelf and slope provide the most relevant information on the potential ecological effects of drilling and drilling mud discharges on soft sediment habitat. These studies found drill cuttings were detectable up to 1 km (0.6 mi) from the well site, depending on whether cuttings were discharged near the water surface or near the bottom (Continental Shelf Associates Inc. 2004a, 2006). Concentrations of barium, hydrocarbons, and synthetic drilling fluids in the sediment were patchily distributed within the sampling radius (up to 500 m [1,640 ft] from the well) but, overall, were higher than at the control sites (Continental Shelf Associates Inc. 2004a, 2006). Several other alterations in habitat were also detected, including anoxic bottom patches, elevated metal concentrations, coarser grain size (all typically less than 300 m [984 ft] from well), and anchor scars (up to 3 km [1.9 mi] from well). Within 250 m (820 ft) of the well, sediment toxicity to certain invertebrates based on bioassays was also reported at several sites, and metrics of invertebrate community health were lower and more variable (Continental Shelf Associates Inc. 2004a). However, a greater abundance of certain species of meiofauna, macrofauna, and fish compared to controls was also detected, potentially because of the organic enrichment of sediments near the well (Continental Shelf Associates Inc. 2006). The spatial extent of the biological, physical, and chemical effects cannot be precisely determined, but drilling discharges, hydrocarbons, and sediment toxicity all dropped off rapidly with distance from the well (Continental Shelf Associates Inc. 2004a, 2006). Habitat recovery time is also unknown, but evidence for biological, physical, and chemical recovery was detected after 1 yr, so full recovery may occur over several years as sediment contaminants are biodegraded and buried by natural deposition and bioturbation (Continental Shelf Associates Inc. 2004a, 2006).

Miscellaneous discharges (deck washing, sanitary waste, and vessel discharge) also have the potential to disturb soft sediment habitats. Miscellaneous discharges could contaminate sediments if discharged in relatively shallow water. However, contaminants in surface discharges would most likely be diluted to non-toxic concentrations before reaching the sediment, especially for platforms located in deep water. Many vessel and platform wastes are disposed of on land, and those that are discharged at sea must meet USEPA and/or USCG regulatory requirements that limit their environmental effects.

Noise from seismic surveys and drilling could kill or injure organisms close enough to the noise source and reduce habitat suitability because some species would avoid the area. The severity and duration of noise would vary with site and development scenario, but overall the impacts would be temporary and localized with overall minimal effects on soft sediment habitat. See Section 4.4.7 for detailed discussions of the effects of noise and different categories of biota.

Production. Production activities that could affect soft sediment habitat are shown in Table 4.4.6-3 and include operational noise, miscellaneous discharges, bottom disturbance from the movement of anchors and mooring structures, and the releases of process water. In addition, the platform would replace existing featureless soft sediments and serve as an artificial reef. The potential impacts of miscellaneous discharges would continue on from the exploration and development phase and are described above. Impacts on soft sediment habitats from vessel and operational noise are expected to be long term, with the impacts lasting the duration of the production phase.

Chronic bottom disturbance from the movement of anchors and chains associated with platforms and support vessels would affect soft sediment habitats as described above for the exploration and site development phase. Pipelines in water less than 60 m (197 ft) must be buried, which would reduce the potential for pipeline movement. However, pipelines could become unearthed or moved following severe storms. These disturbances would be long term and chronic and cause scour, turbidity, and sedimentation of soft sediment habitats.

The platforms and pipelines would also create novel hard substrate, and the area on and immediately around the platform would have habitat functions and biological communities very different from these in the preconstruction period. Algae and sessile invertebrates would attach to the platform and would in turn attract reef-oriented organisms. The ecological function and value of artificial reef habitat are controversial as some species may benefit while others do not. In addition, sediment grain size and the biogeochemical processes around the platform could be altered by the flux of biogenic material from the platform to the seafloor. For example, an increase in shell material and organic matter would likely result along with a transition to benthic species adapted to these conditions (Montagna et al. 2002). The replacement of soft sediment with artificial reef would exist only during the production phase, unless the platform was permitted to remain in place after decommissioning. In deep sea soft sediment, communities may form on mooring structures, but colonization would likely be slow, and mooring structures would be completely removed during decommissioning, so impacts, if any, would be temporary.

Produced water is a normal product of oil and gas extraction that contains contaminants such as polycyclic aromatic hydrocarbons (PAHs) and heavy metals and therefore represents a potential source of contamination to benthic habitats. Before being discharged into the ocean, produced water is typically treated and must meet NPDES requirements regarding discharge rate, contaminant concentration, and toxicity, thereby reducing the potential for sediment contamination. In addition, contaminants in produced water would be diluted with distance from the discharge point and are expected to reach sediments only in biologically negligible concentrations. A major study of produced water discharges across the northern GOM indicated that despite the large volume discharged, the contribution of produced water to bottom water hypoxia is minimal when compared to riverine inputs (Bierman et al. 2007). Overall, produced water did not make a significant contribution to the hypoxic zone (Rabalais 2005).

The results of the GOM Offshore Monitoring Experiment funded by BOEM provide a good summary of the long-term changes to soft sediment habitats resulting from oil and gas development (Kennicutt et al. 1995). For the study, stations at 30–50, 100, 200, 500, and 3,000 m (98–164, 328, 656, 1,640, and 9,842 ft) distances from petroleum wells were sampled in a radial pattern surrounding the platforms. Elevated sediment concentrations of sand, organic matter, hydrocarbons, and metals were generally restricted to sediments less than 200 m (656 ft) from the platforms. PAH levels in sediments were well below levels considered to be toxic to invertebrates, and no significant hydrocarbon bioaccumulation was observed in megafaunal invertebrates near platforms. However, metal levels in invertebrate tissues were higher at the study sites (Kennicutt et al. 1995). The physical and chemical changes to sediments near the platforms were enough to alter the soft sediment communities, but the effects were restricted to within 200 m (656 ft) of the platforms. Overall, the authors concluded that oil and gas development and production resulted in moderate, highly localized changes to soft sediment habitat (Montagna and Harper 1996).

<u>Decommissioning.</u> Miscellaneous discharges and solid waste releases discussed above would continue during the decommissioning phase (Table 4.4.6-3). Platform and mooring structure removal activities could result in increased turbidity, temporary suspension of bottom sediments, and explosive shock-wave impacts. Impacts from decommissioning will vary with platform removal scenario, which ranges from complete to partial removal. The impacts from the explosive removals of the platforms would be attenuated by the movement of the shock wave through the seabed, because the charges typically would be set at 5 m (16 ft) below the seafloor surface. Under the proposed action, it is assumed that a total of 150 to 275 platforms would be removed using explosives. A small area would be disturbed, compared with total seafloor area in the entire GOM. In addition, because soft-bottom benthic habitats are typically recolonized relatively quickly following disturbances, benthic communities in disturbed areas would be

expected to recover over a period of months to years without mitigation. If the platform is toppled and left in place, the remains would serve as hard bottom habitat that would replace the existing soft sediment habitat. Artificial reefs provide habitat to fish, algae, and invertebrates; however, their ecological and population effects are controversial.

Impacts of Expected Accidental Events and Spills. Accidental hydrocarbon releases in marine habitat can occur at the surface from tankers or platforms or at the seafloor from the wellhead or pipelines. Natural gas would quickly rise above the sediment surface, which would minimize its impacts on benthic habitat. Natural gas is also less persistent in the environment than oil. Evidence from the DWH event indicates that methane gas released from the well was rapidly broken down by bacterial action with little oxygen drawdown (Camilli et al. 2010; Kessler et al. 2011). Consequently, the remainder of the discussion focuses on oil spills. It is assumed that up to 8 large spills (≥1,000 bbl), up to 70 spills between 50 and 999 bbl, and up to 400 smaller spills between 1 and 50 bbl could occur during the lease period under the proposed action (Table 4.4.2-1). Impacts would generally increase with the size of the spill. Modeling indicates that oil spilled at the surface could mix by natural dispersion to a depth of 20 m (66 ft) at highly diluted concentrations (MMS 2008a). Therefore, most surface spills would likely reach the sediment at biologically negligible concentrations. Large spills have the potential to affect a greater area of benthic habitat, with the impact magnitude depending on the location of the spill, the direction of bottom currents, and the amount of oil released. Oil from accidental releases would be dispersed by currents and broken down by natural chemical and microbial processes and would rise in the water column, thereby limiting the extent of soft sediment habitat that would be affected by any given spill. The soft sediment habitat would recover without mitigation because of natural breakdown of the oil, sediment movement by currents, and reworking by benthic fauna.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE with an assumed volume of 0.9-7.2 million bbl and a duration of 30–90 days (Table 4.4.2-2). Lethal or sublethal concentrations of hydrocarbons or mixtures of hydrocarbon and dispersant (if used) could accumulate in soft sediments, reducing habitat function. As with large spills, the magnitude of the impact depends primarily on the location of the well, time of the year, and the volume released. Typically oil rises from the seafloor to the surface, forming a surface slick. However, a subsurface plume capable of traveling long distances could form if dispersants are used, or if the well releases oil at high velocity or as a mixture of oil and gas. However, even in the case of a subsurface plume, most oil would stay above the sediment. Sediment contamination could occur from the deposition of oiled sediment and organic matter (dead plankton and organic flocculants) falling from the water column. Such deposition is expected to decrease significantly with distance from the well.

Because of the widespread presence of soft-bottom habitats on the continental shelf and slope and the tendency of oil to stay suspended above the sediment, it is anticipated that impacts from oil spills would affect only a very small proportion of such habitat within the GOM. Following the DWH event, less than 6% of deepwater (>200 m) sediment samples and less than 1% of offshore and nearshore sediment samples exceeded the USEPA chronic aquatic life benchmark for PAHs and were chemically determined to be contaminated with oil from the DWH event (OSAT 2010). Oiled sediments would recover their habitat value as hydrocarbons broke down or were buried by natural processes, and communities would soon recover through larval recruitment from adjacent areas. However, recovery time would vary with local conditions and the degree of oiling. Impacts on soft sediment habitat from accidents could potentially be long term.

Oil spill-response activities such as burning, skimming, and chemical release (e.g., dispersants or coagulants) could affect benthic habitat and biota. Skimming and burning could kill pelagic live stages of benthic biota. The chemicals used during a spill response are toxic, but there is controversy about whether the combination of oil and dispersant is more toxic than oil alone (NRC 2005b; Fingas 2008; Holland-Bartels and Kolak 2011). The use of dispersant would likely reduce oiling of nearshore benthic habitat, but may increase the exposure of subtidal benthic habitat and biota to toxic fractions of oil (NRC 2005b). In shallow water, the presence of, and noise generated by, oil spill-response equipment and support vessels could temporarily disturb benthic habitat in the vicinity of the response action, potentially reducing habitat use or disturbing migration. As with the spill itself, the location and time of the year the cleanup occurs would be an important determinant of impacts on benthic habitat and biota.

Warm Water Coral Reefs and Hard-Bottom Habitat.

Impacts of Routine Operations. BOEM has several protections in place to minimize and mitigate the adverse effects of oil and gas exploration and development on coral reefs and hard-bottom habitat. It is assumed that these current protections will also be implemented during this Program. The mitigations as described in the Topographic Features Stipulation and NTL No. 2009-G39 (available at http://www.gomr.boemre.gov/homepg/regulate/regs/ntls/2009NTLs/09-G39.pdf) create avoidance and mitigation requirements for biologically sensitive hard bottom areas and topographic features in waters 300 m (984 ft) or less.

Four hard bottom or reef habitats are designated for the various protections: (1) banks offshore of Texas and Louisiana (including the Flower Garden Banks National Marine Sanctuary [FGBNMS]), (2) the Pinnacle Trend off the Louisiana-Alabama coast, (3) seagrass and low-relief live-bottom areas primarily located in the CPA and Eastern Planning Area (EPA), and (4) potentially sensitive biological features of moderate to high relief that are not protected by (1) and (2). These protections are explained in greater detail below.

Exploration and Site Development.

<u>Topographic Features (banks).</u> Because FGBNMS is a national sanctuary, no oil and gas exploration or site development would be allowed there. To protect other hard-bottom topographic features, BOEM instituted a Topographic Features Stipulation that established No Activity Zones prohibiting structures, drilling rigs, pipelines, and anchoring around 22 underwater topographic features out to a specified isobaths (typically 85 m [279 ft]) (Table 4.4.6-3). The continuation of this same practice is assumed here. To limit impacts from drilling discharges, the stipulation also requires all drilling muds and cuttings be shunted to within 10 m (33 ft) of the seafloor at distances ranging from 1 to 6.4 km (0.6 to 4 mi) away from topographic features depending on their nature and biological sensitivity. This shunting protects biota by confining the effluent to a level deeper than that of the living components of a high-

relief topographic feature. For low-relief banks in the WPA, shunting drilling effluents is not required because it would put the potentially harmful drilling muds and cuttings in the same water depth range as the topographic features. In addition, NTL No. 2009-G39 prohibits bottom-disturbing activities, including the use of anchors, chains, cables, and wire ropes within 152 m (500 ft) of a No Activity Zone without first consulting NOAA. Maps of the protected banks in the WPA and CPA are available at http://www.gomr.mms.gov/homepg/lsesale/topo_features_package.pdf.

Ninety five percent of the 200 to 450 anticipated new production platforms would be located in water depths less than 200 m (656 ft), which is within the depth range at which coral reefs and live-bottom features are found. Turbidity and sedimentation from bottom disturbance and the discharge of drilling wastes can adversely affect coral in multiple ways, including mortality, decreased growth, and loss of xoozanthelle (Thompson et al. 1980; Nugues and Roberts 2003; Fabricius 2005). The protections described above would minimize the impacts from direct bottom disturbance and sediment resuspension to designated banks from anchoring, drilling, platform placement, and pipeline trenching and placement. It is possible but not likely that turbidity would affect hard-bottom habitat if bottom disturbance occurred near the boundary of a No Activity Zone. The shunting requirements should minimize the adverse effects of discharged drilling muds and cuttings, although low-relief banks in more shallow water may be adversely affected to some degree. The topographic feature stipulations have been very effective in protecting the communities associated with topographic features. For example, despite the proximity of oil and gas development activities, long-term monitoring studies do not indicate any significant detrimental impact on the coral reefs of the FGBNMS (Gittings 1998).

Pinnacle Trend. The Live-Bottom/Pinnacle Trend Stipulation, which currently applies to certain blocks in the CPA and EPA, requires a biological interpretation of bathymetric and geophysical surveys to determine the distribution of pinnacle features before any bottom-disturbing activities can occur. Also, NTL No. 2009-G39 currently requires consultation with NOAA before any bottom-disturbing activities (including those caused by pipelines, anchors, chains, cables, or wire ropes) planned within 30 m (100 ft) bottoms/pinnacles with vertical relief of 2.4 m (8 ft) or more. There are no specific measures requiring drilling muds and cuttings to be discharged near the seafloor, because modeling studies suggest that the discharge would be transported over the pinnacles (Continental Shelf Associates, Inc. and Texas A&M 2001). Limitations on drilling mud discharges required by NPDES permit and the fact that the pinnacle trend area is subject to high levels of natural turbidity and sedimentation should limit impacts on pinnacle features. If it is determined that the live-bottoms might be adversely affected by the proposed activity, BOEM can further require economically, environmentally, and technically feasible measures to protect the pinnacle area. These measures may include, but are not limited to, the relocation of operations and monitoring to assess the impact of the activity on the live-bottoms. See the BOEM Web site at http://www.gomr.mms.gov/homepg/regulate/environ/topoblocks.pdf for the list and http://www.gomr.mms.gov/homepg/regulate/environ/topomap.pdf for the map of the identified pinnacle trend features.

Continued implementation of the Live-Bottom/Pinnacle Trend Stipulations and the requirements in NTL No. 2009-G39 would minimize bottom disturbance within 30 m (100 ft) of the majority of known pinnacle features. Because of these protections, direct effects such as benthic habitat disturbance from drilling, platform placement, trenching, and placement of pipelines would be minimal. However, if these activities occurred in the vicinity of the pinnacles, then sedimentation and turbidity could kill or inhibit respiration, filter feeding, and photosynthesis by hard-bottom biota. Because of the lower vertical relief pinnacles, the effects of turbidity and sedimentation could be greater in their vicinity. In addition, noise from seismic surveys, construction, and drilling could injure, kill, or cause avoidance behavior in organisms within a certain distance from the noise source. Noise disturbance would be temporary and the community would recover if the initial impact did not result in major injury or mortality to organisms associated with a pinnacle trend.

Impacts from drilling discharges would be reduced by compliance with the Pinnacle Trend/Live-Bottom Stipulation, NPDES permit restrictions that limit the amounts and types of drilling discharges and the depth at which the pinnacles are located. However, studies in the pinnacle region indicated that discharges of drilling muds may reach background levels within 1,500 m (4,921 ft) of the discharge point (Shinn et al. 1993). Therefore, pinnacles could be affected by discharges occurring at the surface and outside of the 30-m (98-ft) buffer required by NTL-2009-G39. As described above, increased turbidity and sediment deposition from discharges of muds and cuttings in the vicinity of pinnacles may reduce habitat quality and ecological function. However, biota associated with live-bottom/pinnacle features are usually adapted to life in somewhat turbid conditions and are often observed coated with a sediment veneer (Continental Shelf Associates, Inc. and Texas A&M 2001). The existing bottom currents would also prevent the accumulation of large amounts of mud and cuttings. Documentation of an exploratory well adjacent to hard-bottoms in the pinnacle trend at a depth of 103 m (338 ft), 15 months after drilling, showed cuttings and other debris covering an area of approximately 0.6 ha (1.5 ac) (Shinn et al. 1993), but the hard-bottom feature was still found to support a diverse community, including gorgonians, sponges, ahermatypic stony corals, and antipatharians. If turbidity and sediment deposition did result in extensive damage, existing studies suggest that recovery could take years (Continental Shelf Associates, Inc. and Texas A&M 2001).

Pinnacles not detected may be subject to direct damage from construction activities and discharges during site exploration and development. Previously undiscovered pinnacle features are also protected by the Potentially Sensitive Biological Features component of NTL No. 2009-G39. To minimize impacts on unmapped pinnacle features, BOEM also supports investigations through its Environmental Studies Program to locate hard- and live-bottom features and to understand their ecologies (Continental Shelf Associates, Inc., and Texas A&M University 2001). BOEM updates regulations and mitigations based on the data from these studies and from the biological interpretations of geophysical surveys, which reduces the risk of accidental damage.

<u>Live-bottom (low-relief) Features (CPA and EPA) and Potentially Sensitive Biological Features.</u> NTL No. 2009-G39 and the Live-Bottom (Low-Relief) Stipulation pertains to seagrass communities and low-relief hard-bottom reef within the GOM EPA blocks in water depths of 100 m (328 ft) or less and portions of Pensacola Area Blocks and Destin Dome Area Blocks in the CPA. NTL No. 2009-G39 also covers potentially sensitive biological features, which are features of moderate to high relief (about 2.4 m [8 ft] or higher) that provide habitat but are not protected by a biological lease stipulation.

NTL No. 2009-G39 requires that no bottom-disturbing activities (including drilling, platform placement, or the use of anchors, chains, cables, or wire ropes) may cause impacts on live-bottoms (low-relief features) or potentially sensitive biological communities. It is also required that any exploration or development activity planned within 30 m (100 ft) of either must be reviewed by BOEM. If it is determined that these habitats might be adversely affected by the proposed activity, then BOEM will require measures that may include, but are not limited to, relocation of operations, shunting of all drilling fluids and cuttings to avoid live-bottom areas, and monitoring to assess the adequacy of any mitigating measures. For further information on the live-bottom (low-relief) area stipulation and the protections for potentially sensitive biological features in the GOM, see NTL No. 2009-G39.

Overall, the protections in NTL No. 2009-G39 should minimize the potential for direct disturbance to coral reefs and live-bottom habitat. However, sediment disturbance and the discharge of drilling muds and cuttings in nearby areas could result in turbidity and sedimentation around these features that could kill or inhibit respiration, filter feeding, and photosynthesis by hard-bottom biota. Because of their generally shallow depth, low-relief habitats are particularly vulnerable to turbidity and sedimentation. In addition, low-relief live-bottom areas and potentially sensitive biological features not detected would be subject to direct mechanical damage from site exploration and development activities. Thus, appropriately siting discharge locations in pre-disturbance mitigation plans would be critical in minimizing the effects of bottom disturbance and discharges. NTL No. 2009-G39 states that the developer must provide a map showing the activity, structures, and maximum area of disturbance in relation to the feature. Such mapping would minimize impacts on these habitats and minimize the chance of disturbing as-yet-unmapped features.

Overall, impacts on coral reef and live-bottom habitat from exploration and site development activities should be minimized by existing protections. However, low-relief or small, isolated, unmapped live-bottom habitat could be affected by direct mechanical damage and turbidity and sedimentation. Given the frequent natural bottom disturbance that occurs in the GOM shelf, coral reef and live-bottom communities should be resistant to some extent to the adverse physiological impacts from periodic sedimentation. Live-bottom and coral reef habitat should recover, if they are adversely affected by exploration and site development activities. Recovery could be short term to long term depending on the extent and nature of the impact, species affected, and the suitability for recolonization of the habitat affected.

Production. Impacts on hard-bottom and coral reef habitat during the production phase could result from miscellaneous discharges, the movement of vessel anchors and mooring structures, produced water discharge, and the creation of artificial reef habitat (Table 4.4.6-3). Turbidity and sedimentation generated by chronic movement of anchors could affect coral reefs and hard-bottom habitat if they were located close enough to the disturbance. Impacts on coral and hard-bottom habitat from bottom disturbance would be minimized by existing mitigation measures.

Ninety-five percent of the 200 to 450 anticipated new production platforms would be located on the continental shelf. Algae and sessile invertebrates would rapidly colonize the platform and pipelines and would also attract mobile reef-oriented organisms. Thus, platforms would provide new hard-bottom habitat for a variety of species. However, oil and gas production platforms have been implicated in promoting the establishment of new species through natural range expansion or by providing suitable habitat for introduced exotic species (Sammarco et al. 2004; Page et al. 2006; Hickerson et al. 2008). Introduced species could displace native species and in doing so alter the ecological function of existing hard-bottom and coral habitat. For example, oil and gas platforms may have expedited the establishment of several exotic species on the FGBNMS including sergeant majors (*Abudefduf saxatilis*), yellowtail snapper (*Ocyurus chrysurus*), and orange cup coral (*Tubastraea coccinea*) (Hickerson et al. 2008). It is likely that these species would have spread even without the platforms, although the platforms may have expedited the process. If floating platforms with moorings are used, organisms could colonize mooring structures. Thus the overall benthic footprint may be small depending on the design. Also, in deep sea areas, most platforms and mooring structures would likely be completely removed during decommissioning, so impacts, if any, would be temporary.

Produced water discharges could introduce petroleum hydrocarbons and metals into hard-bottom habitat. However, impacts would be minimized by discharge and toxicity limitations imposed by NPDES permits, as well as restrictions that prevent the placement of oil and gas platforms in the immediate vicinity of these habitats. In addition, the depth of many of the coral reef and hard-bottom habitats, the prevailing current speeds, and the offsets of the discharges from these habitats would substantially dilute produced waters before they could come in contact with sensitive biological communities.

Decommissioning. Coral reefs are not likely to be affected by platform removal because of existing stipulations. Hard-bottom habitat could be adversely affected by explosive platform removal (estimated 150 to 275), which could cause turbidity and sedimentation in nearby hard-bottom habitat. Deposition of suspended sediments could smother and kill the filter-feeding sessile animals that inhabit much of the hard-bottom habitat. Explosive impacts on large topographic features covered by the No Activity Zone Stipulations would be minimized because of their distance from the seafloor and the existing stipulations precluding the placement of structures on or near these communities. However, hard-bottom features located closer to production platforms may be more susceptible to damage. In the event that live-bottom areas were affected during removal of existing platforms, recovery times would vary with damage and species.

Pipelines on the surface of the seafloor that are left in place would continue to provide hard substrate of structure-oriented organisms. In addition, many of the decommissioned platforms will be converted into artificial reefs. By acting as stepping stones across the GOM, oil platforms have been implicated in the introduction of a non-native coral species (*Tubastraea coccinea*) and fishes such as sergeant majors (*Abudefduf saxatilis*) and yellowtail snapper (*Ocyurus chrysurus*) into the FGB (Hickerson et al. 2008).

Impacts of Expected Accidental Events and Spills. Accidental spills in the CPA and WPA could affect hard-bottom and coral reef habitat from south Texas to the west Florida shelf in the EPA. Accidental hydrocarbon releases in marine habitat can occur at the surface or at the seafloor. Natural gas would quickly rise above the sediment surface, which would minimize its impacts on benthic habitat, although natural gas could temporarily reduce the habitat quality of high-relief benthic features. Natural gas is also less persistent in the environment than oil. Evidence from the DWH event indicates that methane gas released from the well was rapidly broken down by bacterial action with little oxygen drawdown (Camilli et al. 2010; Kessler et al. 2011). Consequently, the remainder of the discussion focuses on oil spills.

It is assumed that up to 8 large spills (≥1,000 bbl), up to 70 spills between 50 and 999 bbl, and up to 400 smaller spills between 1 and <50 bbl could occur during the lease period under the proposed action (Table 4.4.2-1). Most spills would be small and occur at the surface from the platform or vessels or at the seafloor from pipeline leaks. Oil from surface spills can sometimes penetrate the water column by natural dispersion to documented depths of 20 m (66 ft) or more, which is within the depth range of the crests of some coral reefs and topographic features including the FGBNMS. However, at these depths, the concentrations of the various chemical components of spilled oil are typically several orders of magnitude lower than those demonstrated to have an effect on marine organisms (MMS 2008a). Therefore, it is likely that only low concentrations of oil from surface spills would reach the sensitive benthic habitats (MMS 2008a). Subsurface spills could rise and come into contact with corals and hard-bottom habitat. Offshore banks are less likely to be affected because of the No Activity Zone stipulation that would create a large buffer between the banks and oil and gas development and production activities. A buffer of only 30 m (98 ft) applies to most hard-bottom areas and therefore low-relief, hard-bottoms could be contacted by small subsurface oil spills. However, because rapid dilution would occur as spilled oil was transported by currents and rose toward the water surface, subsurface oil spills would likely have to come into contact with a topographic feature almost immediately to have detrimental effects on the associated community.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE with an assumed volume of 0.9-7.2 million bbl and a duration of 30–90 days (Table 4.4.2-2). A CDE could degrade coral reef and hard-bottom habitat if it came into contact with large quantities of oil as it moved through the water column. Hydrocarbons have been shown to have lethal and sublethal (reproduction, larval settlement, photosynthesis, and feeding) effects on corals, although no effects on corals following oil spills are also frequently reported (Loya and Rinkevich 1980; Bak 1987; Guzman et al. 1991; Dodge et al. 1995; Haapkyla et al. 2007). Water currents moving around the banks would tend to carry oil around the banks rather than directly over the features, thereby lessening the severity of the impact (Rezak et al. 1983). Corals have the capacity to recover quickly from hydrocarbon exposure. For example, Knap et al. (1985) found that when *Diploria strigosa*, a common massive brain coral at the Flower Garden Banks, was doused with oil, it rapidly exhibited sublethal effects but also recovered quickly. However, larval stages of coral are far more sensitive than adults. Therefore, the impact magnitude of a spill is partly dependent on whether the spill occurs during a period of coral spawning.

If dispersants were used or if oil released from the wellhead had a high ratio of gas, a subsurface hydrocarbon plume covering a large area could form, which would increase the potential for contact with hard-bottom and coral reef habitat. The effect of chemically dispersed oil on corals is equivocal, with some studies finding large effects of oil and dispersant mixtures on corals and others finding only minor effects (Dodge et al. 1984; Wyers et al. 1986;

Epstein et al. 2000; Haapkvla et al. 2007; Shafir et al. 2007). If used, dispersants may slow the natural breakdown of oil, resulting in persistent toxicity. In most cases, effects on sensitive biota would be sublethal, with recovery occurring within months to a few years (MMS 2002a). For lethal exposures, the community would likely recover once the area had been cleared of oil, although full recovery could take many years (Haapkvla et al. 2007). Consequently, it is anticipated that impacts of lethal concentrations of oil reaching coral reef or hard-bottom habitat would be long term but temporary.

Deepwater Corals and Chemosynthetic Communities.

Impacts of Routine Operations.

<u>Exploration and Site Development.</u> In the GOM, both deepwater coral and chemosynthetic communities are currently protected under NTL No. 2009-G40 (available at http://www.gomr.boemre.gov/homepg/regulate/regs/netls/2009NTLs/09-G40.pdf), which covers all high-density deepwater communities (HDDC) in depths 300 m (984 ft) or greater. Impacts on deepwater corals and chemosynthetic communities (HDDC) from exploration and site development could potentially occur during platform and pipeline placement, the discharge of drilling muds and cuttings, and miscellaneous discharges (Table 4.4.6-3). NTL No. 2009-G40 currently prohibits the discharge of drilling muds and cuttings within 610 m (2,000 ft) of HDDC. In addition, NTL No. 2009-G40 requires that all proposed seafloor disturbances (including those caused by anchors, anchor chains, wire ropes, seafloor template installation, and pipeline construction) must be maintained at a distance of at least 76 m (250 ft) from HDDC habitat. In addition, any seafloor disturbances planned within 152 m (500 ft) of a high-density deepwater coral community must be reviewed and approved by BOEM, and the developer must demonstrate that the communities will not be adversely affected by exploration or site development. It is assumed that BOEM will continue to require and implement these measures at the lease sale phase. While these requirements and procedures are believed to be effective in identifying and avoiding most HDDC, it is possible that some unmapped or lower density communities could be mechanically damaged. In addition, despite the 76-m (250-ft) buffer, turbidity and sedimentation created by ground-disturbing activities could contact HDDC habitats. Although data are limited, studies in the GOM indicate that *Lophelia* corals are generally tolerant of turbidity and sedimentation, but at high enough levels suspended sediments can have lethal and sublethal effects (Brooke et al. 2009). Sediment could clog filtering organs, thereby inhibiting food intake and increasing metabolic costs associated with sediment removal. Chronic bottom disturbance by drilling platform moorings could be particularly large in the deep ocean depending on the technology employed. Impacts from pipeline placement barges could be minimized by the use of dynamic positioning when possible. An FPSO system may be employed for deepwater wells. Under the FPSO system, oil would be transported from the well to a surface vessel and ultimately to shore. By eliminating the need for pipelines, an FPSO system would greatly reduce bottom disturbance and the chance for disturbing HDDC.

It is estimated that less than 1% of the deepwater GOM is occupied by features or areas that could support HDDC (NTL No. 2009-G40). HDDC are spread throughout the deep areas of the northern GOM (Figure 3.7.2-2 and Figure 3.7.2-3), which makes it unlikely that the damage to small areas of the bottom would threaten this resource as a whole. The BOEM Environmental

Studies Program funds research to locate and understand the ecology of chemosynthetic communities. BOEM updates regulations and mitigations based on the data from studies and from the biological interpretations of geophysical surveys, and this reduces the risk of accidental damage. If affected by exploration and site development activities, HDDC could be repopulated from nearby undisturbed areas, although the rate of recovery could be slow or nonexistent, particularly for chemosynthetic communities (MacDonald 2000). Recent studies have shown that chemosynthetic communities can be dynamic and that changes in species composition and colonization rates can operate on the order of years to decades (Lessard-Pilon et al. 2010). This suggests chemosynthetic communities could begin recovery relatively quickly if adversely affected by oil and gas activities, although full recovery would take much longer.

Miscellaneous discharges would occur at the surface and are not expected to reach HDDC. HDDC communities are also not likely to be buried or stressed by drilling muds and cuttings because NTL No. 2009-G40 prohibits their discharge within 610 m (2,000 ft) of HDDC. Also, drilling muds and cutting would typically be discharged at the surface, and the depth of most HDDC communities make it unlikely that drilling muds and cuttings would be deposited in thick layers capable of adversely affecting these habitats.

Overall, impacts on HDDC from exploration and site development activities are expected to be minimal because of the provisions in place to protect HDDC and the review required for all drilling plans in water deeper than 300 m (984 ft). The likelihood of the undetected communities is greatly reduced through continuing improvements in the use of remote sensing data and groundtruthing. However, small and unmapped HDDC may be completely or partially destroyed by bottom-disturbing activities. In such cases, recovery would likely be long term.

<u>Production.</u> Impacts on HDDC from routine operations could result from production platform placement; operational noise; miscellaneous discharges; the movement of anchors and chains, and the releases of process water (Table 4.4.6-3). In addition, the platform, pipelines, and mooring structure will create new artificial reef habitat. A general discussion of these impacts can be found in the soft sediments section above.

Impacts from bottom disturbing activities would be similar to those discussed above in the exploration and site development phase. The direct effects of production noise, platform placement, and anchor and chain damage on HDDC would be minimized by the 76-m (250-ft) buffer required between HDDC and ground-disturbing activities, although turbidity plumes resulting from those activities could reach HDDC. Impacts from produced water discharge should also be minimal, given the NPDES requirements and the distance of HDDC from the surface where produced water will likely be discharged. Cold water coral species may colonize the well, pipeline, and platform structures relatively quickly (Gass and Roberts 2006), although growth in the GOM appears to be slower than in other areas (Brooke and Young 2009). Over time, petroleum structures may become an artificial reef functioning in a manner similar to existing coral habitat. Colonization could benefit cold water corals by increasing suitable habitat and improving gene flow among populations (Macreadie et al. 2011). The artificial reef would only exist during the production phase, except in the cases where pipelines remain on the seabed and if tension leg platform templates are allowed to remain on the seabed. There is also possible decommissioning options including leaving portions of deepwater platforms in place.

There is evidence from California that oil and gas extraction reduces the natural release of hydrocarbons that support deep-sea chemosynthetic communities (Quigley et al. 1999). However, there is no evidence for this in the GOM. More research may be needed, but oil and gas operations are not likely to remove enough hydrocarbons to affect seep communities, given the volume of the overall resource. Unlike chemosynthetic communities, *Lophelia* corals do not depend on hydrocarbon seepage to meet their metabolic requirements (Becker et al. 2009) and presumably would not be affected.

Decommissioning. Explosive platform removals would not occur because floating platforms would be used in the deep sea. The removal of anchors and chains could affect nearby HDDC by suspending sediments in the water column as described above. Restrictions that prevent oil and gas extraction activities on or near HDDC would reduce the impacts of sediment disturbance. In the event that HDDC were affected during removal of existing platforms, recovery times would vary with the species affected and the extent and nature of the damage. Cold water corals are likely to recover much more rapidly than chemosynthetic communities.

Impacts of Expected Accidental Events and Spills. It is assumed that up to 8 large spills (≥1,000 bbl), up to 70 spills between 50 and 999 bbl, and up to 400 smaller spills between 1 and <50 bbl could occur during the lease period under the proposed action (Table 4.4.2-1). Impacts would typically increase with the size of the spill. Most accidental spills would be small releases at the surface that are not expected to reach waters deep enough to contact HDDC. The impact of a small pipeline leak would also be reduced by the requirement that pipelines be located 76 m (250 ft) away from HDDC habitats. For large spills, much of the impact magnitude depends on the location of the spill, the direction of bottom currents, and the amount of oil released. Oil from accidental releases would be dispersed by currents, broken down by natural chemical and microbial processes, and would rise in the water column, thereby limiting the extent of HDDC habitat that would be affected by any given spill. However, if oil were to come into contact with a HDDC, it could result in lethal or sublethal impacts (White et al. 2012). However, HDDC are widely distributed in the GOM; therefore, the impacts of any one large spill would not affect the overall resource.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE with an assumed volume of 0.9-7.2 million bbl and a duration of 30–90 days (Table 4.4.2-2). A CDE would cause high turbidity and sedimentation and the potential release of large quantities of oil. Although petroleum hydrocarbons serve as a nutrient source for symbiotic microorganisms associated with chemosynthetic communities, hydrocarbon toxicity and the partial or complete destruction of the habitat could occur if a large concentration of oil were to contact chemosynthetic communities. Similarly, oil covering deepwater corals could kill all or part of the community or cause sublethal physiological and reproductive effects. For example, a survey of a deepwater coral site following the DWH event indicated almost half of the corals at the site had been lethally or sublethally affected by exposure to oil (White et al. 2012). The site was located approximately 11 km (7 mi) to the northeast of the Macando well. The time it would take for the site to return to pre-spill conditions is not known.

Oil typically rises to the surface over the release site. However, if dispersants are used in the subsurface, or if the released oil has a significant fraction of gas or flows from the wellhead at a high velocity, a subsurface plume may form that would increase the potential for contact with a HDDC habitat. A subsurface plume 200 m (656 ft) high and 2 km (1.2 mi) wide was found at a 1,000 m (3,280 ft depth for a distance of 35 km (22 mi) from the DWH site) (Camilli et al. 2010). There is evidence that oil released from the DWH event was mixed with dispersant (Kujawinski et al. 2011). Whether there is a synergistic toxicity from dispersants and oil mixtures for chemosynthetic communities or deepwater corals is not known.

Certain organismal components of chemosynthetic HDDC are slow-growing, and if damaged, recovery would be long term (potentially hundreds of years), if they recover at all. Recent studies have shown that seep communities can be dynamic and that changes in species composition and colonization rates can operate on the order of years to decades (Lessard-Pilon et al. 2010). This suggests chemosynthetic communities could begin recovery relatively quickly if adversely affected by oil and gas activities, although full recovery would take much longer.

***Impact Conclusions*.**

Routine Operations. The primary impacts to marine benthic habitats from routine activities would be temporary and localized impacts on soft sediments from ground disturbance during drilling and pipeline and platform placement as well as the discharge of drilling muds and cuttings and produced water. Existing mitigation measures, if applied, should ameliorate most direct impacts on sensitive benthic marine habitats, including hard-bottoms, coral reefs, and HDDC. However, in some cases, activities that generate noise, turbidity, and sedimentation may affect sensitive habitats depending on their proximity to these activities. In addition, unmapped sensitive benthic habitats not covered by the stipulations may be damaged or destroyed. If sensitive benthic live-bottom and associated biota were damaged or killed, the impacts could be long-term because living benthic habitats are slow-growing and have highly specific habitat requirements. Overall, most routine activities are expected to have negligible impacts, while those activities that result in bottom disturbance may have moderate impacts to marine benthic habitat.

Expected Accidental Events and Spills. Small surface or subsurface hydrocarbon spills are not likely to result in the degradation of benthic marine habitat because small spills would be diluted by mixing in the water column. The impact of a large spill depends on several factors such as the size, duration, timing, and location of the spill and the nature of the benthic habitat contacted by the oil. Oil tends to rise in the water column, which would limit its contact with benthic habitat. There is the potential for oil released during a large spill at the surface or subsurface to reach topographic features, where it could have lethal or sublethal impacts on sensitive coral species. However, existing regulations on the placement of oil and gas infrastructure would limit impacts to high-relief banks and coral reefs. Large releases at the seafloor also affect low-relief hard-bottom and HDDCs, although the overall impacts to the resource from any one large spill would be limited, given their wide distribution. Overall, impacts from small spills would range from negligible for spill less than 50 bbl to minor for spills less than 1,000 bbl and from minor to moderate for large spills greater than 1,000 bbl.

An Unexpected Catastrophic Discharge Event. An unexpected CDE would physically disturb the seafloor around the spill site, and a subsurface plume extending a large distance from the spill could form, if dispersants are used or if the oil released is mixed with gas. As with a large spill, the impact of a CDE depends on several factors such as the size, duration, timing, and location of the spill, and the nature of the benthic habitat contacted by the oil. In the unlikely event that a CDE occurred, sensitive benthic habitats could suffer long-term loss of ecological function because of both hydrocarbon toxicity and the subsequent cleanup activities. Hydrocarbons could persist at sublethal concentrations in sediments. Over time, hydrocarbons would be broken down by natural processes, and most benthic habitats are likely to recover. Sensitive habitats (i.e., HDDC and coral reef) damaged by a spill would likely recover slowly or possibly not recover at all. Many sensitive benthic habitats are widely scattered; therefore, individual spills would be unlikely to threaten the resource as a whole. Overall, impacts to marine benthic habitat from a CDE could range from minor to moderate, depending on the habitats affected and the level of oiling experienced by those habitats. Major impacts to coral reef habitats could occur if the Flower Gardens Banks are heavily oiled and high mortality occurs.

4.4.6.2.2 Alaska – Cook Inlet.

Impacts of Routine Operations.

Exploration and Site Development. Impacting factors for the exploration and site development phase are shown in Table 4.4.6-4. Noise from seismic surveys and drilling could kill or injure organisms close enough to the noise source and reduce habitat suitability, because some species would avoid the area. The severity and duration of noise would vary with site and development scenario, but overall the impacts would be temporary and localized with overall minimal effects on benthic habitat. See Section 4.4.7 for detailed discussions of the effects of noise on different categories of biota.

Drilling exploratory wells would temporarily reduce habitat quality by generating turbidity and sedimentation for some distance around the disturbed area. It is estimated that 4 to 12 exploration wells and 42 to 114 production wells will be drilled in the Cook Inlet Planning Area. Exploration would use jack-up rigs and gravity rigs in water up to 46 m (150 ft), while drilling ships or semisubmersible or floating drilling rigs would be used in deeper water. One to three production platforms may be installed under the proposed action. Production operations will most likely be carried out from fixed platforms. The installation of floating or fixed platforms would eliminate soft sediment where the legs or mooring structures (anchors and chains) encountered the seabed and where subsea equipment (such as reentry collars and blowout preventers) was installed. Chronic local bottom disturbance could result from subsequent movements of anchors and mooring lines associated with floating drilling platforms and support vessels. However, these types of drilling rigs affect only small areas of the bottom.

Under the proposed action, it is estimated that 80 to 241 km (50 to 150 mi) of offshore pipeline may be placed in the Cook Inlet Planning Area, resulting in disturbance of up to 210 ha (519 ac) of seafloor in Cook Inlet. Pipelines would be trenched or installed and anchored on the

TABLE 4.4.6-4 Impacting Factors by Phase and Potential Effects on Marine Benthic Habitat in the Cook Inlet Planning Area

Impacting Factor	Potential Effects[a]
Exploration and Site Development	
Seismic surveys	Noise; localized anchoring disturbance
Anchoring and mooring of platforms, drillships, and seismic survey vessels	Sediment scour; temporary turbidity and sedimentation; localized alteration in sediment grain size and biogeochemical functions
Drilling and production platform placement	Noise; temporary sediment resuspension and turbidity; loss of natural habitat creation of artificial reef;
Drilling	Noise; small habitat loss; local alteration of sediment characteristics; temporary turbidity and sedimentation in surrounding areas
Miscellaneous discharges (deck washing, sanitary waste, vessel discharges)	Sediment contamination
Solid wastes	Sediment contamination
Discharge of drilling muds/cuttings	Sediment and water column contamination; alteration in sediment granulometry and biogeochemical functions
Pipeline trenching and placement	Noise; long-term loss and degradation of existing benthic habitat; temporary sediment resuspension and turbidity
Production	
Scour from anchors and the movement of pipelines and mooring structures	Chronic long-term disturbance of bottom sediments; turbidity
Platform production	Noise; loss of natural habitat creation of artificial reef
Produced water	Sediment contamination
Miscellaneous discharges	Sediment contamination
Solid wastes and debris	Sediment contamination
Decommissioning	
Miscellaneous discharge	Sediment contamination
Solid wastes and debris	Sediment contamination
Platform removal	Temporary turbidity and disturbance of bottom sediments

[a] Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

sediment surface, which would temporarily disturb a large area of benthic habitat by generating turbidity and sedimentation. Placing the pipeline on the sediment surface would result in loss of soft sediment habitat. Vessel anchoring during pipeline placement would also disturb soft sediment. It is anticipated that pipeline placement would displace benthic communities and temporarily alter grain size in areas of the seafloor with soft sediments. Cook Inlet waters are naturally high in suspended sediments, and analyses conducted for pipeline construction for previous lease sales indicated that turbidity from pipeline construction was expected to be within the natural range of turbidities for Cook Inlet (MMS 2003a).

It is assumed that drilling muds and cutting would be discharged into Cook Inlet for exploration wells only. Drilling wastes from development and production wells would be reinjected into the wells. Drill cuttings and drilling muds (including synthetic drilling fluids adhering to the cuttings) could contaminate and alter the sediments immediately around the wellhead and below the area where drilling wastes are discharged. Drill cuttings and muds rapidly reach the sediment surface and could be deposited in highly concentrated thick layers if deposited in shallow water or near the sediment surface. In the case of near-surface discharge in deep water, drilling muds would spread out in a thin veneer over a wide area. Settled muds could cause smothering of organisms, local hypoxia, changes in sediment characteristics and biogeochemical functions, and the loss of food resources in the immediate area. Although such releases could result in temporary impacts, the amount of discharge would be small compared to the more than 44 million tons of suspended sediment carried annually into Cook Inlet by runoff from area rivers (Brabets et al. 1999). The currents in lower Cook Inlet are likely strong enough to prevent the accumulation of muds and cuttings on the bottom; therefore, benthic habitats affected by drilling discharges would recover their natural grain size. In addition, the discharge of these drilling wastes is regulated by the USEPA under NPDES permits and can be discharged into the ocean only if they meet USEPA toxicity and discharge rate requirements. These requirements greatly reduce the potential for sediment contamination. A study of sediment quality in depositional areas of Shelikof Strait and Cook Inlet in 1997–1998 found that the concentrations of metals and polyaromatic hydrocarbons in sediments (1) posed no significant risk to benthic biota or fish and (2) were not linked to oil and gas development in upper Cook Inlet (MMS 2001a). Consequently, degradation of benthic habitat in Cook Inlet from drilling waste is not expected.

Other miscellaneous discharges (deck washing, sanitary waste, and vessel discharge) also have the potential to degrade benthic habitats. Miscellaneous discharges could contaminate sediments if discharged in relatively shallow water. However, considering the high flow rate of Cook Inlet, contaminants in surface discharges would most likely be diluted to non-toxic concentrations before reaching the sediment (MMS 2003a). Many vessel and platform wastes are disposed of on land, and those that are discharged at sea must meet USEPA and/or USCG regulatory requirements that limit their environmental effects.

Production. Production activities that could affect soft sediment habitat are shown in Table 4.4.6-4 and include operational noise; miscellaneous discharges; bottom disturbance from the movement of anchors and mooring structures, and releases of process water. In addition, the platform would replace existing featureless soft sediments and serve as an artificial reef. The potential impacts of miscellaneous discharges would continue on from the exploration and development phase and are described above. Impacts on soft sediment habitats from vessel and operational noise are expected to be long term, with the impacts lasting the duration of the production phase.

Chronic bottom disturbance from the movement of anchors and chains associated with support vessels would affect soft sediment habitats as described above for the exploration and site development phase. Production platforms will most likely be fixed structures, but benthic disturbance from the movement of mooring anchors is possible if floating production platforms are used. The movement of pipelines following severe storms could be a long-term chronic disturbance to benthic habitat causing scour, turbidity, and sedimentation of soft sediment habitats. However, pipelines would either be anchored securely or trenched which would minimize the potential for bottom disturbance.

The platform structure would also create novel hard substrate, and the area on and immediately around the platform may have very different habitat functions and biological communities compared to the preconstruction period. Algae and sessile invertebrates could attach to the platform and in turn attract reef-oriented organisms. Sediments grain size, benthic communities, and biogeochemical processes in sediments around the platform could be altered by the flux of biogenic material (e.g., organic matter and shell material) from the platform to the seafloor.

Produced water can contain hydrocarbons, salts, and metals at levels toxic to marine organisms. Before being discharged into the ocean, produced water is typically treated and must meet NPDES requirements regarding discharge rate, contaminant concentration, and toxicity, thereby reducing the potential for sediment contamination. Under the proposed action, it is assumed that all produced waters would be treated and reinjected into the disposal well. Therefore, no impacts on pelagic habitat are expected to result from produced water.

Decommissioning. Platform removal activities would result in loss of the platforms reef function, bottom disturbance, and a temporary increase in turbidity and sedimentation (Table 4.4.6-4). Over time, most sediments will recover their normal physical characteristics, ecological functions, and biological communities. No explosives would be used during platform removal. Pipelines installed and anchored on the seafloor would be capped and left in place, although there is the potential for chronic sediment disturbance from pipeline movement.

Impacts of Expected Accidental Events and Spills. It is assumed that 1 to 3 small spills between 50 and 999 bbl and 7 to 15 smaller spills between 1 and <50 bbl, and large spills (≥1,000 bbl) could occur under the proposed action (Table 4.4.2-1). Much of the impact magnitude depends on the location of the spill, the direction of bottom currents, and the amount of oil released. Impacts would typically increase with the size of the spill. Oil from accidental releases would be dispersed by currents, broken down by natural chemical and microbial processes, and would rise in the water column, thereby limiting the extent of benthic habitat that would be affected by any given spill. Large spills may persist long enough to drift to shore where they could contaminate benthic habitat. However, it is anticipated that only a small amount of shoreline would be affected by these spills and they would not, therefore, present a substantial risk to the overall resource. The benthic habitat would recover without mitigation because of natural breakdown of the oil, sediment movement by currents, and reworking by benthic fauna.

Oil spill-response activities such as burning, skimming, and chemical release (e.g., dispersants or coagulants) could affect benthic habitat and biota. Skimming and burning could kill pelagic live stages of benthic biota. The chemicals used during a spill response are toxic, but there is controversy about whether the combination of oil and dispersant is more toxic than oil alone (NRC 2005b; Fingas 2008; Holland-Bartels and Kolak 2011). The use of dispersant would likely reduce oiling of nearshore benthic habitat but may increase the exposure of subtidal benthic habitat and biota to toxic fractions of oil (NRC 2005b). In shallow water, the presence of, and noise generated by, oil spill-response equipment and support vessels could temporarily disturb benthic habitat in the vicinity of the response action, potentially reducing habitat use or disturbing migration. As with the spill itself, the location and time of the year the cleanup occurs would be an important determinant of impacts to benthic habitat and biota.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE with an assumed volume of 75,000 to 125,000 bbl and a duration of 50–80 days (Table 4.4.2-2). In the case of a CDE, the likelihood of oil contacting shoreline benthic habitat and biota is relatively high because the Cook Inlet Planning Area is located within a confined estuary. Oil reaching intertidal benthic habitat would likely be drawn below the sediment surface by capillary action. Subsurface oil is more persistent because it is spread throughout a matrix of sediment types and is less subject to physical weathering from sunlight and wave action (Taylor and Reimer 2008). Decades after the *Exxon Valdez* spill, highly weathered, asphalt-like or tar deposits may still be present beneath the surface of intertidal sediments of Prince William Sound, especially in the intertidal zone of low-energy, protected, unexposed bays and beaches with boulder/cobble or pebble/gravel sediments (Short et al. 2007; Taylor and Reimer 2008; *Exxon Valdez* Oil Spill Trustee Council 2010a). NOAA reported that 97 metric tons (tonnes) (107 tons) of oil may still be present in subsurface sediments in discontinuous patches, although this is only a small fraction of the >20,000 metric tons of oil initially deposited on beaches. After a initial rapid decline of 68% per year during 1991–1992, the oil is currently decreasing in concentration at a rate of 0–4% per year (NOAA 2010c; Short et al. 2007). Overall, studies of the *Exxon Valdez* spill indicate that a catastrophic spill could result in long-term degradation of benthic habitat and sublethal effects on benthic biota. As of 2010, intertidal sediments and communities are considered to still be recovering from the *Exxon Valdez* spill (*Exxon Valdez* Oil Spill Trustee Council 2010a).

Following the *Exxon Valdez* oil spill in 1989, highly elevated hydrocarbon concentrations in intertidal sediments were found at heavily oiled sites followed by an apparent migration of the oil into the shallow subtidal zone in 1991 (Wolfe et al. 1996). Oil in the intertidal and subtidal zones can affect not only lower trophic-level organisms but also higher trophic-level organisms, such as marine and coastal birds (Section 4.4.7.2.2) and fish (Section 4.4.7.3.2; Peterson et al. 2003). However, subtidal sediment may be less likely to suffer long-term contamination because oil tends to float and natural weathering, bottom scour, and depositional processes would reduce the oil concentration in the sediment. Biological impacts on subtidal biota are also typically short term (Lee and Page 1997). Oiled subtidal sediments were detected shortly after the *Exxon Valdez* spill, but not in follow-up studies conducted in 2001, and subtidal sediment concentrations of oil are much lower than concentrations in intertidal sediments (Lee and Page 1997). Subtidal habitat and communities are considered to be very likely recovered by the *Exxon Valdez* Oil Spill Trustee Council (2010a).

Broken ice occurs in the northern and western portions of lower Cook Inlet during fall and winter. If an open water spill were to occur at this time, the ice would contain the oil somewhat and reduce spreading and contacting intertidal benthic habitat. However, oil cleanup is also more difficult in broken ice conditions. Oil from spills occurring in the winter may be trapped under ice, resulting in localized, persistent degradation of habitat quality and ecosystem function.

Impact Conclusions.

Routine Operations. Most routine activities conducted during the exploration, development, and production phases would have negligible impacts on benthic habitats. Routine activities that involve in bottom disturbance could result in minor to moderate impacts on benthic habitat in the Cook Inlet Planning Area. The primary impacts would be from ground disturbance during drilling and pipeline and platform placement as well as the discharge of drilling muds and cuttings. It is assumed that drilling muds and cuttings would be discharged into Cook Inlet for exploration wells only. Drill cuttings and drilling muds (including synthetic drilling fluids adhering to the cuttings) could contaminate and alter the sediments immediately around the wellhead and below the area where drilling wastes are discharged. Recovery of seafloor habitat could range from short-term (months) to long-term (decades). Overall, negligible to moderate impacts are expected to result from routine activities.

Expected Accidental Events and Spills. Small hydrocarbon spills are likely to result in localized degradation of benthic marine habitat because oil would typically float above the seafloor and be diluted over time. Therefore, oil reaching benthic marine habitats would likely be in low concentrations. The impact of a large spill (≥1,000 bbl) depends on several factors such as the size, duration, timing, and location of the spill, and the nature of the benthic habitat contacted by the oil. Oil tends to rise in the water column which would limit its contact with benthic habitat. Overall, impacts from small spills would range from negligible for a spill less than 50 bbl to minor for spills less than 1,000 bbl and from minor to moderate for large spills greater than 1,000 bbl.

An Unexpected Catastrophic Discharge Event. The impact of an unexpected CDE depends on several factors such as the size, duration, timing, and location of the spill, and the nature of the benthic habitat contacted by the oil. The season in which the spill occurs is especially important in Alaskan waters due to seasonal ice cover that could hinder cleanup efforts. In the unlikely event that a CDE occurred, hydrocarbons reaching subtidal habitats would likely recover more quickly than intertidal sediments. Oil reaching sensitive intertidal habitats could persist at sublethal concentrations in sediments for decades. However, hydrocarbons would eventually be broken down by natural processes, and most benthic habitats are likely to recover. Overall, impacts to marine benthic habitat from a CDE could be minor to moderate, depending on the habitats affected and the level of oiling incurred by those habitats.

4.4.6.2.3 Alaska – Arctic.

Impacts of Routine Operations.

Exploration and Site Development. Impacting factors for the exploration and site development phase relevant to seafloor habitat are shown in Table 4.4.6-5. It is assumed that oil and gas development activity would be restricted to waters less than 91 m (300 ft). Exploration drilling would employ gravel islands or mobile platforms in waters between 6 to 18 m (20 and 60 ft) in depth and drillships in deeper water. Production operations will be conducted from subsea wells, gravel islands, or gravity-based platforms in water less than 12 m (40 ft) in depth,

TABLE 4.4.6-5 Impacting Factors by Phase and Potential Effects on Marine Benthic Habitat in the Beaufort and Chukchi Sea Planning Areas

Impacting Factor	Potential Effects[a]
Exploration and Site Development	
Vessel traffic	Noise
Seismic surveys	Noise; localized anchoring disturbance
Anchoring and mooring of platforms, drillships, and seismic survey vessels	Sediment scour; temporary turbidity and sedimentation; localized alteration in sediment grain size and biogeochemical functions
Drilling and subsea well and production platform placement (including artificial islands)	Noise; temporary sediment resuspension and turbidity; loss of natural habitat creation of artificial reef; loss of benthic habitat due to artificial islands
Drilling	Noise; small habitat loss; local alteration of sediment characteristics; temporary turbidity and sedimentation in surrounding areas
Miscellaneous discharges (deck washing; sanitary waste, vessel discharges)	Sediment contamination
Solid wastes	Sediment contamination
Discharges of drilling muds/cuttings	Sediment and water column contamination; alteration in sediment grain size and biogeochemical functions
Pipeline trenching and placement	Noise; long-term loss and degradation of existing benthic habitat; temporary sediment resuspension and turbidity
Production	
Scour from anchors and the movement of pipelines and mooring structures	Chronic, long-term disturbance of bottom sediments; turbidity
Platform production	Noise; loss of natural habitat creation of artificial reef
Produced water	Sediment contamination
Miscellaneous discharges	Sediment contamination
Solid wastes and debris	Sediment contamination
Decommissioning	
Miscellaneous discharge	Sediment contamination
Solid wastes and debris	Sediment contamination
Platform removal	Temporary turbidity and disturbance of bottom sediments

[a] Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

and from larger gravity-based platforms in deeper waters. It is assumed that as many as 92 subsea production wells and 9 artificial islands could be constructed during the lease period with a footprint of approximately 1.5 ha (4 ac) per platform or island. Under the proposed action, it is estimated that 89 to 652 km (55 to 405 mi) of new offshore pipeline would be placed in the Beaufort and Chukchi Sea Planning Areas, resulting in disturbance to 77 to 567 ha (190 to 1,402 ac) of seafloor.

Drilling, platform and pipeline placement, and construction and maintenance of artificial islands have the potential to reduce benthic habitat quality by disturbing the seafloor and generating noise, turbidity, and sedimentation for some distance around the disturbed area and potentially adversely affecting benthic biota. Such activities could reduce benthic habitat quality by displacing benthic organisms and interrupting the movement and dispersal of species of all life stages. Chronic bottom disturbance would result from movements of anchors associated with floating drilling vessels and support vessels. The installation of platforms would eliminate soft sediment where the platform and mooring structures (anchors and chains) encountered the seabed and where subsea equipment (such as reentry collars and blowout preventers) was installed and depending on location, habitat loss for benthic feeders could be important. The area of burial around constructed islands could increase over time because of erosion from storm action and ice gouging on island slopes. The construction of subsea wells and gravel islands would eliminate soft sediment habitat, but the total bottom area that could be disturbed would be relatively small compared to the overall area of benthic habitat available in the Beaufort and Chukchi Sea Planning Areas.

Pipelines would be buried in waters less than 50 m (156 ft) to prevent damage from ice gouges, and pipelines in deeper water would be installed and anchored on the seafloor. Pipelines installed and anchored on the seafloor would replace natural soft sediment habitat with hard-bottoms, which would alter species composition and biogeochemical habitat function. For buried pipelines, benthic organisms within the trenched corridor would be killed or injured, and organisms to either side of the pipeline would be buried by sediments. Disturbed sediments with a greater proportion of sand to mud may fill in with fine, silty material that would alter grain size and potentially inhibit the colonization by species that existed prior to the disturbance. The recovery period for soft sediment benthic habitat affected by bottom disturbance would depend on factors such as water depth, sediment type, and community composition. In the Arctic, the benthic community in these areas experiences a naturally high amount of disturbances from ice gouging, strudel scour, and severe storms, and hyposaline and highly turbid conditions occur naturally during spring breakup. Therefore, seafloor biota in the Beaufort and Chukchi Seas may be adapted to such conditions. Turbidity plumes from construction activities under the proposed action would be temporary and disturbed areas would probably be recolonized within a few years, although recovery could take more than a decade (Conlan and Kvitek 2005).

Increased water turbidity and sedimentation from ground-disturbing activities discussed above could directly affect kelp growth by burying kelps and other organisms, altering the optical properties of the water column, and limiting photosynthesis (Maffione 2000; Dunton et al. 2009). It is estimated that kelp contributes 50–56% of annual productivity in the Boulder Patch and is an important source of organic matter that supports various members of the epilithic community (Dunton 1984). Overall, measurements have indicated natural inputs of suspended sediment from runoff and erosion are large relative to any anthropogenic inputs of sediment (Trefry et al. 2004). Therefore, unless activities are located in the immediate vicinity of the Boulder Patch, the proposed action is not expected to substantially increase turbidity or sedimentation on the Boulder Patch. Planning and permitting procedures and requirements will likely be sufficient to avoid such occurrences. Under current regulations, proposed development near the Boulder Patch area requires detailed surveys to identify the boundaries of the Boulder Patch habitat, and the expected levels of impacts from proposed activities must be identified, which will likely be sufficient to minimize impacts from pipeline construction within the Boulder Patch area. However, the construction of offshore pipelines could affect kelp habitat area outside of the Boulder Patch. Recovery would be slow if kelp communities were mechanically damaged by drilling or anchor and chain scour. It is estimated that recovery of kelp growth in areas trenched for pipeline construction could occur within a decade in some cases or could be much longer depending on the proportion of hard substrate exposed after pipeline construction was completed (Konar 2006). Although habitat loss may be relatively small when compared to the large size of the Arctic Planning Areas, even small habitat loss can be significant to specific populations depending on where it occurs.

It is assumed that drilling muds and cutting would be discharged into the Beaufort and Chukchi Sea Planning Areas for exploration wells only. Drilling wastes from development and production wells would be reinjected into the wells. Drill cuttings and drilling muds (including synthetic drilling fluids adhering to the cuttings) could contaminate and alter the grain size of sediments immediately around the wellhead and below the area where these drilling wastes are discharged. Drill cuttings and muds rapidly reach the sediment surface and could be deposited in highly concentrated thick layers if deposited in shallow water or near the sediment surface. In the case of near-surface discharge in deep water, drilling muds would spread out in a thin veneer over a wide area. Settled muds could cause smothering of organisms, local hypoxia, changes in sediment characteristics and biogeochemical functions, and the loss of food resources in the immediate area. Arctic sediments are constantly changing in grain size (Neff & Associates, LLC 2010) due to natural disturbances. Thus, after they reach the sediment, discharged muds and cuttings are likely over time to be redistributed over a broad area. Although such releases could result in temporary, localized increases in sediment load and deposition, this amount of discharge would be small compared to the more than 6.35 million tons of suspended sediment carried annually into the Beaufort Sea alone by runoff from area rivers (Neff and Associates, LLC 2010). In addition, drilling muds or cuttings that are discharged into the ocean are regulated by the USEPA under NPDES permits and can be discharged into the ocean only if they meet USEPA toxicity and discharge rate requirements. These requirements greatly reduce the potential for sediment contamination. Discharges of drilling wastes in the vicinity of the Steffansson Sound Boulder Patch are regulated under NPDES Permit Number AKG280000. Consequently, there should be minimal impacts on Boulder Patch habitat from drilling wastes.

Miscellaneous discharges (deck washing, sanitary waste, and vessel discharge) also have the potential to degrade seafloor habitats. Miscellaneous discharges could contaminate sediments if discharged in relatively shallow water. However, many vessel and platform wastes are disposed of on land, and those that are discharged at sea must meet USEPA and/or USCG regulatory requirements that limit their environmental effects. In addition, stratification of the water column prevents diffusion of chemicals to bottom layers in many areas.

Noise from seismic surveys and drilling could kill or injure organisms close enough to the noise source and reduce habitat suitability as some species would avoid the area. The severity and duration of noise would vary with site and development scenarios, but the impacts would be temporary and localized with overall minimal effects on soft sediment habitat. See Section 4.4.7 for detailed discussions of the effects of noise on different categories of biota.

Production. Production activities that could affect soft sediment habitat are shown in Table 4.4.6-5. The potential impacts of miscellaneous discharges would continue on from the exploration and development phase and are described above. Impacts on soft sediment habitats from vessel and operational noise are expected to be long-term, with the impacts lasting the duration of the production phase. Chronic bottom disturbance from the movement of anchors and chains associated with support vessels would affect soft sediment habitats as described above for the exploration and site development phase. These disturbances would be long term and chronic and cause scour, turbidity, and sedimentation of soft sediment habitats.

Platforms and gravel islands would provide additional habitat for marine plants and animals (e.g., kelp and mussels) that require a hard substrate. Therefore, the overall probable effect of platform placement and island construction would be to alter local species composition. In addition, sediment grain size and biogeochemical processes around the platform would be altered by the flux of biogenic material (shell and organic matter) from the platform to the seafloor. Data from other hard-bottom habitats suggest colonization would be slow and seasonal ice cover may restrict colonization to short-lived opportunistic species. Any artificial reef function the platform does serve would exist only during the production phase, so impacts, if any, would be temporary but lasting decades. However, gravel islands would remain in place. The islands may eventually erode and form a subsea gravel bed that would provide habitat to species attracted to hard substrate.

Produced water is a normal product of oil and gas extraction that contains contaminants such as polycyclic aromatic hydrocarbons and heavy metals and therefore represents a potential source of contamination to benthic habitats. It is assumed that all produced water will be disposed of onshore or reinjected into the well rather than discharged into the ocean. If produced water is discharged into the ocean, it is typically treated and must meet NPDES requirements regarding discharge rate, contaminant concentration, and toxicity, thereby reducing the potential for sediment contamination. Consequently, no impacts from the discharge of produced water are expected.

The results of the Arctic Nearshore Impacts Monitoring in the Development Area study funded by BOEM provide a good summary of the long-term changes to benthic habitats resulting from oil and gas production in the Arctic (Neff and Associates, LLC 2010). No relationship between the location of oil and gas production and the concentration of metals and hydrocarbons in sediment and marine animals was detected. The study concluded that metals and PAHs in Beaufort Sea sediments were primarily derived from sediments delivered by rivers, not oil and gas activities.

Decommissioning. Miscellaneous and solid waste releases discussed above would continue during the decommissioning phase (Table 4.4.6-5). Platform and mooring structure removal activities would result in bottom disturbance and a temporary increase in turbidity and sedimentation. No platforms are expected to be removed using explosives. Over time, sediments will recover their normal physical characteristics, ecological functions, and biological communities.

Impacts of Expected Accidental Events and Spills. It is assumed that large spills (≥1,000 bbl), up to 35 small spills (50 to 999 bbl), and up to 190 smaller spills (>1 and <50 bbl) could occur during the lease period under the proposed action (Table 4.4.2-2). Much of the impact magnitude depends on the location of the spill, the direction of bottom currents, and the amount of oil released. Impact magnitude would typically increase with the size of the spill. Most spills would be small and would degrade benthic habitat quality at relatively local scales. Large spills would affect a wider area of benthic habitat and potentially persist in the sediment for an extended period. Oil from accidental seafloor releases would rise in the water column, thereby limiting the extent of benthic habitat that would be affected by any given spill. Oil from most surface spills is likely to reach the sediment only at biologically negligible concentrations. Benthic habitat would recover without mitigation because of natural breakdown of the oil, sediment movement by currents, and reworking by benthic fauna.

Oil spill-response activities such as burning, skimming, and chemical release (e.g., dispersants or coagulants) could affect benthic habitat and biota. Skimming and burning could kill pelagic live stages of benthic biota. The chemicals used during a spill response are toxic, but there is controversy about whether the combination of oil and dispersant is more toxic than oil alone (NRC 2005b; Fingas 2008; Holland-Bartels and Kolak 2011). The use of dispersant would likely reduce oiling of nearshore benthic habitat, but may increase the exposure of subtidal benthic habitat and biota to toxic fractions of oil (NRC 2005b). In shallow water, the presence of, and noise generated by, oil spill-response equipment and support vessels could temporarily disturb benthic habitat in the vicinity of the response action, potentially reducing habitat use or disturbing migration. As with the spill itself, the location and time of the year the cleanup occurs would be an important determinant of impacts on benthic habitat and biota.

Impacts of an Unexpected Catastrophic Discharge Event. This PEIS analyzes an unexpected CDE with an assumed volume of 1.4-2.2 million bbl and a duration of 40–75 days in the Chukchi Sea Planning Area, and a CDE in the Beaufort Sea Planning Area with an assumed volume of 1.7-3.9 million bbl and a 60-300 day duration (Table 4.4.2-2). A CDE could result in lethal or sublethal concentrations of hydrocarbons or mixtures of hydrocarbons and dispersants (if used), which could accumulate in soft sediments, reducing habitat function. The magnitude of the impact depends primarily on the location of the well, the volume released, and the speed at which the well was capped. Most oil released in a surface or seafloor spill would float above the sediment, but sediment contamination could occur from the deposition of oiled sediment and organic matter (dead plankton and organic flocculants) falling from the water column. In addition, oil could reach the shoreline and contaminate coastal benthic habitat (see Sections 4.4.6.1.3 and 4.4.6.2.2 for a detailed discussion of the impacts of oil spills on coastal habitat). The soft sediment habitat would recover without mitigation because of natural breakdown of the oil, sediment movement by currents, and reworking by benthic fauna. However, the cold temperatures of the Arctic may allow hydrocarbons to persist in the sediments longer than in temperate areas.

The magnitude of impacts on hard-bottom kelp communities from an oil spill would depend on the location and severity of the spill. Oil spills contacting the hard-bottom kelp communities (e.g., the Boulder Patch and communities in Peard Bay and Ledyard Bay) could cause both lethal and sublethal effects on marine plants and invertebrates. Sublethal effects occur at lower concentrations and include reduced growth and/or fecundity, increased physiological stress, and behavioral changes. *Laminaria solidungula*, found in the Stefansson Sound Boulder Patch, has not been studied directly, but other Laminaria species from the Canadian Beaufort Sea showed marked physiological impairment when exposed to oils of several types and concentrations (Hsiao et al. 1978). Photosynthesis would probably be reduced by the floating oil because of reduced light penetration, and if the floating oil persisted long enough, it could affect growth and reproduction of the kelp. Benthic animal communities have also been shown to have major shifts in species composition following exposure to oil (Dean and Jewett 2001). Impacts on kelp habitat from an oil spill could be long-term. *Laminaria* beds oiled by the *Exxon Valdez* spill recovered within 10 years (Dean and Jewett 2001).

If the CDE were to occur during winter, cleanup would be much more difficult because sea ice would limit access to the spill (reviewed in Holland-Bartels and Kolak 2011). Oil cleanup response plans and technologies for ice-covered spills are still evolving, and the efficacy of many proposed spill countermeasures is as yet unknown (Holland-Bartels and Kolak 2011). If the spill were to occur under ice, oil would be trapped and essentially remain unchanged until breakup occurred and the ice began to melt. Oil could float or freeze within the ice, which would limit the potential for oil to reach deeper subtidal seafloor habitat. However, oil transported under ice to nearshore areas would remain unweathered and could degrade intertidal and shallow subtidal benthic habitat throughout the winter and after the ice thaws. The effects on primary and secondary biological productivity could be severe as well, because of loss of epontic and ice-associated fish assemblages due to oil toxicity. Oil under landfast ice would be more easily accessed and cleaned, which could reduce the duration and severity of impacts.

Impact Conclusions.

Routine Operations. Routine activities conducted during the exploration, development, and production phases that involve bottom disturbance could result in minor to moderate impacts on benthic habitat in the Beaufort Sea and Chukchi Sea Planning Areas. The primary impacts would be on soft sediments from ground disturbance during drilling and pipeline and platform placement as well as the discharge of drilling muds and cuttings and produced water. Recovery of seafloor habitat could range from short-term (months) to long-term (decades). Existing mitigation measures, if applied, should ameliorate most direct impacts on sensitive benthic marine habitats, including Boulder Patch communities in the Beaufort and Chukchi Seas. However, in some cases, activities that generate noise, turbidity, and sedimentation may affect sensitive habitats, depending on their proximity to these activities. If sensitive hard-bottom habitats were damaged, the impacts could be long-term because living benthic habitats are slow-growing and have highly specific habitat requirements. Overall, activities conducted during the exploration and site development phase are expected to have negligible to moderate effects on seafloor habitat.

Expected Accidental Events and Spills. Small surface or subsurface hydrocarbon spills are not likely to result in the degradation of benthic marine habitat because hydrocarbons associated with small spills would be diluted to low concentrations as they moved through the water. The impact of a large spill depends on several factors such as the size, duration, timing, and location of the spill, and the nature of the benthic habitat contacted by the oil. Oil from accidental releases would be dispersed by currents, and broken down by natural chemical and microbial processes, and would rise in the water column, thereby limiting the extent of soft sediment habitat that would be affected by any given spill. Overall, impacts from small spills would range from negligible for spill less than 50 bbl to minor for spills less than 1,000 bbl and from minor to moderate for large spills (≥1,000 bbl).

An Unexpected Catastrophic Discharge Event. An unexpected CDE would physically disturb the seafloor around the spill site, and a subsurface plume extending a large distance from the spill could form if dispersants are used or if the oil released is mixed with gas. The impact of a CDE depends on several factors such as the size, duration, timing, and location of the spill, and the nature of the benthic habitat contacted by the oil. The season in which the spill occurs is especially important in Arctic waters due to heavy seasonal ice cover that could hinder cleanup efforts. In the unlikely event that a CDE occurred, sensitive benthic habitats could suffer long-term loss of ecological function because of both hydrocarbon toxicity and the subsequent cleanup activities. Hydrocarbons could persist at sublethal concentrations in sediments for decades, and sensitive habitats (i.e., kelp beds and intertidal zones) damaged by a spill would likely recover slowly. However, hydrocarbons would be broken down by natural processes, and most benthic habitats are likely to recover. Overall, impacts to marine benthic habitat from a CDE could range from minor to moderate, depending on the habitats affected and the level of oiling experienced by those habitats. Major impacts to hard-bottom kelp habitat could occur if these areas were heavily oiled and high mortality occurs.

4.4.6.3 Marine Pelagic Habitats

4.4.6.3.1 Gulf of Mexico

Water Column.

Impacts of Routine Operations.

Exploration and Site Development. See Section 4.4.3.1.1 for a general discussion of the impacts of exploration and site development on water quality. During the exploration and site development phase, pelagic habitat would be affected by platform and pipeline placement, drilling activity, seismic surveys, platform lighting, and aircraft and vessel traffic, and miscellaneous vessel and platform discharges (Table 4.4.6-6). Noise impacts would be greatest near the source and would temporarily reduce habitat quality (i.e., induce physiological stress, injury, or behavioral changes) for certain species whose noise tolerance is below that of the noise level generated by the exploration and development activities. See Section 4.4.7 for detailed discussions of the effects of noise on different categories of biota. Construction lighting would alter the pelagic light regime of a small area and would attract phototaxic organisms to the platform. Studies in the northern GOM suggest that platform lighting could enhance phytoplankton productivity around the platform, potentially increase prey availability, and improve the visual foraging environment for fishes (Keenan et al. 2007).

Bottom water quality would be temporarily affected by turbidity from sediment disturbance during drilling, platform placement, and pipeline trenching and placement. Turbidity from bottom-disturbing activities could kill zooplankton, although it is not expected to result in

TABLE 4.4.6-6 Impacting Factors by Phase and Potential Effects on Marine Pelagic Habitat in the CPA and WPA of the GOM

Impacting Factor	Disturbance[a]
Exploration and Site Development	
Vessel traffic	Noise
Seismic surveys	Noise
Miscellaneous discharges (deck washing, sanitary waste, bilge and ballast water)	Degraded water quality
Drilling and discharge of drilling muds/cuttings	Noise; degraded water quality
Pipeline trenching	Noise; turbidity
Drilling platform placement	Noise; turbidity
Offshore lighting	Alteration of light field
Production	
Production platform placement	Noise; turbidity
Production	Noise
Produced water discharge	Degraded water quality
Miscellaneous discharges (deck washing, sanitary waste)	Degraded water quality
Offshore lighting	Alteration of light field
Decommissioning	
Miscellaneous discharges (deck washing, sanitary waste, bilge and ballast water)	Degraded water quality
Explosive platform removal	Noise, turbidity
Offshore lighting	Alteration of light field

[a] Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

population-level effects. Photosynthetic productivity of phytoplankton that specialize in near-bottom habitats may be reduced if the turbidity plume reduced solar irradiance at depth. However, the turbidity plume would be temporary, and phytoplankton populations have rapid replacement times (Behrenfeld et al. 2006). Therefore no long-term impacts on phytoplankton populations are anticipated. FPSO systems could potentially be used in deep water, which would reduce the need for pipeline placement and greatly reduce water quality impacts.

The discharge of drilling muds and cuttings can occur near the water's surface or the seafloor. Releases at the seafloor would affect bottom waters in ways similar to those of bottom-disturbing activities, resulting in a temporary reduction in water quality. Surface discharge of drilling muds and cuttings would create a turbidity plume that would diminish within some distance from the release point. The turbidity plume could smother or stress small zooplankton and reduce phytoplankton productivity by decreasing the depth and intensity of light penetration. While synthetic drilling fluids are not discharged directly, they do enter the pelagic environment by adhering to drilling cuttings (Neff et al. 2000). These cuttings tend to aggregate and settle rapidly to the sea floor. This tendency for aggregation increases the higher the concentration of adhered synthetic fluid. The rapid settling of the cuttings reduces their dispersion in the water column and water column turbidity (Neff et al. 2000). In addition, synthetic drilling fluids have low toxicity (Neff et al. 2000). Consequently, the release of such cuttings and associated synthetic drilling fluids should result in short-term and relatively localized impacts.

Similarly, in well-mixed ocean waters, water-based drilling muds and cuttings are diluted by 100-fold within 10 m (33 ft) of the discharge and by 1000-fold at a distance of about 100 m (330 ft) from the platform (Neff 2005). These estimates are for well-mixed water, and therefore the size of the turbidity field will vary with hydrology. The generally rapid dilution would limit the degradation of pelagic habitat to a localized area. Degradation of pelagic habitat would also be limited by NPDES permits regulating the discharge of drill cuttings in a way that reduced impacts on water quality (Neff et al. 2000; Neff 2005).

Pelagic habitat would be affected minimally and temporarily by miscellaneous discharges (deck drainage, sanitary and domestic waste, bilge and ballast water) during site development. Such releases would be small in quantity and would be rapidly diluted. In addition, many vessel and platform wastes are disposed of on land, and those that are discharged at sea must meet USEPA and/or USCG regulatory requirements that limit their environmental effects.

<u>Production.</u> Impacts from offshore lighting, miscellaneous discharges, and bottom disturbance from the movement of platform and support vessel anchors and chains will also exist in the production phase and are described above. In addition, production noise and produced water discharge could affect pelagic habitat quality (Table 4.4.6-6). Production noise is not expected to appreciably degrade habitat quality, as production platforms are known to have high biological abundance and diversity. Impacts on pelagic habitat from produced water are not expected because produced water is treated before being discharged and must meet NPDES permitting guidelines regarding discharge rate and toxicity. Produced water is high in organic matter and has the potential to generate local hypoxia (Rabalais 2005). However, a major study of produced water discharges across the northern GOM indicated that despite the large volume discharged, the contribution of produced water to bottom water hypoxia is minimal when compared to riverine inputs, and produced water did not make a significant contribution to the hypoxic zone in the GOM (Rabalais 2005).

Algae and sessile invertebrates would rapidly colonize the platform and would in turn attract mobile reef-oriented organisms. Thus, the platform structure would serve as a novel artificial reef in formerly open water habitat. The platform would function in a manner similar to existing reefs, banks, and topographic features and may increase zooplankton densities around the platform. A floating platform would extend from the surface to some depth below the waterline, potentially creating a floating reef habitat that would attract organisms to adjacent surface waters. The artificial reef would only exist during the production phase, unless the platform was permitted to remain in place after decommissioning. In deep sea areas, the platform and mooring structures would likely be completely removed during decommissioning, so impacts from bottom disturbance would be temporary.

<u>Decommissioning.</u> Impacts from vessel noise, platform lighting, and miscellaneous discharges are discussed above and would continue throughout the decommissioning phase (Table 4.4.6-6). In addition, bottom disturbance during platform removal (potentially including

the use of explosives) would temporarily disturb pelagic habitat by increasing noise and turbidity for some length of the water column (see individual sections on marine biota for discussions of the impacts of explosive platform removal). These impacts would temporarily degrade habitat quality, but conditions would return to normal as suspended sediments dispersed and resettled.

Impacts of Expected Accidental Events and Spills. Accidental hydrocarbon releases can occur at the surface or at the seafloor. Although not well studied, natural gas can be toxic to marine life, and therefore its release into the water would represent a degradation of habitat quality within the area affected by the gas release. A large methane release in the Sea of Azov resulted in cell damage, biochemical alteration, impaired movement, blood disorders, and alteration of biochemical processes in fish collected around the platform and in fish held in water near the platform (Patin 1999). However, natural gas is also less persistent in the environment than oil. Evidence from the DWH event indicates that methane gas released from the well was rapidly broken down by bacterial action with little oxygen drawdown (Kessler et al. 2011; Atlas and Hazen 2011). Consequently, the remainder of the discussion focuses on oil spills.

It is assumed that large spills (≥1,000 bbl), up to 70 spills between 50 and 999 bbl and 400 smaller spills between 1 and 50 bbl could occur during the lease period under the proposed action (Table 4.2.2-1). Accidental oil spills could be surface releases from platforms or vessels or seafloor releases from pipelines and the wellhead. Modeling indicates that oil spilled at the surface could mix by natural dispersion to a depth of 20 m (66 ft) at highly diluted concentrations (MMS 2008a). Accidental oil releases from pipeline leakage would degrade bottom water quality at local scales. Large spills would degrade pelagic habitat quality over a wider area and potentially reduce the habitat value and ecosystem function in the areas affected. Most released oil and gas would float above the seafloor, so exposures would be expected for zooplankton, which lack the mobility to avoid the oil. Oil exposure can also reduce the abundance of zooplankton in the oiled area, induce narcosis, and bind to feeding appendages (Teal and Howarth 1984). Zooplankton are known to ingest oil, some of which is retained in the gut and some of which is exported to the seafloor in fecal pellets (Teal and Howarth 1984). The oil would be broken down by natural processes, and pelagic habitat would recover. See Section 4.4.3.2.1 for a further discussion of the effects of oil spills on water quality in the GOM.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE with an assumed volume of 0.9-7.2 million bbl and a duration of 30–90 days (Table 4.4.2-2). Pelagic organisms could be exposed to lethal or sublethal concentrations of hydrocarbons or mixtures of hydrocarbons and dispersants (if used). The extent and magnitude of the impact depend primarily on the location of the well, the volume of oil released, and the season in which the spill occurs. Typically oil rises from the seafloor to the sea surface forming a surface slick. However, a subsurface plume capable of traveling long distances could form if dispersants are used, or if the well releases oil at high velocity or as a mixture of oil and gas. In the case of the DWH event, hydrocarbons were detected as far as 35 km (22 mi) northeast and southwest of the well (Camilli et al. 2010; Haddad and Murawski 2010). Existing studies of the DWH event suggest the GOM has a tremendous natural capacity to assimilate oil from accidental releases. Comprehensive sampling over a wide area and depth strata of the GOM reported less than 2% of water column samples taken from offshore and deepwater areas contained toxic PAH concentrations (OSAT 2010). The toxicity of water samples decreased with distance from the wellhead; after August 2010, no water samples exceeded the aquatic life benchmark for PAHs (OSAT 2010). Menthanotropic and oil-eating bacteria were greatly increased following the DWH event, which allowed rapid breakdown of the released oil and gas (Atlas and Hazen 2011; Kessler et al. 2011). However, the increase in microbial biomass did not result in significant oxygen depletion, even in deep water. The hydrocarbons appeared to be assimilated by bacteria and transferred up through the zooplankton food web (Graham et al. 2010). However, the DWH event may not be indicative of future oil spills, because recovery time would vary with local conditions and the degree of oiling. For example, shallow pelagic habitats would probably recover more quickly than deepwater pelagic habitats because of the greater physical and biological activity in shallow water.

CDE-response activities such as burning, skimming, and chemical release (e.g., dispersants or coagulants) could affect pelagic habitat and biota. Burning would kill pelagic biota in the burn area, and skimming would remove aquatic organisms from the water column or trap them in oiled water. The chemicals used during a spill response are toxic, but there is controversy about whether the combination of oil and dispersant is more toxic than oil alone (NRC 2005b; Fingas 2008; Holland-Bartels and Kolak 2011). The use of dispersant would likely increase the areal extent of oil dispersion and the exposure of pelagic biota to oil. The presence of, and noise generated by, oil spill-response equipment and support vessels could temporarily disturb pelagic habitat in the vicinity of the response action, potentially reducing habitat use or disturbing migration. As with the spill itself, the location and time of year the cleanup occurs would be important determinants of impacts on pelagic habitat and biota.

Sargassum.

Impacts of Routine Operations.

Exploration and Site Development. *Sargassum* could be affected by several activities during the exploration and site development phase of OCS oil and gas development including vessel traffic, miscellaneous discharge, and drilling waste discharge. Drilling muds and cuttings are typically discharged near surface waters and could come into contact with *Sargassum* mats. Turbidity generated by the discharge could reduce photosynthesis in *Sargassum* and cause physiological stress on associated animal communities. The cuttings should settle to the bottom within 1,000 m (3,280 ft) of the release point (Continental Shelf Associates, Inc. 2006), so the contact should be minimal. NPDES permit requirements regulating the toxicity and amount of drilling wastes discharged would also limit the potential for impacts on *Sargassum*. Miscellaneous discharges (deck drainage, sanitary and domestic waste, bilge and ballast water) are not expected to affect *Sargassum* because the releases would be small in quantity and would be rapidly diluted. Service vessels and drilling ships could damage *Sargassum* mats with their propeller or by entraining *Sargassum* in their cooling water intake. The effects on individual *Sargassum* mats and the associated communities could be complete or partial loss of the *Sargassum*. Given the small area affected relative to the size of known *Sargassum* habitat, vessel traffic is not expected to measurably reduce the biomass or productivity of *Sargassum* in the northern GOM.

Sargassum appears to originate in the northwestern GOM, and little new oil and gas development is expected to occur in this region. Given the small overall area of seafloor affected by new oil and gas development, and the new spring production of *Sargassum* that occurs in the GOM (Gower and King 2008), no detectable population level effects on *Sargassum* are anticipated.

Production. Miscellaneous discharges and vessel traffic will continue through the production phase, but they are not expected to affect *Sargassum* for the reasons described above. Contaminants in produced water discharged from the platform could affect *Sargassum* and associated biota. However, produced water is treated before discharge and must meet NPDES permitting guidelines. Other production activities would primarily affect subsurface habitat and are not anticipated to affect *Sargassum*.

Decommissioning. Miscellaneous discharges and vessel traffic will continue through the decommissioning phase, but they are not expected to affect *Sargassum* for the reasons described above. Platform removal activities would primarily affect subsurface communities, and while they are not anticipated to affect adult *Sargassum*, they could affect sediment-dwelling germlings. However, decommissioning impacts will be highly localized over a relatively small area.

Impacts of Expected Accidental Events and Spills. Spills could occur at the surface or at the seafloor. Surface spills as well as seafloor spills that rise to the surface could contact *Sargassum*, potentially resulting in complete or partial mortality of the *Sargassum* mat and lethal or sublethal effects to associated biota. Surface slicks would pose a potential threat to *Sargassum* communities until dilution and natural chemical, physical, and biological processes reduced the toxicity of the oil. Upon release, hydrocarbons would be diluted and broken down by natural processes, which would limit the potential for contact with and toxicity to Sargassum communities. The warm waters of the GOM are particularly conducive to rapid chemical and microbial breakdown of hydrocarbons.

Impacts of an Unexpected Catastrophic Discharge Event. The effects from a CDE would depend on the location of the particular spill and on various environmental factors, including water depth, currents, and wave action. Seafloor releases could reach *Sargassum* in surface waters if the spill occurred in shallow water or if dispersants were used or the oil released was well mixed with gas. A CDE could affect a large portion of the *Sargassum* population if the spill occurred in an area of high *Sargassum* density or if toxic concentrations of oil were spread over a large area of surface water. Surprisingly little is known about the lifecycle of *Sargassum*. *Sargassum* is generally only present in the WPA and CPA in spring through early fall, and recent data suggest *Sargassum* originates in the northwest GOM and is exported from the GOM by ocean currents (Gower and King 1998). Therefore, the potential for impacts on *Sargassum* are highly dependent on when the spill occurs. *Sargassum* reproduces every year, so it is expected that the population will recover if affected by an oil spill.

***Impact Conclusions*.**

Routine Operations. Impacts on pelagic habitat in the GOM planning areas could occur during the exploration through decommissioning phases. Impacts from routine Program activities would range from short-term for the exploration, site development, and decommissioning phases to long-term for those impacts occurring throughout the production phase. Impacts would primarily occur from noise and turbidity generated by bottom-disturbing activities. Temporary reduction in habitat quality could also result from the discharge of produced water and drilling muds and cuttings. Overall, impacts to pelagic habitats from routine oil and gas activities would be negligible to minor.

Expected Accidental Events and Spills. Most accidental oil spills would be small and result in only negligible, localized impacts on pelagic habitat. Large spills would temporarily reduce habitat quality over large areas of pelagic habitat. Accidental oil releases from pipeline leakage would degrade bottom water quality at local scales. Most released oil and gas would float above the seafloor, so exposures would be expected for zooplankton, which lack the mobility to avoid the oil. The oil would be broken down by natural processes, and pelagic habitat would recover. Surface spills as well as seafloor spills that rise to the surface could contact *Sargassum*, potentially resulting in complete or partial mortality of the *Sargassum* mat and lethal or sublethal effects to associated biota. However, *Sargassum* is widely distributed in the GOM so any one spill would generally not affect the resource as a whole. Overall, the impacts of oil spills on pelagic habitat would range from negligible for spills less than 50 bbl to minor for spills less than 1,000 bbl and from minor to moderate for large spills (≥1,000 bbl).

An Unexpected Catastrophic Discharge Event. A CDE would degrade pelagic habitat quality over a wider area and potentially reduce the habitat value and ecosystem function in the areas affected. Pelagic organisms could be exposed to lethal or sublethal concentrations of hydrocarbons or mixtures of hydrocarbons and dispersants (if used). The extent and magnitude of the impact depend primarily on the location of the well, the volume of oil released, and the season in which the spill occurs. CDE-response activities such as burning, skimming, and chemical release (e.g., dispersants or coagulants) could also affect pelagic habitat and biota. Unique pelagic habitat and associated biota such as *Sargassum* mats in the GOM could also be affected by oil spills. Contact with spilled oil could completely or partially kill *Sargassum* and cause lethal or sublethal effects to associated biota. The potential for impacts on *Sargassum* are highly dependent on when the spill occurs. *Sargassum* reproduces every year, so it is expected that the population will recover if affected by an oil spill. Over time, hydrocarbons in the water column would be diluted and broken down by natural processes and pelagic habitat would recover. Overall, a CDE could result in minor to moderate impacts to pelagic habitat.

4.4.6.3.2 Alaska – Cook Inlet.

Impacts of Routine Operations.

***Exploration and Site Development*.** See the Section 4.4.3.2.1 for a general discussion of the impacts of exploration and site development on water quality. During the exploration and site development phase, pelagic habitat would be affected by platform and pipeline placement, drilling activity, seismic surveys, platform lighting, and aircraft and vessel traffic (Table 4.4.6-7). Noise impacts would be greatest near the source and would temporarily reduce habitat quality for certain species. Construction lighting would alter the pelagic light regime of a small area and would attract phototaxic organisms to the platform.

Bottom water quality would be temporarily affected by turbidity from sediment disturbance during drilling, platform placement, and pipeline placement. Turbidity from bottom-disturbing activities could kill phytoplankton, although it is not expected to result in population-level effects. Photosynthetic productivity of phytoplankton that specialize in near-bottom habitats may be reduced if the turbidity plume reduced solar irradiance at depth. The turbidity plume would be temporary, and the effects on pelagic habitat are expected to be short term.

It is assumed that drilling muds and cutting would be discharged into Cook Inlet for exploration wells only. Drilling wastes from development and production wells would be reinjected into the wells. The discharge of drilling muds and cuttings can occur near the water's surface or the seafloor, and both would create a turbidity plume that would diminish within some distance from the release point. The turbidity plume could smother or stress small zooplankton and reduce phytoplankton productivity by decreasing the depth and intensity of light penetration. In well-mixed ocean waters, water-based drilling muds and cuttings are diluted by 100-fold within 10 m (33 ft) of the discharge and by 1,000-fold at a distance of about 100 m (330 ft) from the platform (Neff 2005). These estimates are for well-mixed water, and therefore the size of the turbidity field will vary with hydrology. Because the waters of Cook Inlet generally are vertically well mixed with a relatively large tidal range, dilution of drilling discharges would be expected to occur rapidly. Drilling wastes that are discharged are regulated by the USEPA under NPDES permits and must meet the toxicity, water quality, and discharge rate standards set by the permits, thereby reducing impacts on water quality (Neff et al. 2000; Neff 2005). Although such releases could result in temporary, localized increases in sediment load and deposition, this amount of sediment is small compared to the more than 40 million tons of suspended sediment carried annually into Cook Inlet by runoff from area rivers (Brabets et al. 1999). .

Pelagic habitat would be affected minimally and temporarily by miscellaneous discharges (deck drainage, sanitary and domestic waste, bilge and ballast water) during site development. Such releases would be small in quantity and would be rapidly diluted. In addition, many vessel and platform wastes are disposed of on land, and those that are discharged at sea must meet USEPA and/or USCG regulatory requirements that limit their environmental effects.

Production. Impacts from offshore lighting, miscellaneous discharges, and bottom disturbance from the movement of support vessel anchors and chains will also exist in the production phase and are described above. In addition, production noise and produced water discharge could impact pelagic habitat quality (Table 4.4.6-7). Production noise is not expected to have significant impacts on habitat quality, because production platforms are known to have high biological abundance and diversity (Stanley and Wilson 2000). There would be minimal impacts on pelagic habitat from produced water because it is assumed that all produced water will be reinjected into the well.

TABLE 4.4.6-7 Impacting Factors by Phase and Potential Effects on Marine Pelagic Habitat in the Cook Inlet Planning Area

Impacting Factor	Disturbance[a]
Exploration and Site Development	
Vessel traffic	Noise
Seismic surveys	Noise
Miscellaneous discharges (deck washing, sanitary waste, bilge and ballast water)	Degraded water quality
Drilling and discharge of drilling muds/cuttings	Noise; degraded water quality
Pipeline trenching	Noise; turbidity
Drilling platform placement	Noise; turbidity
Offshore lighting	Alteration of light field
Production	
Production platform placement	Noise; turbidity
Production	Noise
Produced water discharge	Degraded water quality
Miscellaneous discharges (deck washing, sanitary waste)	Degraded water quality
Offshore lighting	Alteration of light field
Decommissioning	
Miscellaneous discharges (deck washing, sanitary waste, bilge and ballast water)	Degraded water quality
Platform removal	Noise, turbidity
Offshore lighting	Alteration of light field

[a] Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

Decommissioning. Impacts from vessel noise, platform lighting, and miscellaneous discharges are discussed above and would continue throughout the decommissioning phase. In addition, bottom disturbance during platform removal would temporarily disturb pelagic habitat by increasing noise and turbidity for some length of the water column. These impacts would temporarily degrade habitat quality, but conditions would return to normal as suspended sediments dispersed and resettled. The use of explosives to remove platforms is not expected. Overall, activities conducted during the decommissioning phase are expected to have minor effects on pelagic habitat.

Impacts of Expected Accidental Events and Spills. Impacts on pelagic habitat from accidental oil spills could result from surface releases from platforms or vessels or from seafloor releases from pipelines and the wellhead. Spills could vary in size. It is assumed that 1 large spill (≥1,000 bbl), 1 to 3 small spills between 50 and 999 bbl and 7 to 15 smaller spills between 1 and 50 bbl could occur under the proposed action (Table 4.4.2-1). Such releases would reduce the habitat value and ecosystem function of pelagic habitat. Most spills would be small and the overall impacts on pelagic habitat resources will be localized and short term, given the natural dilution and breakdown of hydrocarbons. Large spills would degrade pelagic habitat quality over a wider area and potentially reduce the habitat value and ecosystem function in the areas affected. Most released oil and gas would float above the seafloor, so exposures would be expected for zooplankton, which lack the mobility to avoid the oil. Oil exposure can reduce the abundance of zooplankton in the oiled area, induce narcosis, and bind to feeding appendages (Teal and Howarth 1984). Zooplankton are known to ingest oil, some of which is retained in the gut and some of which is exported to the seafloor in fecal pellets (Teal and Howarth 1984). Pelagic habitat would recover as the oil was broken down by natural processes.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE with an assumed volume of 75,000-125,000 bbl and a duration of 50–80 days (Table 4.4.2-2). Oil from a CDE (Table 4.4.2-2) would form a surface slick and kill, injure, or displace pelagic biota over a large area of Cook Inlet. The extent and magnitude of the impact depend primarily on the time of year, the location of the well, the volume released, and the speed at which the well was capped. Most oil released would be rapidly diluted and broken down in the water column by physical and biological processes. Studies of water quality after the *Exxon Valdez* spill indicated that the hydrocarbon concentrations were highest in the first two months after the spill, but were well below the State of Alaska's water quality standard (Neff and Stubbenfield 1995). PAH concentrations in the water column of Prince William Sound reached background concentrations by 5 to 6 months after the spill. Toxicity tests also indicated no lethal or sublethal toxicity to pelagic phytoplankton, invertebrates, or larval fish test organisms due to exposure to water from Prince William Sound (Neff and Stubbenfield 1995). Within 1 yr of the *Exxon Valdez* spill, PAH concentrations generally declined to background levels (Boehm et al. 2007). In heavily oiled areas, toxic fractions of oil trapped in intertidal sediments can be periodically resuspended into the water column, where they are available to filter-feeding biota (Boehm et al. 2007). However, data from the *Exxon Valdez* spill suggest resuspended oil represented a contamination threat for biota less than 1 to 2 yr, with the highest PAH concentrations in intertidal waters (Boehm et al. 2007).

CDE-response activities such as burning, skimming, and chemical release (e.g., dispersants or coagulants) could affect pelagic habitat and biota. Burning would kill pelagic biota in the burn area, and skimming would remove aquatic organisms from the water column or trap them in oiled water. The chemicals used during a spill response are toxic, but there is controversy about whether the combination of oil and dispersant is more toxic than oil alone (NRC 2005b; Fingas 2008; Holland-Bartels and Kolak 2011). The use of dispersant would likely increase the areal extent of oil dispersion and the exposure of pelagic biota to oil. The presence of, and noise generated by, oil spill-response equipment and support vessels could temporarily disturb pelagic habitat in the vicinity of the response action, potentially reducing habitat use or disturbing migration. As with the spill itself, the location and time of year the cleanup occurs would be important determinants of impacts to pelagic habitat and biota.

Broken ice occurs in the northern and western portions of lower Cook Inlet during fall and winter. If an open water spill were to occur at this time, the ice would contain the oil somewhat and reduce spreading. However, oil cleanup is also made more difficult in broken ice conditions. Oil from spills occurring in winter would likely freeze in ice where it could be transported hundreds of kilometers. If the spilled oil became frozen in the ice, cleanup would not be possible and the unweathered oil would be released into pelagic habitat as the ice melted.

However, oil frozen into shorefast ice could be recovered using terrestrial cleanup methods, assuming the ice was stable and thick enough to support the cleanup activities.

Impact Conclusions.

***Routine Operations*.** Impacts on pelagic habitat in the Cook Inlet Planning Area could occur during the exploration through decommissioning phases, and would range from negligible to minor. Impacts from routine Program activities would range from short-term for the exploration, site development, and decommissioning phases to long-term for those impacts occurring throughout the production phase. Impacts would primarily occur from turbidity generated by bottom-disturbing activities. Temporary reduction in habitat quality could also result from the discharge of drilling muds and cuttings.

Expected Accidental Events and Spills. Most accidental oil spills would be small and result in only negligible, localized impacts on pelagic habitat. Large spills would temporarily reduce habitat quality over large areas of pelagic habitat. Accidental oil releases from pipeline leakage would degrade bottom water quality at local scales. Most released oil and gas would float above the seafloor, so exposures would be expected for zooplankton, which lack the mobility to avoid the oil. The oil would be broken down by natural processes, and pelagic habitat would recover. Overall, the impacts of oil spills on pelagic habitat would range from negligible for spill less than 50 bbl to minor for spills less than 1,000 bbl and from minor to moderate for large spills greater than 1,000 bbl.

***An Unexpected Catastrophic Discharge Event*.** An unexpected CDE would degrade pelagic habitat quality over a wider area and potentially reduce the habitat value and ecosystem function in the areas affected. Pelagic organisms could be exposed to lethal or sublethal concentrations of hydrocarbons or mixtures of hydrocarbons and dispersants (if used). The extent and magnitude of the impact depend primarily on the location of the well, the volume of oil released, and the season in which the spill occurs. CDE-response activities such as burning, skimming, and chemical releases (e.g., dispersants or coagulants) could also affect pelagic habitat and biota. Oil spills occurring near or under ice could be difficult to clean and may persist in the water column for an extended period. Over time, hydrocarbons in the water column would be diluted and broken down by natural processes and pelagic habitat would recover. Overall, a CDE could result in minor to moderate impacts to pelagic habitat.

4.4.6.3.3 Alaska – Arctic.

Impacts of Routine Operations.

***Exploration and Site Development*.** See Section 4.4.3.3.1 for a general discussion of the impacts of exploration and site development on water quality. During the exploration and site development phase, pelagic habitat would be affected by multiple activities (Table 4.4.6-8). Noise impacts would be greatest near the source and would temporarily reduce habitat quality for certain species. (See Section 4.4.7 for detailed discussions of the effects of noise on different

TABLE 4.4.6-8 Impacting Factors by Phase and Potential Effects on Marine Pelagic Habitat in the Beaufort and Chukchi Sea Planning Areas

Impacting Factor	Disturbance
Exploration and Site Development	
Vessel traffic	Noise; air emissions
Seismic surveys	Noise
Miscellaneous discharges (deck washing, sanitary waste, bilge and ballast water)	Degraded water quality
Drilling and discharge of drilling muds/cuttings	Noise; degraded water quality
Pipeline trenching	Noise; turbidity
Drilling and subsea well an platform placement	Noise; turbidity
Offshore lighting	Alteration of light field
Production	
Production platform placement	Noise; turbidity
Production	Noise
Produced water discharge	Degraded water quality
Miscellaneous discharges (deck washing, sanitary waste)	Degraded water quality
Offshore lighting	Alteration of light field
Decommissioning	
Miscellaneous discharges (deck washing, sanitary waste, bilge and ballast water)	Degraded water quality
Platform removal	Noise, turbidity
Offshore lighting	Alteration of light field

[a] Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

categories of biota.) Construction lighting would alter the pelagic light regime of a small area and would attract phototaxic organisms to the platform.

Bottom water quality would be temporarily affected by turbidity from sediment disturbance during drilling, placement of subsea wells, platforms and pipelines, and the construction of artificial islands. In addition to lethal or sublethal impacts to benthic organisms (Section 4.4.7.5), turbidity from bottom-disturbing activities could kill plankton, but it is not expected to result in population-level effects. Photosynthetic productivity of phytoplankton that specialize in near-bottom habitats may be reduced if the turbidity plume reduced solar irradiance at depth. However, the turbidity plume would be temporary, and the effects on pelagic habitat are expected to be short-term.

It is assumed that drilling muds and cuttings would be discharged into the Beaufort and Chukchi Sea Planning Areas for exploration wells only. Drilling wastes from development and production wells would be reinjected into the wells. The discharge of drilling muds and cuttings can occur near the water's surface or the seafloor, and both would create a turbidity plume that would diminish within some distance from the release point. The turbidity plume could smother or stress small zooplankton and reduce phytoplankton productivity by decreasing the depth and intensity of light penetration. In well-mixed ocean waters, water-based drilling muds and cuttings are diluted by 100-fold within 10 m (33 ft) of the discharge and by 1,000-fold at a distance of about 100 m (330 ft) from the platform (Neff 2005). These estimates are for well-mixed water, and therefore the size of the turbidity field will vary with hydrology. The drilling wastes that are discharged are regulated by the USEPA under NPDES permits and must not exceed the toxicity, water quality, and discharge rate standards set by the permits. These requirements greatly reduce the potential for sediment alteration and contamination.

Pelagic habitat would be affected minimally and temporarily by miscellaneous discharges (deck drainage, sanitary and domestic waste, bilge and ballast water) during site development. Such releases would be small in quantity and rapidly diluted. In addition, many vessel and platform wastes are disposed of on land, and those that are discharged at sea must meet USEPA and/or USCG regulatory requirements that limit their environmental effects.

Production. See Section 4.4.3.3.1 for a general discussion of the impacts of exploration and site development on water quality. Impacts from offshore lighting, miscellaneous discharges, and bottom disturbance from support vessel anchors and chains will also exist in the production phase and are described above. In addition, production noise and produced water discharge could impact pelagic habitat quality (Table 4.4.6-8). Recent analyses indicate that the discharge of produced water into the Chukchi Sea could result in elevated PAH concentrations in shallow water areas or in the winter (MMS 2007b). However, impacts on pelagic habitat from produced water are not anticipated because it is assumed that all produced water will be reinjected into the well.

Decommissioning. Impacts from vessel noise, platform lighting, and miscellaneous discharges are discussed above and would continue throughout the decommissioning phase. In addition, bottom disturbance during platform removal would temporarily disturb pelagic habitat by increasing noise and turbidity for some length of the water column. In addition, gravel islands would be left in place where they would wash away and introduce fine sediments into the water column over time. These impacts would temporarily degrade habitat quality, but conditions would return to normal as suspended sediments dispersed and resettled.

Impacts of Expected Accidental Events and Spills. It is assumed that up to 3 large oil spills (≥1,000 bbl) up to 35 small spills (50 to 999 bbl) and up to 190 smaller spills (>1 and <50 bbl) could occur during the lease period under the proposed action (Table 4.4.2-1). See Section 4.4.3.3.2 for a detailed discussion of the effects of oil spills on water quality in the Beaufort and Chukchi Sea Planning Areas. Accidental oil spills could result from surface releases from platforms or vessels or from seafloor releases from pipelines and the wellhead. Small releases would degrade bottom water quality, but the overall contaminant impacts on pelagic habitat resources will be short-term, given the localized nature of a small release and the natural dilution and breakdown of hydrocarbons. Large spills would degrade pelagic habitat quality over a wider area and potentially reduce the habitat value and ecosystem function in the areas affected. Most released oil and gas would float above the seafloor, so exposures would be expected for zooplankton, which lack the mobility to avoid the oil. Oil exposure can reduce the abundance of zooplankton in the oiled area, induce narcosis, and bind to feeding appendages

(Teal and Howarth 1984). Zooplankton are known to ingest oil, some of which is retained in the gut and some of which is exported to the seafloor in fecal pellets (Teal and Howarth 1984). The oil would be transported from the area as well as broken down by natural processes. Oil is not expected to persist in marine pelagic habitat for an extended period (Section 4.4.3.3).

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE in the Chukchi Sea Planning Area with an assumed volume of 1.4-2.2 million bbl and a duration of 40–75 days, and a CDE in the Beaufort Sea Planning Area with an assumed volume of 1.7-3.9 million bbl with a duration of 60–300 days. A CDE may affect pelagic habitats (Table 4.4.2-2). The extent and magnitude of the impact depend primarily on the time of year, the location of the well, the volume released, and the speed at which the well was capped. Typically oil rises from the seafloor to the surface, forming a surface slick capable of traveling greater than 50 km (31 mi) (MMS 2007b). Pelagic organisms could be exposed to lethal or sublethal concentrations of hydrocarbons or mixtures of hydrocarbons and dispersants (if used). Pelagic habitats would recover their habitat value as hydrocarbons broke down and were diluted. Recovery time would vary with local conditions and the degree of oiling. Studies following the *Exxon Valdez* spill indicated that PAH concentrations generally declined to background levels in less than 1 year, and during that period, water column hydrocarbon concentrations were not found to be toxic to marine life (Neff and Stubbenfield 1995; Boehm et al. 2007).

Spills in open water could be contained and much of the oil removed by standard oil spill-response methods. Oil spill-response activities such as burning, skimming, and chemical releases (e.g., dispersants or coagulants) could affect pelagic habitat and biota. Burning would kill pelagic biota in the burn area, and skimming would remove aquatic organisms from the water column or trap them in oiled water. The chemicals used during a spill response are toxic, but there is controversy about whether the combination of oil and dispersant is more toxic than oil alone (NRC 2005b; Fingas 2008; Holland-Bartels and Kolak 2011). The use of dispersant would likely increase the areal extent of oil dispersion and the exposure of pelagic biota to oil. The presence of, and noise generated by, oil spill-response equipment and support vessels could temporarily disturb pelagic habitat in the vicinity of the response action, potentially reducing habitat use or disturbing migration. As with the spill itself, the location and time of the year the cleanup occurs would be an important determinant of impacts on pelagic habitat and biota.

If the spill were to occur under ice or during winter, cleanup would be much more difficult because sea ice would limit access to the spill (reviewed in Holland-Bartels and Kolak 2011). For spills affecting areas of broken ice, the ice would contain the oil somewhat and reduce spreading. However, cleanup is also more difficult in broken ice conditions. Oil cleanup response plans and technologies for ice-covered areas are still evolving, and the efficacy of many proposed spill countermeasures is as yet unknown (Holland-Bartels and Kolak 2011). The oil could freeze into the ice where it could be transported hundreds of kilometers. Oil under ice or frozen in ice would undergo little weathering (Holland-Bartels and Kolak 2011) and could therefore degrade pelagic habitat for an extended period of time, with the extent of the impacts increasing with the size of the oiled area. Sea ice habitat could be degraded or lost if contact with oil spills results in lethal or sublethal effects on biota growing beneath the ice (e.g., fish, invertebrates, and algae).

Impact Conclusions.

***Routine Operations*.** Impacts on pelagic habitat in the Beaufort and Chukchi Sea Planning Areas could occur during the exploration through decommissioning phases. Impacts from routine Program activities would range from short-term for the exploration, site development, and decommissioning phases to long-term for those impacts occurring throughout the production phase. Impacts would primarily occur from turbidity generated by bottom-disturbing activities. Temporary reduction in habitat quality could also result from the discharge of produced water and drilling muds and cuttings. Overall, impacts to pelagic habitats from routine oil and gas activities would be negligible to minor.

Expected Accidental Events and Spills. Most accidental oil spills would be small and result in only negligible, localized impacts on pelagic habitat. Large spills would temporarily reduce habitat quality over large areas of pelagic habitat. Accidental oil releases from pipeline leakage would degrade bottom water quality at local scales. Most released oil and gas would float above the seafloor, so exposures would be expected for zooplankton, which lack the mobility to avoid the oil. The oil would be broken down by natural processes, and pelagic habitat would recover. Overall, the impacts of oil spills on pelagic habitat would range from negligible for spill less than 50 bbl to minor for spills less than 1,000 bbl and from minor to moderate for large spills (≥1,000 bbl).

***An Unexpected Catastrophic Discharge Event*.** A CDE could potentially reduce habitat quality over potentially large areas. Pelagic organisms could be exposed to lethal or sublethal concentrations of hydrocarbons or mixtures of hydrocarbons and dispersants (if used). The effects from oil spills would depend on the size, timing, duration, and location of the spill and on various environmental factors. Pelagic habitat in nearshore areas would likely have the greatest potential for long-term contamination. Unique pelagic habitat and associated biota such as sea ice could also be affected by oil spills. In the Arctic planning areas, oil could become trapped under sea ice for an extended period, where it would remain relatively unweathered and capable of being transported large distances. Oil under ice or frozen in ice could therefore degrade pelagic habitat for an extended period of time with the extent of the impacts increasing with the size of the oiled area; the largest area affected would occur with a CDE. Sea ice habitat could be degraded or lost if contact with oil spills results in lethal or sublethal effects on biota growing beneath the ice. CDE response activities such as burning, skimming, and chemical releases (e.g., dispersants or coagulants) could also affect pelagic habitat and biota. Over time, hydrocarbons in the water column would be diluted and broken down by natural processes and pelagic habitat would recover. Overall, a CDE could result in minor to moderate impacts to pelagic habitat and sea ice habitat.

4.4.6.4 Essential Fish Habitat

4.4.6.4.1 Gulf of Mexico. As described in Section 3.7.4.1, most of the coastal and marine waters of the GOM are considered EFH for life stages of one or more managed species, and any oil and gas development activity that degrades coastal or marine benthic and pelagic environments would affect EFH. Also, several offshore banks are considered HAPC (Section 3.7.4.1). EFH consists of benthic and water column habitats in marine coastal areas. The potential effects of exploration, site development, and production activities on these habitats are discussed in individual sections including coastal and estuarine habitats (Sections 4.6.1.1), marine benthic habitats (Section 4.4.6.2.1), and the marine water column (Section 4.4.6.3.1). Impacts on fish and fisheries from the Program are discussed in Sections 4.4.7.3.1 and 4.4.1.1.1.

Impacts of Routine Operations.

Exploration and Site Development. During the exploration and site development phase, impacts on EFH could occur as a result of drilling and drilling waste discharge, seismic surveys, and the placement of drilling units, production platforms, and pipelines. Noise from drilling, construction, and seismic surveys would temporarily disturb EFH and potentially kill, injure, or displace managed species. See Section 4.4.7.3.1 for a discussion of the impacts of noise on fish. It is anticipated that behavioral and distributional responses to such acoustic stimuli would be small and that these temporary effects would not persist for more than several hours after acoustic surveys are ended. All the noise associated with these activities would be temporary and affect a small area.

The vast majority of marine EFH affected by the Program would be soft sediments. The estimated bottom habitat that may be directly disturbed by new pipeline and platform installation ranges from 2,150 to 14,000 ha (5,313 to 34,594 ac) over the entire GOM. Pipelines placed on the sediment surface would eliminate natural soft sediment EFH. Sediment-disturbing activities would result in increased turbidity, which would lower the water quality of EFH in small areas for a limited time. Given their mobility, adult managed species are not likely to be injured or killed by bottom disturbance. However, bottom-disturbing activities could injure, displace, or kill early life stages of managed species or bury the benthic prey of managed species. Although mobile, adult managed species are not likely to be directly affected by bottom disturbance, bottom-disturbing activities could injure, displace, or kill early life stages of managed species or bury the benthic prey of managed species. Bottom disturbance would affect a small area relative to the size of the GOM, and no population-level effects on managed species are expected. Also, FPSO systems could potentially be used in deep water, and would reduce the need for pipelines.

The potential for bottom-disturbing activities to affect sensitive marine EFH such as hard-bottoms, deepwater corals, and chemosynthetic communities would be reduced by stipulations requiring buffers between these features and bottom-disturbing activities (NTL No. 2009-G39; Section 4.4.6.2.1). Up to two FPSO systems may be employed for deepwater wells. Under the FPSO system, oil would be transported from the well to a surface vessel and ultimately to shore. By eliminating the need for pipelines, an FPSO system would greatly reduce bottom disturbance and the chance for disturbing deepwater corals and chemosynthetic communities. Topographic features classified as HAPC are also protected by the Topographic Features Stipulation, which prohibits direct bottom disturbance or the deposition of drilling muds and cuttings in areas containing such habitat. Therefore, HAPC should be minimally affected by exploration and site development activities.

Coastal EFH could be affected by the estimated 0 to 12 new pipeline landfalls that are anticipated under the proposed action. Routing the pipelines through the most sensitive coastal EFH (i.e., mangroves and seagrass) is not likely to be permitted.

A total of up to 4,700 exploration and production wells will be drilled in the WPA and CPA under the proposed action. The subsequent discharges of drilling cuttings and muds would alter the grain size distribution and chemical characteristics of sediments immediately surrounding the drill sites and for some distance around the wells (typically less than 1 km [3,281 ft]), depending on the depth at which the material is discharged (Kennicutt et al. 1995; Continental Shelf Associates, Inc. 2004a, 2006). The deposited material could alter benthic habitat for EFH prey species and potentially affect spawning sites, which are often chosen on the basis of sediment grain size. Elevated sediment metal and PAH concentrations near the well (<500 m [1,640 ft]) would also likely result from drilling discharge, but with the exception of some metals, elevated tissue concentrations of contaminants have not been found in demersal fish or their benthic invertebrate food sources sampled around platforms in the GOM (Kennicutt et al. 1995; Continental Shelf Associates, Inc. 2004a, 2006).

It is expected that the overall impacts of exploration and site development activities on marine EFH would not result in population-level impacts on managed species. Recovery rates of EFH habitat and benthic food resources could range from short term to long term depending on the spatial and temporal scope of the disturbance.

Production. The primary production activities that could affect EFH include chronic bottom disturbance from the movement of platform mooring structures and the discharge of produced water. Bottom disturbance represents chronic, long-term, but localized impacts on marine EFH. NPDES permits would limit the potential for produced water discharges to contaminate sediment and water column EFH. Fish and invertebrates collected near platforms in the GOM do not appear to bioaccumulate the common contaminants in produced water such as radionuclides, metals, and hydrocarbons and do not exceed the USEPA-specified tissue concentrations considered to be harmful (Continental Shelf Associates, Inc. 1997).

After new platforms have been established, sessile fouling organisms would colonize the underwater portions of the structures, which would attract managed reef species such as snapper, grouper, and some coastal migratory pelagics. Over time, this could change the spawning, breeding, and feeding patterns of some managed fish. The effects of artificial reefs on fish populations are controversial (Section 4.4.7.3.1), as the reefs may benefit some species and adversely affect others. The benefit or detriment of artificial reefs as habitat depends on how fisheries on the reef are managed and on the individual life histories and habitat requirements of the species present (Bohnsack 1989; Macreadie et al. 2011). Unless platforms are permitted to remain, the reef function of the platforms would last only through the production phase.

Decommissioning. During decommissioning and structure removal, both explosive and nonexplosive methods may be used to sever conductors and pilings. With the exception of some water quality concerns, nonexplosive removals (e.g., abrasive, mechanical, or diver cutters) have little impact on the fish resources. With explosive removal, impacts on managed species range from disturbance and habitat loss to injury and death. From 150 to 275 explosive platform removals are expected, and most would occur in relatively shallow water. Floating platforms would not require explosive removals, although the seafloor would be temporarily disturbed by the removal of platform mooring structures. Removing structures would also remove the associated fouling communities that serve as prey for managed fish species, thereby forcing these species to relocate to other foraging areas. Pipelines would typically be left in place. Pipelines on the sediment surface could periodically move, resulting in chronic bottom disturbance to soft sediment EFH. Pipelines not buried, in both shallow and deepwater, would provide hard substrate and habitat. Overall, decommissioning activities are not expected to result in population-level impacts on managed species.

Impacts of Expected Accidental Events and Spills. It is assumed that up to 8 large spills (≥1,000 bbl), up to 70 spills between 50 and 999 bbl, and up to 400 smaller spills between 1 and <50 bbl could occur during the lease period under the proposed action (Table 4.4.2-1). See individual sections for detailed discussions of the potential impacts of oil spills on fish, shellfish, and marine and coastal habitat. Impacts to EFH would typically increase with the size of the spill. Small accidental hydrocarbon releases occurring in surface or near-bottom offshore habitats would temporarily degrade EFH in the vicinity of the release, but are not likely to reach sensitive marine EFH such as hard-bottom EFH (Section 4.4.6.2.1). Most nearshore spills would be small, so they are not likely to degrade a large fraction of EFH because the hydrocarbons would be rapidly metabolized and diluted. Large spills (≥1,000 bbl) have the potential to degrade EFH over a wider area that potentially reduce the habitat value and ecosystem function in the areas affected. Lethal and sublethal impacts to managed species at the individual level would result from large spills, particularly eggs and larvae which do not have the capability of avoiding oil. Impacts would be greatest if oil from the spill were to contact sensitive coastal marine habitat such as seagrass beds and wetlands resulting in long-term but temporary degradation of these EFH habitats. However, in most cases, the area affected would likely be small compared to the overall resources and the oil would be transported from the area as well as broken down by natural processes.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE with an assumed volume of 0.9-7.2 million bbl and a duration of 30–90 days (Table 4.4.2-2). See individual sections for detailed discussions of the potential impacts of a CDE on fish, shellfish, and marine and coastal habitat. Much of the hydrocarbon would likely be consumed relatively quickly by bacteria, both at the surface and at depth (Camilli et al. 2010; Kessler et al. 2011). The potential for oil from a CDE to reach marine HAPC at lethal concentrations would be reduced by the Topographic Features Stipulation prohibiting oil and gas development near these features. However, topographic features as well as unique deepwater communities could be partly or completely destroyed if contacted by a large quantity of oil. Oil from surface and subsurface spills contacting intertidal and estuarine habitats with emergent and submerged vegetation, sand and mud flats, and shell and oyster reefs would have the greatest impacts on EFH. These areas provide food and rearing substrate for a variety of federally managed juvenile fish and shellfish. In most cases, the coastal habitat would recover as the hydrocarbons were metabolized or buried, but marsh grasses currently stressed by subsidence may not recover.

A catastrophic spill could affect all life stages of federally managed species and their food sources. Managed species could be affected by the spill directly due to lethal or sublethal toxicity or indirectly by long-term reduction in food resources and juvenile and reproductive habitat. Adult life stages will likely avoid heavily oiled areas, although sublethal exposures are possible (Roth and Baltz 2009). Early life stages of managed species may be most vulnerable to hydrocarbon spills, which could trap and kill planktonic eggs and larvae in the affected area. Mortality to pelagic eggs and larvae contacting the oil could be particularly high in the case of a catastrophic spill at the surface that spreads over a wide area. In addition to the size of the spill, the location of the spill and the season in which the spill occurred would be important determinants of the impact magnitude. For example, catastrophic spills occurring during recruitment periods or spills that oil critical spawning areas could result in temporary population-level impacts on managed fish and invertebrates. Also, managed species currently in serious population decline, such as bluefin tuna, may experience population-level impacts if the spill were to kill a significant number of eggs and larvae in a given year. For example, the HAPC for bluefin tuna extends from the 100 m (328 ft) isobath and could also be affected by oil spills, and population-level impacts to Bluefin tuna could result from catastrophic spills (Teo et al. 2007; Atlantic Bluefin Tuna Status Review Team 2011).

Wave and wind action, weathering, and biological degradation would dissipate oil in the surface water, and suitable habitat condition would return. The period of time needed to reestablish appropriate habitat conditions following a spill would depend upon the characteristics of the individual spill and would be related to many factors, including the EFH resource affected, the location of the spill, the nature of transporting currents, the magnitude of the spill, and the chemical characteristics of the spilled oil. With the exception of sensitive habitats such as corals and chemosynthetic communities, EFH affected by oil spills is expected to fully recover within a few years. Sensitive habitats with slow-growing biota may take longer to recover or may not recover at all.

Impact Conclusions.

Routine Operations. Most impacts on EFH from oil and gas exploration and production activities would likely result from bottom disturbance and the creation of artificial reefs by production platforms, and would range from negligible to moderate. The magnitude of impacts on sensitive marine and coastal EFH would be limited by specific lease stipulations developed from site-specific analyses conducted for particular lease sales. Recovery of EFH habitat and benthic food resources from oil and gas activities would range from short-term to long-term. Managed species, particularly egg and larval stages, could be killed, injured, or displaced from the immediate vicinity of oil and gas activities, but no population-level impacts on managed species are expected. No more than moderate impacts on EFH are expected to result from routine Program activities.

Expected Accidental Events and Spills. The severity of effects of accidental hydrocarbon spills on EFH would depend on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH. While most accidents would be small and would have negligible to minor impacts on EFH, large spills that reach coastal EFH could have more persistent impacts and could require remediation. Adult managed species would probably not be greatly affected by a hydrocarbon spill in open-water areas, but small obligate benthic species, eggs, larvae, and some managed species and their prey could experience lethal and sublethal effects from contact with hydrocarbons. Overall, impacts to EFH from small spills would range from negligible for spill less than 50 bbl to minor for spills less than 1,000 bbl and from minor to moderate for large spills (≥1,000 bbl).

An Unexpected Catastrophic Discharge Event. A CDE could cause long-term declines of managed species that rely on shallow coastal, intertidal, and freshwater areas. Managed species that are currently in decline that suffer large losses of early life stages could suffer population-level effects from a CDE. Overall, a CDE could result in moderate to major impacts on EFH, largely depending on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH. Major impacts to coral EFH habitat could occur if the Flower Gardens Banks are heavily oiled and high mortality occurs.

4.4.6.4.2 Alaska – Cook Inlet. The Cook Inlet Planning Area contains EFH for a variety of fish and invertebrate species that can be broadly categorized into three groups based upon the relevant Fishery Management Plans (FMPs): Gulf of Alaska groundfish, Alaska salmon, and Alaska weathervane scallop. As identified in the FMPs, the EFH includes bottom and water-column habitat in streams, lakes, ponds, wetlands, and marine and coastal waters. Consequently, activities that degrade these aquatic habitats could adversely affect EFH for one or more species. For the purposes of this analysis, potential impacts on EFH resources in the Cook Inlet Planning Area and adjacent waters are generally addressed. EFH in Cook Inlet potentially affected by exploration, site development, and production activities are discussed in detail in individual sections including coastal and estuarine (Sections 4.4.6.1.2) and marine benthic habitats (Section 4.4.6.2.2) and the marine water column (Section 4.4.6.3.2). Impacts on Cook Inlet fish and fisheries from the Program are discussed in (Sections 4.4.7.3.2 and 4.4.11.2). Because of the connection with adjacent marine areas, this evaluation also considers the potential for effects on fish populations in the overall Gulf of Alaska.

As required by the Magnuson-Stevens Fishery Conservation and Management Act, the National Marine Fisheries Service, Alaska Region, has provided conservation recommendations that will avoid or minimize adverse impacts to EFH from oil and gas development activities. These recommendations are described in "Impacts to Essential Fish Habitat from Non-fishing Activities in Alaska" (NMFS 2011d) and include the following:

1. Avoid the discharge of produced waters into marine waters and estuaries. Reinject produced waters into the oil formation whenever possible.

2. Avoid discharge of muds and cuttings into the marine and estuarine environment. Use methods to grind and reinject such wastes down an approved injection well or use onshore disposal wherever possible. When not possible, provide for a monitoring plan to ensure that the discharge meets USEPA effluent limitations and related requirements.

3. To the extent practicable, avoid the placement of fill to support construction of causeways or structures in the nearshore marine environment.

4. As required by Federal and State regulatory agencies, encourage the use of geographic response strategies that identify EFH and environmentally sensitive areas. Identify appropriate cleanup methods and response equipment.

5. Evaluate potential impacts that may result to EFH that may result from activities carried out during the decommissioning phase of oil and gas facilities. Minimize such impacts to the extent practicable.

6. Vessel operations and shipping activities should be familiar with Alaska Geographic Response Strategies (GRS), which detail environmentally sensitive areas of Alaska's coastline.

Impacts of Routine Operations.

Exploration and Site Development. During the exploration and site development phase, the primary impacts on EFH could occur as a result of drilling and drilling waste discharge, seismic surveys, and the placement of drilling units, production platforms, and pipelines. Each seismic survey would be completed within weeks. Individual fishes, especially egg and larval life stages in close proximity (1 to 5 m [3 to 16 ft]) to airgun arrays (Dalen and Knutsen 1986; Holliday et al. 1987; Turnpenny and Nedwell 1994), could suffer mortality or injury, and adult fishes located farther from the noise could exhibit short-term avoidance and behavioral alteration. The migration of managed salmon could also be temporarily disrupted. Additional sources of noise from drilling, construction of platforms and pipelines, and boat traffic could also temporarily disturb or displace individual fish. All the noise associated with these activities would be temporary.

The vast majority of marine EFH affected by the Program would be soft sediments. It is anticipated that 1.5 to 4.5 ha (4 to 11 ac) of seafloor habitat in the Cook Inlet Planning Area could be affected by platform construction under the proposed action. It is also estimated that 80 to 241 km (50 to 150 mi) of new pipelines would be installed offshore. Pipelines could be trenched or installed and anchored on the sediment surface. Placing the pipeline on the sediment surface could result in loss of soft sediment EFH. Ground-disturbing activities would result in increased turbidity, which would lower the water quality of EFH in small areas for a limited amount of time. Although adult managed fish are not likely to be killed or injured during bottom disturbance, bottom-disturbing activities could injure, displace, or kill early life stages of managed species or bury the benthic prey of managed species. Scallops have less mobility than fish and may be killed, injured, or displaced by bottom disturbance. The migration of managed salmon could also be temporarily disrupted by bottom disturbance.

Pipeline construction in nearshore subtidal habitats could damage marine plant EFH by mechanically removing the plants or smothering them through sedimentation. Areas containing high densities of aquatic vegetation are typically avoided during construction activities due to a lease stipulation calling for protection of important or unique biological populations or habitats. Pipeline crossings of streams could affect EFH for several life stages of anadromous salmon, including eggs, larvae, juveniles, and adults. The Alaska Department of Fish and Game (ADFG) reviews plans for construction activities for potential impacts on salmon and other fish species and requires permits to be issued before stream pipeline crossings can be installed. Therefore, it is anticipated that impacts on anadromous salmon from freshwater pipeline crossings would be minimized through appropriate permitting and management actions once site-specific assessments are conducted.

It is anticipated that 4 to 12 exploration and delineation wells and 42 to 114 production wells will be drilled in Cook Inlet under the proposed action. It is assumed that drilling muds and cuttings from the exploration and delineation wells would be discharged into Cook Inlet and could temporarily affect benthic and water-column EFH resources. While the toxicity of those cuttings is expected to be low and within permitted levels, the drilling wastes that are discharged would temporarily increase turbidity and sediment deposition, and small numbers of managed species could be temporarily displaced. In the mixing area near the discharge site, eggs and larvae of managed groundfish and scallops could be killed or injured. Settlement of discharged cuttings on the seafloor could smother some prey species and change substrate composition in the area where the cuttings settle. However, the discharge of all drilling muds and cuttings would be subject to NPDES permitting requirements that would greatly reduce the impacts on EFH and managed species.

Production. The primary production activities that could affect EFH include bottom disturbance from anchors and the discharge of produced water. Bottom disturbance represents a chronic, long-term but localized impact on EFH. It is assumed that all produced water would be disposed of by injection into permitted disposal wells. Therefore, the effects of produced water discharges on sediment and water-column EFH are expected to be minimal.

After new platforms have been established, sessile fouling organisms would colonize the underwater portions of the structures, and they would attract prey for unmanaged species as well as managed species such as rockfish. Over time, this could change the spawning, breeding, and feeding patterns of some managed fish.

Decommissioning. During decommissioning and structure removal, only nonexplosive methods would be used to sever conductors and pilings. Nonexplosive removals (e.g., abrasive, mechanical, or diver cutters) are expected to have little impact on EFH resources and managed species (Section 4.4.7.3.2). Many platforms would be floating, and the seafloor would be temporarily disturbed by the removal of platform mooring structures. Removing structures would also remove the associated biological communities that serve as prey for managed fish species, thereby forcing these species to relocate to other foraging areas.

Impacts of Expected Accidental Events and Spills. It is assumed that 1 large spill (≥1,000 bbl), 1 to 3 small spills between 50 and 999 bbl and 7 to 15 smaller spills between 1 and 50 bbl could occur under the proposed action (Table 4.4.2-1). See individual sections for detailed discussions of the potential impacts of oil spills on fish, shellfish, and marine and coastal habitat. Most accidental hydrocarbon releases in the Cook Inlet Planning Area would be small and would result in short-term localized impacts on EFH and managed species, given the natural dilution and breakdown of hydrocarbons. Larger releases could have a greater adverse impact on various life stages of managed species and could potentially reduce the habitat value and ecosystem function of the EFH areas affected. Impacts from spills would be greatest if a large spill occurred during a reproductive period or contacted a location important for spawning or growth such as intertidal and nearshore subtidal habitats. In particular, egg and larval life stages of managed species as well as planktonic organisms that serve as their prey may be unable to avoid hydrocarbon spills. Impact to EFH from a large spill would depend upon the timing, location, and size of the oil spill. Oil reaching the intertidal zone can persist in the sediments and cause sublethal impacts on fish eggs and larvae for multiple years. Following the spill, the oil would be transported from the area as well as broken down by natural processes. Wave and wind action, weathering, and biological degradation by microbes would dissipate oil in the surface water, and EFH would be reestablished after some period of time.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE with an assumed volume of 75,000-125,000 bbl and a duration of 50–80 days (Table 4.4.2-2). See individual sections for detailed discussions of the potential impacts of a CDE on fish, shellfish, and marine and coastal habitat. The potential for severe impacts from accidents would be greatest from oil washed inshore into wetlands, intertidal zones, and shorelines where spilled oil could contaminate nearshore habitat and associated prey species. Deeper subtidal sediment EFH may be less affected because hydrocarbons would tend to float over the sediments. Spilled oil could also kill kelp and other marine plants that provide food and nursery habitat for managed salmon and groundfish. Spilled oil concentrated along the coastline at the mouths of streams or rivers may disrupt migration patterns for some species, such as eulachon or salmon, by causing fish to avoid contaminated areas. In some cases, toxic fractions (e.g., PAHs) of spilled oil could also reach freshwater areas where salmon eggs are deposited in stream bottoms. PAHs in the parts-per-billion range can cause sublethal impacts on developing fishes (MMS 2007b). Depending on the timing and severity of an oil spill, adult anadromous fish migrating from marine waters to freshwater to spawn and juveniles migrating seaward from freshwater could be harmed by high concentrations of hydrocarbons. Large, mobile adult managed species in Cook Inlet would likely avoid hydrocarbon spills by temporarily moving to other areas. However, small obligate benthic species as well as pelagic eggs and larvae of some managed species and organisms that serve as their prey may be unable to avoid the oil.

The period of time needed to reestablish appropriate EFH conditions following a CDE would depend upon the characteristics of the individual spill and many other factors, including the location of the spill, the nature of transporting currents, the magnitude of the spill, and the chemical characteristics of the spilled oil. For example, while most of the waters within the Cook Inlet Planning Area remain open throughout the winter, currents could transport oil under ice to surrounding areas. Oil spilled under ice is more difficult to locate and clean than that in surface spills. As evidenced by effects of the *Exxon Valdez* oil spill, recovery of some EFH resources could occur within less than a year, while shoreline resources could continue to be affected at some level for 10 years or more (*Exxon Valdez* Oil Spill Trustee Council 2009a). Wave and wind action, weathering, and biological degradation would dissipate spilled oil in the surface water, and water-column EFH resources would likely recover most quickly. Sediments could recover much more slowly. Following the *Exxon Valdez* oil spill, contamination persisted in some freshwater benthic habitats for at least 4 years and oil contaminating intertidal sediments continued to reduce survival of eggs for anadromous salmon for a number of years after the spill (reviewed in Peterson et al. 2003). Similarly, intertidal sediments and benthic communities are still listed as recovering (*Exxon Valdez* Oil Spill Trustee Council 2010a). Like EFH, managed species would recover from catastrophic spills, although the recovery could take many years. The *Exxon Valdez* Oil Spill Trustee Council evaluated the status of several managed species following the *Exxon Valdez* spill, including sockeye salmon, pink salmon, and rockfish. The salmon were listed as recovered within a decade after the spill and rockfish as very likely recovered (*Exxon Valdez* Oil Spill Trustee Council 2010a).

Impact Conclusions.

Routine Operations. Most impacts on EFH from oil and gas exploration and production activities would likely result from bottom disturbance associated with platform and pipeline placement, and result in negligible to moderate impacts to EFH. The magnitude of impacts on sensitive marine and coastal EFH would be limited by specific lease stipulations developed from site-specific analyses conducted for particular lease sales. Recovery of EFH habitat and benthic food resources from oil and gas activities would range from short-term to long-term. Managed species, particularly egg and larval stages, could be killed, injured, or displaced from the immediate vicinity of oil and gas activities, but no population-level impacts on managed species are expected.

***Expected Accidental Events and Spills*.** The severity of effects of accidental hydrocarbon spills on EFH would depend on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH. While most accidents would be small and would have relatively small impacts on EFH, large spills that reach coastal EFH could have more persistent impacts and could require remediation. Adult managed species would probably not be greatly affected by a hydrocarbon spill in open water areas, but small obligate benthic species, eggs, larvae, and some managed species and their prey could experience lethal and sublethal effects from contact with hydrocarbons. Overall, impacts to EFH from small spills would range from negligible for spill less than 50 bbl to minor for spills less than 1,000 bbl and from minor to moderate for large spills greater than 1,000 bbl.

An Unexpected Catastrophic Discharge Event. A CDE could cause long-term declines of managed species that rely on shallow coastal, intertidal, and freshwater areas. Managed species that suffer large losses of early life stages or long-term sublethal impacts could suffer population-level effects from catastrophic oil spills. Overall, a CDE could result in moderate to major impacts on EFH, largely depending on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH.

4.4.6.4.3 Alaska – Arctic. There are two FMPs designating EFH in the Beaufort/Chukchi Planning Areas: one for Alaska salmon and one for Arctic fishes (NPFMC and NMFS 1990; NPFMC 2009). Activities that degrade these aquatic habitats could adversely affect EFH for one or more species. For the purposes of this analysis, potential impacts on EFH resources in the Beaufort/Chukchi Planning Area and adjacent waters are generally addressed. EFH in the Beaufort and Chukchi Seas potentially affected by exploration, site development, and production activities are discussed in detail in individual sections including coastal and estuarine (Sections 4.4.6.13) and marine benthic habitats (Section 4.4.6.2.3) and the marine water column (Section 4.4.6.3.3). Impacts on Beaufort/Chukchi Planning Area fish and fisheries from the Program are discussed in Section 4.4.7.3.3 and Section 4.4.11.3.

As required by the Magnuson-Stevens Fishery Conservation and Management Act, the National Marine Fisheries Service, Alaska Region, has provided conservation recommendations that will avoid or minimize adverse impacts to EFH from oil and gas development activities. These recommendations are described in *Impacts to Essential Fish Habitat from Non-fishing Activities in Alaska* (NMFS 2011d) and can be found in Section 4.4.6.4.2.

Impacts of Routine Operations.

Exploration and Site Development. During the exploration and site development phase, impacts on EFH could occur as a result of drilling and drilling waste discharge, seismic surveys, the placement of subsea drilling units, production platforms, pipelines, and construction of artificial islands. Individual fishes, especially egg and larval life stages, in close proximity (1 to 5 m [3 to 16 ft]) to airgun arrays could suffer mortality or injury, and juvenile and adult fishes located farther away could exhibit temporary behavioral alteration including spawning/migratory behavior (Dalen and Knutsen 1986; Holliday et al. 1987; Turnpenny and Nedwell 1994). Additional sources of noise from activities such as drilling, platform and pipeline placement, and boat traffic could also temporarily disturb or displace individual fish. All the noise associated with these activities would be temporary and affect a small area of EFH in the Beaufort/Chukchi Planning Area.

The vast majority of marine EFH affected by the Program would be soft sediments on the continental shelf in less than 91 m (300 ft) of water. Under the proposed action, up to 13.5 ha (33 ac) of seafloor habitat could be covered by up to 9 artificial islands, and as much as 567 ha (1,401 ac) of seafloor habitat could be disturbed by pipeline placement. Pipelines located in water less than 50 m (165 ft) would be trenched to avoid damage from ice scour. In addition, up to 92 subsea production wells could be constructed. The construction of artificial islands and the placement of pipelines on the sediment surface would alter existing seafloor EFH and the associated communities. Sediment-disturbing activities would increase turbidity, which would lower the water quality of EFH in small areas for a limited amount of time, typically causing fish to leave the areas until water quality improves. The migration of managed salmon could also be temporarily disrupted by bottom disturbance, although salmon are relatively uncommon in the Beaufort and Chukchi Seas. Although adult managed species are less likely to be killed or injured during bottom disturbance, bottom-disturbing activities could injure, displace, or kill early life stages of managed species or bury the benthic prey of managed species. However, the sediments would eventually settle out. Pipeline trenching and island construction could damage marine plants associated with EFH by mechanically removing the plants or smothering them through sedimentation. Marine vegetation is concentrated in relatively few areas within the Beaufort Sea and Chukchi Sea Planning Areas (e.g., the Stefansson Sound Boulder Patch

Community), and impacts on such areas are typically minimized during construction activities by stipulations protecting sensitive biological habitats.

It is assumed that drilling muds and cuttings from the exploration and delineation wells would be discharged into the Beaufort and Chukchi Seas. The discharges of drilling fluids and cuttings could temporarily affect some EFH resources. While the toxicity of those cuttings is expected to be low and within permitted levels, the drilling wastes that are discharged would temporarily increase turbidity and sediment deposition, and a small number of managed species could be temporarily displaced. In the mixing area near the discharge site, eggs and larvae of managed Arctic fishes could be killed or injured. Settlement of discharged cuttings on the seafloor could smother some prey species and change substrate composition in the area where the cuttings settle. However, the discharge of all drilling muds and cuttings would be subject to NPDES permitting requirements that would greatly reduce the impacts on EFH and managed species.

Gravel island and ice road construction may affect freshwater fish and fish habitat. Gravel for island construction is mined from river bars and water for construction of ice roads is pumped from local rivers and lakes to desired areas to build a rigid surface. Removal of gravel could increase turbidity and reduce the water quality in affected rivers. Water withdrawal for ice road construction could potentially remove large numbers of fish from the water body and reduce dissolved oxygen concentrations in the remaining lake water (Cott et al. 2008). For ice roads traversing lakes, long-term impacts to fish populations could result from traffic-related noise disturbance. Truck noise is not expected to be great enough to result in injury to fish, even in the vicinity of the road noise (Stewart 2003). However, fish may temporarily avoid the area experiencing noise and vibrational disturbance (Stewart 2003). The potential for entrainment can be reduced by mitigative intake screens and by taking water from lakes with groundfast ice, which are less likely to contain significant fish populations. Impacts to water quality can be avoided by avoiding excessive water removal. For example, Cott et al. (2008) found that water withdrawals of 10% of under-ice water volume did not significantly reduce oxygen concentration, while a 20% reduction reduced both dissolved oxygen and the amount of suitable fish habitat. Impacts to fish will also be reduced by the ADFG, which requires reviews of gravel extraction and water withdrawal activities for potential impacts on salmon and other fish species and requires permits to be issued before activities can be initiated.

Artificial islands would increase the diversity of habitat available on an otherwise homogeneous ocean. Specifically, such construction would introduce an artificial hard substrate that opportunistic benthic species, especially those that prefer gravel substrate, could colonize. Fishes may be attracted to the newly formed habitat complex, and fish population numbers in the immediate vicinity of the platforms are likely to be higher than in surrounding waters away from the structures. The overall change in habitat could result in changes in local community assemblage and diversity. The number of platforms projected for the Beaufort Sea and Chukchi Sea Planning Areas under the proposed action (up to nine) would create a small amount of hard substrate habitat and would likely have little effect on overall fish populations.

Production. The primary production activities that could affect EFH include bottom disturbance from anchors and the discharge of produced water. Bottom disturbance represents chronic, long-term, but localized impacts on EFH. Pipelines not buried would be anchored in place which would minimize their movement and potential to disturb sediment EFH. It is assumed that all produced water would be disposed of by injection into permitted disposal wells. Therefore, the effects of produced water discharges on sediment and water-column EFH are expected to be minimal. Platform and island construction will introduce floating or benthic hard substrate that may attract managed species and their prey. Over time, this could change the spawning, breeding, and feeding patterns of some managed fish.

Chronic discharges of contaminants in ice roads would occur during every breakup from fluids entrained in the roads. Entrained contaminants from vehicle exhaust, grease, antifreeze, oil, and other vehicle-related fluids could potentially affect EFH. These discharges would exist over the life of the field.

Decommissioning. Bottom disturbance during platform removal would temporarily disturb EFH by increasing noise and turbidity for some length of the water column. During decommissioning and structure removal, only nonexplosive methods would be used to sever conductors and pilings. Nonexplosive removals (e.g., abrasive, mechanical, or diver cutters) are expected to have little impact on EFH resources and managed species (Section 4.4.7.3.2). These impacts would temporarily degrade EFH quality and potentially kill or injure managed species, but conditions would return to normal as suspended sediments dispersed and resettled with no long-term impacts on EFH. Removing structures would also remove the associated fouling communities that serve as prey for managed fish species, thereby forcing these species to relocate to other foraging areas. Gravel islands would be left in place where they would wash away and introduce fine sediments into the water column over an extended period of time.

Impacts of Expected Accidental Events and Spills. It is assumed that up to 3 large oil spills (≥1,000 bbl) up to 35 small spills (50 to 999 bbl) and up to 190 smaller spills (>1 and <50 bbl) could occur during the lease period under the proposed action (Table 4.4.2-1). Impacts to EFH and managed species would generally increase with the size of the spill. See individual sections for detailed discussions of the potential impacts of oil spills on fish, shellfish, and marine and coastal habitat. Most accidental hydrocarbon releases in the Beaufort and Chukchi Planning Areas would be small. Small releases would degrade bottom water quality, but the overall contaminant impacts on pelagic habitat resources will be short-term, given the localized nature of a small release and the natural dilution and breakdown of hydrocarbons. Large spills would degrade EFH over a wider area than small spills and potentially reduce the habitat value and ecosystem function in the areas affected. Impacts from spills would be greatest if a large spill occurred during a reproductive period or contacted a location important for spawning or growth such as intertidal and nearshore subtidal habitats. The oil would be transported from the area as well as broken down by natural processes. Wave and wind action, weathering, and biological degradation by microbes would dissipate oil in the surface water, and EFH would be reestablished after some period of time.

Toxic fractions of oil in the parts-per-billion range can cause sublethal impacts on developing fishes (MMS 2007b). Depending on the timing and severity of an oil spill, adult anadromous fish migrating from marine waters to fresh water to spawn and juveniles migrating seaward from freshwater could be harmed by high concentrations of hydrocarbons. Most adult managed species in the Beaufort and Chukchi Seas are highly mobile and would likely avoid oil spills by temporarily moving to other areas. However, small obligate benthic species and egg and larval life stages of managed species as well as planktonic organisms that serve as their prey may be unable to avoid hydrocarbon spills. In addition, oil reaching the intertidal zone can persist in the sediments and cause sublethal impacts on fish eggs and larvae for multiple years (Peterson et al. 2003).

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE in the Chukchi Sea Planning Area with an assumed volume of 1.4- 2.2 million bbl and a duration of 40–75 days, and a CDE in the Beaufort Sea Planning Area with an assumed volume of 1.7-3.9 million bbl and a duration of 60–300 days (Table 4.4.2-2). See individual sections for detailed discussions of the potential impacts of a CDE on fish, shellfish, and marine and coastal habitat. Deeper subtidal sediment EFH may be less affected because hydrocarbons would tend to float over the sediments. The potential for severe impacts from accidents would be greatest if large quantities of oil from catastrophic spills washed inshore into wetlands, intertidal zones, and shorelines where spilled oil could contaminate nearshore EFH and associated prey species. Spilled oil reaching wetland habitat could kill vegetation and associated invertebrates and small fish that are prey species for managed species. Oil spills occurring under ice or frozen in ice would be more difficult to clean and may persist for longer in the environment.

The period of time needed to reestablish appropriate EFH conditions following a CDE would depend upon the characteristics of the individual spill and would be related to many factors, including the habitat affected, the location of the spill, the nature of transporting currents, the magnitude of the spill, and the chemical characteristics of the spilled oil. Studies following the *Exxon Valdez* spill found that water column EFH recovered in less than 1 to 2 years (Boehm et al. 2007). Subtidal habitat and communities are considered to be very likely recovered by the *Exxon Valdez* Oil Spill Trustee Council (2010a), but as of 2010, intertidal sediments and communities are considered to still be recovering from the *Exxon Valdez* spill (*Exxon Valdez* Oil Spill Trustee Council 2010a). Impacts to kelp habitat from an oil spill could be long-term. Laminaria beds oiled by the *Exxon Valdez* spill recovered within 10 years (Dean and Jewett 2001).

Deeper subtidal sediment EFH may be less affected because hydrocarbons would tend to float over the sediments. Similar effects are expected to those described above, but managed species that suffer large losses of early life stages or that are currently in decline could suffer population-level effects from catastrophic oil spills. A single catastrophic spill could cause long-term declines of managed species that rely on shallow coastal, intertidal, and freshwater areas. Of the offshore managed species, the Arctic cod is particularly vulnerable to spills because they spawn in winter under ice when cleanup is most difficult. In addition, their larvae are pelagic and likely to come into contact with oil and gas, which tends to float on the surface. Arctic cod are also susceptible because they are dependent on algal production in open water and under sea ice, which could be affected by oil and gas exposure. Arctic cod are keystone species in the Arctic, and significant impact to this species could have broad ecosystem effects. Spilled oil could smother kelp and other marine plants, reducing habitat and substrate for potential prey of managed species. Oil spilled under ice is more difficult to locate and remove than surface spills.

Since weathering would be greatly reduced by ice cover, managed species with mobility could continue to be harmed or killed as they drift into the trapped oil. In addition, the sea ice that provides habitat for managed species such as juvenile Arctic cod could be uninhabitable.

Impact Conclusions.

Routine Operations. Most impacts on EFH from oil and gas exploration and production activities would likely result from bottom disturbance during the placement of pipelines and production platforms, and result in negligible to moderate impacts to EFH. The magnitude of impacts on sensitive marine and coastal EFH would be limited by specific lease stipulations and site-specific analyses conducted for particular lease sales. Recovery of EFH habitat and benthic food resources from oil and gas activities would range from short-term to long-term. Managed species, particularly egg and larval stages, could be killed, injured, or displaced from the immediate vicinity of oil and gas activities, but no population-level impacts on managed species are expected.

***Expected Accidental Events and Spills*.** The severity of effects of accidental hydrocarbon spills on EFH would depend on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH. While most accidents would be small and would have relatively small impacts on EFH, large spills that reach coastal EFH could have more persistent impacts and could require remediation. Most adult managed species could avoid hydrocarbon spills in open water areas, but small obligate benthic species, eggs, larvae, and some managed species and their prey could experience lethal and sublethal effects from contact with hydrocarbons. Overall, impacts to EFH from small spills would range from negligible for spill less than 50 bbl to minor for spills less than 1,000 bbl and from minor to moderate for large spills (≥1,000 bbl).

An Unexpected Catastrophic Discharge Event. A CDE could cause long-term declines of managed species that rely on shallow coastal, intertidal, and freshwater areas or species that are associated with sea ice. Spills occurring under ice could result in long-term degradation of EFH and managed species because of the cleanup difficulties. Managed species that suffer large losses of early life stages or long-term sublethal impacts could suffer population-level effects from a CDE. Overall, a CDE could result in moderate to major impacts on EFH, largely depending on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH.

4.4.7 Potential Impacts on Marine and Coastal Fauna

4.4.7.1 Mammals

This section addresses the potential impacts to both marine mammals and terrestrial mammals in context of each program area. It should be noted that both NMFS and USFWS have statutory and regulatory mandates under the ESA and MMPA for mammals. Under the MMPA (16 USC 1371; 50 CFR Subpart 1), the taking of marine mammals without a permit or exemption is prohibited. The term "take" under the MMPA means "to harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect." The MMPA has defined takes by "harassment" in two ways: (1) Level A harassment is "any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild," and (2) Level B harassment is "any act of pursuit, torment, or annoyance, which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild." In 30 CFR Part 250, Subpart B, BOEM requires operators of Federal oil and gas leases to meet the requirements of ESA and MMPA. The regulations outline the environmental, monitoring, and mitigation information that operators must submit with proposed plans for exploration, development, and production.

4.4.7.1.1 Gulf of Mexico.

Marine Mammals. There are 29 species of marine mammals, including six endangered whale species and the endangered West Indian manatee, that may occur in the northern GOM (Section 3.4.4.2.1), and which therefore could be affected by normal operations associated with the proposed action.

Impacts of Routine Operations. As part of the proposed action, 1,000 to 2,100 exploration and delineation wells and 1,300 to 2,600 development and production wells are projected to be drilled, while 200 to 450 new platforms and up to 2 FPSOs are projected to be used. Additional activities planned as part of the proposed action include 3,862 to 12,070 km (2,400 to 7,500 mi) of new pipeline (Table 4.4.1-1). Although a specific scenario for geophysical operations has not been prepared, exploratory and on-lease seismic surveys are expected to result from the Program. Table 4.4.7-1 illustrates how each of the impacting factors associated with OCS oil and gas development may affect marine mammals and their habitats, while Figure 4.4.7-1 presents a conceptual model of potential impacting factors for marine mammals from oil- and gas-related activities (including accidental oil spills).

Because of differences in the distribution and ecology of marine mammal species, routine operations under the proposed action would not equally affect marine mammal species. All of the mysticetes (baleen whales), except for the Bryde's whale, are considered extralimital or rare in the northern GOM (Würsig et al. 2000). Because of their rarity, it is unlikely that individuals of these species would be present where OCS-related activities would occur, and thus they would not be affected by routine operations of the proposed action. Although the Bryde's whale is the most frequently sighted mysticete whale, it is uncommon. While the Bryde's whale is present throughout the year, it occurs primarily in the Eastern Planning Area (Davis et al. 2000; Würsig et al. 2000; MMS 2004a). Most sightings are recorded in the region of the DeSoto Canyon and over the Florida Escarpment (Mullin et al. 1994a; Davis et al. 2000). Waring et al. (2010) estimate a population size of 15 individuals. Thus, it would not be expected to be affected to any great extent by routine operations under the proposed action.

TABLE 4.4.7-1 Impact Factor Data Matrix for Marine Mammals[a]

	O&G Impacting Factor								
		Noise							
Resource Receptor Category Potentially Affected	Collisions with Support Vessels	Seismic Exploration	Construction, Operation, and Decommissioning	Presence of Support Vessels	Onshore Construction and Operation	Offshore Infrastructure Construction, Operation, Decommissioning	Produced Water, Drill Cuttings and Mud	Solid Wastes and Debris	Accidental Oil Spills
Individuals (adults and juveniles)	Injury from ship strikes (A)[b]	Injury; disruption of normal behavior (A)	Disruption of normal behavior (B)[b]	Disruption of normal behavior (B)	Physical disturbance or reduced habitat quality associated with noise and/or human presence (A)	Physical disturbance or reduced habitat quality associated with noise and/or human presence (A)	Toxicity (A)	Ingestion and/or entanglement (A)	Fouling, toxicity (A)
Onshore Habitats (e.g., haul-out sites and rookeries)	–	–	–	–	Physical disturbance or loss; reduced habitat quality (A)	–	–	–	Physical habitat loss; reduced quality (A)
Offshore Habitats (e.g., calving grounds, foraging areas, or wintering grounds)	–	–	–	–	–	Temporary habitat disturbance during construction; possible long-term increase in habitat (B)	Reduced habitat quality (A)	–	Physical habitat loss; reduced quality (A)
Migration	Displacement or impediment (B)	Displacement or impediment (B)	Displacement or impediment (B)	Displacement or impediment (B)	Displacement or impediment for terrestrial movements (e.g., polar bears) (B)	Displacement or impediment (B)	–	–	Displacement or impediment (B)

[a] A dash indicates that no impact is anticipated.

[b] A = Level A Harassment (potential to injure a marine mammal or marine mammal stock in the wild). B = Level B Harassment (potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but that does not have the potential to injure a marine mammal or marine mammal stock in the wild).

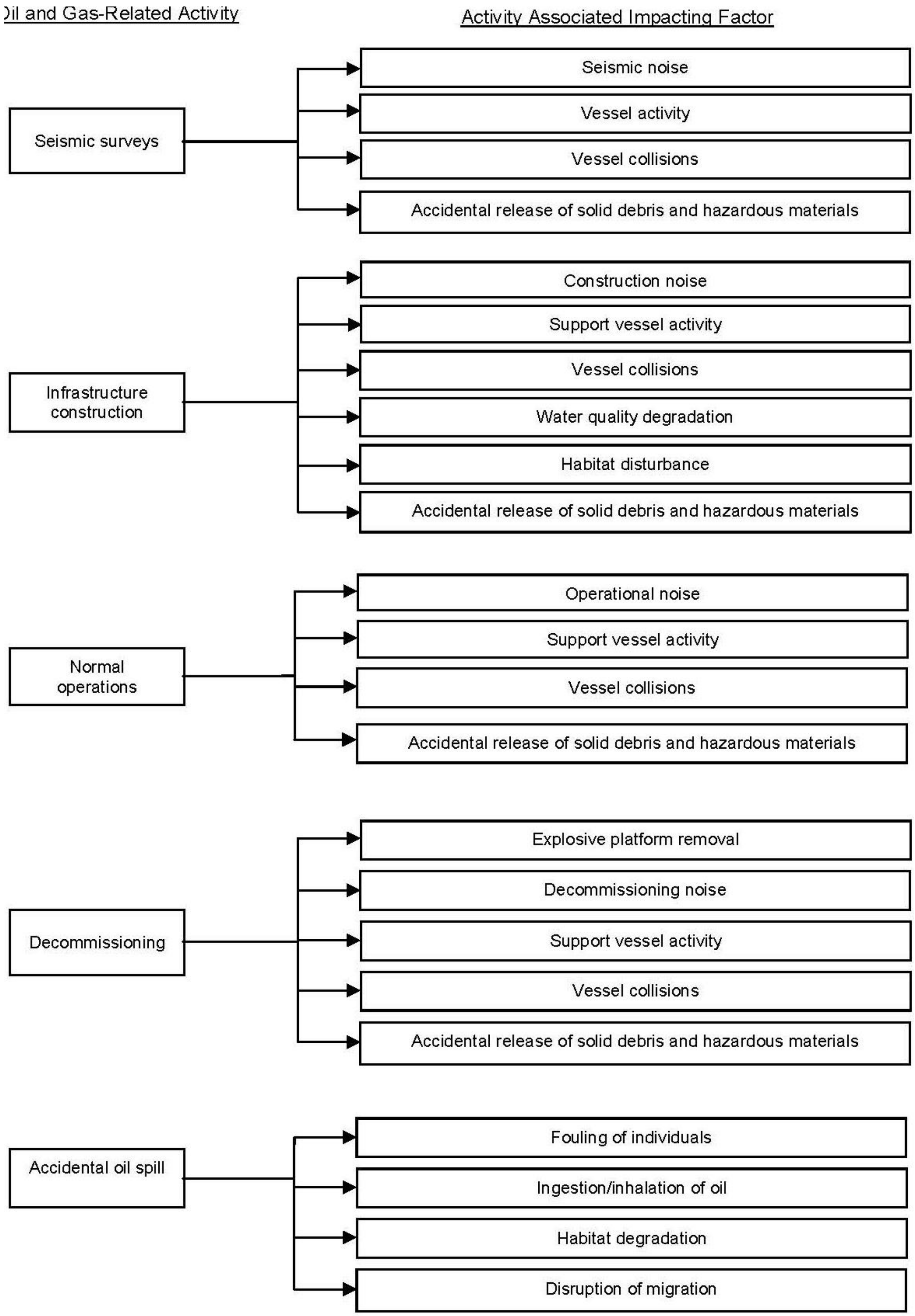

FIGURE 4.4.7-1 Conceptual Model for Anticipated Impacting Factors for Marine Mammals

In contrast to the mysticetes, many of the odontocetes (toothed whales) are considered relatively common in the GOM OCS (Davis et al. 2000; MMS 2004a). Thus, there is a greater potential that some individuals of these species to occur in areas where OCS-related activities occur and to be affected during routine operations. The only odontocete listed as endangered is the sperm whale, which is the most common large whale in the GOM. Sperm whales occur year-round in all deepwater areas of the U.S. GOM, with a well-documented aggregation consistently found in the shelf-edge waters around the 305-m (1,000-ft) depth contour south of the Mississippi River Delta (Davis et al. 2000; MMS 2004a). Jochens et al. (2008) reported that females and immature sperm whales have a high site fidelity to the region south of the Mississippi Delta and Mississippi Canyon and in the western GOM, while bachelors and lone males were mainly observed in the DeSoto Canyon and along the Florida slope. Thus, this species may encounter OCS-related activities occurring within the northern GOM, especially in deepwater areas of the Central Planning Area.

Although manatees appear to prefer nearshore habitats, there are rare observations around structures at offshore sites. Negligible impacts on the West Indian manatee are anticipated because the 2012-2017 proposed action does not include routine operations in most of the Eastern Planning Area. The potential for impacts on manatees would occur in nearshore habitats where interactions with OCS-related activities (i.e., vessel traffic) exist. Service vessel impacts would mainly occur in the Central and Western Planning Areas where manatees occasionally occur during warmer months (Fertl et al. 2005).

The following analysis presents an overview of impacts on marine mammals from the following routine operations: (1) seismic surveys, (2) construction of offshore facilities and pipelines, (3) operations of offshore facilities and drilling rigs, (4) discharges and waste generation, (5) service vessel and helicopter traffic, and (6) decommissioning.

<u>Seismic Surveys.</u> Sections 4.4.1.1 and 4.4.5.1.1 provide descriptions of seismic survey technologies, energy outputs, operations, and general acoustic impacts. The type of O&G activities presently occurring in the GOM include:

- Seismic surveys (includes high-resolution site surveys and various types of seismic exploration and development surveys, including narrow azimuth, multi azimuth and wide azimuth);

- Side-scan sonar surveys;

- Electromagnetic surveys;

- Geological and geochemical sampling; and

- Remote sensing (including gravity, gravity gradiometry, and magnetic surveys).

Marine mammals produce and use sound to communicate as well as to orient, locate and capture prey, and to detect and avoid predators (Hofman 2004; Southall et al. 2007). A panel of experts in acoustic research from behavioral, physiological, and physical disciplines generated a report, *Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations* (Southall et al. 2007), which summarized existing acoustic and marine mammal data and made recommendations for regulatory criteria and research. Noise generated by seismic surveys may have physical and/or behavioral effects on marine mammals, such as (1) permanent or temporary hearing loss, discomfort, and injury; (2) masking of important sound signals; and (3) behavioral responses such as fright, avoidance, and changes in physical or vocal behavior (Richardson et al. 1995; Davis et al. 1998; Gordon et al. 2003/2004; Nowacek et al. 2004, 2007). Parente et al. (2007) noted a decrease in the diversity of cetacean species, possibly associated with an increase in the number of seismic surveys off Brazil. The authors hypothesized that lowered diversity resulted from avoidance or changes in migration routes in some cetacean species exposed to seismic pulses. Seismic surveys may also indirectly impact marine mammals by altering prey availability (Gordon et al. 2003/2004).

Southall et al. (2007) synthesized the understanding of underwater and aerial hearing in some marine mammal groups and recommended some acoustic criteria. A precautionary approach was used to derive frequency-specific marine mammal weighting functions; the marine mammal hearing groups are broken down into five categories: (1) low-frequency cetaceans, which are the mysticetes, have an estimated lower and upper frequency range of 7 Hz to 22 kHz; (2) mid-frequency species are estimated to have lower and upper frequency limits of hearing at approximately 150 Hz and 160 kHz, respectively; (3) high-frequency cetaceans have an estimated functional hearing between approximately 200 Hz and 180 kHz; (4) pinnipeds in air have an estimated functional hearing between 75 Hz and 30 kHz; and (5) pinnipeds in water have an estimated functional hearing between 75 Hz and 75 kHz.

Although airgun arrays are a source of primarily low-frequency sound energy, they are a broadband source, so higher frequencies are also transmitted. Some pulse components of airgun arrays have the bulk of their energy at frequencies from 300 Hz to 3 kHz, frequency ranges beyond those of interest to seismic exploration but of concern for potential impact on odontocetes such as the sperm whale, beaked whales, and dolphins (Madsen et al. 2006). Although airguns concentrate energy at low frequencies, noise was detectable to at least 100 kHz (Bain and Williams 2006). Goold and Coates (2006) noted that 60 cubic inch and 250 cubic inch airguns both had a high frequency output up to 150 kHz at 10 m (33 ft) from the source. Therefore, airguns cover the entire frequency range known to be used by marine mammals (Goold and Coates 2006).

Almost all impacts of seismic surveys have been inferred or assumed by implication rather than observed. There have been no documented instances of deaths, physical injuries, or auditory (physiological) effects on marine mammals from seismic surveys. Behavioral responses have been observed but the biological importance of such behavioral responses (to the individual animals and populations involved) has not been determined.

The types of potential effects can be broken down into non-auditory injury, auditory effects, behavioral effects, and masking. Nowacek et al. (2007), Richardson et al. (1995), and Southall et al. (2007) have reviewed the effects of anthropogenic sound on marine mammals and are incorporated by reference.

For the purpose of analysis, it is assumed that operators will implement survey and monitoring mitigation (e.g., ramp-up, marine mammal observers, speed restrictions, exclusion zones) currently required in the GOM to minimize or avoid impacts of seismic on marine mammals with an emphasis on prevention of injury (auditory and non-auditory). Assuming the implementation of these mitigations, the potential for injury is minimized. There remains a greater potential for behavioral effects; therefore, the following discussion focuses on the potential behavioral changes resulting from exposure to seismic operations. More detailed discussions of impacts to marine mammals from seismic surveys in the GOM can be found in MMS (2004a).

Non-Auditory Injury. Non-auditory injury could include direct acoustic impact on tissue, indirect acoustic impact on tissue surrounding a structure, acoustically mediated bubble growth within tissues from supersaturated dissolved nitrogen gas, or resonance. However, resonances are not anticipated given that the resonance frequencies of marine mammal lungs are generally below that of the G&G seismic survey source signal (Nowacek et al. 2007; Zimmer and Tyack 2007).

Auditory Effects (PTS and TTS). The hearing of marine mammals varies based on individuals, thresholds of the species, location in relation to the sound source, frequency discrimination, and the motivation of an individual to change behaviors due to the sound (Richardson et al. 1995). Permanent loss of hearing in a marine mammal (i.e., permanent threshold shift [PTS]) is defined as the deterioration of hearing due to prolonged or repeated exposure to sounds that accelerate the normal process of gradual hearing loss (Kryter 1985), or the permanent hearing damage due to brief exposure to extremely high sound levels (Richardson et al. 1995). PTS results in a permanent elevation in hearing threshold — an unrecoverable reduction in hearing sensitivity (Southall et al. 2007); this is considered Level A harassment under the MMPA. NMFS' policy has been to use the 180 dB rms isopleths, where onset Level A harassment from acoustic sources potentially begins for cetaceans. Noise may cause a temporary threshold shift (TTS), a temporary and reversible loss of hearing that may last for minutes to hours. Animals suffering from TTS over longer time periods, such as hours or days, may be considered to have a change in a biologically significant behavior, because they could be prevented from detecting sounds that are biologically relevant, including communication sounds, sounds of prey, or sounds of predators. TTS is considered Level B harassment under the MMPA. NMFS uses the 160 dB rms isopleth to indicate where Level B harassment begins for acoustic impulse sounds, such as those created by airguns used for seismic surveys.

Behavioral Effects. A number of studies have documented behavioral effects in response to seismic surveys, primarily for marine mammals (Richardson et al. 1995, Southall et al. 2007). Species with similar hearing capabilities can exhibit markedly different behavioral responses to airgun noises (Bain and Williams 2006). The Bryde's whale is the only mysticete species occurring regularly in the GOM. As discussed in Southall et al. (2007), the expected frequencies of best hearing sensitivity in mysticetes and maximal airgun output at source may overlap. Given that no direct audiograms of mysticetes have been obtained, it is impossible to define what level of sound above hearing threshold may cause behavioral effects, which would be expected to be variable, complicated, and dependent upon more than just the received sound level. For this reason, observations at sea have concentrated on relating received sound levels to observed behavioral changes (Malme et al. 1983, 1986; Richardson et al. 1986; Ljungblad et al. 1988; McDonald et al. 1995; Richardson 1998; McCauley et al. 2000a, b).

Auditory thresholds of adult sperm whales have not been obtained. Ridgeway and Carder (2001) studied the vocalizations of a neonate sperm whale which led them to believe that they are sensitive to a wide range of frequencies. This was also hypothesized by Bowles et al. (1994). Miller et al. (2009) did not observe the course of travel or foraging dives of sperm whales to be affected by seismic surveys at distances of 1 to 13 km (0.6 to 8 mi), although the benefits of staying in an area could possibly outweigh the costs of moving away from the noise. Sperm whales are a highly vocal species under natural conditions (i.e., they click almost continuously during dives). Jochens et al. (2008) synthesized the findings of the Sperm Whale Seismic Study (SWSS) in the GOM. They stated that it does not appear that sperm whales in the SWSS study area showed any horizontal avoidance to controlled exposure of seismic airgun sounds. The data analysis suggested that, for at least some individuals, it is more likely that some decrease in foraging effort may occur during exposure to full-array airgun firing as compared to the post-exposure condition (Jochens et al. 2008). Sperm whales are most likely acoustically aware of their environment and can exhibit behavioral reactions in a number of ways, including interruption of vocal activity and foraging. However, there are insufficient data to assign thresholds for acoustic disturbance to sperm whales. Sperm whales are also deep divers, spending relatively little time at the surface while feeding. Therefore, they may be less likely to receive any surface shielding afforded by refractive effects caused by near surface hydrographic conditions, which can sometimes occur. As airgun arrays are generally configured to produce a maximum, low frequency energy lobe directly downwards toward the seabed, sperm whales may enter a region of increased ensonification.

Behavioral changes observed in sperm whales may result from behavioral changes in their prey to seismic surveys (Miller et al. 2009). In addition, strandings of giant squid (*Architeuthis dux*) along the west coast of Asturias, Spain, were linked to acoustic trauma caused by high-intensity, low-frequency sound waves from seismic surveys (Andre et al. 2011). There is no record of acoustic trauma to squid from seismic surveys in the GOM.

Dwarf and pygmy sperm whales are also deep-diving and use echolocation clicks in the sonic and low ultrasonic frequency range (Willis and Baird 1998). Few audiograms have been obtained for pygmy sperm whales, dwarf sperm whales, or beaked whales (Cook et al. 2006; Finneran et al. 2009; Ridgway and Carder 2001), so there still are insufficient data to determine avoidance thresholds. Like sperm whales, they may be sensitive to a wide range of sound frequencies, including those produced by airgun arrays. Similarly, beaked whales are also deep divers, use echolocation clicks to find their prey, and have been shown to be susceptible to acoustic disturbance (Frantzis 1998; Balcomb and Claridge 2001). Since they have similar deep-diving habits and relatively widespread distributions in the GOM, this may warrant concern for dwarf and pygmy sperm whales and beaked whales.

Delphinids include dolphins, killer whales, and pilot whales. Several studies have been conducted documenting the effects of seismic operations on delphinid species. Finneran et al. (2000a) discuss a behavioral response study measuring masked underwater hearing thresholds in bottlenose dolphin and beluga whale, before and after exposure to seismic pulses from a watergun. Ridgway et al. (1997) showed that captive delphinids produced behavioral reactions at levels at least 10 dB below those that induced TTS. Soto et al. (2006) and Van Parijs and Corkeron (2001) showed vessel presence is sufficient to change behavior in some species and situations.

Dolphin species are generally mid- to high-frequency hearing specialists (Southall et al. 2007). While airguns are primarily low frequency (<200 Hz), they are considered broadband and therefore there is energy at higher frequencies. These energies encompass the entire audio frequency range of 20 Hz to 20 kHz (Goold and Fish 1998), and extend well into the ultrasonic range up to 50 kHz (Sodal 1999). This high-frequency energy must be taken into account when considering seismic interactions with Delphinids. The high-frequency components of airgun emissions are of sufficient level to exceed the dolphin auditory threshold curve at these low frequencies, even after spreading loss (Goold and Fish 1998).

Marine mammal vocalizations may be altered by airguns (Gordon et al. 2003/2004). Stone and Tasker (2006) reported that cetaceans can be disturbed by seismic surveys. However, some marine mammals are known to continue calling in the presence of seismic pulses. Their calls can be heard between the seismic pulses (e.g., Richardson et al. 1986; McDonald et al. 1995; Greene et al. 1999; Nieukirk et al. 2004). Although Delphinids specialize in hearing ranges generally outside of the majority of seismic survey impulse sounds, there is still the potential for sounds from these surveys to fall within the acoustic sensitivity of toothed whales and for behavioral responses to seismic noise to occur.

Masking. Auditory masking occurs when a sound signal that is of importance to a marine mammal (e.g., communication calls, echolocation, environmental sound cues) is rendered undetectable due to the high noise-to-signal ratio in a frequency band relevant to a marine mammal's hearing range. In other words, noise can cause the masking of sounds that marine mammals need to hear to in order to function effectively (Erbe et al. 1999). If sounds used by the marine mammals are masked to the point where they cannot provide the individual with needed information, critical natural behaviors could be disrupted and harm could result (Erbe and Farmer 1998; Di Iorio and Clark 2010).

In the case of seismic surveys, where potential masking noise takes a pulsed form with a low duty cycle (~10%, or 1 s of active sound for every 10 s of ambient noise) (MMS 2004a) to very low duty cycle (<1.3 to 2%, or <200 ms of active sound for every 10 s to 15 s of ambient noise) (Pulfrich 2011), the effect of masking is likely to be low relative to continuous sounds such as ship noise. Some marine mammals are known to continue calling in the presence of seismic pulses. Their calls can be heard between the seismic pulses (e.g., Richardson et al. 1986; McDonald et al. 1995; Greene et al. 1999; Nieukirk et al. 2004). Bowles et al. (1994) reported that sperm whales ceased calling when exposed to pulses from a very distant seismic ship, while other studies reported that sperm whales continued calling in the presence of seismic pulses (Madsen et al. 2002; Tyack et al. 2003; Smultea et al. 2004; Holst et al. 2006; Jochens et al. 2008).

Some marine mammals are known to increase the source levels of their calls in the presence of elevated sound levels, or to shift their peak frequencies in response to strong sound signals (Dahlheim 1987; review in Richardson et al. 1995; Lesage et al. 1999; Terhune 1999; Parks et al. 2007). However, these studies tested other anthropogenic sounds, not seismic pulses, and it is not known if airguns would elicit this same response. If so, these adaptations would all reduce the importance of masking.

Construction of Offshore Facilities and Pipelines. Figure 4.4.7-2 presents a conceptual model for potential effects of infrastructure construction on marine mammals. Construction and trenching activities may affect habitat use for the short or long-term. Marine mammals are mobile and able to avoid areas where construction or trenching is occurring so they are less likely to be injured or killed but their behavior may be altered. Noise and human activity associated with the construction of offshore facilities and pipelines (e.g., pile driving, vessel presence) could disturb marine mammals that may be present in the vicinity of the construction activity. Construction activities could disturb normal behaviors (e.g., feeding, social interactions), mask calls from conspecifics, disrupt echolocation capabilities, temporarily affect localized air/water quality and mask sounds generated by predators. Depending on the size of the project, at any single location, offshore construction and trenching activities would be of relatively short duration since the majority of construction activities would occur on land. The length of time necessary for offshore construction depends on what is being constructed, the water depth, procurement activities, the climatic conditions to install the platform could be considered. It also depends on if the construction project is a fixed platform, semi-submersible platform, or jack-up drilling platform and each one could take approximately 1 to 2 months to set up, depending on the contractor. In addition, running a pipeline likely would not take more than 2–3 weeks.

Animals may leave the vicinity of a constructions area. Some known locations for the endangered sperm whale includes, but is not limited to, the continental slope waters off the Mississippi River Delta in the Central Planning Area (Jochens et al. 2008; Davis et al. 2000; MMS 2004a). Portions of the GOM that would be disturbed by the construction of new wells and pipelines would be largely limited to the immediate footprint of the new structure and its surroundings. Animals would be expected to locate to other suitable habitat nearby. Some long-term displacement may occur, but would be largely limited to the local environment surrounding individual wells or areas with well aggregations, and thus would not be expected to affect overall habitat availability or cetacean access.

Currently in the northern GOM, the West Indian manatee is the only marine mammal that has a federally designated critical habitat, and this habitat is limited to specific coastal and inland marine and freshwater areas in peninsular Florida (west, southeast, and northeast Florida). As pipeline landfalls and land-based facilities associated with the proposed action would not be located in Florida, no impacts to West Indian manatee critical habitat would occur.

Under the proposed action, only a few individuals or small groups of marine mammals would be temporarily disturbed behaviorally by routine construction of offshore facilities, and disturbance of these individuals, given their localized nature, would not be expected to result in

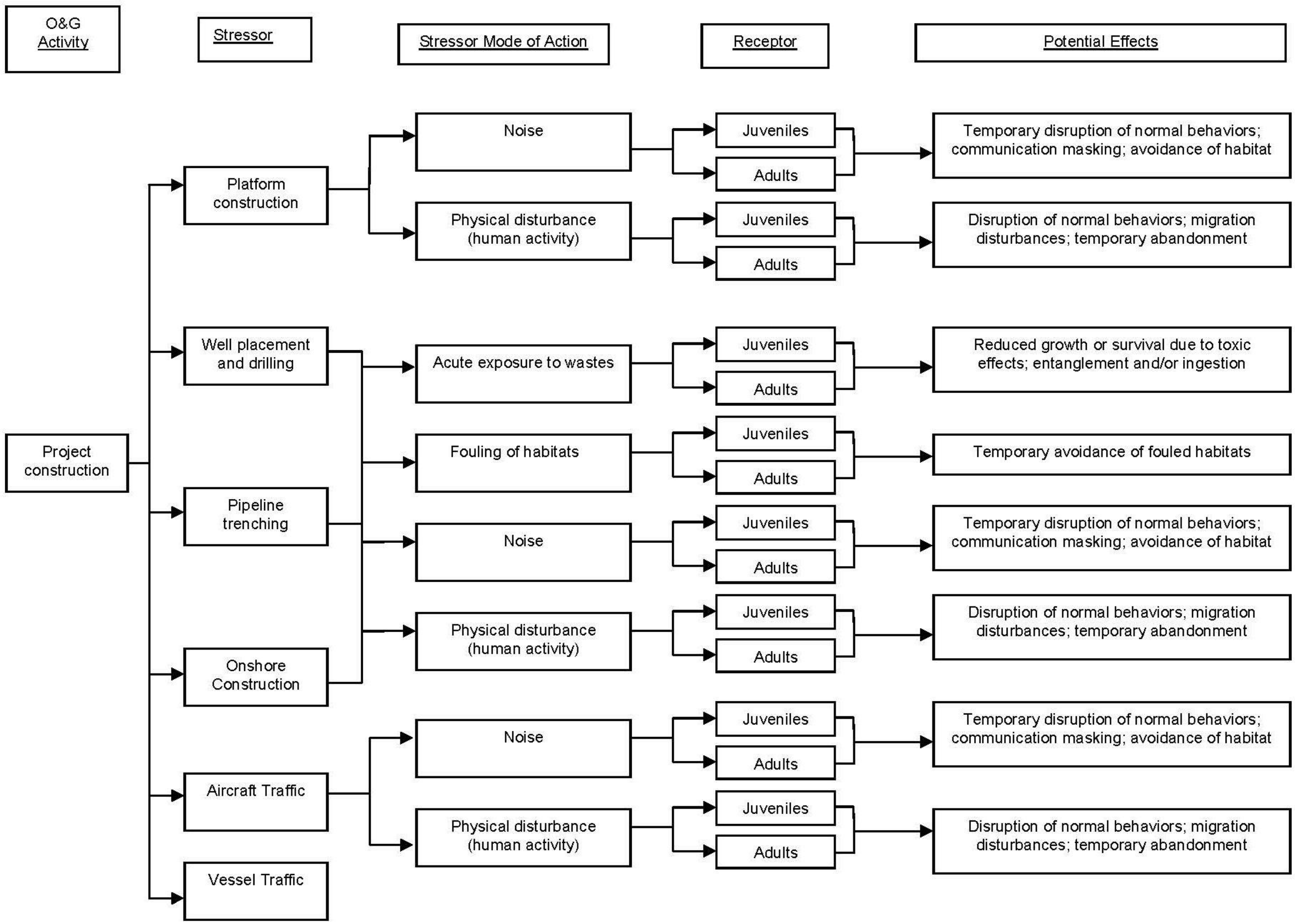

FIGURE 4.4.7-2 Conceptual Model for Potential Effects of Infrastructure Construction on Marine Mammals

population-level effects. Any impacts on marine mammals incurred from structure placement or trenching would be short term and localized to the construction area and immediate surroundings, and therefore unlikely to cause more than minor impacts to marine mammals. Onshore construction and operation activities are unlikely to impact cetacean and sirenian populations. Overall, the impacts associated with construction of offshore facilities and pipelines are unlikely to have significant adverse effects on the size and recovery of any marine mammals species or population in the GOM. It is assumed that BOEM will continue to implement GOM guidelines currently in place to reduce impacts to marine mammals such as vessel strike avoidance measures and marine debris awareness.

Operations of Offshore Facilities and Drilling Rigs. Noise from drilling could be intermittent, sudden, and at times could be high intensity as operations take place. Sound from a fixed, ongoing source like an operating drillship is continuous. However, the distinction between transient and continuous sounds is not absolute on a drillship, as generators and pumps operate essentially continuously; however, there are occasional transient bangs and clangs from various impacts during operations (Richardson et al. 1995). Estimated frequencies from drilling by semisubmersible vessels are broadband from 80 to 4,000 Hz, with an estimated source level of 154 dB re: 1 µPa at 1 m. Tones of 60 Hz had source levels of 149 dB, 181 Hz was 137 dB, and 301 Hz was 136 dB (Greene 1987). The potential effects that water-transmitted noise have on marine mammals include disturbance (subtle changes in behavior, interruption of previous activities, or short- or long-term displacement), masking of sounds (calls from conspecifics, reverberations from own calls, and other natural sounds such as surf or predators), physiological stress, and hearing impairment. Individual marine mammals exposed to recurring disturbance could be negatively affected. Malme et al. (1986) observed the behavior of feeding gray whales in the Bering Sea during four experimental playbacks of drilling sounds (50–315 Hz; 21-minute overall duration and 10% duty cycle; source levels of 156–162 dB re: 1 µPa-m). In two cases for received levels 100–110 dB re: 1 µPa, there was no observed behavioral reaction. Avoidance behavior was observed in two cases where received levels were 110–120 dB re: 1 µPa. These source levels are at or below NMFS's current 120-dB Level B harassment threshold for non-pulse noise under the MMPA.

The source levels from drilling are relatively low (154 dB and below, as cited by Greene [1986] in Richardson et al. [1995]), below the Level B (behavioral) harassment threshold of 160 dB (set by NMFS). According to Southall et al. (2007), for behavioral responses to nonpulses (such as drill noise), data indicate considerable variability in received levels associated with behavioral responses. Contextual variables (such as novelty of the sound to the marine mammal and operation features of the sound source) appear to have been at least as important as exposure level in predicting response type and magnitude. While there is some data from the Arctic on baleen whales, there is little data on the behavioral responses of marine mammals in the GOM from the sound of drilling. Southall et al. (2007) summarized the existing research, stating that the probability of avoidance and other behavioral effects increases when received levels increase from 120 to 160 dB. Marine mammals may exhibit some avoidance behaviors, but their behavioral or physiological responses to noise associated with the proposed action, however, are unlikely to have population-level impacts to marine mammals in the northern GOM. NMFS' policy has been to use the 180 dB rms isopleths, where onset Level A harassment from acoustic sources potentially begins for cetaceans. The Level B harassment onset level is at the 160 dB rms isopleth for impulsive noise and 120 dB rms for non-pulse noise.

Discharges and Waste Generation. Table 4.4.1-1 presents information on drilling fluids, drill cuttings, and produced waters discharged offshore as a result of the proposed action. Produced water, drilling muds, and drill cuttings are discharged into offshore marine waters in compliance with applicable regulations and permits. Compliance with regulations and permits will limit the exposure of marine mammals to waste discharges. The discharge or disposal of solid debris into offshore waters from OCS structures and vessels is prohibited by BOEM (30 CFR 250.40) and the USCG (International Convention for the Prevention of Pollution from Ships [MARPOL], Annex V, P.L. 100-220 [101 Statute 1458]).

Most operational discharges are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (NRC 1983; API 1989; Kennicutt et al. 1996). Any potential impacts from drilling fluids would be indirect, either as a result of impacts to prey species or possibly through ingestion via the food chain (Neff et al. 1989). However, marine mammals are generally not considered good bioaccumulators of petroleum compounds from eating contaminated prey due to rapid metabolism and excretion rates (Geraci and St. Aubin 1988). As such, impacts from discharges related to the proposed action would not be expected to result in long-term impacts to marine mammals because these compounds would not assimilated.

Many types of plastic materials end up as solid waste during drilling and production operations. Some of this material is accidentally lost overboard where cetaceans could consume it or become entangled in it. The incidental ingestion of marine debris and entanglement could adversely affect marine mammals. Industry has made good progress in debris management on vessels and offshore structures in the last several years. It is assumed that BOEM will continue to require implementation of current trash and debris elimination guidelines that appreciably reduce the likelihood of marine mammals encountering marine debris from the proposed action.

Service Vessel and Helicopter Traffic. There may be 300 to 600 vessel and 2,000 to 5,500 helicopter trips per week under the proposed action (Table 4.4.1-1). Figure 4.4.7-3 presents a conceptual model for the potential effect of vessel traffic on marine mammals. Vessel traffic could occur during seismic exploration, drilling and platform construction, platform operation, and platform decommissioning.

Ship strikes are a concern for marine mammals. There have been documented reports of cetaceans being struck by ships in the oceans throughout the world (Laist et al. 2001; Jensen and Silber 2004; Glass et al. 2008), although none to date in the GOM as a result of offshore oil/gas operations. Analyses by Vanderlaan and Taggart (2007) provides evidence that as vessel speeds fall below 15 knots (27.75 km/hr or 17.25 mph), there is a substantial decrease in the probability of a vessel strike to prove lethal to a large whale. Collisions with vessels greater than 80 m (260 ft) in length are usually either lethal or result in severe injuries (Laist et al. 2001). In addition, a majority of ship strikes seemed to occur over or near the continental shelf. Collisions with vessels can cause major wounds on marine mammals and/or be fatal. Debilitating injuries may have negative effects on a population through impairment of reproductive output (MMS 2003e). Cetaceans are more likely to be struck by vessels if they are young or sick, slow

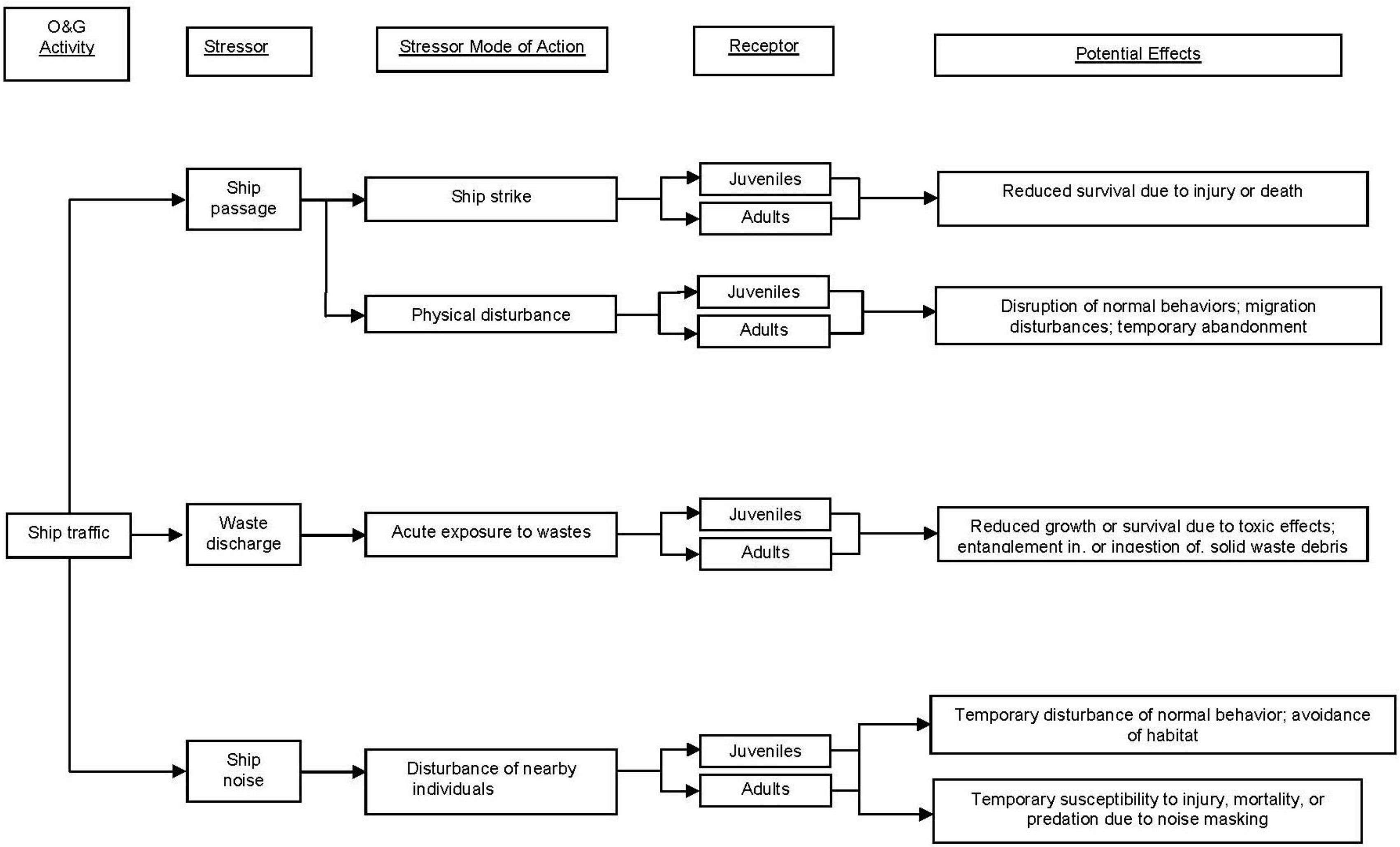

FIGURE 4.4.7-3 Conceptual Model for Potential Effects of Vessel Traffic on Marine Mammals

swimmers, distracted by feeding or mating activities, habituated to vessels, or congregated in an area for feeding or breeding (Dolman et al. 2006). Vessel strikes in inland waterways are a major cause of death in the manatee population. Because this species is rare in these planning areas, encounters with OCS-related vessels in these areas would be unlikely.

Deep-diving whales, such as the sperm whale, may be more vulnerable to vessel strikes given the longer surface period required to recover from extended deep dives. NMFS has determined that vessel strikes are a "discountable" concern for sperm whales when vessel avoidance measures are implemented (NMFS 2007b); it is assumed for the purpose of this analysis that BOEM will continue to requirement operator implementation of such avoidance criteria and speed limitations.

It is possible that noise produced from vessels and, to a lesser extent helicopters, can cause disturbance, masking of sounds, and physiological stress. The dominant source of noise from vessels is from the propeller operation, and the intensity of this noise is largely related to ship size and speed. Vessel noise from activities resulting from the proposed action will produce levels of noise, generally in the 150- to 170-dB re 1 µPa-m at frequencies below 1,000 Hz. Most ship noise occurs at low frequencies; however, modern cargo ships can produce frequencies as high as 30 kHz (Arveson and Vendittis 2000; Soto et al. 2006), which can mask the vocalization and echolocation of many toothed-whale species. Soto et al. (2006) believe that Cuvier's beaked whale may react to shipping noise by changing dive and foraging behaviors.

The noise and the shadow from helicopter overflights, take-offs, and landings can cause a startle response and can interrupt whales and dolphins while resting, feeding, breeding, or migrating (Richardson et al. 1995). The Federal Aviation Administration's Advisory Circular 91-36D (September 17, 2004) encourages pilots to maintain higher than minimum altitudes over noise-sensitive areas. Guidelines and regulations put in place by NOAA Fisheries under the authority of the Marine Mammal Protection Act include provisions specifying that helicopter pilots maintain an altitude of 305 m (1,000 ft) within 91 m (300 ft) of marine mammals. Helicopter occurrences would be temporary and pass within seconds. Marine mammals are not expected to be adversely affected by routine helicopter traffic operating at prescribed altitudes.

Decommissioning. Under the proposed action, 150 to 275 platforms may be removed with explosives from the northern GOM. Figure 4.4.7-4 presents a conceptual model for potential impacts of decommissioning on marine mammals.

BOEM published a programmatic EA on decommissioning operations (MMS 2005d) that, in part, addresses the potential impacts of explosive- and nonexplosive-severance activities on OCS resources, particularly upon marine mammals and sea turtles. Pursuant to 30 CFR 250 Subpart Q, operators must obtain a permit from BOEM before beginning any platform removal or well-severance activities. The NMFS has issued regulations (50 CFR Part 216) under the MMPA for "Taking Marine Mammals Incidental to the Explosive Removal of Offshore Structures in the Gulf of Mexico," and operators are required to obtain a Letter of Authorization from NMFS in accordance with these regulatory conditions. This analysis assumes the continued implementation of current BOEM guidelines on decommissioning which specify

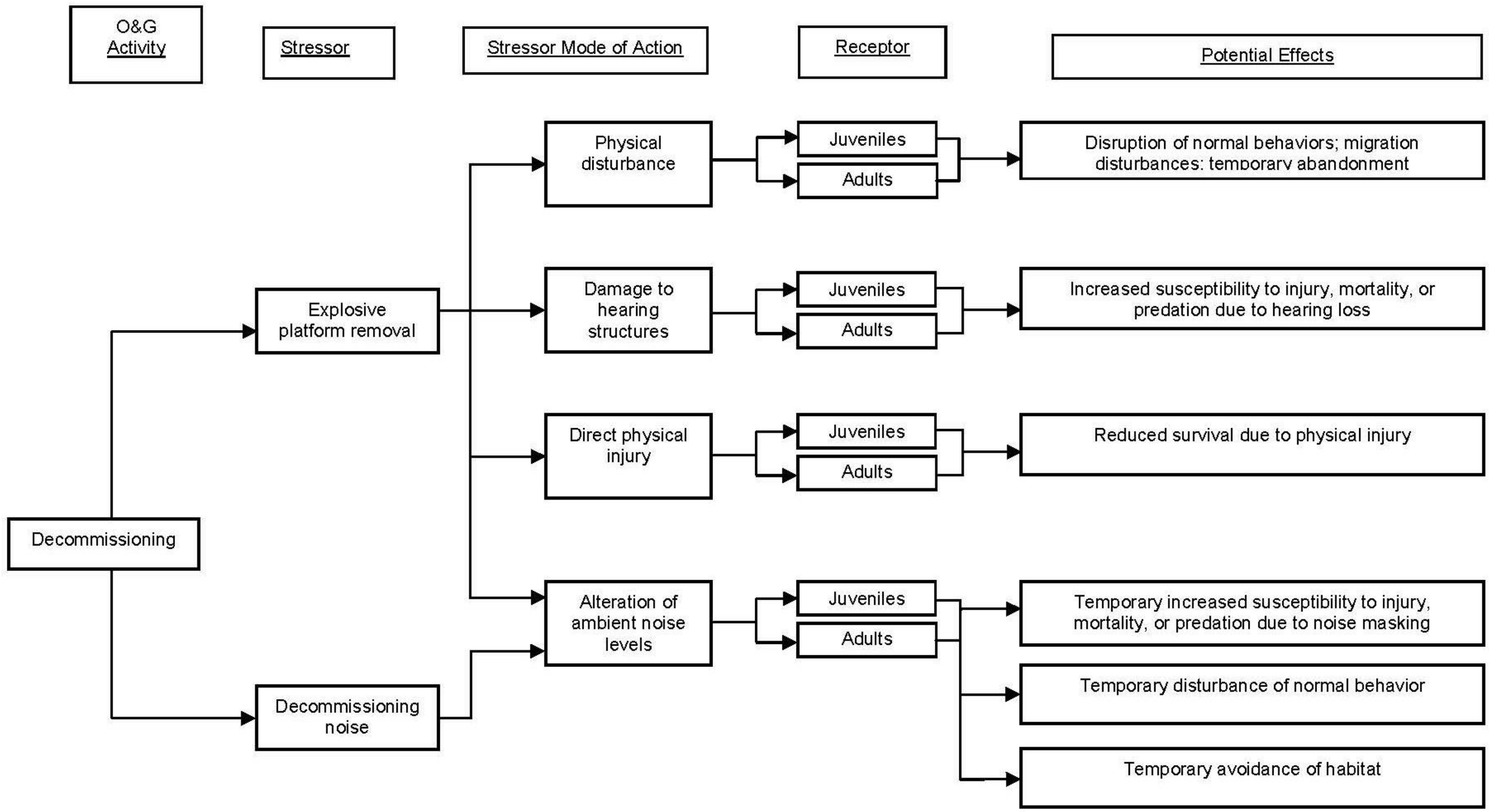

FIGURE 4.4.7-4 Conceptual Model for Potential Effects of Decommissioning on Marine Mammals

limits on the type and size of explosives that can be used and the times when detonations can occur; require explosives to be placed at a minimum depth of 15 m (49 ft) below the sediment surface; and require a monitoring plan that uses qualified observers to monitor the detonation area for protected species, including all marine mammals, prior to and after each detonation. The detection of a marine mammal (or other applicable biota) within the blast zone would, without exception, would delay explosive detonation. Thus, explosive platform removals conducted under the proposed action and complying with BOEM guidelines would not be expected to adversely affect marine mammals in the GOM.

Impacts of Expected Accidental Spills. Potential effects on marine mammal species could occur from accidental activities associated with the proposed action and may be direct or indirect. Accidental spills, including oil spills, chemical spills, vessel collisions, and loss of well control, could occur in the GOM under the proposed action (Section 4.4.2.1). Tables 4.4.2-1 presents the expected oil spill assumptions for the purpose of analyzing the proposed action, while Figure 4.4.7-5 presents a conceptual model for potential effects of oil spills on marine mammals. Between 200 and 400 spills of 50 bbl or less, 35 to 70 spills between 50 and 1,000 bbl (both considered small spills), and 4 to 8 large spills greater than 1,000 bbl are postulated for the GOM Program.

The major potential impact-producing factors include accidental blowouts, platform and pipeline oil spills, and spill-response activities. Impacts (i.e., acute vs. chronic impacts) depend on the magnitude, frequency, location, and date of accidents; characteristics of spilled oil; spill-response capabilities and timing; and various meteorological and hydrological factors. Impacts could include decreased health, reproductive fitness, and longevity; and increased vulnerability to disease). Spilled oil can cause soft tissue irritation, fouling of baleen plates, respiratory stress from inhalation of toxic fumes (e.g., irritation and damage to mucus membranes), direct ingestion of oil and/or tar, and temporary displacement from preferred habitats (St. Aubin and Lounsbury 1988; Geraci and St. Aubin 1980, 1988). An oil spill can also lead to the localized reduction, disappearance, or contamination of prey species. Generally, the potential for ingesting oil-contaminated prey is highest for benthic-feeding marine mammals (e.g., those that feed on clams and polychaetes that tend to concentrate petroleum hydrocarbons), reduced for plankton-feeding whales, and lowest for fish-eating marine mammals, as food-web biomagnification of petroleum hydrocarbons does not occur (Würsig 1988). Depending on the extent and magnitude of a spill, diminished prey abundance and availability may cause marine mammals to move to less suitable areas and/or consume less suitable prey.

The long-term impacts to marine mammal populations are poorly understood but could include decreased survival and lowered reproductive success. Chronic or acute exposure could result in harassment, harm, or mortality to marine mammals. In some cases, marine mammals made no apparent attempt to avoid spilled oil (Smultea and Würsig 1995); however, marine mammals have been observed apparently detecting and avoiding slicks in other cases (Geraci and St. Aubin 1980, 1988). One assumption concerning the use of dispersants is that the chemical dispersion of oil will considerably reduce the impacts of oil on marine mammals, primarily by reducing their exposure to petroleum hydrocarbons (French-McCay 2004; NRC 2005b). However, the impacts on marine mammals from chemical dispersants could include nonlethal injury (e.g., tissue irritation, inhalation), long-term exposure through

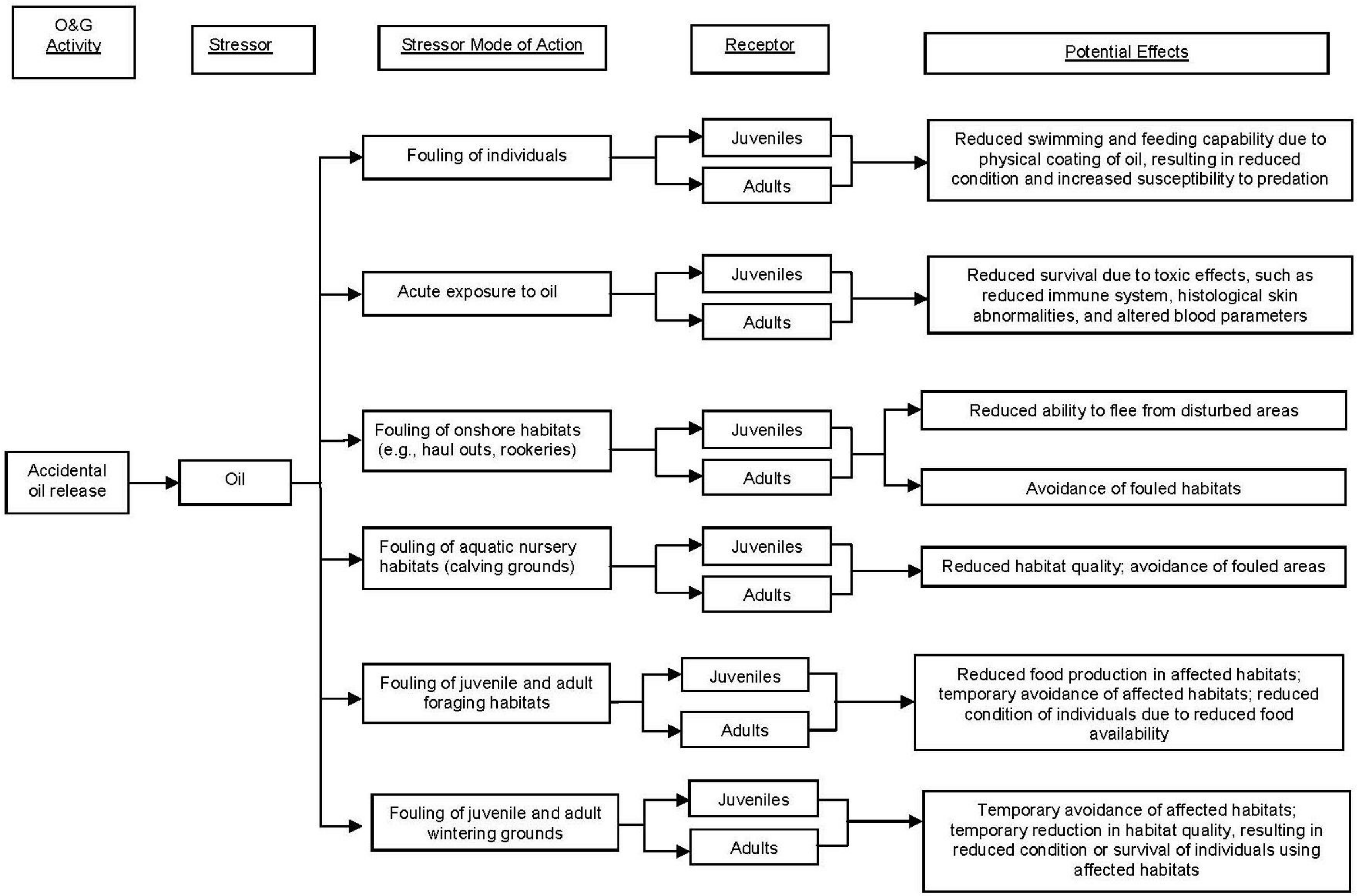

FIGURE 4.4.7-5 Conceptual Model for Potential Effects of Oil Spills on Marine Mammals

bioaccumulation, and potential shifts in distribution from some habitats. Water and air quality degradation associated with response and cleanup vessels could also affect marine mammals.

Impacts on marine mammals from smaller accidental events could adversely affect individual marine mammals in the spill area, but are unlikely to rise to the level of population effects (or significance) given the size and scope of such spills. Assuming that all small spills would not occur at the same time and place, water quality could rapidly recover and therefore not have significant effects on marine mammals or their prey species. The potential effects associated with a large spill could be more adverse than a smaller accidental spill and could potentially contribute to longer lasting effects. Impacts from dispersants are unknown but could be irritants to tissues and sensitive membranes (NRC 2005b).

Spill response activities that may impact marine mammals include increased vessel traffic, use of dispersants, and remediation activities (e.g., use of controlled burns, skimmers, and booms). Vessel noise and other factors related to increased human presence would likely cause changes in marine mammal behavior and/or distribution. This could increase stress levels and perhaps make individuals more vulnerable to various physiologic and toxic effects of spilled oil. Increased numbers of response vessels could also increase the risk for vessel collisions with marine mammals.

Impacts of an Unexpected Catastrophic Discharge Event. A CDE is considered to be an unexpected, very low-probability event unlikely to occur during routine operations (see Section 4.4.2.2). The PEIS analyzes a CDE in the GOM with an assumed volume of 0.9-7.2 million bbl and lasting from 30 to 90 days (Table 4.4.2-2). If a CDE occurs, there is greater potential for more severe effects compared to the risk of effects from an assumed large oil spill. A CDE would result in sustained degradation of water quality and, to a lesser extent, air quality that would impact marine mammals from direct contact, inhalation, and ingestion (either directly or indirectly through the consumption of oiled forage or prey species). These effects would be significant, causing a multitude of acute and chronic effects. Additional effects on marine mammals would occur from water and air quality degradation associated with response and cleanup vessels, *in situ* burning of oil, dispersant use, discharges and seafloor disturbances from relief well drilling, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring.

A CDE has the potential to increase the area and duration of an oil spill, thereby increasing the potential for population-level effects, or at a minimum, an increase in the number of individuals killed. For example, following the DWH event, dead marine mammals collected from April 30, 2010 (before the DWH event), through April 12, 2011, included 142 bottlenose dolphins, 3 spinner dolphins, and 2 each of *Kogia* spp., melon-headed whales, and sperm whales (NMFS 2011b). The actual number of marine mammal deaths is undoubtedly underestimated (Williams et al. 2011). In addition, it is not known if other species, such as the Bryde’s whale, were impacted by the DWH event, as much of the data collected after the spill has not yet been released. It is important to note that the cause of death of these marine mammals has not yet been confirmed; therefore, it is possible that many, some, or none of the deaths were related to the DWH event. The final determinations regarding damages to marine mammal resources from the DWH event will ultimately be made through the NRDA process.

There have not been any reported cases of manatee strandings within the areas affected by the DWH event. Therefore, it is likely that there were few to no effects on manatees. Nevertheless, a spill from a CDE could enter coastal waters, where manatees and coastal and estuarine dolphins would be the most likely marine mammals affected. Individual manatees would most likely be impacted if a spill occurred during warmer months, when manatees may occur along most of the coastal areas of the GOM. However, a population-level impact to manatees would be most likely during winter if an oil spill reached the Florida coast and contaminated areas where manatees are concentrated in their warm-water refuges.

Impact Conclusions.

Routine Operations. Within the GOM planning area, noise generated during seismic surveys, exploration and production activities, platform removal, and by OCS-related vessels and helicopters may temporarily disturb some individuals. Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification, although the scope of effects and their magnitude are not known. However, this information is not essential to the determination of a reasoned choice among alternatives. Small numbers of marine mammals could be killed or injured by chance collision with service vessels and by eating indigestible debris, particularly plastic items, lost from service vessels, drilling rigs, and platforms (including FPSO facilities). While vessels may collide with marine mammals, the most likely impact on marine mammals would be changes in behavior (e.g., avoidance responses). Normal behavior is expected to return once a vessel or helicopter has passed. The potential also exists for some individuals to entangle in OCS-related trash and debris. Structure removal would cause only minor behavioral changes and non-injurious physiological effects on cetaceans as a result of the implementation of BOEM guidelines and the NOAA Fisheries Observer Program for explosive removals.

Overall, impacts on cetaceans from routine operations could range from negligible to moderate, while impacts on the West Indian manatee would be negligible. Rare or extralimital species are not likely to be affected by routine operations.

Expected Accidental Spills. Any of the expected oil spill scenarios developed for the proposed action (Section 4.4.2) may expose marine mammals to oil or its weathering products. The magnitude of effects from expected accidental spills would depend on the location, timing, and volume of the spills; the environmental settings of the spills (e.g., restricted coastal waterway, deepwater pelagic location); and the species (and its ecology) exposed to the spills. Spill cleanup operations could result in short-term disturbance of marine mammals in the vicinity of the cleanup activity, while a collision with a cleanup vessel could injure or kill the affected individual. Most spills would occur far from shore and would be cleaned up or dissipate before reaching shore. Impacts from small coastal spills are likely to have localized, short-term effects. Large spills would have more of an effect on marine mammals.

Overall, small oil spills ≤50 bbl are expected to have negligible to minor impacts on marine mammals. Small spills (>50 bbl) and large spills (≥1,000 bbl) are expected to have minor to moderate impacts on marine mammals. Oil spill impacts on species that are extralimital to rare are expected to be negligible to minor, but could in unusual circumstances be moderate to major depending on the number of individuals contacted by a spill. Impacts on marine mammals from oil spill response activities are expected to be minor.

An Unexpected Catastrophic Discharge Event. In the case of an unexpected, low-probability CDE, there is greater potential for more severe and population-level effects compared to a large oil spill (i.e., impacts could be moderate to major on one or more species of marine mammals). The combination of a CDE and cleanup efforts could persist beyond one season, perhaps lasting several years.

Terrestrial Mammals. The terrestrial mammals considered in this section are those species listed as endangered under the ESA that may be affected by routine OCS operations or accidents under the proposed action. These include the Alabama, Choctawhatchee, Perdido Key, and St. Andrew beach mice (subspecies of the old-field mouse) and the Florida salt marsh vole (Section 3.8.1.1.2).

Impacts of Routine Operations. The endangered beach mice subspecies inhabit mature coastal barrier sand dunes on the Alabama and northwest Florida coasts; the Florida salt marsh vole inhabits salt marsh habitats and is known from two locations (Waccasassa Bay in Levy County, Florida, and the Lower Suwannee National Wildlife Refuge), in southeastern Dixie and northwestern Levy Counties, Florida; Figure 3.8.1-1). Under the proposed action, no new OCS-related facilities or activities would occur in close proximity to the known habitats for these species; therefore, routine operations would not affect the beach mice subspecies or the Florida salt marsh vole.

Impacts of Expected Accidental Spills. Three types of oil residues on or near beach environments are particularly challenging or potentially damaging to the environment if removed (OSAT 2011):

- Supratidal buried oil — oil residue typically buried below the 15-cm (6-in.) surface cleaning depth near sensitive habitats, removal of which would damage these sensitive habitats and affect protected species;

- Small surface residual balls — oil residue left behind after beaches are cleaned (removal would involve sieving sand so finely that it could remove material used for habitat by organisms, thus altering the natural condition of the beach; and

- Surf zone submerged oil mats — submerged oil mats in nearshore surf zone in troughs between sand bars.

In the event of an accidental offshore or coastal oil spill, the four beach mice subspecies and the Florida salt marsh vole could be affected by oil washing up on their beach or marsh habitats, respectively, and by subsequent spill containment and cleanup activities. Individuals coming in direct contact with spilled oil may experience skin, ear, eye, throat, and mucous membrane irritations. Oiling of fur may affect thermoregulation. Individuals inhaling petroleum vapors may aggravate linings of the respiratory system and in extreme cases may result in asphyxiation. Oil may be ingested through contaminated food or during cleaning of oiled fur. Exposure to oil via inhalation or ingestion may lead to a variety of lethal and sublethal effects, including lung, liver, and kidney damage. Beach mice could be exposed to small surface residual balls via ingestion of residual oil in soil and by exposure in their burrows (OSAT 2011).

In addition to affecting individuals, an oil spill may also affect the habitats of these small mammals. Oil contacting their habitats could result in a reduced food supply (oiled vegetation), reduced physical habitat quality (oiled sands), and fouling of nests and burrows. The fouling of nests and burrows may also lead to a temporary displacement from or long-term abandonment of these habitats. Depending on the persistence of the oil in these habitats and the effectiveness of spill cleanup, long-term reductions in overall habitat quality and quantity may occur.

An accidental spill fairly close to shore would have the potential to contact beaches adjacent to beach mouse habitat, particularly if a spill were to occur nearshore or within inshore waterways. However, beach mice are generally restricted to interior dune habitats, which would not be expected to come in contact with spilled oil unless the accident occurred during a period of high storm surge. However, erosion from high seas during storms is likely to do more damage than oiling. For example, Yuro (2011) postulated that the Alabama beach mouse population would be extirpated in the event of successive major hurricanes. In contrast, habitats of the Florida salt marsh vole may be more vulnerable to an oil spill because of their being connected to coastal waters. However, the location of this species and its habitat on the western Florida coast are far removed from those portions of the GOM OCS where expected accidental spills might occur.

If an oil spill occurs and contacts a coastal area associated with these species, oil spill response activities, including beach cleanup activities and vehicular and pedestrian traffic, could result in habitat degradation. However, cleanup activities would be designed and conducted in consultation with the USFWS and other appropriate stakeholders so that the potential for impacts on these species and their habitats would be minimized or avoided.

It is not expected that small oil spills, particularly those <50 bbl that are most likely to occur, would contact beach mouse or Florida salt marsh vole habitats. The probabilities of large oil spills (≥1,000 bbl) resulting from the proposed action occurring and contacting beach mouse or Florida salt marsh vole habitat within 3 to 30 days from a spill in various locations in the WPA, CPA, and far western EPA is ≤5%. In most instances, the probabilities were 0% to 1% (MMS 2004a). Large-scale oiling of beach mice or vole habitats, and if not properly regulated, oil spill-response and cleanup activities could have a significant impact on the species and their habitats (up to and including population extirpations or subspecies/species extinctions). Vehicle traffic and activity associated with oil spill cleanup can trample or bury nests and burrows or cause displacement from preferred habitat (MMS 2008b). If disturbance results in the temporary abandonment of young by adults, survival of young may be reduced (MMS 2007e).

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE with an assumed volume of 0.9-7.2 million bbl and lasting 30 to 90 days (Table 4.4.2-2). If a CDE occurs, there is greater potential for oiling of beach or marsh habitats in Alabama or Florida, increasing the potential for impacts to beach mouse subspecies or the

Florida salt marsh vole compared to the risk of effects from expected small to large oil spills. A CDE would potentially result in sustained degradation of water quality, shoreline terrestrial habitats, and, to a lesser extent, air quality that could impact terrestrial mammals from direct contact, inhalation, and ingestion (either directly or indirectly through the consumption of oiled forage or prey species). These effects could be significant, causing a multitude of acute and chronic effects. Additional effects on terrestrial mammals would occur from land and air quality degradation associated with response and cleanup vessels, *in situ* burning of oil, dispersant use, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring. A CDE has the potential to alter terrestrial mammal habitats and populations, and, could foreseeably contribute to population-level effects on one or more of the beach mice subspecies and/or the Florida salt marsh vole. The potential for these impacts would be more probable if the CDE occurs coincident with a severe storm event (e.g., a hurricane). BOEM (2012) concluded that in all likelihood beach mice were minimally impacted by the DWH event. An investigation, conducted through the NRDA process, regarding the effects of the DWH event cleanup activities on beach mice and their habitat is still pending.

Impact Conclusions.

Routine Operations. The four federally endangered GOM coast beach mice subspecies and the federally endangered Florida salt marsh vole and their habitats would not be affected by normal operations under the proposed action. Thus, routine operations would have negligible effects on these species.

Expected Accidental Spills. Oil spills may expose terrestrial mammals to oil or its weathering products. Most expected spills would occur far from shore and would be cleaned up or dissipate before reaching shore. A large spill in coastal waters could potentially reach beach or salt marsh habitats. Because of their locations on inner dunes, the beach mouse habitats are unlikely to be affected by an accidental offshore oil spill (particularly by the more commonly expected small spills). While the habitat of the Florida salt marsh vole could be affected by an oil spill, this species and its habitat are located far from areas where oil leasing and development may occur under the proposed action. Thus, it is unlikely that their habitats would be contacted by expected small or large oil spills. If their habitats are oiled, the potential impacts on terrestrial mammals are expected to be minor (for small spills) to minor or moderate for large spills. Protective measures required under the ESA should prevent any oil spill response and cleanup activities from having more than minor to moderate impacts on beach mice, the Florida salt marsh vole, and their habitats. Extirpation of beach mouse populations or the extinction of a beach mouse subspecies or the Florida salt marsh vole from expected spill are not expected (i.e., major impacts from an expected spill are not anticipated).

An Unexpected Catastrophic Discharge Event. In the case of an unexpected, low-probability CDE, there is greater potential for the habitats of the beach mice subspecies and the Florida salt marsh vole to be oiled. An unexpected, low-probability CDE and associated cleanup activities could potentially result in the oiling and physical destruction of habitats (including critical habitat) for one or more subspecies of beach mice and, less likely, habitat for the Florida salt marsh vole. The combination of a CDE and cleanup efforts could persist beyond one season, perhaps lasting several years. Impacts from a CDE could be minor to major. A CDE would increase the threat of their extinction for one or more beach mice subspecies and the Florida salt marsh vole.

4.4.7.1.2 Alaska – Cook Inlet.

Marine Mammals. There are 18 species of marine mammals that occur in south Alaskan waters and that may either occur in or near (such as the Gulf of Alaska, Kenai Peninsula, and Kodiak Archipelago) the Cook Inlet Planning Area (Section 3.8.1.2.1; Table 3.8.1-2). Nine of these species or species stocks are threatened or endangered under the ESA. These species include the North Pacific right, sei, blue, fin, humpback, sperm, and beluga whales; the Steller sea lion; and the sea otter. The non-listed species commonly occur in portions in or near the Cook Inlet Planning Area (MMS 2003e). Marine mammals may be exposed to OCS-related oil and gas exploration, development, and operations that could occur under the proposed action.

Impacts of Routine Operations. As part of the proposed action, a maximum of 4 to 12 exploration and delineation wells and 42 to 114 development and production wells will be drilled and 1 to 3 new platforms are projected to be used. Additional activities planned as part of the proposed action include 40 to 241 km (25 to 150 mi) of new offshore pipeline. No onshore facilities or pipelines are proposed under the proposed action (Section 4.4.1.2). Table 4.4.7-1 (Section 4.4.7.1) illustrates how each of the impacting factors associated with OCS oil and gas development may affect marine mammals and their habitats, while Figure 4.4.7-1 (Section 4.4.7.1) presents a conceptual model of potential impacting factors for marine mammals from oil- and gas-related activities (including accidental oil spills). The following text presents an overview of potential impacts to marine mammals in and near Cook Inlet from the following routine operations (seismic surveys, construction of offshore facilities and pipelines, operations of offshore facilities and drilling rigs, discharges and waste generation, service vessel and helicopter traffic, and decommissioning) and from accidents.

<u>Seismic Surveys.</u> Section 4.4.5 provides a detailed discussion of the issues surrounding anthropogenic noise. In Cook Inlet, noise generated by seismic surveys may have physical and/or behavioral effects on marine mammals, such as (1) permanent or temporary hearing loss, discomfort, and injury; (2) masking of important sound signals; and (3) behavioral responses such as fright, avoidance, and changes in physical or vocal behavior (Richardson et al. 1995; Davis et al. 1998; Gordon et al. 1998; Nowacek et al. 2004, 2007). Seismic surveys may also indirectly impact marine mammals by altering prey availability (Gordon et al. 2003/2004). Section 4.4.7.1.1 provides a more detailed discussion on the impacts of noise from seismic surveys on marine mammals.

Non-Auditory Injury. Direct acoustic impact on tissue, indirect acoustic impact on tissue surrounding a structure, and acoustically mediated bubble growth within tissues from supersaturated dissolved nitrogen gas (if source intense and animals within short distance to source: Nowacek et al. 2007; Zimmer and Tyack 2007); resonance (although not anticipated given resonance frequencies of marine mammal lungs are generally below that of the G&G seismic survey source signal).

Auditory Injury (Temporary or Permanent Hearing Loss). The hearing of marine mammals varies based on individuals, absolute threshold of the species, masking, localization, frequency discrimination, and the motivation to be sensitive to a sound (Richardson et al. 1995). As stated previously (Section 4.4.7.1.1), Southall et al. (2007) described the frequency sensitivity in five functional hearing categories. Similarly, the previous discussion in Section 4.4.7.1.1 on permanent and temporary loss of hearing in a marine mammal (i.e., PTS, TTS) is incorporated.

Masking. In the case of seismic surveys in Cook Inlet, , the effect of masking is likely to be low relative to continuous sounds such as ship noise. In addition, a few cetaceans are known to increase the source levels of their calls in the presence of elevated sound levels, or to shift their peak frequencies in response to strong sound signals (Dahlheim 1987; review in Richardson et al. 1995; Lesage et al. 1999; Terhune 1999; Parks et al. 2007). These studies involved exposure to other types of anthropogenic sounds, not seismic pulses, and it is not known whether these types of responses ever occur upon exposure to seismic sounds. If so, these adaptations, along with directional hearing and preadaptation to tolerate some masking by natural sounds (Richardson et al. 1995), would all reduce the importance of masking.

Behavioral Change. As described in Section 4.4.7.1.1, a number of studies have documented behavioral effects in response to seismic surveys, primarily for mysticetes (Richardson et al. 1995), given their possible overlap between the expected frequencies of best hearing sensitivity (low threshold) in mysticetes and maximal airgun output at source. Given that no direct audiograms of mysticetes have been obtained, it is impossible to define what level of sound above hearing threshold may cause behavioral effects, which could be expected to be variable, complicated and dependent upon more than just the received sound level. For this reason, observations at sea have concentrated on relating received sound levels to observed behavioral changes.

Beluga whales are mid-frequency hearing specialists. For belugas exposed to a single seismic watergun pulse (a watergun was used in the experiment rather than an airgun because its impulses contain more energy at higher frequencies where odontocete hearing thresholds are relatively low), TTS-onset occurred with unweighted peak levels of 224 dB re: 1 μPa (peak) and 186 dB re: 1 μPa2-s (Finneran et al. 2002). The latter is equivalent to a weighted (M- weighting for mid-frequency marine mammals) SEL exposure of 183 dB re: 1 μPa2-s as some of the energy in the pulse was at low frequencies to which the beluga is less sensitive. Adding 6 dB to the former (224 dB) values, Southall et al. (2007) estimates the pressure criterion for injury for mid-frequency cetaceans is 230 dB re: 1 μPa (peak).

Southall et al. (2007) also went on to discuss pinnipeds, which include 16 species and subspecies of sea lions and fur seals (otariids), 23 species and subspecies of true seals (phocids), and two subspecies of walrus (odobenids). They produce a variety of social signals, most occurring at relatively low frequencies but lack the highly specialized active biosonar systems of toothed cetaceans. Because of they are active both in and out of water, pinnipeds communicate acoustically in air and water, have significantly different hearing capabilities in the air versus water, and may be subject to both aerial and underwater noise exposure (Kastak & Schusterman 1998; Kastak et al. 2005). Therefore, pinnipeds have different hearing criteria. NMFS' policy has been to use 190 dB rms, where onset Level A harassment from acoustic sources potentially begins for pinnipeds in water. NMFS has not established in-air Level A harassment criteria. However, USFWS uses 180 dB-A (air) for their Level A harassment criteria. The Level B harassment criteria are 160 dB rms for impulsive noise and 120 dB rms for non-pulse noise (NMFS 2012).

Since seismic surveys are less likely to affect pinnipeds, such as Steller sea lions, in air, the in-water impacts are discussed here. It is also acknowledged that there are "among species differences in the exposure conditions that elicited TTS under water" (Southall et al. 2007). Steller sea lion hearing has not specifically been studied but for the purposes of this analysis, it is assumed that their hearing is comparable to that of California sea lions. Comparative analyses of the combined underwater pinniped data (Kastak et al. 2005) indicated that, in the harbor seal, a TTS of *ca*. 6 dB occurred with 25-min exposure to 2.5 kHz OBN with SPL of 152 dB re: 1 μPa (SEL: 183 dB re: 1 μPa2-s). Under the same test conditions, a California sea lion showed TTS-onset at 174 dB re: 1 μPa (SEL: 206 dB re: 1 μPa2-s), and a northern elephant seal experienced TTS-onset at 172 dB re: 1 μPa (SEL: 204 dB re: 1 μPa2-s). Data on underwater TTS-onset in pinnipeds exposed to pulses are limited to a single study. Finneran et al. (2003) exposed two California sea lions to single underwater pulses from an arc-gap transducer. They found no measurable TTS following exposures up to 183 dB re: 1 μPa (peak-to-peak) (SEL: 163 dB re: 1 μPa2-s).

Southall et al. (2007) did not discuss sea otters due to a lack of key hearing data. Further, there is little information on the effects of noise associated with oil and gas exploration on sea otters. Their production and use of sound underwater has not been studied. Airborne sounds are diverse and include screams, whines, whistles, growls, cooing, squeaks, hisses, and grunts (McShane et al. 1995). Mothers and their pups communicate by calling, and both call to one another if separated. Most of the sounds in these mother-pup communications are 3-5 Hertz, but there are higher harmonics. Sandegren, Chu, and Vandervere (1973) recorded these calls from a distance of 50 meters in air. It is not known how far sea otters can hear these sounds. Available data do not indicate that sea otters are likely to be seriously impacted by seismic exploration. Riedman (1983) reported no evident disturbance reactions by sea otters in California coastal waters in response to noise from a full-scale array of airguns (67 L) and a single airgun. No disturbance was noted either when the operating seismic ship passed as close as 1.85 and 0.9 kilometers to sea otters. Sea otters continued to feed, groom, interact with pups, rest, and to engage in other normal behaviors. Riedman (1983) reported there was also no apparent reaction to the single airgun. Riedman (1983) cautioned that there are no data for the reactions of sea otters more than 400 meters offshore. Riedman (1983) reported no evidence of changes in behavior of sea otters during underwater playbacks of drillship, semisubmersible, and production platform sound. Most of the animals studied were 400 or more meters from the source of the sound. Foraging otters continued to dive and feed.

Whales and other marine mammals sometimes continue with important behaviors even in the presence of noise. Some marine mammals may be motivated by feeding opportunities to the extent that they subject themselves to increased noise levels. For example, Native hunters reported to Huntington (2000) that beluga whales often ignore the approach of hunters when feeding, but at other times will attempt to avoid boats of hunters. There is a potential for effects from geophysical survey operations on marine mammals found in Cook Inlet from non-auditory or auditory effects, including PTS, but this is expected to be negligible. Local effects could result to endangered species near noise and other disturbance caused by exploration. For example, in specific areas, particularly near the Barren Islands, these disturbances could affect the haulouts and behavior of Steller sea lions; cause local, short-term effects on the feeding of mysticetes; and locally affect some Cook Inlet beluga whales. Behavior of sea otters could be affected and some displacement of sea otters could occur near areas of activity. Although small numbers of individuals could be affected, regional population or migrant populations of non-endangered marine mammals would experience a negligible effect from disturbance and habitat alteration. The potential for injury is greatly lessened through effective implementation of assumed mitigation. Mitigation that is often implemented to reduce impacts includes use of marine mammal observers, survey vessel speed reductions, and establishment of exclusion zones.

Construction and Operation of Offshore Platforms and Pipelines. Figure 4.4.7-2 (Section 4.4.7.1.1) presents a conceptual model for potential effects of infrastructure construction on marine mammals. Under the proposed action, up to 1 to 3 offshore platforms and 40 to 241 km (25 to 150 mi) of offshore pipeline could be constructed in the Cook Inlet Planning Area (Table 4.4.1-3).

If exploration leads to development and production, impacts likely could occur from the following:

- Noise from construction of pipelines and production facilities;
- Routine and recurring traffic associated with crew and supply activities;
- Domestic wastewaters generated at the offshore facility (the scenario assumes on-platform disposal wells will reinject drilling fluids, muds, cuttings, and produced waters generated from production wells. Discharges and Wastes are described further below.);
- Trash and debris from production activities;
- Gaseous emissions from production facilities, both onshore and offshore, and from transportation vessels and aircraft; and
- Physical placement, presence, and removal of offshore production facilities, including platforms and pipelines to onshore common carrier pipelines.

Noise generated by industrial activities can come from a variety of sources, such as transportation, general machinery use, construction, and human activity. Noise, whether carried through the air or under water, may cause some species to alter their feeding routines, movement, and reproductive cycles. For cetaceans, effects from noise and disturbance associated with development would be much the same as discussed for exploration. The most likely impacts could be the disturbance of sea otters and Steller sea lions that are hauled out and the displacement of females and pups that occur near regions of focused activity. These effects are expected to be extremely local and have no population-level impacts on sea otters or Steller sea lions.

Construction may also cause an alteration in habitat and water quality for marine mammals. However, the activities associated with construction are not likely to significantly affect water quality. Construction activities would increase the turbidity in the water column along segments of the 40-km (25-mi) corridors for up to a few months, but no significant water quality degradation could occur. Further, construction activities could affect benthic organisms and fish (prey species) in the immediate vicinity. Organisms in soft substrates (bivalves and polychaetes) could be adversely affected; however, platforms would add a hard substrate to the marine environment, providing additional habitat for marine plants and animals (for example, kelp and mussels) that require a hard substrate. Therefore, the overall effect of platform and pipeline installation could be to alter species diversity in a small area. Construction activities may disturb pelagic and demersal finfishes and shellfishes, potentially displacing them from preferred habitat, as turbidity, vibrations, and noise from construction increases. Positive effects may accrue because following construction, offshore structures provide refugia to some species and their prey. Any disturbance or displacement should be localized and short term (hours to days to months), limited to only the time of construction and shortly thereafter. Effects are expected to be limited to negligible numbers of individuals in the immediate vicinity of construction activities.

The landfall of a pipeline would avoid sensitive aquatic habitat. The route for the pipeline would be sited inland from shorelines and beaches, and pipeline crossings of anadromous fish streams would be minimized and consolidated with other utility and road crossings of such streams. Pipelines would be buried wherever possible and sited in existing rights-of-way for other utilities or transportation systems wherever possible, such as that provided by the Sterling Highway. The pipelines would be designed, constructed, and maintained to minimize risk to fish habitats from a spill, pipeline break, or other construction activity. Habitat alteration due to pipeline laying and platform construction are expected to be localized and should not cause significant impacts to mobile species.

The immediate response of disturbed individuals or groups could be to leave or avoid the construction areas. This displacement or avoidance could be short or long term in duration, depending on the duration of the construction activity. Because relatively few individuals would be expected to be affected by the limited amount of construction and few new facilities that would be operating, the construction and operation of new offshore facilities would not be expected to result in population-level effects to affected marine mammals.

Facilities to be constructed and operated under the proposed action may occur in or near beluga whale critical habitat area 2 (76 FR 20180). Construction and operation of offshore platforms and pipelines are expected to have negligible impact to beluga habitat and would not be expected to affect movement of belugas within Cook Inlet. However, if activities were to occur in or near the beluga whale critical habitat, ESA consultation would occur to ensure the protection of the species and their habitat.

Critical habitat designation for the Steller sea lion (50 CFR 226.202) includes a 0.9-km (3,000-ft) radius terrestrial and air zones around designated rookeries within the Cook Inlet Planning Area, as well as a 37-km (20-NM or 23-mi) aquatic zone around all major rookeries and haulouts. Additional restrictions (50 CFR 223.202) associated with Steller sea lion critical habitat include a 5.5-km (3-NM or 3.4-mi) radius vessel approach zone around listed rookeries, and 1.9-km a (1-NM or 1.2-mi) minimum distance for vessel passing near rookery sites (50 CFR 223.202). Compliance with these critical habitat designations, restrictions, and buffer zones could greatly reduce the likelihood of exposure of Steller sea lion rookeries and haulouts to OCS activities that could occur in the Cook Inlet Planning Area.

Discharges and Wastes. Table 4.4.1-3 presents information on drilling fluids, drill cuttings, and produced waters discharged offshore as a result of the proposed action. Figure 4.4.7-3 (Section 4.4.7.1.1) presents a conceptual model for potential effects of operational waste discharges on marine mammals. Produced water, drilling muds, and drill cuttings are discharged into offshore marine waters in compliance with applicable regulations and permits. Compliance with regulations and permits will limit the exposure of marine mammals to waste discharges.

Up to 500 bbl of drill fluids and 600 tons of drill cuttings will be discharged at each exploration and delineation well (Table 4.4.1-3). Heavier components of these muds and cuttings (such as rock) would settle to the bottom, while lighter components could increase turbidity around the drill site. While this increased turbidity could cause marine mammals to avoid the area, any increase in suspended solids associated with the discharge of drilling wastes would be rapidly diluted and dispersed, and thus not be expected to adversely affect marine mammals in the area. Drilling fluids and cuttings associated with development and production wells would be treated and disposed of in the wells, minimizing impacts to marine mammals from these wastes.

The OCS-related vessels supporting exploration activities and the construction and operation of offshore platforms and pipelines will generate waste fluids (such as bilge water) which may be discharged to the surface water. Such discharges, if allowed, would be regulated under applicable NPDES permits. Sanitary and domestic wastes would be processed through shipboard waste treatment facilities before being discharged overboard, and deck drainage would also be processed aboard ship to remove oil before being discharged. Because of the low level of expected vessel traffic, relatively small volumes of operational wastes would be discharged, and these would be rapidly diluted and dispersed.

Solid debris can adversely impact marine mammals through ingestion or entanglement (Marine Mammal Commission 2003). Mammals that ingest debris, such as plastics, may experience intestinal blockage, which in turn may lead to starvation, while toxic substances present in the ingested materials (especially in plastics) could lead to a variety of lethal and sublethal toxic effects. Entanglement in plastic debris can result in reduced mobility, starvation, exhaustion, drowning, and constriction of, and subsequent damage to, limbs caused by tightening of the entangling material. The discharge or disposal of solid debris into offshore waters from OCS structures and vessels is prohibited by BOEM (30 CFR 250.40) and the USCG

(International Convention for the Prevention of Pollution from Ships [MARPOL], Annex V, P.L. 100-220 [101 Statute 1458]).

Only small amounts of drilling fluids and produced waters are anticipated to be discharged during production. The hydrodynamic processes in the Cook Inlet suggest the water column generally is well mixed, and dilution would reduce the concentration of the substances in the discharges. Degradation processes also act to continuously reduce the concentrations of many substances deliberately or accidentally released into the environment. We do not expect the discharge of drilling muds and cuttings and other discharges associated with exploration drilling to have any effect on the overall quality of Cook Inlet water. Within a distance of between 100 and 200 m (328 and 656 ft) from the discharge point, the turbidity caused by suspended-particulate matter in the discharged muds and cuttings would dilute to levels that are less than the chronic criteria (100–1,000 parts per million) and within the range associated with the variability of naturally occurring suspended particulate matter concentrations. Mixing in the water column would reduce the toxicity of the drilling muds that already fall into the "practically nontoxic" category to levels that would not be harmful to organisms in the water column. In general, the amounts of additives in the other discharges are likely to be relatively small (from 4 to 400 or 800 liters/month and diluted with seawater several hundred to several thousand times before being discharged into the receiving waters. The potential effects in any of the areas where there are permitted discharges would last for about 3–4 months for each exploration well drilled.

<u>Vessel and Aircraft Traffic.</u> There may be up to 9 surface vessels and 9 helicopter trips per week under the proposed action (Table 4.4.1-3). Figure 4.4.7-3 (Section 4.4.7.1.1) presents a conceptual model for potential effect of vessel traffic on marine mammals. Vessel traffic could occur during seismic exploration, drilling and platform construction, platform operation, and platform decommissioning. Generally, marine mammals may be affected by direct collisions with vessels or by visual and noise disturbances.

In addition to possible collision-related injuries and/or mortalities, cetaceans and pinnipeds in the vicinity of an OCS-related vessel may be disturbed by the presence of vessels and helicopters and the noise they generate. Noises emitted by shipping vessels are expected to range between 140 dB re 1 μPa for smaller vessels to 198 dB re 1 μPa for larger tankers and cargo ships (Heathershaw et al. 2001; Erbe 2002; Hildebrand 2004). Helicopters flying at 150 m (492 ft) altitude are expected to emit noises received at ground level of approximately 80 to 86 dB re 20 μPa (Born et al. 1999). Reactions of cetaceans, including both odontocetes and mysticetes, may include apparent indifference, cessation of vocalizations or feeding activity, increases in vocal behavior, and evasive behavior (e.g., turns, diving, etc.) (Richardson et al. 1995; Nowacek et al. 2001; Buckstaff 2004; Doyle et al. 2008). Noise from service vessels may also mask cetacean sound reception (MMS 2003e). Disturbed individuals would be expected to cease their normal behaviors and likely move away from the vessel. Following passage of the vessel, affected individuals may return and resume normal behaviors.

Cetaceans, such as humpback whales, near the Barren Islands and the southern portions of the Cook Inlet also could be negatively affected by vessel transport and construction activities. However, this area has a high volume of fishing- and tourism-related vessel traffic in the summer months when the whales are present. The incremental addition of noise from two vessels per day associated with the proposed action is unlikely to add significantly to this existing noise.

Based on their distributions, humpbacks are more vulnerable to aircraft noise than fin whales. Shallenberger (1978) reported that some humpbacks were disturbed by overflights at 305 m (1,000 ft), whereas others showed no response at 152 m (500 ft). As with the response to airgun noise, pods varied in their response. Humpbacks in large groups showed little or no response but some adult-only groups exhibited avoidance (Lukenberg and Parsons 2009). Other authors report no response (for example, Friedl and Thompson, 1981).

Belugas could be disturbed by noise and disturbance from exploration and development-related aircraft, especially helicopters. Belugas reacted to aircraft flying at 150–200 m (492–656 ft) by diving for longer periods, reducing surfacing time and sometimes swam away (see references cited in Richardson et al. 1995). They did not respond to aircraft at 500 m (1,640 ft). Richardson et al. (1991) found variable reactions to turbine helicopters and fixed wing aircraft in offshore waters near Alaska. Some individuals exhibited no discernible response even when the aircraft was within 100–200 m (328–656 ft), whereas other individuals dove abruptly, looked upward, or turned sharply in response to aircraft at altitudes up to 460 m (1,510 ft). As reviewed by Norman (2011), beluga whales are apparently less responsive to overflights when engaged in feeding, social activities, or mating than when resting. Also, Cook Inlet belugas rarely react to fixed-wing aircraft flown at altitudes of 244 m (800 ft). They tend to react to overflights at lateral distances of ≤250 m (820 ft) than to overflights at farther lateral distances.

Vessel traffic may disturb pinnipeds and sea otters (which are discussed further below) in the water and hauled out on ice or terrestrial habitats. For example, when approached too closely or disturbed too often, harbor seals are known to abandon their favorite haul-out sites or their pups (Kinkhart et al. 2008). Hauled out pinnipeds may exhibit behavioral reactions to the physical disturbance of an approaching vessel or aircraft by exhibiting startle reactions, slipping into the water. In recognition of their vulnerability to loud and startling noises, Steller sea lion critical habitat has been defined to include a terrestrial zone that extends 914 m (3,000 ft) landward from the baseline or base point of each Steller sea lion major rookery or major haulout and an air zone that extends 914 m (3,000 ft) above the terrestrial zone, as measured at sea level around them. Assuming aircraft flying to any platforms maintain sufficient distances from these rookeries, based on recognition of this critical habitat, it not likely this form of disturbance would have a major impact on Steller sea lions. However, it is possible that sea lions could be negatively affected by oil- and gas-activity-related helicopters (and possibly by other noise) operating at further distances. Under the proposed scenario, one to two helicopter trips per day would be made to oil and gas operations from Kenai or other sites along the western Kenai Peninsula shore. In most of the proposed Cook Inlet multiple-sale area, these flights would not require transit over any terrestrial components of Steller sea lion critical habitat and adverse effects could easily be avoided. The greatest potential for such disturbance could come from helicopters transiting to blocks on the far side of the Barren Islands if flights originated on the Kenai Peninsula and stayed, as geography permits, near land until crossing of the entrances of Cook Inlet was required to reach drill (or production) sites on the far sides of the Barren Islands.

Major rookeries in and near the Cook Inlet include Outer Island, Sugarloaf Island, Marmot Island, Chirikof Island, and Chowiet Island. There are several major haulouts in and near the Cook Inlet, 20-NM aquatic zones, and an aquatic foraging area in Shelikof Strait. All of these are part of Steller sea lion critical habitat. Support-vessel traffic would be unlikely to adversely affect these habitats as long as operators avoided transiting near to the rookeries or haulouts or deliberately approaching sea lions in the water. Critical habitat of Steller sea lions is unlikely to be impacted by exploration activities. As noted above, terrestrial zones are legally protected from activities degrading them by disturbance. Shelikof Strait was designated as critical habitat because of its proximity to major rookeries and important haulouts, its use by foraging sea lions and its value as an area of high forage-fish production. Any adverse impacts of oil and gas development that adversely affect the production and availability of prey to Steller sea lions in this and other critical habitat could adversely modify the habitat. Aircraft restrictions associated with Steller sea lion critical habitat protection (50 CFR 223.202; 50 CFR 226.202) could further reduce the likelihood of helicopter flights impacting designated rookery sites for this listed species. Careful planning of flight paths to avoid rookeries and haulouts of other pinnipeds could further reduce or eliminate the potential for disturbing animals in these habitats.

Boat traffic associated with OCS oil and gas exploration activity could disturb sea otters in specific areas. In summer, these impacts are likely to be insignificant compared to the quantity of fishing, tourism, shipping, and other boat traffic in the region. In winter, boat traffic in a remote region could have local impacts on distribution of females and pups. Garshelis and Garshelis (1984) reported that sea otters in Prince William Sound avoided waters with frequent boat traffic but reoccupy these areas when boats are less frequent. Rotterman and Monnett (2002) concluded that disturbance after the *Exxon Valdez* oil spill was sufficient to keep sea otters from feeding habitat in certain bays in oiled areas of Prince William Sound. Udevitz et al. (1995) reported that about 15% of sea otters along boat survey transects are not detected because they move away from the approaching boat. Boat traffic could disturb resting patterns of sea otters. Sea otters in Alaska haul out regularly. Sea otters that are hauled out will often move into the water with the approach of a boat. Garrott et al. (1993) reported that sea otters on shore would move into the water with approach of a single small motorboat moving parallel to and 100 m (328 ft) from shore.

As previously discussed, the FAA Advisory Circular 91-36D (FAA 2004) encourages pilots to maintain higher than minimum altitudes over noise-sensitive areas. Also, guidelines and regulations issued by NMFS under the authority of the MMPA include provisions specifying helicopter pilots to maintain an altitude of 305 m (1,000 ft) within 91 m (300 ft) of marine mammals (MMS 2007e). Helicopter operations would only be expected to occur below specified minimums during inclement weather. In MMS (2007e), it was concluded that this could occur for about 10% of helicopter operations. Because of the low level of vessel and aircraft traffic that could occur under the proposed action, potential impacts to marine mammals from this traffic would likely be limited to a few individuals, be largely short-term in nature, and not result in population-level effects.

<u>Decommissioning.</u> Under the proposed action, no platforms will be removed with explosives from the Cook Inlet Planning Area. Therefore, potential impacts of decommissioning on marine mammals, as summarized in Figure 4.4.7-4 (Section 4.4.7.1.1), will not occur.

Impacts of Expected Accidental Spills. Accidental oil spills are expected to occur in Cook Inlet under the proposed action (Section 4.4.2). Table 4.4.2-1 presents the oil spill assumptions for the proposed action, while Figure 4.4.7-5 (Section 4.4.7.1.1) presents a conceptual model for potential effects of oil spills on marine mammals. It is assumed that as many as 15 very small oil spills (≤50 bbl), 3 small oil spills between 50 and 1,000 bbl, and 1 large spill greater than 1,000 but less than 75,000 bbl could occur under the Program. Small oil spills (≤1,000 bbl) break-up and dissipate within hours to a day (MMS 2009a). Larger spills, particularly those that continue to flow fresh hydrocarbons into waters for extended periods (i.e., days, weeks, or months), pose an increased likelihood of impacting marine mammal populations (MMS 2008b). While the numbers of spills have been steadily decreasing since the 1970s, operational discharges such as tank washing with seawater, oil content in ballast water, and fuel oil sludge are among the sources of small oil spills from tankers (Jernelöv 2010). Large oil spills from tankers have decreased significantly in recent years (modern tankers have double hulls and are sectioned to prevent losing the ship's entire cargo and sea lanes have been established) while spills from ageing, ill-maintained or sabotaged pipelines have increased.

Characteristics of impacts (i.e., acute vs. chronic impacts) depend on the magnitude, frequency, location, and date of accidents; characteristics of spilled oil; spill-response capabilities and timing; and various meteorological and hydrological factors. Chronic or acute exposure may result in harassment, harm, or mortality to marine mammals. Studies have shown varying results. Bottlenose dolphins made no consistent avoidance of spilled oil (Smultea and Würsig 1995); however, marine mammals have been observed apparently detecting and avoiding slicks in other cases (Geraci and St. Aubin 1988). Marine mammals' exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick may result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) to marine mammals.

Impacts on marine mammals from exposure to oil spills could include decreased health, reproductive fitness, and longevity, and increased vulnerability to disease. Spilled oil can cause soft tissue irritation, fouling of baleen plates, respiratory stress from inhalation of toxic fumes (e.g., irritation and damage to mucus membranes), food reduction or contamination, direct ingestion of oil and/or tar, and temporary displacement from preferred habitats (St. Aubin and Lounsbury 1988; Geraci and St. Aubin 1980, 1988). The long-term impacts to marine mammal populations are poorly understood but could include decreased survival and lowered reproductive success. One assumption concerning the use of dispersants is that the chemical dispersion of oil will considerably reduce the impacts to marine mammals, primarily by reducing their exposure to petroleum hydrocarbons (French-McCay 2004; NRC 2005b). However, the impacts to marine mammals from chemical dispersants could include nonlethal injury (e.g., tissue irritation, inhalation), long-term exposure through bioaccumulation, and potential shifts in distribution from some habitats. Water and air quality degradation associated with response and cleanup vessels could also affect marine mammals.

Impacts on marine mammals from smaller accidental spill events could adversely affect individual marine mammals, but are unlikely to rise to the level of population-level effects, given the size and scope of such spills. Assuming that all small spills would not occur at the same time and place, water quality could rapidly recover and therefore not have significant effects on marine mammals or their prey species. The potential effects associated with a large spill could be more adverse than a smaller accidental spill and could potentially contribute to longer-lasting effects. Impacts from dispersants are unknown, but they could be irritants to tissues and sensitive membranes (NRC 2005b).

Small and large spills occurring in the Cook Inlet Planning Area are not expected to affect the listed blue, sei, sperm, or North Pacific right whales, as these species occur only infrequently, if at all, within the area (MMS 2003e). However, it is important to note that any impacts that affect the survival or reproductive capacity of individuals of species that are already declining (listed species) could result in population-level impacts. The endangered beluga, fin, and humpback whales, as well as the minke and killer whales, which do occur within or in the vicinity of the Cook Inlet Planning Area, could be affected by accidental spills occurring in or reaching the Shelikof Strait. Gray whales migrating past Cook Inlet could be exposed to accidental spills occurring near the Kennedy and Stevenson entrances to Cook Inlet. Accidental spills in the Cook Inlet Planning Area could also expose beluga whales and smaller cetacean species (such as Dall's porpoise) and pinnipeds foraging in open marine waters. Because of the small number and mostly small size of spills expected under the proposed action, anticipated exposures of most of these species to spilled oil would be temporary and likely affect only a few individuals (MMS 2003e). However, a large oil spill in upper Cook Inlet could severely impact beluga whales and put the population at risk (NMFS 2008a).

Oil spills could have serious impacts on pinnipeds during periods when they are concentrated at rookeries (typically, late spring, summer, and early fall). At such times, spills and/or spill response operations have the potential to disturb hundreds of pinnipeds. If a spill contaminates a rookery, a significant population decline could occur (Calkins et al. 1994). Sea otters, sea lions, and harbor seals had elevated hydrocarbon levels in areas contaminated by the *Exxon Valdez* oil spill; but only sea otters and harbor seals showed population declines associated with the spill (Loughlin et al. 1996). The findings for harbor seals were refuted by Hoover-Miller et al. (2001). They concluded that rather than high unsubstantiated mortality, the evidence was more consistent with harbor seals avoiding or moving away from oiled haulouts. Also, the cause of deaths of the harbor seals recovered (mostly pups) could not be determined, nor could the proportion of individuals that would have died naturally.

Spills occurring in or reaching coastal areas, especially sheltered coastal habitats such as bays and estuaries, pose the greatest risk to marine mammals. These spills may be more likely to affect species such as the sea otter and the Steller sea lion that use coastal habitats for pupping, foraging, and resting. A large spill contacting an active pinniped rookery site could result in population-level effects for some species, while spills in nearshore areas could result in the direct oiling of large numbers of pinnipeds and sea otters, and adversely affect local populations of some of these species (primarily the sea otter and fur seals), while sublethal effects may be incurred by all individuals ingesting or inhaling spilled oil.

As discussed in Section 4.4.7.1.1, oil spill response activities may affect marine mammals through exposure to spill response chemicals (e.g., dispersants or coagulants) and through behavioral disturbance during cleanup and restoration operations. The chemicals used during a spill response are toxic, but are considered much less so than the constituents of spilled oil (Wells 1989), although there is little information regarding their potential effects on marine mammals. The presence of, and noise generated by, oil spill response equipment and support vessels could temporarily disturb marine mammals in the vicinity of the response action, with affected individuals likely leaving the area. While such displacement may affect only a small number of animals, cleanup operations disturbing adults in pup-rearing areas may decrease pup survival and result in population-level effects. While some smaller marine mammal species such as seals and otters can be collected and examined closely, impacts on whales from oil spills are difficult to assess because large numbers of most of the species cannot be easily captured, examined, weighed, sampled, or monitored closely for extended periods of time.

If loss of control of a natural gas well occurs and results in explosion and fire, beluga whales or other marine mammals in the immediate vicinity could be killed. Natural gas and gas condensates that did not burn would be hazardous to any organism exposed to high concentrations. Effects from losses of natural gas well control are likely to be short-term and localized, lasting a year or less and extending for about 1.6 km (1 mi) (MMS 2003a).

Impacts of an Unexpected Catastrophic Discharge Event. A CDE in the Cook Inlet Planning Area would be a possible, but unexpected, very low-probability event under the five-year plan. The PEIS analyzes an unexpected CDE in the Cook Inlet Planning Area that ranges from 75 to 125 thousand bbl that lasts from 50 to 80 days (Table 4.4.2-2). If a CDE occurs, there is greater potential for more severe effects compared to the risk of effects from an assumed large oil spill. A CDE would result in sustained degradation of water quality and, to a lesser extent, air quality that would impact marine mammals from direct contact, inhalation, and ingestion (either directly or indirectly through the consumption of oiled forage or prey species). These effects would be significant, causing a multitude of acute and chronic effects. Additional effects on marine mammals would occur from water and air quality degradation associated with response and cleanup vessels, *in situ* burning of oil, dispersant use, discharges and seafloor disturbances from relief well drilling, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring. Contraction of the Cook Inlet beluga whale population northward into the upper portions of the inlet makes the population more vulnerable to a CDE (NMFS 2008a). A CDE in Cook Inlet would potentially impact marine mammals throughout much of south central Alaska and has the potential to increase the area and duration of an oil spill, thereby increasing the potential for population-level effects, or at a minimum, an increase in the number of individuals killed.

One resident killer whale pod (AB Pod) and one transient killer whale population (AT1 Group) suffered losses of 33 and 41%, respectively, in the year following the *Exxon Valdez* oil spill. Sixteen years after the spill, the resident pod had not returned to pre-spill numbers, while the transient population lost nine members following the spill and continued to decline to the point that it is listed as depleted under the MMPA (Matkin et al. 2008). Additionally, sea otters and harbor seals showed population declines associated with the spill (Loughlin et al. 1996). An estimated 3,905 sea otters were killed by the *Exxon Valdez* oil spill (DeGange et al. 1994). Sea otter abundance in some oiled areas remains under pre-spill estimates, suggesting that sea otters have not fully recovered (USFWS 2008). Oiling and ingestion of oil-contaminated shellfish may have affected reproduction and caused a variety of long-term sublethal effects (Fair and Becker 2000). The recovery of sea otters may be constrained by residual spill effects resulting from elevated mortality and emigration (Bodkin et al. 2002). An estimated 302 harbor seals were killed by the *Exxon Valdez* oil spill, probably due to the inhalation of toxic fumes (Frost and Lowry 1994). Subsequent investigations revealed that there were no significant quantities of oil in the tissues (liver, blubber, kidney, and skeletal muscles) of harbor seals exposed to the *Exxon Valdez* spill (Bence and Burns 1995), and that the cause of the decreasing trend in harbor seal numbers since the spill (4.6% per year) is complicated because seal populations were declining prior to the spill (Frost et al. 1999). As previously discussed, Hoover-Miller et al. (2001) also refuted Frost and Lowry's (1994) findings for harbor seals.

During an oil spill off Santa Barbara in 1969, an estimated 80,000 bbl of oil may have entered the marine environment. Gray whales, beginning their annual northern migration during the spill event, swam through the slick. Several dead whales were observed and six carcasses recovered. No link was established between oil contamination and the death of the gray whales. Also, no effects on the gray whale population or migration were observed (BOEMRE undated). The Battelle Memorial Institute concluded the whales were either able to avoid the oil or were unaffected when in contact with it. Similarly, extensive beached carcass surveys made after the *Exxon Valdez* oil spill included a number of gray whales. The number of carcasses found was the result of such an atypical survey effort and were comparable to gray whale strandings along the Pacific coast, well south of the *Exxon Valdez* oil spill area.

MMS (2003a) provided an assessment of an unexpected, low-probability CDE on marine mammals in the Cook Inlet Planning Area. In that assessment, it was determined that individuals or small groups of humpback, fin, and beluga whales, and potentially larger groups of humpback whales, could be exposed, injured, or potentially killed. At a minimum, this could cause short-term changes in the local distribution and abundance of these species. A population-level impact to humpback whales could potentially occur if a CDE occurred in the Barren Islands area when large numbers of humpback whales are present and feeding. Fin whales would be vulnerable to a CDE if oil entered the Shelikof Strait at any time of the year; humpback whales would primarily be vulnerable from late spring through late fall. Beluga whales from the Cook Inlet DPS could incur both direct and indirect adverse impacts, particularly during the winter months when they occur in the middle and lower reaches of Cook Inlet. A CDE could potentially result in a population-level impact to the beluga whale DPS. Some Steller sea lion rookeries and haulouts could be exposed to oil from a CDE. A population-level effect could occur if pups are on the rookeries or large numbers of sea lions are exposed when on haulouts. Possible population-level effects could also occur to sea otters. Impacts could also occur to most of these marine mammal species if their prey are significantly reduced or contaminated by a CDE. Other cetaceans such as harbor seals, Dall's porpoise, and killer and gray whales could potentially encounter oil. Some individuals could potentially be killed (e.g., if they inhaled lethal amounts of toxic fumes). If such losses occurred in a family group of killer whales, recovery could take more than one generation (e.g., more than 10 years).

Impact Conclusions.

Routine Operations. Within the Cook Inlet Planning Area, noise generated during seismic surveys, exploration and production activities, platform removal, and by OCS-related vessels and helicopters may temporarily disturb some individuals. Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification, although the scope of effects and their magnitude are not known. However, this information is not essential to the determination of a reasoned choice among alternatives. Small numbers of marine mammals could be killed or injured by chance collision with service vessels and by eating indigestible debris, particularly plastic items, lost from service vessels, drilling rigs, and platforms. While vessels may collide with marine mammals, the most likely impact on marine mammals would be changes in behavior (e.g., avoidance responses). Normal behavior is expected to return once a vessel or helicopter has passed. The potential also exists for some individuals to entangle in OCS-related trash and debris.

Overall, impacts on marine mammals could range from negligible to moderate. Many of the listed cetacean species occur infrequently, if at all, within the Cook Inlet Planning Area and thus would not be expected to be affected by normal operations. However, some areas inhabited by the Cook Inlet beluga DPS, including portions of their critical habitat, overlap the Cook Inlet Planning Area.

Expected Accidental Spills. Any of the oil spill scenarios developed for the proposed action (Section 4.4.2) may expose marine mammals from the Cook Inlet Planning Area to oil or its weathering products. The magnitude of effects from accidental spills would depend on the location, timing, and volume of the spills; the environmental settings of the spills (e.g., restricted coastal waterway, deepwater pelagic location); and the species (and its ecology) exposed to the spills. Spill cleanup operations could result in short-term disturbance of marine mammals in the vicinity of the cleanup activity, while a collision with a cleanup vessel could injure or kill the affected individual.

Overall, small oil spills ≤50 bbl are expected to have negligible to minor impacts on marine mammals. Small spills (>50 bbl) and large spills (≥1,000 bbl) are expected to have minor to moderate impacts on marine mammals. Oil spill impacts on species that are extralimital to rare are expected to be negligible to minor, but could in unusual circumstances be moderate to major depending on the number of individuals contacted by a spill. Impacts on marine mammals from oil spill response activities are expected to be minor.

An Unexpected Catastrophic Discharge Event. In the case of an unexpected, low-probability CDE, there is greater potential for more severe and population-level effects compared to a large oil spill (i.e., impacts could be moderate to major on one or more species of marine mammals). The combination of a CDE and cleanup efforts could persist beyond one season, perhaps lasting several years.

Terrestrial Mammals. There are approximately 40 species of terrestrial mammal that occur in southern Alaska. Among these, 10 species may regularly use mainland and island habitats adjacent to or near the Cook Inlet Planning Area (Section 3.8.1.2.2), and thus could be affected by OCS-related activities.

Impacts of Routine Operations. Under the proposed action, up to 80 km (50 mi) of new onshore pipeline would be installed along Cook Inlet, which could result in up to 364 ha (900 ac) of soil disturbance. The area disturbed represents an extremely small portion of terrestrial wildlife habitat that occurs inshore of the Cook Inlet Planning Area. Wildlife are expected to avoid the area where construction of new pipeline is occurring. Few additional impacts, other than those that might occur from helicopter overflights, would occur on terrestrial mammals. Helicopter traffic could disturb wildlife near the existing onshore facilities and pipelines or along the overland portions of flight paths between the existing onshore facilities and new offshore platforms. The aircraft effects on wildlife vary by species, habitat type, and the wildlife activity occurring at the time of the overflight. During overflights, some wildlife will cease their normal behaviors until the aircraft has passed and then resume their normal activity; others may flee the area, while some species may become habituated and experience no disturbance (Harting 1987). Aircraft overflights would be relatively infrequent (no more than three flights per week per offshore platform). Thus, no long-term, population-level effects are expected from aircraft overflights associated with routine operations.

Impacts of Expected Accidental Spills. An offshore oil spill that contaminates beaches and shorelines could affect terrestrial mammals, such as the Sitka black-tailed deer, brown bear, and river otter, that forage in intertidal habitats (*Exxon Valdez* Oil Spill Trustees 1992). An onshore oil spill could similarly affect terrestrial animals, such as American black bear or moose that may forage in the area of the onshore pipeline. Spills contacting high-use areas, such as coastal habitats along Shelikof Strait heavily used by brown bears, could locally affect a relatively large number of animals (MMS 2003e). The impacts on wildlife from an oil spill would depend on such factors as the time of year and volume of the spill, type and extent of habitat affected, and home range or density of the wildlife species. The potential effects on wildlife from oil spills could occur from direct contamination of individual animals, contamination of habitats, and contamination of food resources (ADNR 1999). Acute (short-term) effects usually occur from direct oiling of animals, while chronic (long-term) effects generally result from such factors as accumulation of contaminants from food items and environmental media (e.g., sediments). Terrestrial mammals directly contaminated by an accidental release of oil could inhale volatile organics and/or ingest oil while grooming contaminated fur (MMS 1996b). Exposure may also occur through the consumption of contaminated foods. The moose and opportunistic omnivores, such as brown and American black bears, may experience a greater potential of exposure than many other wildlife species. Staging and support activities for a large spill cleanup could temporarily displace terrestrial mammals not only from the contaminated habitats but also from nearby uncontaminated habitats. Depending on the effectiveness of the cleanup activities, chronic oil exposure may continue for years in some habitats.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected, very low-probability CDE of 75 to 125 thousand bbl lasting 50 to 80 days (Table 4.4.2-2). If a CDE occurs, there is greater potential for more severe effects compared to the risk of effects from an assumed large oil spill. A CDE would result in sustained degradation of water quality, shoreline terrestrial habitats, and, to a lesser extent, air quality that could impact terrestrial mammals from direct contact, inhalation, and ingestion (either directly or indirectly through the consumption of oiled forage or prey species). These effects could be significant, causing a multitude of acute and chronic effects. Additional effects on terrestrial mammals would occur from land and air quality degradation associated with response and cleanup vessels, *in situ* burning of oil, dispersant use, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring. A CDE has the potential to alter terrestrial mammal habitats and populations. However, only minor impacts to terrestrial mammals were observed from the *Exxon Valdez* oil spill. No Sitka black-tailed deer were found whose death could be attributed to the *Exxon Valdez* oil spill. However, some deer that fed on kelp in the intertidal areas had slightly elevated concentrations of petroleum hydrocarbons in their tissues (*Exxon Valdez* Oil Spill Trustees 1992). Several river otter carcasses were found following the *Exxon Valdez* oil spill. Analysis showed that they accumulated petroleum hydrocarbons. Also, home ranges in oiled areas were twice that of unoiled areas, suggesting that increased foraging was required to find sufficient food resources. Body lengths, weights, and dietary diversity were also lower in oiled areas (*Exxon Valdez* Oil Spill Trustees 1992). Sellers and Miller (1999) examined the impacts of the *Exxon Valdez* oil spill on Katmai National Park coastal brown bears from 1989 through 1995. Four of the 27 fecal samples from bears captured in 1989 contained hydrocarbons, indicating exposure to crude oil. Many bears remained at higher elevations during May 1989 and, thus, were not present along the coastal areas where most oiled carcasses that bears could have consumed occurred. Oil may have caused the deaths of two yearling brown bears. However, no population-level impacts on the bears of Katmai were indicated (Sellers and Miller 1999).

MMS (2003a) provided an assessment for a low-probability CDE on select terrestrial mammals that occur in the Cook Inlet Planning Area. It was determined that oil from a CDE could cause the loss of up to 50 river otters, 20 brown bears, and 20 Sitka black-tailed deer. River otter habitat could remain contaminated for up to 5 years and brown bear habitat for more than 1 year. If oil contaminated the shorelines of Raspberry, Afognak, and Kodiak Islands, elk and Sitka black-tailed deer could be impacted by direct oiling or by consuming oiled vegetation. No population-level impacts were expected.

Impact Conclusions.

<u>Routine Operations.</u> Up to 120 km (75 mi) of onshore pipeline would be constructed and operated as part of the proposed project; thus impacts to terrestrial mammals would include a minor loss or modification of habitat and behavioral responses associated with occasional helicopter traffic to and from new platforms. Loss or modification of habitat for the pipeline would affect a very minor amount of wildlife habitat within the Cook Inlet area. The disturbance of wildlife by helicopter flights would be short-term in nature and not expected to result in population-level effects. Overall, routine operations associated with the proposed action will have negligible to minor impacts on terrestrial mammals along the shorelines of Cook Inlet.

<u>Expected Accidental Spills.</u> Oil spills may expose terrestrial mammals to oil or its weathering products. In the event of an expected accidental small or large spill, terrestrial mammals may be exposed via ingestion of contaminated food, inhalation of airborne oil droplets, and direct ingestion of oil during grooming, which may result in a variety of lethal and sublethal effects. However, because most spills would be relatively small (<1,000 bbl and most <50 bbl), relatively few individuals would likely be exposed. While some individuals may incur lethal effects, population-level impacts would not be expected. Cleanup activities could temporarily disturb terrestrial mammals, causing those animals to move from preferred to less optimal habitats, which, in turn, could affect overall condition. Such displacement would be limited to

those relatively few animals in the vicinity of cleanup activities, and thus would not be expected to result in population-level effects. Overall, accidental oil spills and associated cleanup activities are expected to have negligible to minor impacts to terrestrial mammals. Habitat recovery from small spills would probably require no more than a year.

An Unexpected Catastrophic Discharge Event. In the case of an unexpected, very low-probability CDE, there is greater potential for terrestrial habitats to be impacted compared to an assumed large oil spill. Impacts to terrestrial mammals could be minor to major. The combination of a CDE and cleanup efforts could persist beyond one season, perhaps lasting several years.

4.4.7.1.3 Alaska – Arctic.

Marine Mammals. There are 15 resident or seasonal species of marine mammals in the Arctic region, including 9 species of cetaceans, 5 species of pinnipeds, and 1 fissiped species (Table 3.8.1-4; Section 3.8.1.3.1). All of the species occur in the Chukchi Sea; the Pacific walrus and the bearded and ribbon seals also occur in the western portions of the Beaufort Sea, while the ringed and spotted seals, bowhead and beluga whales, and polar bear occur throughout both seas (Section 3.8.1.3.1). The endangered fin and humpback whales are only occasional transients in the southern portion of the Chukchi Sea during summer. The endangered bowhead whale migrates through the Chukchi and Beaufort Seas between its wintering grounds in the Bering Sea and its summering grounds primarily in the Canadian portion of the Beaufort Sea (Figure 3.8.1-4; Section 3.8.1.3.1). However, some individuals remain in the Alaska portion of the Beaufort Sea and in the Chukchi Sea during summer. Thus, the bowhead whale has the greatest potential of the endangered whale species to occur in areas where OCS-related activities are occurring and be affected by normal operations or oil spills. The potential for this would be most probable during the bowhead whale’s spring and fall migrations that generally occur from March through June and September through November, respectively (Allen and Angliss 2011).

There are at least 9 species of seasonal or resident cetaceans- bowhead, fin, humpback, minke, gray, beluga, and killer whales; harbor porpoise (Suydam and George 1992) occur with rare or observational accounts of narwhals. Bearded seals occur throughout the Beaufort Sea and into the Canadian High Arctic and Greenland. There are more seasonal residents (3,150) than year-long resident bearded seals, but some seals remain in the Beaufort year-round. Spotted seals have small haul-outs east to the Colville River Delta and historically to Prudhoe Bay. Spotted seals are rare past Harrison Bay and are not known to occur throughout the Beaufort Sea. Gray whales occur primarily nearshore and are occasionally found as far east as the Canadian Beaufort Sea. The continental shelf in the Beaufort is much narrower than in the Chukchi, and therefore it can support fewer gray whales. Humpback whales have been observed nearshore in the Chukchi Sea and as far east as the Western Beaufort Sea. Observations of fin whales have occurred in the southern and east central Chukchi Sea. Observations of a few individuals have been more consistent over the last five years during the open water period.

Impacts of Routine Operations. Table 4.4.7-1 (Section 4.4.7.1.1) illustrates how each of the impacting factors associated with OCS oil and gas development may affect marine mammals and their habitats, while Figure 4.4.7-1 (Section 4.4.7.1) presents a conceptual model of potential impacting factors for marine mammals from oil and gas-related activities (including accidental oil spills). The following text presents an overview of potential impacts to marine mammals in and near the Beaufort and Chukchi Sea Planning Areas from the following routine operations (seismic surveys, construction of offshore facilities and pipelines, operations of offshore facilities and drilling rigs, discharges and waste generation, service vessel and helicopter traffic, and decommissioning) and from accidents. NMFS' policy has been to use the 180 dB rms isopleths, where onset Level A harassment from acoustic sources potentially begins for cetaceans and 190 dB rms for pinnipeds. The Level B harassment onset level is 160 dB rms isopleth for impulsive noise and 120 dB rms for non-pulse noise.

Seismic Surveys. During offshore exploration, seismic surveys conducted in offshore areas and in lagoon systems could affect marine mammals. Seismic surveys generally occur during the ice-free periods, normally from July to October (NMFS 2002). In the Beaufort Sea, there are also on-ice seismic surveys, which may impact ice seals and polar bear. Noise generated by seismic surveys may have physical and/or behavioral effects on marine mammals, such as hearing loss, discomfort, and injury; masking of important natural sound signals, including communications among individual whales; behavioral responses such as flight, avoidance, displacement of migration route, and changes in physical or vocal behavior (Richardson et al. 1995; Davis et al. 1998; Gordon et al. 1998; MMS 2003e). It has not been possible to predict the type or magnitude of responses to such surveys (and other oil and gas activities) nor to evaluate the potential effects on populations (NRC 2003a). However, there is no evidence to suggest that routine seismic surveys may result in population-level effects for any of the marine mammal species. Cudahy and Ellison (2002) indicated that tissue damage from exposure to underwater low-frequency sound will occur at a damage threshold on the order of 180 to 190 dB or higher. There have been no documented instances of deaths, physical injuries, or physiological effects on marine mammals from seismic surveys (MMS 2004c).

Noise from airguns and survey vessels could disturb nearby marine mammals that may be foraging in open waters or using floe ice for resting, birthing, and the rearing of young. These disturbances would be largely limited to the immediate area of the survey vessel, although animals within a few kilometers of seismic operations may be affected (Richardson et al. 1986). Because cetaceans and pinnipeds are highly mobile species, they may leave an area when a seismic survey is initiated, thereby greatly reducing their exposure to maximal sound levels and, to a lesser extent, masking frequencies. However, if they surveys occur during the winter or spring when areas of open water are restricted or isolated, young ringed or bearded seals may have some difficulty avoiding the on-ice seismic surveying, and if there are ice breakers, some ringed seal pups could be crushed inside of their lairs. If an animal is able to relocate, would likely resume its normal behavioral patterns. During the open water season, displaced or disturbed individuals may return to the area and/or resume normal behavioral patterns after the survey activities have ceased, but this is not necessarily also true for individuals displaced from on-ice seismic surveys.

Among cetaceans, the odontocetes generally demonstrate relatively poor low-frequency hearing sensitivity, and thus might not be expected to experience hearing loss from seismic surveys (unless they are in close proximity to airgun arrays) (MMS 2004a). The odontocetes in the Arctic region (beluga and killer whales and the less frequently encountered harbor porpoise and rare narwhal) may respond behaviorally to seismic surveys by leaving the areas where seismic surveys are being conducted. Unless the surveyed area is further developed, such displacement would be temporary and not expected to result in long-term impacts to either individual animals or populations of these species.

The mysticetes, which include the endangered bowhead, fin, humpback whales, as well as gray and minke whales, are considered to possess good hearing sensitivity at low frequencies down to approximately 10 Hz, and many of their vocalizations occur in the low tens to a few hundred Hz (Richardson et al. 1995; Crane and Lashkari 1996; Ketten 1998; Stafford et al. 1998). Seismic survey airgun arrays output maximal energy in the region of a few tens of Hz, which overlaps with the expected lower end of the hearing sensitivity of mysticetes. Thus, the mysticetes that occur regularly in the Chukchi and Beaufort Seas may be affected by seismic surveys. Exposure of these whales to maximal airgun output during a seismic survey may result in behavioral changes such as area avoidance or short-term or long-term hearing loss, while less than maximal exposure could result in masking effects (Ljungblad et al. 1988; Malme et al. 1989). It may also alter or deter migration paths and displacement may then result in fewer feeding opportunities where prey are aggregated.

Bowhead whales can detect sounds produced by seismic pulses from 10 to 100 km (6 to 62 mi) away from the source (MMS 2002a). Bowheads have been rarely observed within 20 km (12 mi) of where airguns are operating. However, occurrences of bowheads within 20 km (12 mi) are similar to those outside this radius about 12 to 24 hours after seismic operations cease (MMS 2002a). At seismic pulses as high as 248 dB re 1 μPa-m, bowhead whales respond by orienting away from the seismic vessels at distances up to 7.5 km (4.7 mi) (Richardson et al. 1986). While high-energy noises have the potential to permanently harm cetaceans, there is evidence that some cetaceans may habituate to lower-energy noises. For example, Richardson et al. (1986) found that bowhead whales initially responded to moderate underwater noise levels (110 to 115 dB re 1 μPa-m) by avoiding areas in which seismic exploration activities were occurring, but later became tolerant to prolonged noise exposure. Migrating bowhead whales have also been shown to exhibit avoidance of a 20-km (12-mi) area around seismic surveying where received levels were estimated to be approximately 120 to 130 dB re 1 μPa at 1 m (Richardson et al. 1999). Given their mobility and avoidance reactions to approaching seismic vessels, it is unlikely that whales would occur close to injurious noise levels (MMS 2003e). Some bowhead whales may tolerate noise levels that may reach injury levels when they are engaged or highly motivated during behaviors such as feeding, while others may exhibit more sensitivity, such as females with calves. Quakenbush et al. (2010) documented the interaction of one bowhead whale and a seismic vessel. The whale stayed at least 9.2 km (5.7 mi) from the ship. The seismic activity did not apparently affect overall whale behavior, as the whale remained in the area after seismic activity ceased. Also, the seismic activity did not cause a long-term disruption in feeding or migratory behaviors (Quakenbush et al. 2010).

Todd et al. (1996) found that humpback whales exhibited little behavioral reaction to underwater anthropogenic noises as high as 153 dB re 1 μPa. However, Richardson et al. (1990) observed that bowhead whales in close proximity to underwater anthropogenic noise sources (<1 km [0.6 mi]) reacted to sound levels as low as 122 dB re 1 μPa by ceasing their feeding behaviors and moving away from the noise source. Watkins and Schevill (1975) observed sperm whales cease vocalization behaviors in the presence of underwater anthropogenic sounds at frequencies between 6 and 13 kHz. Anthropogenic underwater noises as low as 180 dB re 1 μPa can elicit startle reactions and avoidance behaviors in sperm whales and gray whales (Malme et al. 1984; Andre et al. 1997). Malme et al. (1984) also observed behavioral reactions (avoidance) in gray whales in response to received levels of around 164 dB re 1 μPa at 1 m (3 ft); and Richardson et al. (1995) reported that individual gray whales that reacted to noise generally slowed, turned away from the noise source, and increased their respiration rates. Humpback whales off the western coast of Australia changed course at 3 to 6 km (1.9 to 3.7 mi) from an operating seismic survey vessel, with most animals maintaining a distance of 3 to 4 km (1.9 to 2.5 mi) from the vessel. Humpback whale groups containing females involved in resting behavior were more sensitive than migrating animals and showed an avoidance response estimated at 7 to 12 km (4.3 to 7.5 mi) from a large seismic source (McCauley et al. 2000).

As discussed for the GOM (Section 4.4.7.1.1), it is assumed that BOEM will continue to require ramp-up of seismic activities coupled with visual monitoring and clearance within an exclusion zone around a seismic array. These actions would reduce the potential for cetaceans to be exposed to sound levels that could affect hearing or behavior. The avoidance reactions of whales to approaching seismic vessels would normally prevent exposure to potentially injurious noise pulses (NMFS 2002). The geographic scale of any potential noise effect is probably relatively small compared to the total habitat used by whales in the Chukchi and Beaufort Seas (MMS 2004c). For example, in the Chukchi Sea, fall migrating bowhead whales are commonly seen from the coast to about 150 km (93 mi) offshore (MMS 2004c), while fall migration in the Beaufort Sea occurs over a 100 km (62 mi) wide corridor (Malme et al. 1989).

Pinnipeds in close proximity to sources of seismic noise may experience intense sound pressure levels that could cause temporary hearing loss by masking ambient noise levels, causing damage to hearing structures and body tissues (Richardson et al. 1995). Generally seals move away from seismic vessels, although some are observed swimming in the bubbles generated by large seismic airgun arrays (MMS 2003e).

Walrus hearing has been reviewed in the Pacific Walrus Status Review (Garlich Miller et al. 2011). If exposed to seismic surveys, some walruses may be temporarily displaced or may even experience temporary threshold shifts in hearing. Seismic surveys occur in open water where walruses may be feeding or passing through but are less likely to be present in large numbers (BOEMRE 2010d).

Noises associated with seismic surveys are less likely to harm fissipeds than cetaceans (MMS 2007e). It is unlikely that polar bears are affected by seismic noise in water, as they swim with their heads above water, reducing the risk of hearing damage. In contrast, on-ice seismic work during the winter is more apt to disturb polar bears. Females with cubs will abandon den sites when a seismic crew is operating nearby (Amstrup 1993; Linnell et al. 2000). Premature den abandonment could lead to an increase in cub mortality. Polar bears are sensitive to noise (Nachtigall et al. 2007), thus bears in the vicinity of a seismic survey may leave the area. Female bears excavate dens in snow on drifting pack ice and on land. Pregnant females and females with newborn cubs in maternity dens are sensitive to noise and may be disturbed by seismic exploration, and have been reported to abandon den sites when seismic crews are operating nearby (Amstrup 1993). Such abandonment of a maternity den, even if short-term, could reduce cub survival. In addition, polar bears encountered along seismic survey lines may be killed in defense of life and property, although regulatory agencies and the oil and gas industry have made serious efforts to minimize interactions with polar bears (NRC 2003a). However, companies are required to search for dens prior to the onset of work and are also required to maintain a 1-mile buffer around the dens, which, so far, appears to be an effective mitigation measure.

For more information on potential effects to marine mammals from seismic exploration, see the MMS Programmatic Environmental Assessment for Arctic Ocean Outer Continental Shelf Seismic Surveys (MMS 2006c). In summary, seismic noise can alter ambient noise levels, damage marine mammal hearing structures, and cause direct physical injury to marine mammals. Potential effects caused by these stressors include:

- Temporary increased susceptibility to injury, mortality, or predation due to noise masking (e.g., communication, predator avoidance);
- Temporary disturbance of normal behavior;
- Temporary avoidance of habitat;
- Increased susceptibility to injury, mortality, or predation due to hearing loss; and
- Reduced survival due to physical injury.

<u>Construction of Offshore Platforms and Pipelines.</u> As part of the proposed action, 6 to 16 exploration wells and 40 to 120 production wells will be drilled in the Beaufort Sea, while 1 to 20 exploration wells and 60 to 280 production wells will be drilled in the Chukchi Sea. There will also be 1 to 4 platforms in the Beaufort Sea and 1 to 5 platforms in the Chukchi Sea. Additional offshore activities planned as part of the proposed action include 10 subsea production wells and 48 to 217 km (30 to 135 mi) of new offshore pipeline in the Beaufort Sea, and between 18 and 82 subsea production wells and 40 to 402 km (25 to 250 mi) of new offshore pipeline in the Chukchi Sea (Table 4.4.1-4).

Noise and human activity associated with construction of offshore facilities and pipelines could disturb marine mammals that may be present in the vicinity of the construction site. Construction activities could disturb normal behaviors (e.g., feeding, social interactions), mask calls from conspecifics, disrupt echolocation capabilities, and mask sounds generated by predators or prey. Generally, the immediate response of disturbed individuals is to leave or avoid the construction area. From a behavioral perspective, increased anthropogenic noise could interfere with communication among cetaceans, such as gray, minke, beluga, and killer whales and harbor porpoise, mask important natural and conspecific sounds, or alter natural behaviors (i.e., displacement from migration routes or feeding areas, disruption of feeding or nursing). Behavioral impacts appear to be affected by the animal's sex and reproductive status, age, accumulated hearing damage, type of activity engaged in at the time, group size, and/or whether the animal has heard the sound previously (e.g., Olesiuk et al. 2002; Richardson et al. 1995; Johnston 2002; NRC 2003a, 2005a). Toothed whales can be particularly sensitive to high-frequency sounds given their use of high-frequency sound pulses in echolocation, and moderately high-frequency calls for communication. Baleen whales, a group including gray and minke whales, are similarly sensitive to the low frequency noise that is often characteristic of construction, machinery operation, vessel noise, and aircraft noise. Bowhead whales stop feeding and move from within 0.8 km (0.5 mi) of experimental dredge sounds to more than 2 km (1.2 mi) away (MMS 2002a). In addition, some individuals may habituate to dredging and other construction activities (MMS 2002a). Because some marine mammal species exhibit seasonal changes in distribution and are absent or infrequent in the Beaufort and Chukchi Sea Planning Areas in winter, winter construction of offshore platforms would affect relatively few animals. In spring and summer, species present in construction area would be expected to leave the area to other habitats. Displacement could be of short- or long-term duration and could affect survival of young if adults abandon young or are displaced from important foraging areas as well as adults if they are kept from their feeding areas for a long period of time. The construction of new infrastructure in polar bear habitat has the potential to adversely impact these animals through disturbance and displacement.

To date, documented impacts to polar bears in Alaska by oil and gas development activities are few. The potential for adverse impacts is largely associated with increases in industrial activity or expansion of industrial footprints, as well as related increases in human/polar bear interactions. Minimal impacts could result from the potential increase in human/polar bear interactions associated with expanding the onshore facility, installing the offshore and onshore pipelines, and extending the production timeframe within the action area. The USFWS (2008b, 2011) has developed regulations that authorize the nonlethal, incidental take of small numbers of polar bears (and Pacific walruses) during oil and gas industry activities in the Chukchi Sea and Beaufort Sea areas. These regulations include the requirement to maintain a 1.6-km (1.0-mi) exclusion zone around known polar bear dens. The USFWS and USGS have predicted that polar bears may be extirpated throughout much of their range within the next 40 to 75 yr if current trends in sea ice reduction continue (73 FR 28212 [15 May 2008]). Nonetheless, impacts to bears as a direct result of routine, OCS-related oil and gas activities appear to be minimal.

Any activity causing an impulse noise of 160 dB rms or non-pulse noise of 120 dB rms would risk Level B harassment take of whales, and require a take authorization under the MMPA. Additional mitigation measures required to avoid significant adverse impacts would be required by later BOEM and NMFS review processes. Detailed analysis of potential Exploration Plans and Development & Production Plans, along with mitigation measures incorporated into any necessary Incidental Take Authorizations (ITA), would further reduce the potential for any significant adverse impacts. Overall, while development activities may impact whales through masking and avoidance, significant impacts are not expected. Such effects would likely be limited to individuals or small groups, be limited in duration to the construction period, and be sublethal.

Pipeline trenching may also disrupt mammal species (e.g., Pacific walrus, gray whale, bowhead whale). Despite the long, linear nature of pipelines, their construction is a slow-moving, relatively stationary operation. Thus, pipeline construction represents a temporary and avoidable source of disturbance. The extent to which benthic food sources are affected and the subsequent impact to marine mammals depend on the type and amount of benthic habitat that would be disturbed by trenching, the importance of the specific habitats in providing food resources to marine mammals, and the marine mammal species and numbers of individuals that could be affected.

Pipeline construction could cross barrier island and nearshore coastal habitats. Polar bears may be temporarily displaced, or their behavior modified (e.g., by changing direction or speed of travel), by construction activities. As explained in a recent biological opinion, "disturbance from stationary activities could elicit several different responses in polar bears. Noise may act as a deterrent to bears entering the area, or conversely, it could attract bears. Bears attracted to development facilities may result in human–bear encounters, leading to unintentional harassment, or intentional hazing of the bear" (USFWS 2009). Mitigation measures (such as implementation of a human-bear conflict management plan) generally required under MMPA Incidental Take Authorizations (typically a Letter of Authorization) would reduce the potential for these impacts. Any adverse impacts would be localized and negligible.

Because no more than 13.5 ha (33.4 ac) of bottom area would be disturbed by platform construction and no more than 567 ha (1,401 ac) of bottom area would be disturbed by pipeline construction under the proposed action (Table 4.4.1-4), relatively little benthic habitat would be disturbed compared to that present in the Beaufort and Chukchi Sea Planning Areas. Natural recovery of the disturbed benthic habitats would occur within 3 to 10 yr of initial disturbance (Section 4.4.6.2.3). Pipeline trenching is expected to have a limited effect on the overall availability of food sources for marine mammals. Impacts to marine mammal food sources would be localized and would not result in population-level impacts. To avoid or minimize adverse impacts, relevant organizations (i.e., project proponents, BOEMRE, NMFS) will need to develop timing guidelines and operational protocols to govern the specifics of this project. This review would take place at a later stage of review, when more site-specific information would be known.

Construction of Onshore Pipelines. Under the proposed action, 16 to 129 km (10 to 80 mi) of new pipelines onshore of the Beaufort Sea will occur, causing up to 584 ha (1,443 ac) of soil disturbance (Table 4.4.1-4). No other onshore construction will occur under the proposed action (Section 4.4.1.3). Onshore construction activities would not affect most of the marine mammals in the Arctic region because these species typically occur in offshore open-water habitats and ice floes and along pack ice away from coastal areas where construction might occur. Individuals that might be present in nearshore waters adjacent to a construction area would leave the area. Onshore pipeline construction has the potential to directly affect pinnipeds and fissipeds and their habitats through impacts associated with direct contact with construction equipment or infrastructure, as well as indirect impacts associated with perceived habitat loss. Most pinnipeds and fissipeds are alert and mobile enough to be able to avoid areas where construction is occurring. Juveniles are smaller and less mobile than adults; therefore, human disturbances associated with construction activities may have a greater effect on younger pinniped and fissiped individuals.

The activities associated with onshore construction may also indirectly affect pinniped and fissiped species by reducing habitat quality, and thereby affecting the distribution of the species. Pinnipeds and fissipeds may avoid certain areas of human disturbance. Polar bears may be affected by oil and gas development by abandoning dens in close proximity to onshore disturbances, which may lead to range conflicts with other polar bears or greater cub mortality (Amstrup 1993; Linnell et al. 2000). However, there is evidence that some species or individuals of pinnipeds and fissipeds may be capable of habituating to moderate levels of oil and gas exploration and development activities (Moulton et al. 2003; Blackwell et al. 2004; Smith et al. 2007).

The spotted seal, Pacific walrus, and polar bear are the three species of marine mammals in the Beaufort and Chukchi Sea Planning Areas likely to occur in coastal habitats, and therefore to be affected by onshore construction. The spotted seal uses coastal habitats such as beaches and river delta sandbars for sunning and resting, while the polar bear forages along shore ice locations, and may have onshore maternity dens located as much as 8 to 10 km (5 to 6 mi) inland of the coast (Section 3.6.4.2.1). Walrus also haul out in large numbers along the Chukchi Sea Coast and beluga use the near shore areas, such as Kaseguluk Lagoon, in the spring. Foraging bears and resting seals would probably leave or avoid areas where onshore construction is occurring. If an active maternity den is present at or near the construction site, construction may cause the female to abandon the den and her cubs, potentially decreasing cub survival (Linnell et al. 2000); however, there is evidence that denning polar bears can become tolerant of low levels of human activity (Amstrup 1993). This was also recently seen (2011) when a sow with cubs denned on Spy Island next to an offshore facility. As only a small number of individuals of either species might be disturbed, no population-level effects are expected.

Given the small amount of onshore construction that could occur under the proposed action, it is unlikely that onshore construction would have long-term impacts to pinniped and fissiped populations. Onshore construction activities would be sited to avoid areas of known sensitive habitats (e.g., polar bear dens), minimizing the potential for affecting pinniped and fissiped populations.

<u>Operations of Offshore and Onshore Facilities.</u> Noise associated with OCS drilling and production is of relatively low frequency, typically between 4.5 and 30 Hz (Richardson et al. 1995). Potential effects on marine mammals may include disturbance (e.g., changes in behavior, short- or long-term displacement) and masking of calls from conspecifics or other natural sounds (e.g., surf, predators).

Because odontocetes use sounds at frequencies that are generally higher than the dominant sounds generated by offshore drilling and production activities, they may not be sensitive to or affected by these sounds. In contrast, mysticetes (the minke, gray, humpback, fin and bowhead whales) are considered to have good low-frequency hearing and exhibit vocalizations at low frequencies, and thus may be affected by drilling and production noise. Effects would be similar to those identified for exploration and construction activities, namely, behavioral disruption and avoidance of or displacement from the immediate vicinity of the operating facility. For example, bowhead whales have been observed to deflect from their migratory path by 20 km (12 mi) or more in response to drilling noises (MMS 2002a). However, bowhead whales tolerate high levels of continuous drilling noise when necessary to continue with migration (MMS 2002a).

Avoidance or displacement can be of short- or long-term duration, depending on whether or not affected individuals may become acclimated to the operational activities. Because affected individuals would most likely leave the area for other appropriate habitats, neither behavioral disturbance nor the displacement of individuals by normal operations would be expected to result in long-term effects to either individuals or populations. The presence of an operating onshore facility could reduce the suitability of some areas for use by denning female polar bears, while normal operations of offshore facilities could decrease the suitability of offshore areas as pinniped foraging or pup-rearing habitats. Exposure events that elicit a response also may induce stress and further energy expenditure. The frequency that an individual is exposed and reacts to noise levels throughout a given season or lifetime can reach thresholds whereby individual health or reproductive performance could be adversely affected.

Under the Final Rule designating critical habitat for polar bears, terrestrial denning habitat (Critical Habitat Unit 2) was not designated along the U.S. Chukchi Sea coastline (75 FR 76086 [Dec. 7, 2010]). In the Bering and Chukchi Seas, the majority of dens that have been documented occur on Wrangel and Herald islands, and on the Chukotka Peninsula in Russia. In recent years, sea ice formation along the coastline is occurring later in winter, which may preclude access to coastal denning areas along the U.S. Chukchi Sea coastline. While the USFWS has determined that the coastlines of the Chukchi and Bering Seas are not critical habitat, some dens may occur along the coast. Disturbance at den sites from construction or other human activities could result in a female with cubs abandoning the den site, resulting in death from hypothermia or predation to the cubs. Should construction activities be proposed near an active den, mitigation measures (such as den detection and avoidance) generally required under the Letter of Authorization would reduce the potential for these impacts. The raised onshore pipeline would not pose a physical barrier to polar bear movement, and once away from the coast, would not be in polar bear habitat.

<u>Discharges and Wastes.</u> Table 4.4.1-4 presents information on drilling fluids, drill cuttings, and produced waters discharged offshore as a result of the proposed action in the Beaufort and Chukchi Seas. Produced water, drilling muds, and drill cuttings will be discharged into offshore marine waters in compliance with applicable regulations and permits. Compliance with regulations and permits will limit the exposure of marine mammals to waste discharges. In some cases, drilling muds may be recycled and not discharged and cuttings may be transported offsite.

Up to 500 bbl of drill fluids and 600 tons of drill cuttings will be discharged at each exploration and delineation well (Table 4.4.1-4). Heavier components of these muds and cuttings (such as rock) would settle to the bottom, while lighter components could increase turbidity around the drill site. While this increased turbidity could cause marine mammals to avoid the area, any increase in suspended solids associated with the discharge of drilling wastes would be rapidly diluted and dispersed, and thus not be expected to adversely affect marine mammals in the area. Drilling fluids and cuttings associated with development and production wells would be treated and disposed of in the wells, minimizing impacts to marine mammals from these wastes.

Some marine mammals may be exposed to waste fluids (such as bilge water) generated by and discharged from OCS vessels. Discharges of such wastes from OCS service and construction vessels, if allowed, would be regulated under applicable NPDES permits and would also be rapidly diluted and dispersed. Sanitary and domestic wastes would be processed through shipboard waste treatment facilities before being discharged overboard, and deck drainage would also be processed shipboard to remove oil before being discharged. Thus, permitted waste discharges from OCS service and construction vessels would not affect marine mammals.

Ingestion or entanglement with solid debris can adversely impact marine mammals (Marine Mammal Commission 2004). Mammals that have ingested debris, such as plastic, may experience intestinal blockage which, in turn, may lead to starvation, while toxic substances present in the ingested materials (especially in plastics) could lead to a variety of lethal and sublethal toxic effects. Entanglement in plastic debris can result in reduced mobility, starvation, exhaustion, drowning, and constriction of, and subsequent damage to, limbs caused by tightening of the entangling material. The discharge or disposal of solid debris into offshore waters from OCS structures and vessels is prohibited by BOEM (30 CFR 250.40) and the USCG (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]). Thus, entanglement in or ingestion of OCS-related trash and debris by marine mammals would not be expected under the proposed action during normal operations.

<u>Vessel and Aircraft Traffic.</u> There would be up to 12 surface vessels and 12 helicopter trips per week in the Beaufort Sea and up to 15 surface vessels and 15 helicopter trips per week in the Chukchi Sea under the proposed action (Table 4.4.1-4). The majority of vessel traffic in the Beaufort and Chukchi Seas primarily occurs during summer, at which time it could contribute to ambient noise and potential disturbance to marine mammals (MMS 2002a). Which species could be affected by vessel and aircraft traffic, the nature of their response, and the potential consequences of the disturbance, will be a function of a variety of factors, including the specific routes, the number of trips per day, the altitude of the aircraft overflights, the seasonal habitats along the routes, the species using the habitats and the level of their use, and the sensitivity of the mammals to vessel and aircraft traffic. Traffic over heavily used feeding or calving habitats could result in population-level effects for some species, while impacts from traffic over other areas with less sensitive species would likely be limited to a few individuals and not result in population-level effects.

Marine mammals may be affected by this traffic either by disturbance from passing vessels or helicopters or by direct collisions with vessels. Among the cetaceans, the beluga, gray, and bowhead whales are the most abundant in the Beaufort and Chukchi Sea Planning Areas. Thus, these species have the potential to encounter OCS-related vessels. The other cetaceans are present in relatively low numbers (e.g., less than 2,000 throughout the entire planning area), and thus are less likely to encounter OCS-related vessels. During their spring migration (April through June), bowhead whales would likely encounter few, if any, vessels along their migration route, as NMFS (in their IHAs) and FWS (in their LOAs) restrict access to the Chukchi Sea to protect animals in the spring lead system.

Bowheads react to the approach of vessels at greater distances than they react to most other industrial activities. According to Richardson and Malme (1993), most bowheads begin to swim rapidly away when vessels approach rapidly and directly. This avoidance may be related to the historic commercial and continuing subsistence hunting. Avoidance usually begins when a rapidly approaching vessel is 1 to 4 km (0.6 to 2.5 mi) away. A few whales may react at distances from 5 to 7 km (3 to 4 mi), and a few whales may not react until the vessel is <1 km (<0.6 mi) away. Received noise levels as low as 84 dB re 1 μPa (decibels relative to one micropascal) or 6 dB above ambient may result in strong avoidance of an approaching vessel at a distance of 4 km (2.5 mi) (Richardson and Malme 1993). Vessel disturbance has been known to disrupt activities and social groups. Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering may persist for a longer period. Parks et al. (2011) note for North Atlantic right whales (a species similar to bowhead whales) and Holt et al. (2009) note for killer whales that individuals modified calls in response to increased background and vessel noise, respectively, by increasing the amplitude of their calls. McDonald et al. (2009), however, noted the decline in blue whale song tonal frequencies was not fully explained by the hypothesis of increasing ocean noise. But these authors suggest that post whaling population increase is altering sexually selected trade-offs for singing males between song intensity (ability to be heard at a greater distance) and song frequency (ability to produce songs of lower pitch).

Where vessels approach slowly or indirectly, bowheads are much more tolerant, and reactions are generally less dramatic. The encounter rate of bowhead, humpback, and fin whales with vessels associated with natural gas development would depend on the location of the platform in relation to both shipping routes and areas of heavy use. During their spring migration (April through June), bowheads likely would encounter few, if any, vessels along their migration route, because ice at this time of year typically would be too thick for supply vessels to operate in. Bowheads, as with other "right whales" (family Balaenidae), are among the slowest moving of whales, which may make them particularly susceptible to ship strikes. Despite their likely greatest susceptibility to vessel strikes, records of strikes on bowheads are rare compared with records of strikes on some other large whales (Laist et al. 2001). About 1% of the bowhead whales taken by Alaskan Iñupiat bore scars from ship strikes (George et al. 1994). Until recently, few large ships have passed through most of the Western Arctic bowhead's range but this situation is changing and the potential for increasing opportunity for vessel strikes may be increasing as northern sea routes become more navigable with the decline in sea ice. At present, bowheads, humpback, and fin whales probably would adjust their individual swimming paths to avoid approaching within several kilometers of vessels attending the production platform, and would also move away from vessels that approached them within a few kilometers (Richardson et al. 1995).

Worldwide, at least 11 species of cetaceans have been documented as being hit by ships (Laist et al. 2001; Jensen and Silber 2003). In most cases, the whales are not seen beforehand or are seen too late to avoid collision. Most lethal or severe injuries involve ships traveling ≥14 knots (26 km/hr or 16 mph) or faster, and collisions with vessels greater than 80 m (262 ft) in length are usually either lethal or result in severe injuries (Laist et al. 2001). Most seismic vessels typically operate around 4–5 knots. Gray whale use of shallow coastal habitat during migration makes ship strikes a potential source of mortality. Only one ship strike mortality has been reported in Alaska when a killer whale hit the prop during a groundfish trawl in the Bering

Sea (MMS 2008b; Allen and Angliss 2011), however, to-date, there have been no vessel strikes reported in the Arctic. Although, harvested bowhead whales have had scarring, indicating they had been hit by the prop of a ship (Rosa 2008). Pinnipeds may also be struck by vessels. There is a possible, but unlikely, potential for polar bears to be struck by vessels (MMS 2009a).

In addition to possible collision-related injuries, cetaceans may be disturbed by the observation of the vessel and the noise it generates. Disturbed individuals would be expected to cease their normal behaviors and likely move away from the vessel. Following passage of the vessel, affected individuals may return and resume normal behaviors. However, high vessel traffic along a consistent route may cause long-term avoidance. If the abandoned areas represent important feeding or calving areas, physical condition and reproductive success may be adversely affected. Of 236 bowhead whales examined between 1976 and 1992, only three ship-strike injuries were documented, indicating that they do not often encounter vessels, avoid interactions with vessels, or that interactions usually result in the death of the animals (Shelden and Rugh 1995; Rosa 2008). Current rates of vessel strikes of bowheads are low, and there are no known fin or humpback strikes in the Alaskan Arctic (BOEMRE 2010d). Bowhead whales do not seem to react to aircraft overflights at altitudes above 300 m (984 ft). Most bowheads do not deflect more than a few kilometers from a single noise disturbance, and behavioral responses last only a few minutes. Most reactions include a change in migration speed and swimming direction to avoid the sound source (Richardson et al. 1991). Bowhead whales typically avoid vessels at distances ranging from 1 to 4 km (0.6 to 2.5 mi); drilling noise may deflect individuals 20 km (12.4 mi) or more from their migratory paths. Schick and Urban (2000) suggest that the spatial pattern of bowhead distribution is highly correlated with distance from drilling rigs, and the presence of drilling rigs results in a temporary loss of available habitat. Miles et al. (1987) suggest icebreakers pushing ice would cause half of the bowheads within 4.6 to 20 km (2.9 to 12.4 mi) of the source to demonstrate an avoidance behavior. Beluga whales are also known to avoid ice breakers by long distances (Erbe 1997, 2000; Cosens and Dueck 1993).

Fixed wing aircraft may be used by whale spotters during pipeline route surveys or pipeline installation activities in the nearshore areas. The use of spotter aircraft could be an important mitigation technique that would reduce the overall potential for gas development to cause adverse impacts to whales. Helicopters are likely to be used to transport crews and supplies in support of modification of the production platform for gas development. Aircraft noise may elicit a response, such as a turn or hasty dive, from a whale or group of whales. But given the altitude at which these aircraft are expected to fly, the potential for adverse reactions is small. Any impacts that did occur would be temporary and minor. To avoid potential disturbance effects on marine mammals, aircraft maintain minimum flight altitudes — human safety will take precedence at all times over this recommendation.

Construction- and operation-related noises that have the greatest potential to impact pinnipeds, including those generated from vessel and aircraft traffic. Noises emitted by shipping vessels range between 140 dB re 1 μPa for smaller vessels to 198 dB re 1 μPa for larger tankers and cargo ships (Heathershaw et al. 2001; Erbe 2002; Hildebrand 2004). Helicopters flying at 150 m (492 ft) altitude are expected to emit noises received at ground level of approximately 80 to 86 dB re 20 μPa (Born et al. 1999). These noises may impact nearby pinniped species, which typically have in-air hearing thresholds between 20 to 80 dB and underwater hearing thresholds between 60 to 120 dB (Kastak and Schusterman 1998; NRC 2005a). Noises associated with approaching vessels and helicopters may cause hauled out pinnipeds to flee to aquatic habitats. For example, ringed, spotted, and bearded seals have also been known to avoid approaching vessels by fleeing from haul out sites into the water (Frost et al. 1993; Born et al. 1999; COSEWIC 2003). During pinniped flight reactions, young pups could be trampled or become isolated from their mothers, leading to injury or making them more susceptible to predators. Despite this, there is evidence that pinnipeds may habituate to moderate levels of human activity (Moulton et al. 2003; Blackwell et al. 2004).

Vessel traffic may disturb pinnipeds in the water and hauled out on ice or terrestrial habitats. Hauled out pinnipeds may exhibit behavioral reactions to the physical disturbance of an approaching vessel or aircraft (sometimes >1 km [0.6 mi] away) by exhibiting startle reactions, escaping the immediate area into the water. Project aircraft has the greatest potential to adversely affect pinnipeds haul out and rookery sites (Frost et al. 1993), where disturbed adults may temporarily cease normal behaviors (such as feeding of young), leave the rookery site, and thereby increase predation risks of unattended pups, or risk of trampling while adults are fleeing. However, pinnipeds may habituate to the presence of project vessels (Moulton et al. 2003; Blackwell et al. 2004), and the escape reactions of hauled out pinnipeds may be minimized over time. At times, many of these species, such as seals, are attracted to moving vessels. Pinnipeds could be injured or killed by ship collisions.

Vessel traffic associated with icebreaking activities in the Alaskan OCS may alter the behaviors of walruses at greater distances (sometimes >2 km [1.2 mi] away) than ordinary ship traffic. In response to icebreaking vessels, female and young walruses typically react more than males do. Hauled out females and young typically responded to approaching icebreaking vessels by fleeing into the water at distances of 0.5 to 1 km (0.3 to 0.6 mi); males responded by entering the water at distances of 0.1 to 0.3 km (0.06 to 0.2 mi) (Johnson et al. 1989, and see MMS 2007d).

Vessel and aircraft traffic may disturb fissipeds in aquatic and terrestrial habitats. It is unlikely for polar bears to be directly impacted by vessel collisions; instead, impacts to polar bears from vessel and aircraft traffic may occur from the physical disturbance associated with such activities. Fissipeds are generally considered to be more tolerant than other marine mammals to noises associated with the construction of offshore oil and gas platforms (MMS 2007e). However, construction-related noises may still affect fissiped populations. Vessel, terrestrial vehicle, and aircraft activities can affect polar bear behavior. Vessel traffic associated with natural gas development activity is not expected to cause impacts to polar bears, because they show little reaction to vessels and generally do not linger in open water where vessels are more likely to travel. As explained in a Biological Opinion (USFWS 2009), "During the open-water season, most polar bears remain offshore on the pack ice. Barges and vessels transporting materials for construction and on-going operations of facilities usually travel in open-water and avoid large ice floes. Therefore, there is some spatial separation between vessels and polar bears." If there is an encounter between a vessel and a bear, it would most likely result in short-term behavioral disturbance only. Polar bear responses to vessels are brief, and generally include walking toward, stopping and watching, and walking/swimming away from the vessel.

Polar bears typically flee from low flying aircraft that are at an altitude of <200 m (656 ft) and a lateral distance of <400 m (<1,312 ft) (Shideler 1993). Extensive or repeated overflights by helicopters travelling to and from offshore facilities could disturb polar bears. Polar bears have been known to run from other sources of noise and the sight of aircraft, especially helicopters. According to a Biological Opinion (USFWS 2009), "Behavioral reactions of polar bears would likely be limited to short-term changes in behavior and have no long-term impact on individuals. In addition, [BOEMRE] requires these types of flights to operate at an altitude of >1,500 ft AGL where possible, which would significantly reduce disturbance." It is expected that flight altitude requirements will minimize disturbances and that adverse impacts from this activity will be temporary and minimal.

The effects of air traffic on pinnipeds in the action area are expected to be localized and transient. Some seals may be disturbed on the ice or at haulouts on land and enter the water, although their responses may be highly variable and brief in nature (Born et al. 1999; Boveng et al. 2008, 2009; Burns and Harbo 1972; Cameron et al. 2010; Kelly et al. 2010). Mitigation measures prohibiting aircraft overflights below 457 m (1,500 ft) will lessen aircraft impacts to these pinnipeds. Results from studies of an existing facility (specifically, the Northstar development) are roughly analogous to what is contemplated under the present natural gas development scenario and suggest that any adverse impacts to phocids would be minor, short-term, and localized, with no measurable consequences to seal populations.

Pacific walrus are particularly vulnerable to disturbance events given their tendency to aggregate in large groups. Reactions to disturbances when on ice are highly variable (Richardson et al. 1995). Reactions at group haulouts (on land) are more consistent; walrus will flee haulout locations in response to disturbance from aircraft and ship traffic, though walrus in the water are thought to be more tolerant. Females with dependent young are considered the least tolerant of disturbances. Walrus are particularly sensitive to helicopters and changes in engine noise, and are more likely to stampede when aircraft turn or bank overhead. Disturbances caused by vessel and air traffic may cause walrus groups to abandon land or ice haulouts. Severe disturbance events could result in trampling injuries or cow-calf separations, both of which are potentially fatal. But while adverse impacts can be severe, they are also to a large extent avoidable. The USFWS has concluded that a minimum altitude of 1000 ft ASL is sufficient in sea ice habitats (see p. 24 of the USFWS Chukchi Sea EA, 2008) with a 0.5-mi (80-m) horizontal buffer. BOEMRE has taken the more precautionary approach of a 1-mi horizontal buffer and 1500-ft AGL or ASL based in part on industry data and on unpublished ADFG and USFWS haulout monitoring data. While BOEMRE does not regulate air space within the project area, direct overflights of terrestrial or sea ice walrus haulouts by industry are strongly discouraged. Typical mitigation measures include flight corridors, a minimum of 1 to 2 mi inland and directly from shore to the exploration site, while maintaining a minimum of 1 horizontal mi from groups of walruses hauled out on ice or land. Overall, the potential for adverse impacts to individuals or groups of walrus do exist, but the probability is minimal in light of mitigation techniques, such as minimum altitude requirements for aircraft.

Decommissioning. Under the proposed action, no platforms will be removed with explosives from the Beaufort and Chukchi Sea Planning Areas. Therefore, potential impacts of decommissioning on marine mammals, as summarized in Figure 4.4.7-4 (Section 4.4.7.1.1), will not occur.

Impacts of Expected Accidental Spills. Accidental oil spills could occur in the Beaufort and Chukchi Sea Planning Areas under the proposed action (Section 4.4.2). Table 4.4.2-1 presents the oil spill assumptions for the proposed action; while Figure 4.4.7-5 (Section 4.4.7.1.1) presents a conceptual model for potential effects of oil spills on marine mammals. It is assumed that 50 to 190 very small oil spills (<50 bbl), between 35 and 70 small oil spills (≥50 bbl but <1,000 bbl), and 1 to 3 large spills (≥1,000 bbl) would be associated with the Program in the Arctic (Section 4.4.2). Small oil spills break up and dissipate within hours to a day (MMS 2009a). Large spills, particularly those that continue to flow for extended periods (i.e., days, weeks, or months), pose an increased likelihood of impacting marine mammal populations (MMS 2008b). Operational discharges such as tank washing with seawater, oil content in ballast water, and fuel oil sludge are among the sources of small oil spills from tankers (Jernelöv 2010). Large oil spills from tankers have decreased significantly in recent years while spills from ageing, ill-maintained, or sabotaged pipelines have increased. The Arctic environment is particularly vulnerable to the effects of oil releases, which are expected to persist longer in the environment because of colder temperatures and difficulty in conducting cleanup operations (e.g., if oil occurs under ice). Nevertheless, recovery from small spills would probably require no more than a year (MMS 2003a).

Oil spills could affect marine mammals in a number of ways, and the magnitude and severity of potential impacts would depend on the location and size of the spill, the type of product spilled, weather conditions, the water quality and environmental conditions at the time of the spill, and the species and habitats exposed to the spill. Marine mammals may be exposed to spilled oil by direct contact, inhalation, and ingestion (directly, or indirectly through the consumption of contaminated prey species). Such exposures may result in a variety of lethal and sublethal effects (Geraci and St. Aubin 1988).

Fresh crude oil releases toxic vapors that when inhaled may irritate or damage respiratory membranes, congest lungs, and cause pneumonia. Following inhalation, volatile hydrocarbons may be absorbed into the bloodstream and accumulate in the brain and liver, leading to neurological disorders and liver damage (Geraci and St. Aubin 1988). Toxic vapor concentrations may occur just above the surface of a fresh oil spill, and thus be available for inhalation by surfacing cetaceans. Inhalation would be a threat only during the first few hours after a spill (Hayes et al. 1992; ADNR 1999). Prolonged exposure to freshly spilled oil could kill some whales (including bowheads, pinnipeds, and polar bear), but the numbers would be small due to a low chance of such contact. This would most likely occur if oil spilled into a lead that bowhead whales could not escape (MMS 2001f).

Direct contact of oil may irritate, inflame, or damage skin and sensitive tissues (such as eyes and other mucous membranes) (Geraci and St. Aubin 1988). Prolonged contact to petroleum products may reduce food intake; foul baleen on mysticete whales, elicit agitated behavior; alter blood parameters, respiration rates, and gas exchange; and depress nervous functions (Lukina et al. 1996). Under less extreme exposures (lower concentrations or shorter durations), oil does not appear to readily adhere to or be absorbed through cetacean skin, which, due to a thick fat layer, may provide a barrier to the uptake of oil-related aromatic hydrocarbons through the body surface (Geraci and St. Aubin 1985, 1988).

Effects of oil spills would depend on how many whales contacted oil, the duration of contact, and the age/degree of weathering of the spilled oil. The number of whales contacting spilled oil would depend on the size, timing, and duration of the spill; how many whales were near the spill; the whales' inclination or ability to avoid contact; and the effectiveness of cleanup activities (MMS 2001, 2004c). Some displacement of bowhead whales may occur in the event of a large oil spill, and avoidance of the contaminated area may last for several years (MMS 2001; NMFS 2002). This indicates that bowhead whales may have some ability to detect an oil spill and would avoid surfacing in the oil by detouring away from the spill area (NMFS 2002). Modeling efforts have indicated that only up to 2% of the Beaufort Sea bowhead whale population would be affected by a large oil spill (NMFS 2002).

An oil spill into ice leads or polynyas in the spring could have devastating effects, trapping bowhead whales where they may encounter fresh crude oil. Calves would be more vulnerable than adults because they need to surface more often to breathe. Feeding bowhead whales are also sometimes observed aggregating in large numbers during the summer open-water season, when they could also be vulnerable to a spill. Beluga whales, that also use the spring lead system to migrate, would be susceptible to a spill that concentrates in these leads (Nuka Research and Planning Group, LLC and Pearson Consulting, LLC 2010).

Pinnipeds and fissipeds may be exposed while coming ashore onto oiled beaches. In addition, adults and juveniles may also be indirectly affected if an accidental spill reduces the quality or quantity of foraging or breeding habitats. Impacts to calving grounds could result in population-level effects. Fouling of fur of some species (e.g., ringed seal pups, polar bear cubs) could affect thermoregulation and reduce survival of the affected young. Ice seals tend to be solitary and would most likely be exposed to oil at sea or on ice. Walruses and spotted seals would most likely be exposed at sea, on ice, or at coastal haulouts. Polar bears would most likely come into contact with spilled oil at sea, on ice, or on shore.

Oil would affect pinnipeds if it were to directly contact individuals, haulouts, or major prey species. For example, bearded seals and walruses are vulnerable to spilled oil from direct exposure and from the indirect effects through the benthic organisms on which they feed (Cameron and Boveng 2009). Although some adult pinnipeds (e.g., walruses) have thick skin that would protect them from absorption of oil, direct contact with oil would affect sensitive tissue areas, causing irritation to eyes, nasal passages, and lungs. Inhalation of hydrocarbon vapors may damage or irritate lung tissue. These injuries may affect already stressed adults and could lead to some fatalities. While adult ice seals depend on a thick fat layer for insulation, seal pups rely on a dense layer of underfur until they are several weeks old. The fouling of this underfur in young pups could reduce its insulating properties, increasing the potential for hypothermia and increasing pup mortality. While there is no conclusive evidence of past oil spills causing a decline in prey species sufficient to result in a decline in any marine mammal population, there is still the possibility of such an effect occurring. Because pinniped species in the Arctic do not congregate in rookeries, the overall effects of accidental oil spills on pinnipeds will be species-specific.

An oil spill that contacts an aggregation of walruses or displaces them from their haulouts may have a severe impact on the population. Walruses could also be impacted by consuming contaminated molluscs and being exposed to oil residues in sediments. As they have a long life span, they could suffer severe effects from the bioaccumulation of oil-derived contaminants (Nuka and Pearson 2010). According to Geraci and St. Aubin (1988), ice seals have the ability to metabolize oil if ingested in low amounts and some researchers believe that the walrus may share this ability (Scholz et al. 1992).

Accidental oil spills could potentially affect polar bears through contamination of prey or reduction of prey availability, fouling of fur, and oiling of ice. Oil contact can cause serious health concerns to polar bears (USFWS 1996). Fouling of fur greatly reduces its ability to insulate, and can result in hypothermia and death. Direct contact with oil or secondary contact with contaminated ice could be fatal. However, in most areas, polar bears occur at low densities; therefore, small numbers of bears would be affected by a single spill. Multiple spills or spills along the ice edge where bear density is greater would potentially increase mortality rate. Ringed seals are the primary prey of polar bears and are, therefore, directly linked to their survival. If seal density is affected by oil spills or cleanup operations, polar bears could experience increased stress and possibly lower survivorship.

Marine mammals may incidentally ingest floating or submerged oil or tar, and may consume oil-contaminated prey (Geraci 1990). Spilled oil may also foul the baleen fibers of mysticete whales, temporarily impairing food-gathering efficiency or resulting in the ingestion of oil or oil-contaminated prey (Geraci and St. Aubin 1988). Ingested oil can remain within the gastrointestinal tract and be absorbed into the bloodstream, thus irritating and/or destroying epithelial cells in the stomach and intestine. Oil ingested during grooming of fouled fur has been reported to result in liver and kidney damage in polar bears and ringed seals (NRC 2003a; Oritsland et al. 1981). It should be noted that ringed seals and likely other ice seals can detoxify their bodies by renal and bilary pathways. Further, seals do not typically orally groom themselves and are therefore less likely to ingest toxins in that way (Kooyman et al. 1976; Geraci and Smith 1976).

Depending on their habitat preferences, feeding styles, and migration patterns, some species may be more vulnerable to exposure than other species. Spills occurring in spring may affect a greater number of individuals due to animals congregating during migration. Spills occurring in or reaching coastal areas, especially sheltered coastal habitats such as bays and estuaries, would be more likely to affect species such as the beluga whale and spotted seal that use coastal habitats for calving and resting. Bowheads are most sensitive to oil contamination during the spring migration when calves are present and their movements are restricted to open leads in the ice (MMS 2002a).

Polar bears may be directly affected by an oil spill, since they spend the majority of their time on ice, through oiling of fur, ingestion of oil from grooming, or by feeding on oiled prey or carcasses. Large oil spills could have a significant impact on polar bear habitat and can result in food chain effects. Spills associated with onshore facilities (and especially any onshore pipelines) would potentially affect polar bears. While it is unlikely that a bear would be directly exposed to an accidental pipeline release, bears could be affected by feeding on contaminated prey. However, because of the relatively low density of bears in the Arctic region, no more than a few individuals would be expected to be affected by an onshore release. Onshore spills that enter a stream system may be carried to coastal areas, where other marine mammals may be exposed.

An accidental oil spill may result in the localized reduction, extirpation, or contamination of prey species. Invertebrate and vertebrate species (such as zooplankton, crustaceans, mollusks, and fishes) may become contaminated and subsequently expose marine mammals that feed on these species. Because benthic organisms (such as crustaceans and mollusks) accumulate oil compounds more readily and to higher levels than pelagic biota, the potential for ingesting oil-contaminated prey is highest for benthic feeding species, such as the gray whale, less so for zooplankton-feeding cetaceans, and least for fish-eating cetaceans (Würsig 1988). Similar differences in exposure via food ingestion may be expected among benthic and fish-eating pinnipeds (i.e., Pacific walrus, spotted seal). Species with a dependence on or preference for offshore areas or habitats for feeding, shelter, or reproduction would be more likely to be affected by a spill than would other marine mammals (Würsig 1988).

Spills occurring in winter may accumulate and may be incorporated into the ice matrix and move with the ice pack. In spring, this oil may be released into ice leads that are used by migrating whales (such as beluga and bowhead whales) and by pinnipeds that use these areas, resulting in the exposure of relatively large numbers of individuals. Spills under ice or associated with leads may affect haulout sites, causing either abandonment or repeated exposure through use of the contaminated haulout. Because some species are relatively restricted to open-water areas associated with ice, individuals may not be able to disperse from spills in these areas, and thus may incur increased exposures. Because polar bears are closely associated with ice edges, spills accumulating along these areas may expose the greatest number of bears to an offshore spill. An oil spill in areas where polar bears congregate (e.g., leads or polynyas and beachcast marine mammal carcasses) could have negative population effects.

Marine mammals that frequently groom, such as polar bears, would be most likely to ingest oil. Feeding on contaminated prey or carcasses also causes ingestion of oil (Fair and Becker 2000). With the exception of bearded seals who may enter the water within hours of being born, newborn seals are more sensitive to oil than adult seals, as they have little fat and rely on a dense layer of fur (lanugo). Loss of this waterproofing by oil could cause hypothermia and death (Fair and Becker 2000).

The magnitude and extent of any adverse effects will also depend on how quickly a spill is contained and how quickly and effectively cleanup is accomplished (USFWS 2004). Arctic conditions (i.e., sea ice, wind, temperature, limited visibility, and sea state) can potentially impact oil spill responses. Other than high sea state (choppy waves), which can enhance the effectiveness of chemical dispersants, most extremes in Arctic conditions hinder spill response activities (Nuka Research and Planning Group 2007a). Lessees are required to have contingency plans to prevent, address, and clean up oil spills (ADNR 1999). Spill cleanup operations could result in short-term disturbance of marine mammals in the vicinity of the cleanup activity, while a collision with a cleanup vessel could injure or kill marine mammals. Disturbance of adults with young during cleanup could reduce survival of the young animals. For example, vessel and human activities associated with cleanup efforts may cause pinnipeds to abandon coastal haulout areas and/or rookeries for an extended period of time. Cleanup operations, including helicopter overflights and vessel traffic, could also potentially increase pup mortality if operations were to occur near rookeries. Aircraft readily disturb pinnipeds and walruses, which can cause adults to stampede into the water, trampling pups in the process. Any increased mortality in a pinniped population could impact the population as a whole, especially for sensitive or declining populations (e.g., Pacific walruses).

An approved oil spill response plan would be required for all exploration and production activities. Oil-containment and cleanup activities would be initiated a short time following an oil spill (MMS 2003e). Oil spill response activities may affect marine mammals through exposure to spill response chemicals (e.g., dispersants or coagulants) or through behavioral disturbance by cleanup operations or habitat disturbance. The chemicals used during a spill response are toxic, but are considered much less so than the constituents of spilled oil (Wells 1989), although there is little information regarding their potential effects on marine mammals. The presence of, and noise generated by, oil spill response equipment and support vessels could temporarily disturb marine mammals in the vicinity of the response action, with affected individuals likely leaving the area. While such displacement may affect only a small number of animals and not result in population-level effects, cleanup operations disturbing adults in pup-rearing areas may decrease pup survival. Oil spill response support vessels may also increase the risk of collisions between these vessels and marine mammals in the vicinity of the spill response. During oil spill cleanup activities, interactions with humans could cause polar bear disturbance, injury, or death. For example, cleanup operations that disturb a den could result in the death of cubs through abandonment and perhaps death of the mother.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected, very low-probability CDE of 1.4 to 2.2 million bbl for the Chukchi Sea Planning Area that lasts 40 to 75 days and a CDE of 1.7 to 3.9 million bbl for the Beaufort Sea Planning Area that lasts 60 to 300 days (Table 4.4.2-2). If a CDE occurs, there is greater potential for more severe effects compared to the risk of effects from an assumed large oil spill. A CDE would result in sustained degradation of water quality and, to a lesser extent, air quality that would impact marine mammals from direct contact, inhalation, and ingestion (either directly or indirectly through the consumption of oiled forage or prey species). These effects would be significant, causing a multitude of acute and chronic effects. Additional effects on marine mammals would occur from water and air quality degradation associated with response and cleanup vessels, *in situ* burning of oil, dispersant use, discharges and seafloor disturbances from relief well drilling, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring. A CDE has the potential to increase the area and duration of an oil spill, thereby increasing the potential for population-level effects, or at a minimum, an increase in the number of individuals killed. For example, a CDE contaminating ice leads or polynyas in the spring could have devastating effects, trapping bowhead whales where they may encounter fresh crude oil. Beluga whales that also use the spring lead system to migrate would also be susceptible to a spill that concentrates there.

Direct contact with spilled oil from a CDE would have the greatest potential to adversely affect cetaceans when toxic fumes from fresh oil are inhaled at times and places where aggregations of cetaceans may be exposed. In addition, cetaceans would likely avoid oil spill response and cleanup activities. This could cause displacement from preferred feeding habitats, and could deter migration paths for the duration of those activities. Overall, cetaceans would likely be impacted by some loss of seasonal habitat, and by reduction or contamination of prey (BOEMRE 2011k). The potential impacts of a CDE on ice seals would depend on habitat use, densities, season, and spill characteristics. For example, oil from a CDE reaching a polynyas or lead system could have moderate to major impacts on ringed and bearded seals (e.g., could cause the deaths of hundreds to thousands of seals) (BOEMRE 2011k). Significant impacts to the walrus population from a CDE would be most likely to occur if a large-scale contamination of prey and habitat persisted for years (BOEMRE 2011k).

Cleanup of a CDE would have negative consequences as well. Cleanup activities and increased human presence could displace marine mammals from their usual habitats (e.g., alter their migration pathways or avoid areas they normally inhabit).

Impact Conclusions.

Routine Operations. Within Arctic planning areas, noise generated during seismic surveys, exploration and production activities, platform removal, and by OCS-related vessels and aircraft may temporarily disturb some individuals. Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification, although the scope of effects and their magnitude are not known. However, this information is not essential to the determination of a reasoned choice among alternatives. Small numbers of marine mammals could be killed or injured by chance collision with service vessels and by eating indigestible debris, particularly plastic items, lost from service vessels, drilling rigs, and platforms. While vessels may collide with marine mammals, the most likely impact on marine mammals would be changes in behavior (e.g., avoidance responses). Normal behavior is expected to return once a vessel or aircraft has passed. Overall, impacts on marine mammals from routine operations would range from negligible to moderate.

Expected Accidental Spills. The magnitude of effects from expected accidental spills would depend on the location, timing, and volume of the spills; the environmental settings of the spills (e.g., restricted coastal waterway, deepwater pelagic location); and the species (and its ecology) exposed to the spills. Spill cleanup operations could result in short-term disturbance of marine mammals in the vicinity of the cleanup activity, while a collision with a cleanup vessel could injure or kill the affected individual. Overall, oil spills are expected to have minor to moderate impacts to marine mammals, while impacts from oil spill response activities are expected to be minor. Impacts on species that are extralimital to rare are expected to be negligible to minor, but under unusual circumstances could be moderate to major depending on the number of individuals contacted by a spill.

An Unexpected Catastrophic Discharge Event. In the case of an unexpected, very low-probability CDE, there is greater potential for more severe and population-level effects compared to an assumed large oil spill (i.e., impacts could be moderate to major). The combination of a CDE and cleanup efforts could persist beyond one season, perhaps lasting several years.

Terrestrial Mammals. The terrestrial mammal communities present within the Beaufort and Chukchi Sea Planning Areas include a variety of small mammals (e.g., rodents), big game, and furbearer species. Species of particular concern are the caribou, muskoxen, brown bear, and Arctic fox. Section 3.6.4.2.1 provides an overview of these species.

Impacts of Routine Operations. Under routine operations for the proposed action, terrestrial mammals could be affected by the construction and operation of new onshore pipelines and from vehicle traffic and helicopter overflights.

Construction and Operation of Onshore Pipelines. Under the proposed action, 16 to 129 km (10 to 80 mi) of new onshore pipeline would be installed along the Beaufort Sea, which could result in 73 to 584 ha (180 to 1,443 ac) of soil disturbance (Table 4.4.1-4). The areas disturbed represent an extremely small portion of terrestrial wildlife habitat that occurs inshore of the Beaufort and Chukchi Sea Planning Areas.

Caribou. In general, caribou use coastal areas of the North Slope largely in June, July, and August, although a portion of the Western Arctic Herd may overwinter in coastal habitats bordering the Chukchi Sea, and in some years, the Teshekpuk Lake Herd may remain on the Arctic Coastal Plain throughout the winter. Because onshore pipeline construction would likely occur in winter to minimize impacts on the ground surface and vegetation, construction activities would not affect caribou calving or foraging in summer. Construction could, however, disturb caribou in overwintering areas, causing them to vacate preferred overwintering areas and move into less suitable habitats. Such displacement could affect individuals or local populations as a result of increased energy expenditure associated with movement to, and use of, suboptimal habitat, with subsequent mortality and reduced productivity (NRC 2003a).

If construction were to occur in late spring and summer, calving caribou, females with newborn calves, and older foraging calves could be disturbed. Affected individuals would likely leave or avoid habitats in the vicinity of the construction activities and move into potentially less suitable habitats. During the calving season from late May until late June, which includes the actual calving dates and the following 2 to 3 weeks, cows with calves are particularly susceptible to disturbance by human activities, and such displacement could result in population-level effects if calving success and calf survival are reduced (NRC 2003a).

Overall, caribou may be disturbed during construction or affected by the presence of new onshore pipeline. The response of caribou may include the avoidance or abandonment of preferred habitats in the vicinity of the new pipeline, with subsequent displacement to other potentially suboptimal areas. The magnitude of any such effects would be a function of the specific location of the new pipeline relative to preferred habitats (such as calving and foraging grounds and insect-avoidance areas), the location and length of the pipeline, and the number of individuals affected — the greater the length and distance of the new pipeline from existing pipelines (particularly TAPS), the greater the potential for affecting caribou and the greater the number of caribou and caribou herds that could be affected.

While pipelines built lower than 1.5 m (4.9 ft) above the ground surface may act as physical barriers to movement (NRC 2003a), a pipeline constructed to current clearance standards (with a minimum clearance of 1.5 m [4.9 ft]) would not be expected to physically hinder caribou crossings (Curatolo and Murphy 1986). Caribou have been shown to be reluctant in approaching pipelines and to exhibit reduced crossing success of pipelines located in close proximity to roadways with traffic. Thus, the presence of a new pipeline may affect daily or seasonal movements of some individuals and herds.

Muskoxen. Muskoxen are expected to avoid the area where construction of new pipeline is occurring. It is not known how construction disturbance or the presence of a completed pipeline would affect muskoxen habitat use and reproductive success. However, muskoxen may be particularly vulnerable to disturbance in winter because of limited habitat, the length of the Arctic winter, the need to conserve energy throughout the winter, and, for females, the need to maintain good body condition throughout winter and spring for calving (Reynolds et al. 2002). However, because of the small population size of muskoxen, disturbance from pipeline construction could result in population-level effects, especially if this species is disturbed during winter. The limited distribution and small population size of muskoxen in the coastal and inland areas adjacent to the Beaufort and Chukchi Sea Planning Areas would greatly reduce the likelihood for disturbance of this species.

The presence of a completed pipeline may hinder movement by muskoxen if there is insufficient pipeline clearance for this species. However, muskoxen do not exhibit as extensive seasonal or daily movements as caribou. If undisturbed, muskoxen remain in relatively small areas throughout the winter, while in summer they exhibit longer movements that track the emergence of high-quality forage plants (Reynolds et al. 2002). In summer, most daily movements of radio-tracked individuals in the Arctic National Wildlife Refuge (ANWR) were reported to be less than 5 km (3 mi) in length, and many were typically less than 1 km (0.6 mi) in length (Reynolds et al. 2002). Existing pipelines associated with the North Slope oil fields and TAPS do not appear to have hindered the westward expansion of muskoxen from ANWR. For muskoxen to have expanded their range from ANWR to the Colville River, some individuals had to cross the TAPS ROW or travel through the oil fields on the North Slope (BLM 2002). Thus, the presence of a new pipeline is not expected to adversely affect muskoxen populations in onshore areas adjacent to the Beaufort and Chukchi Sea Planning Areas.

Brown Bear. The brown bear uses the coastal environments and/or terrestrial oil transportation routes onshore of the entire Beaufort and Chukchi Sea Planning Areas. Winter construction of onshore pipeline could disrupt individual bear dens. In summer, some individuals may temporarily leave habitats in the vicinity of active construction. However, because bears often habituate to human activities and facilities (Follmann and Hechtel 1990), the presence of new pipeline is not expected to directly adversely affect the brown bear.

Arctic Fox. Arctic foxes occur throughout the Beaufort and Chukchi Sea Planning Areas, using the coastal and shore-fast ice habitats. The Arctic fox would not be adversely affected by the construction or operation of new pipeline. Individuals would likely abandon habitats temporarily in the vicinity of construction activities. Because the completed pipeline could provide increased shelter and den habitat, populations of Arctic fox could increase along the pipeline corridor. An increase in fox abundance could lead to increased outbreak of disease (rabies, canine distemper) among foxes living along the pipeline corridor, as well as increased predation pressures on populations of prey species.

Foxes are highly mobile, and in late autumn and winter, they disperse out onto the sea ice in search of food. Because of this mobility, foxes may visit new offshore facilities (e.g., drilling platforms, ice roads, exploratory seismic trains) in search of food when sea ice is present. Arctic foxes were regularly observed near Seal Island in the Northstar development during the ice-covered season (MMS 2002a). Thus, depending on their number and distance from shore, new offshore platforms may provide additional winter food supplies and increase winter survival of some individuals.

<u>Vehicle Traffic and Helicopter Overflights.</u> Vehicle traffic associated with operations of a pipeline (e.g., pipeline monitoring) could affect wildlife along the new pipeline and any associated access roads. In addition, new access roads may also increase the incidence of vehicles associated with recreation, subsistence hunting, and other activities. Vehicle traffic could disturb wildlife foraging along roadways, causing affected wildlife to temporarily stop normal activities (e.g., foraging, resting) or leave the area. Collision with vehicles could result in mortality, especially in areas with concentrations of wildlife or along migration corridors. Vehicle traffic along any access road associated with the proposed action would likely be light. Thus, the incidence of such collisions would be very low and not expected to result in population-level impacts on wildlife.

Helicopter overflights associated with pipeline monitoring and transport of personnel and supplies may disturb wildlife. The effects of helicopters on wildlife vary by species, populations, habitat type, and environmental variables. Some species may become habituated and experience no adverse effects (e.g., see Harting 1987). Routine overflights by surveillance helicopters would result in a short-term disturbance to animals along the pipeline route, causing them to temporarily alter behaviors, and would not be expected to result in long-term population-level effects.

<u>Caribou.</u> Responses to vehicle and helicopter traffic by caribou can vary from no response to panic behavior. Cow and calf groups appear to be most sensitive (Valkenburg and Davis 1984; MMS 1998). Because caribou tend to avoid transportation corridors (Dau and Cameron 1986; Griffith et al. 2002; Cameron et al. 2002; NRC 2003a), disturbance of caribou by vehicle traffic associated with normal operations of an onshore pipeline would be infrequent. Single passes by helicopters may result in short-term disturbances that should not adversely affect caribou (MMS 1998). Low-flying helicopters are more likely to produce negative responses from caribou than are light, fixed-wing aircraft (Maier et al. 1998). McKechnie and Gladwin (1993) evaluated altitude tolerance thresholds below which aircraft overflights elicit panic and escape responses and determined that the tolerance threshold for a fixed-wing aircraft was 61 m (200 ft), with few or no response reactions observed above 153 m (500 ft). Calef et al. (1976) observed panic or strong escape reactions when aircraft flew at altitudes less than 60 m (200 ft).

<u>Muskoxen.</u> Vehicle traffic along a pipeline access road would likely result in temporary disturbance of muskoxen in the immediate vicinity of the roadway. The response of muskoxen

to aircraft overflights has been reported to range from calm to excitable, and the nature of the response depends in part on the altitude of the overflight, terrain, climate, sex, group size, number of calves present in a group, and habituation (Miller and Gunn 1979, 1980). Helicopter and low-flying aircraft overflights can cause muskoxen to stampede and abandon their calves (NRC 2003a). While responses of muskoxen to vehicle traffic and aircraft overflights associated with the proposed action are not expected to adversely affect muskoxen populations, energetic costs associated with forced movements (especially if frequent) in winter could adversely affect spring calving and could result in population-level effects.

Brown Bear. Some brown bears may be injured or killed by collisions with vehicles along access roads, while bears in the vicinity of vehicle traffic may be disturbed and temporarily cease normal behavior or leave the area until the vehicle has passed. Aircraft overflights have been reported to elicit a variety of responses in brown bears, including escape behavior and hiding (Larkin 1996). While vehicle traffic and aircraft overflights associated with the proposed action may on occasion temporarily disturb individual bears, long-term population-level effects would not be expected from normal operations.

Arctic Fox. The Arctic fox may experience temporary disturbance from vehicle traffic and aircraft overflights, resulting in hiding, departure from the immediate area, or cessation of normal behaviors. Some individuals crossing or traveling along access roads may be injured or killed by vehicle traffic. Relatively few individuals are expected to be affected, and population-level impacts would not be expected under normal operations.

Impacts of Expected Accidental Spills. Accidents under the proposed action that could affect terrestrial wildlife would be largely limited to an oil spill from a new pipeline. The impacts on wildlife from an oil spill would depend on such factors as the time of year and volume of the spill, type and extent of habitat affected, and home range or density of the wildlife species. The Arctic environment is particularly vulnerable to the effects of both large and small oil releases, which are expected to persist longer in the environment because of colder temperatures. However, recovery from small spills would probably require no more than a year (MMS 2003a). The potential effects on wildlife from oil spills could occur from direct contamination of individual animals, contamination of habitats, and contamination of food resources. Acute (short-term) effects usually occur from direct oiling of animals (e.g., exposure to toxic hydrocarbons via inhalation and/or by ingestion of oil while grooming contaminated fur), while chronic (long-term) effects generally result from such factors as accumulation of contaminants from food items and environmental media (e.g., water).

Up to two large pipeline spills are assumed to occur over the lifetime of the proposed action (Table 4.4.2-1). Most spills would be small (<1,000 bbl with more than 80% assumed to be <50 bbl). For the most part, the small spills would occur at offshore facilities rather than from the onshore pipeline. Wildlife may be exposed to spilled oil by eating a variety of oiled vegetation, wildlife, and/or contaminated carrion. In addition, animals occurring within a spill area may also be exposed via inhalation of aromatic hydrocarbons. Such exposure would likely result in sublethal or lethal effects. Oil spills could also potentially affect terrestrial mammals by fouling of fur, causing loss of its insulating capacity. Species such as Arctic foxes would be vulnerable to oil ingestion from grooming their fur (Nuka and Pearson 2010). The magnitude of the effect will depend on the level of exposure, the life stage of the exposed animal (e.g., adult, cub), and the condition of the exposed animal (e.g., healthy, injured).

Staging and support activities for cleanup of a large offshore spill could temporarily displace terrestrial mammals. Oil spill cleanup activities on land may displace these animals from not only contaminated habitats but also nearby uncontaminated habitats. This displacement could reduce energy reserves (especially in winter), which in turn could affect body condition and reproductive success.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected, very low-probability CDE of 1.4 to 2.2 million bbl lasting 40 to 75 days in the Chukchi Sea Planning Area and a CDE in the Beaufort Sea Planning Area of 1.7- 3.9 million bbl and lasting 60 to 300 days (Table 4.4.2-2). If a CDE occurs, there is greater potential for more severe effects compared to the risk of effects from an assumed large oil spill. A CDE would result in sustained degradation of water quality, shoreline terrestrial habitats, and, to a lesser extent, air quality that could impact terrestrial mammals from direct contact, inhalation, and ingestion (either directly or indirectly through the consumption of oiled forage or prey species). These effects could be severe where persistent, heavy oil makes contact with important habitat and prey base, causing a multitude of acute and chronic effects. Additional effects on terrestrial mammals would occur from land and air quality degradation associated with response and cleanup vessels, *in situ* burning of oil, dispersant use, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring. A CDE has the potential to alter terrestrial mammal habitats and populations. The potential for a population-level impact would occur in the unlikely event that a spill occurred in an area where a large number of individual animals are concentrated. For instance, population-level effects to caribou would be most likely from spills occurring in calving areas and along migration corridors. For the muskoxen, the potential for population-level effects would be greatest for a spill occurring in winter when this species remains in small areas, restricted by the availability of forage (Reynolds et al. 2002).

BOEMRE (2011k) concluded that if even several thousand caribou died from oil contamination from a CDE, herd sizes are sufficient to recover within 1 to 2 years. A CDE would probably not impact more than a few brown bears. The home ranges of these bears could be reoccupied within the same season, and population recovery would most likely occur within 1 to 2 years (BOEMRE 2011k). Impacts from a CDE on muskoxen are not anticipated as they spend most of their time inland and away from the Chukchi and Beaufort Sea coasts. Large litters would compensate for any losses of Arctic foxes due to a CDE, and low densities of wolves and wolverines would be expected to prevent more than a few individuals at most from potentially being exposed to oil.

Impact Conclusions.

Routine Operations. The construction and normal operations of new pipeline could result in a variety of short-term and long-term impacts to terrestrial mammals. Short-term impacts would largely be behavioral in nature, with affected animals avoiding or vacating the construction areas. Similarly, vehicle and aircraft traffic associated with the proposed action could temporarily disturb mammals near access roads or under flight paths. While the disturbance of these animals would be short-term in nature, the energetic costs incurred by some of the disturbed biota (especially overwintering muskoxen and pre-calving female caribou) could affect reproductive success. Therefore, disturbances could result in longer term impacts to animal populations. The presence of a new onshore pipeline may result in the displacement from preferred habitats to less suitable habitats for overwintering muskoxen, calving female caribou, and female caribou and their calves. Such displacement may reduce overwinter conditioning or survival as well as calving success. While population-level effects may not be likely for caribou, local population-level effects may occur for muskoxen because of the small population size in Alaska. While vehicle traffic and aircraft overflights associated with the proposed action may on occasion temporarily disturb brown bears and Arctic foxes, long-term population-level effects would not be expected from normal operations. Overall, routine activities associated with the proposed action are not expected to have long-term major impacts on terrestrial mammal species of the North Slope of Alaska. Impacts to terrestrial mammals could range from negligible to moderate.

<u>Expected Accidental Spills.</u> Oil spills may expose terrestrial mammals to oil or its weathering products. In the event of an accidental small or large spill, terrestrial mammals may be exposed via ingestion of contaminated food, inhalation of airborne oil droplets, and direct ingestion of oil during grooming, which may result in a variety of lethal and sublethal effects. However, because most spills would be relatively small (<1,000 bbl with over 80% assumed to be <50 bbl), relatively few individuals would likely be exposed. While some individuals may incur lethal effects, population-level impacts would not be expected. Cleanup activities could temporarily disturb terrestrial mammals, causing those animals to move from preferred to less optimal habitats, which, in turn, could affect their overall condition. Such displacement would be limited to those animals in the vicinity of the cleanup activity, and thus would not be expected to result in population-level effects. Overall, oil spills and associated oil spill response activities are expected to have negligible to minor impacts on terrestrial mammals.

<u>An Unexpected Catastrophic Discharge Event.</u> In the case of a low-probability CDE, there is greater potential for terrestrial mammals and their habitats to be impacted compared to an assumed large oil spill. Impacts to terrestrial mammals would be minor to major. The combination of a CDE and cleanup efforts could persist beyond one season, perhaps lasting several years.

4.4.7.2 Marine and Coastal Birds

Each of the four phases of OCS oil and gas development have associated impact-producing factors (Table 4.1.1-1), some of which may affect marine and coastal birds in the Planning Areas included in the proposed action. Oil and gas development activities that may occur following lease sales under the proposed action and that may affect marine and coastal birds include (1) offshore structure placement and pipeline trenching; (2) offshore structure removal; (3) operational discharges and wastes; (4) OCS vessel and aircraft traffic; (5) construction and operation of onshore infrastructure (including new pipeline landfalls); and (6) noise. Table 4.4.7-2 identifies the impacting factors associated with routine operations that

TABLE 4.4.7-2 Impacting Factors and the Marine and Coastal Bird Resource Components That Could Be Affected with Oil and Gas Development under the Proposed Action

	Resource Component Potentially Affected								
	Habitat[a]			Life Stage[b]			Behavior		
Development Phase and Impacting Factors That May Affect Marine and Coastal Birds	Nesting	Foraging	Overwintering	Nestlings	Juveniles	Adults	Foraging	Courtship/ Nesting	Migration/ Staging
Impacting Factors Common to All Phases									
Helicopter noise	-[c]	-	-	+	+	+	+	+	-
Helicopter traffic	-	-	-	+	+	+	+	+	-
Ship noise	-	-	-	-	-	-	-	-	-
Ship traffic	-	-	-	+	+	+	+	+	+
Hazardous materials	-	-	-	+	+	+	-	-	-
Solid wastes	-	-	-	+	+	+	-	-	-
Offshore lighting	-	-	-	-	+	+	-	-	+
Offshore air emissions	-	-	-	-	-	-	-	-	-
Exploration – Exploratory Drilling									
Seismic noise	-	-	-	-	-	-	+	-	-
Drilling noise	-	-	-	-	+	+	-	-	-
Drilling mud/debris	-	-	-	-	+	+	-	-	-
Offshore Development									
Drilling noise	-	-	-	-	+	+	+	-	-
Trenching noise	-	-	-	+	+	+	+	+	-
Drilling mud/debris	-	-	-	-	+	+	+	-	-
Pipeline trenching	-	+	+	+	+	+	+	-	-
Wellhead and platform placement	-	-	-	-	+	+	+	-	-
Onshore Development									
Site clearing	++	++	-	++	+	+	++	++	+
Construction activity	-	-	-	+	+	+	+	+	+
Construction noise	-	-	-	+	+	+	+	+	+
Production									
Platform collisions	-	-	-	-	+	+	-	-	-
Production noise	-	-	-	-	+	+	-	-	-
Produced water	-	-	-	-	+	+	-	-	-
Drill mud/debris	-	-	-	-	-	-	-	-	-
Decommissioning									
Explosive platform removal	-	-	-	-	+	+	+	-	-
Non-explosive platform removal	-	-	-	-	+	+	+	-	-

[a] Reflects only direct loss or physical degradation of the habitat and not habitat use.

[b] Reflects only injury or mortality of affected life stage.

[c] A dash (-) indicates no effect anticipated; "+" indicates a potential for short-term impacts, "++" indicates a potential for long-term impacts, and "+++" indicates possible population-level effects.

could affect birds and the aspects of marine and coastal birds that could be affected by those factors.

In general, routine operations associated with oil and gas development are not expected to result in population-level effects on marine and coastal birds. Most impacts from routine operations would be localized to the site of the project infrastructure or along support vehicle routes, would for most operations be short term or transient, and would likely affect relatively few individuals or habitats. The greatest potential for longer term and possibly population-level impacts would be associated with very large accidental oil spills. In most areas, small spills would likely affect relatively small numbers of birds and habitats. In contrast, very large spills could affect habitats along extensive areas of coastline and large numbers of birds and important habitats (such as nesting colonies or wintering grounds). Depending on the timing, duration, size, and location of a very large spill, population-level impacts could be incurred by some species.

4.4.7.2.1 Gulf of Mexico.

Impacts of Routine Operations. Routine activities associated with the proposed action that may affect marine and coastal birds in the northern GOM include (1) offshore structure placement and pipeline trenching, (2) offshore structure removal, (3) operational discharges and wastes, (4) OCS vessel and aircraft traffic, (5) construction and operation of onshore infrastructure (including new pipeline landfalls), and (6) noise. Potential impacts associated with these activities may include injury or mortality of birds from collisions with platforms, vessels, and aircraft; exposure to operational discharges; ingestion of trash or debris; loss or degradation of habitat due to construction; and behavioral disturbance due to the presence of, and noise generated by, equipment and human activity (Russell 2005). The nature and magnitude of effects on birds will depend on the specific location of an activity or completed structure (e.g., with greater impacts if a pipeline landfall construction would occur adjacent to a heron rookery), the timing of the activity (e.g., construction that occurs during nesting), and the nature and magnitude of the activity (e.g., the number of miles of trenching through nearshore coastal habitats, the quantity and concentrations of the production water discharges). Consultation with Federal agencies concerning construction and operation of onshore and offshore infrastructure will assure compliance with the Endangered Species Act and the Migratory Bird Treaty Act.

Offshore Structure Placement and Pipeline Trenching. The construction of new offshore infrastructure is not expected to adversely affect marine and coastal birds. Pipeline trenching may affect birds in nearshore coastal areas if trenching occurs in or near foraging or nesting areas. For many species, the effects would be primarily behavioral, namely, the short-term avoidance or abandonment of habitats in the immediate area of trenching. Pipeline trenching near nesting colonies (such as heron rookeries) may disturb adults that are incubating eggs or feeding young, potentially affecting nesting success. Because trenching could result in some long-term loss of coastal habitat (see Section 4.4.6.1.1), habitat loss for some species may also occur. Such impacts could be avoided or minimized by locating pipeline corridors away from nesting aggregations and/or by scheduling trenching activities to avoid the nesting period.

Seabirds such as the brown pelican often use offshore oil and gas production platforms as rest areas or as temporary shelters during inclement weather. In addition, offshore platforms are also used in spring and fall for resting and feeding stopovers by birds migrating to and from more southern wintering areas (Russell 2005). For example, in the fall, many migratory species (including waterfowl, shorebirds, and passerines) arrive at the GOM coast and then fly several hundred miles across the open GOM waters directly for to Central and South America (Lincoln et al. 1998). This route appears to be preferred over the safer but more circuitous land or island routes by way of Texas or Florida. The use of offshore platforms may increase the survivability of individuals using these structures to rest or as shelter during bad weather conditions in the open waters of the GOM (Russell 2005).

Migrating birds may collide with offshore platforms. Annual bird mortality from collisions with offshore platforms has been estimated at 200,000 birds in the northern GOM, with an average of 50 collision deaths per platform per year (Russell 2005). This is probably an underestimate of actual collision mortality incurred by migrating birds, because it is based only on birds recovered from the platforms; birds falling into the water are not reflected in these mortality estimates (Russell 2005). Applying the 50 collision deaths per platform per year estimate, new platforms that could be constructed following lease sales held under the proposed action may result in a total incremental increase of about 10,000 to 22,500 bird collision mortalities. By comparison, hundreds of millions of birds are killed each year colliding with communication towers, windows, electric transmission lines, and other structures (e.g., see Klem 1989, 1990; Dunn 1993). Migrating birds may also be drawn to a lighted platform and circle the platform before moving on or stopping on the platform (Russel 2005). Such circling behavior could increase the potential for a platform collision, and use up valuable energy reserves needed for completing the trans-GOM migration.

Offshore Structure Removal. Under the proposed action, up to 275 existing platforms could be removed from the GOM planning areas. Because many marine birds, as well as migratory birds, are attracted to platforms, there is a potential for some individuals to be affected if they are present during platform removal activities. Typical platform decommissioning involves dismantling many of the above-platform structures, followed by the use of underwater explosives to collapse the platform proper. Birds using a platform undergoing decommissioning would likely leave the platform during dismantling activities. Any remaining birds would be startled by the underwater detonations and quickly leave the collapsing structure. Thus, relatively few individual birds would be affected by decommissioning activities under the proposed action.

Operational Discharges and Wastes. Normal operational wastes may include produced water, drilling muds, and drill cuttings discharged from offshore platforms, waste fluids produced on OCS vessels, and trash and debris generated on platforms and vessels. A number of normal operational discharges and wastes have the potential to affect marine and coastal birds.

The discharge of production wastes into open water is prohibited in coastal waters but permitted in marine waters under the NPDES program (see Section 4.4.3.1). Produced water, drilling muds, and drill cuttings are routinely discharged from production platforms in the GOM into offshore marine waters in compliance with applicable regulations and permits, and would continue to be so discharged with any development following lease sales under the proposed action. The discharged materials may contain a variety of constituents (e.g., trace metals, hydrocarbons) that may be toxic to birds. In marine waters, birds could be exposed to these materials by direct contact or through the ingestion of contaminated food items. Birds most likely to be present at offshore production locations where operational discharges are occurring are those that forage on fish in offshore waters and may frequent offshore facilities; these include pelicans, frigatebirds, gannets, and terns.

Upon discharge in accordance with permit specifications, production wastes would be rapidly diluted in the water column (i.e., to ambient levels within several thousand meters of discharge [see Section 4.4.3.1.1]) and dispersed by currents, thus greatly reducing the magnitude of exposure that a bird might incur. If constituents of the discharged materials bioaccumulate or biomagnify, there is a potential that some birds may be exposed through their food. Field studies have shown that the concentrations of trace metals, hydrocarbons, or NORM in the tissues of fishes collected around production platforms are within background levels (Continental Shelf Associates 1997). Thus, food chain uptake is likely not a major exposure pathway for fish-eating birds at offshore facilities.

Some bird species may also be affected indirectly if the discharges reduce the abundance of prey species (NRC 1983; MMS 1995c). However, because of the rapid dilution that would occur, potential impacts on prey populations inhabiting the water column (e.g., fish, plankton) would likely be limited in extent and not be expected to significantly affect overall prey abundance (see Sections 4.4.7.3.1 and 4.4.7.5.1). While some production-related contaminants may reach sediments and reduce macroinfaunal abundance (Rabalais et al. 1998), the potentially affected macroinvertebrate biota would be at depths beyond the diving limits of birds. Sediment impacts can last for years after the discharge period has ended (Rye et al. 2008) and can cause an overall impoverishment of the benthic community (Daan and Mulder 1996). These sediment changes may affect benthic larval or juvenile stages of species which would eventually become prey for seabirds. However, the relative amount of sediment that could be affected would be very small.

Many species of marine birds (especially gulls) often follow ships and forage in their wake on fish and other prey injured or disoriented by the passing vessel. In doing so, these birds may be affected by discharges of waste fluids (such as bilge water) generated by OCS vessels. Discharges of such wastes from OCS service and construction vessels, when allowed, would be regulated under applicable NPDES permits (see Section 4.4.3.1); any discharged wastes would be quickly diluted and dispersed and thus not be expected to affect marine birds.

Marine and coastal birds may become entangled in or ingest floating, submerged, and beached debris (Heneman and the Center for Environmental Education 1988; Ryan 1987, 1990). Entanglement may result in strangulation, the injury or loss of limbs, entrapment, or the prevention or hindrance of the ability to fly or swim, and all these effects may be considered lethal. Ingestion of debris may irritate, block, or perforate the digestive tract, suppress appetite, impair digestion of food, reduce growth, or release toxic chemicals (Fry et al. 1985; Dickerman and Goelet 1987; Ryan 1988; Derraik 2002). Because the discharge or disposal of solid debris into offshore waters from OCS structures and vessels is prohibited by BOEM (30 CFR 250.40) and the USCG (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]), entanglement in or ingestion of OCS-related trash and debris by marine and coastal birds would not be expected under normal operations.

Vessel and Aircraft Traffic. Under the proposed action, up to 600 vessel and 5,500 helicopter trips may take place weekly within the northern GOM planning areas. Birds may be affected in the following ways by this traffic: (1) they may be induced by vehicle noise to cease a particular activity (such as nesting or feeding) and leave the area, (2) they may incur injury or mortality through collision with a ship or helicopter, or (3) nests may be disturbed by excessive boat wakes.

Disturbance from noise is addressed later in this section. Birds disturbed by the presence of an OCS vessel may flee an area. Displaced birds would move to other habitats and may or may not return. In most cases, such displacement would be short term and transient and would not be expected to result in any lasting effects. However, if the displaced birds were occupying active nests, incubating eggs, or feeding and protecting hatchlings, even a short-term absence of the adult birds could increase predation of eggs or unfledged young, or reduce hatching success. However, because of the heavy commercial and recreational boat traffic in the northern GOM, most birds of the area are likely habituated to ship traffic and may only minimally react to passing OCS support vessels. In addition, OCS vessel traffic would likely occur within designated traffic lanes and not in waterways where birds may be nesting on beaches or other shoreline habitats. For this same reason, wakes from OCS-related vessels are also not expected to affect coastal birds and their nests. In addition, low-wake or wake-free vessel speeds are required while transiting across waterways that have sensitive shoreline resources (such as shorebird nesting colonies). Thus, compliance with such requirements would further minimize potential wake-induced impacts on birds.

A number of studies have examined the responses of birds to low-flying aircraft and atypical noise (see *Noise* discussion below). The results of many of these studies have indicated that although habituation may vary among species (Conomy et al. 1998), many species of birds will habituate to low-flying aircraft and noise and exhibit no effects on reproductive success (Black et al. 1984; Andersen et al. 1989; Delaney et al. 1999).

FAA guidelines for helicopter operations in the GOM request that pilots maintain a minimum altitude of 213 m (600 ft) while in transit offshore, 305 m (1,000 ft) over unpopulated areas or across coastlines, and 610 m (2,000 ft) over populated areas and sensitive habitats such as wildlife refuges and park properties (FAA 2010). Compliance with these guidelines regarding service altitudes for OCS helicopters would minimize disturbance of nesting or roosting birds within coastal areas.

Construction and Operation of Onshore Infrastructure. Loss or alteration of preferred habitat due to new OCS pipeline landfalls could result in the displacement of individuals or groups of birds from the affected area(s), including a possible decrease in nesting activities although relatively few birds and nests are likely to be affected. Some pipelines in the central and western GOM have been brought to shore using a directional drilling process (MMS 2006a, 2008a) in which pipelines pass beneath coastal habitats to emerge inland at an onshore receiving facility, away from coastal habitats. Where used, this process could greatly reduce or avoid impacts on coastal habitats that are important to listed and non-listed marine and coastal birds.

Under the proposed action, up to 12 landfalls would be expected in the Western and Central GOM Planning Areas, with none occurring in the EPA. The location and small number of landfalls that could occur with development associated with the proposed action would greatly limit the amount of coastal bird habitat that might be disturbed. In addition, siting of pipeline landfalls would consider the presence of sensitive habitats and areas, and avoid such areas to the maximum extent possible, further reducing the likelihood of affecting coastal bird habitats and the magnitude and extent of impacts on such habitats.

Noise. Noise generated during facility and pipeline construction, production operations, and platform removal activities, and by OCS ships and helicopters, may affect birds in a variety of ways. Unexpected noise can startle birds and potentially affect feeding, resting, or nesting behavior, and often causes flocks of birds to abandon the immediate area.

Much of the wildlife-related noise effects research has shown that noise may affect territory selection, territorial defense, dispersal, foraging success, fledging success, and song learning (e.g., Anderson et al. 1986; Gladwin et al. 1988; Larkin 1996). In many cases, the effects are temporary, with the birds becoming habituated to the noise. For example, weapons testing noise has been reported to have no significant effect on bald eagle activity or reproductive success, suggesting habituation of the birds to the noise (e.g., Brown et al. 1999). Studies of birds exposed to frequent low-level military jet aircraft overflights and simulated (with mortars, shotguns, and propane cannons) mid- to high-altitude sonic booms have shown aircraft and detonation noise to elicit some short-term behavioral responses but to have little effect on reproductive success (Ellis et al. 1991). Birds of prey have been reported to habituate to low-level helicopter flights and exhibit no effects on their reproductive success (Delaney et al. 1999; Andersen et al. 1989), and low-level (<500 ft AGL) military training flights have been shown to have no effects on the establishment, size, and reproductive success of wading bird colonies in Florida (Black et al. 1984). On the basis of these studies, noise generated during normal operations is expected to have only short-term and transient effects on birds, and would not be expected to result in long-term disturbance or population-level effects.

Potential Effects on ESA-listed Species in the Gulf of Mexico Planning Areas. Normal operations may affect listed bird species in the same manner as non-listed species (i.e., primarily behavioral disturbance). Compliance with ESA regulations and coordination with the NMFS and USFWS would ensure that lease-specific operations would be conducted in a manner that avoids or greatly minimizes the potential for affecting these species.

The threatened Audubon's crested caracara, the endangered Mississippi sandhill crane, the threatened and endangered piping plover, the endangered roseate tern, the endangered whooping crane, the endangered wood stork, and the candidate red knot occur in the GOM planning areas and thus could be affected by oil and gas development in the area. Those species reported from Florida (the Audubon's crested caracara and the roseate tern are exclusive to Florida) would not be expected to be affected by normal OCS oil and gas operations.

The roseate tern, which is known to occur in oceanic waters, occurs within the Florida Keys and southeastern Florida (USFWS 1999; FFWCC 2003). Because these areas are hundreds of kilometers away from the portion of the Eastern GOM Planning Area where oil and gas leasing and development might occur under the proposed action, the roseate tern would not be expected to be exposed to production wastes generated at offshore facilities. The roseate tern is likely to visit offshore platforms during normal foraging activities, but the NMFS has previously evaluated the explosive removal of offshore platforms in the GOM and issued a Biological Opinion that concluded that such structure removal would not jeopardize birds listed under the ESA (NMFS 1988). In addition, BOEM has established guidelines for explosive platform removals (30 CFR Part 250). Compliance with the BOEM guidelines should further reduce the likelihood that offshore structure removal could affect the roseate tern.

Because its distribution is limited to within or near a wildlife refuge in Mississippi, relatively few Mississippi sandhill cranes would be expected to be present in areas where seismic exploration, offshore platform and pipeline construction, or OCS vessel and aircraft traffic is occurring. This species is non-migratory, so collision with offshore platforms is unlikely. While it is possible for daily aircraft traffic to result in the long-term displacement of birds from frequently used flight line locations, the very low number of Mississippi sandhill cranes that could be present along flight lines means that few, if any, birds would be expected to be impacted.

Overwintering flocks of piping plovers could be temporarily disturbed by seismic exploration and by the construction of offshore platforms and pipelines, if those activities were to occur in or near areas where the birds are overwintering. Overwintering birds may also be disturbed by OCS-related vessel and aircraft traffic. If affected, birds would be expected to move away from oncoming vessels and would not be adversely affected. Overwintering birds may be startled by helicopter overflights and may or may not take flight and flee the immediate vicinity. Some birds could be killed or injured as a result of collisions with platforms or OCS-related aircraft; however, piping plovers migrate north for the breeding season and do not travel across the GOM, so collisions with offshore platforms would not be expected.

Overwintering flocks of whooping cranes could be temporarily disturbed by seismic exploration and by the construction of offshore platforms and pipelines, if those activities were to occur in or near areas where the birds are overwintering. Construction would not occur in the Aransas National Wildlife Refuge, but birds occurring outside of the refuge may be disturbed. Overwintering birds may also be disturbed by OCS-related vessel and aircraft traffic. If affected, birds would be expected to move away from oncoming vessels and would not be adversely affected. Overwintering birds may be startled by helicopter overflights and may or may not take flight and flee the immediate vicinity. Some birds could be killed or injured as a result of collisions with OCS-related aircraft; however, whooping cranes migrate north for the breeding season and do not travel through the GOM, so no population-level effects would be expected from collision with offshore platforms.

While the wood stork can be found in the GOM Central and Eastern Planning Areas, the only coastal counties where breeding occurs are located in Florida where normal OCS oil and gas operations will not occur. Non-breeding individuals located in Alabama could be temporarily disturbed by seismic exploration and by the construction of offshore platforms and pipelines, if those activities were to occur in or near areas where the birds are overwintering. Overwintering birds may also be disturbed by OCS-related vessel and aircraft traffic. If affected, birds would be expected to move away from oncoming vessels and would not be adversely affected. Overwintering birds may be startled by helicopter overflights and may or may not take flight and flee the immediate vicinity. Some birds could be killed or injured as a result of collisions with platforms or OCS-related aircraft; however, exposure to routine operations would be expected to be infrequent and localized due to the limited distribution of wood storks in coastal GOM counties outside of Florida.

While the red knot can be found in the GOM planning areas, nesting occurs in mid- and high-Arctic latitudes, so breeding individuals would not be impacted by OCS-related activities. Overwintering flocks of red knots could be disturbed by seismic exploration and by the construction of offshore platforms and pipelines, if those activities were to occur in or near areas where the birds are overwintering. Overwintering birds may also be disturbed by OCS-related vessel and aircraft traffic. If affected, birds would be expected to move away from oncoming vessels and would not be adversely affected. Overwintering birds may be startled by helicopter overflights and may or may not take flight and flee the immediate vicinity. The red knot might visit an offshore platform during spring and fall migrations, but only if stopping to rest on a platform while crossing the GOM. BOEM has established guidelines for explosive platform removals (30 CFR Part 250). Compliance with the BOEM guidelines should further reduce the likelihood that offshore structure removal could affect the red knot. Some birds could be killed or injured as a result of collisions with platforms or OCS-related aircraft, but population-level impacts are not expected. As this species is not an open-water feeder or swimmer, no exposure to operational discharges would be expected.

Impacts of Expected Accidental Events and Spills. The accidental oil spill scenario for the GOM under the proposed action identifies as many as 8 large (≥1,000 bbl) and as many as 470 small (<1,000 bbl) oil spills potentially occurring with development resulting from the lease sales of the proposed action (Table 4.4.2-1). The majority of the expected small accidental spills would be <50 bbl (see Table 4.4.2-1), would quickly dissipate, and would only have the potential to affect a very small amount of habitat and relatively few individuals. Small spills larger than 50 bbl (≤1,000 bbl) would similarly be relatively easy to contain and would only affect small areas of habitat and few individuals. A large spill (≥1,000 bbl), depending on the season and location, would be more difficult to contain and may result in lethal and sublethal effects on relatively large numbers of birds. In the event of an accidental oil spill, birds may be adversely affected through direct contact with the spilled oil, by the fouling of their habitats and contamination of their food by the oil, and as a result of oil spill-response activities. Exposure of eggs, young, and adult birds to oil may result in a variety of lethal and sublethal effects. Fouling of habitats can reduce habitat quality, while contamination of foods may lead to a variety of lethal and sublethal toxic and physiological effects. Finally, oil spill-response activities may disturb birds in nearby habitats that are unaffected by an oil spill.

Adult and young birds may come in direct contact with oil on the water's surface or on oiled beaches, mudflats, and other shore features. Oil may also be physically transferred by nesting adults to eggs or young. Direct contact with oil by young and adult birds may result in the fouling or matting of feathers, which would affect flight and/or diving capabilities, affecting such activities as foraging and fleeing predators. Birds that have been fouled by oil also experience a loss in the insulating properties of their feathers, making them susceptible to hypothermia during cold weather periods. Oil making contact with skin, eyes, or other sensitive tissues may result in an irritation or inflammation of skin or sensitive tissues (Fry and Lowenstine 1985), while oiled eggs would incur reduced gas exchange.

Birds may ingest oil incidentally while foraging and while preening oiled feathers. Ingested oil may depress egg-laying activity or may result in the death or deformities of young (Fry et al. 1985; Leighton 1993). Direct effects of oil contact may be amplified under conditions of environmental stress such as low temperatures, migration movements, and molting. Indirect effects of oil contact include toxic effects from the consumption of contaminated food or starvation from the reduction of food resources (Lee and Socci 1989). The latter effects may hinder the recovery of impacted bird populations after a spill (Hartung 1995; Piatt and Anderson 1996; Piatt and Ford 1996).

Certain species of marine and coastal birds may be more susceptible to contact with spilled oil than others, based on their life histories. For example, diving birds and underwater swimmers such as loons, cormorants, and diving ducks may be the most susceptible to spilled oil because of their relatively long exposure time within the water and at the sea surface (Camphuysen 2007; Williams et al. 1995). Shorebirds and wetland birds may also be susceptible to direct oiling if a spill were to reach the beach intertidal zone or inshore wetland habitats, respectively, where these species forage and raise young (King and Sanger 1979). Oiled birds collected during response actions to the DWH event included seabirds, shorebirds, wetland birds, waterfowl, passerines, and raptors, with the majority of oiled birds being seabirds (see Section 3.8.2.1.5 and Table 3.8.2-6).

The magnitude of the impact would depend on the size, location, and timing of the spill; the species and life stage when exposed; and the size of the local bird population.

Spills in deep water are not likely to affect the listed and candidate bird species identified for the northern GOM (Table 3.8.2-3). Only the roseate tern and the red knot would be expected in areas of the outer inner continental shelf where deepwater spills could occur, and these occurrences would be transient and not expected to result in direct exposure to spilled oil. In contrast, all the listed and candidate species with the exception of the roseate tern could be exposed if a deepwater spill were to move into coastal waters and reach coastal habitats utilized by these species. Even if a deepwater spill were to reach coastal habitats, because of the great distance from shore at which a deepwater spill would originate the oil would be greatly weathered, and therefore reduced in toxicity, by the time it reached the shore (see Section 4.4.3.1.2).

In contrast, a number of non-listed seabird species (e.g., terns, gulls, shearwaters, boobies, frigatebirds) could be exposed to deepwater spills. Some of these species are found only in pelagic areas of the GOM, while others inhabit waters of the continental shelf (see Section 3.1.2.3.2) (Duncan and Havard 1980; Davis et al. 2000). A number of these species forage in deepwater areas, are attracted to offshore platforms, and often follow vessels. These birds may be directly exposed while feeding or resting in spills originating from deepwater platforms or transport tankers and could incur lethal or sublethal effects. Depending on its size, location, and timing, a deepwater spill may affect only a few individuals or, as in the case of aggregations of overwintering gannets, a relatively large number of birds.

A shallow water spill in an offshore or nearshore area that reaches shoreline habitats has the potential to affect a greater number of bird species than a deepwater spill of comparable size that does not reach the coast. Most threatened or endangered avian species are not likely to be affected by a spill unless a hurricane were to occur and spread oil inland to freshwater and terrestrial habitats. However, the piping plover and red knot could be exposed if their beach habitats become fouled by a spill. Because shorebirds tend to be flocking species, spills reaching habitats used by these species could result in the exposure of a relatively large number of individuals. The sandhill crane, wood stork, and whooping crane could be exposed if a spill were to foul their coastal wetland habitats. Because of the very specific and limited winter habitat that supports the majority of whooping cranes, a spill affecting this habitat could result in population-level effects on this species. Audubon's crested caracara, while reported to use coastal dune habitats, is generally more of a terrestrial species and would not be expected to occur along beach and wetland habitats. The roseate tern breeds in scattered colonies along the Florida Keys (see Section 3.8.2.1.2) and could be exposed if a spill were to occur in the extreme southeastern portion of the EPA. Under the proposed action, however, lease sales would be limited to the extreme western portion of this planning area, hundreds of miles from the nearest nesting colony of this tern. Thus, this species would not be expected to be exposed to any accidental spills that might occur in association with a lease sale under the proposed action.

Accidental spills in shallow water could affect a wide variety of non-listed species. In offshore locations, shallow water spills could expose any of a large variety of ducks, cormorants, terns, grebes, and gulls. Spills reaching shoreline habitats such as beaches, mudflats, and wetlands could affect shorebirds (e.g., sandpipers, plovers), wading birds (e.g., herons, bitterns), wetland birds (e.g., rails, coots, blackbirds), and a wide variety of migratory birds. Spills occurring during the fall or spring migrations have the potential to expose large numbers of birds in both nearshore coastal waters and in coastal habitats such as beaches, flats, and wetlands. The magnitude of impacts that could result from an accidental spill in shallow water would depend on the timing, duration, location, and size of the spill; the habitats that came in contact with the spill; and the species and numbers of birds exposed to the spill.

Besides being affected by the spill itself, marine and coastal birds may be affected during spill containment and cleanup activities. Spill response plans will include consultations with Federal and/or State wildlife agencies to minimize potential impacts of response actions on marine and coastal birds. During cleanup, some oiled birds could be successfully cleaned, and cleanup of the affected habitat could be necessary to avoid chronic exposure. Nesting or roosting birds in nearby habitats unaffected by the spill could be disturbed by cleanup of contaminated habitats. Coastal cleanup and remediation activities in coastal habitats may impact local populations of coastal birds, resulting in their temporary displacement from these areas. If the abandoned area is an important nesting habitat (especially during the breeding season), local population-level impacts may be incurred. The application of dispersant chemicals to spilled surface oil could also affect birds. While dispersant chemicals contain constituents that are considered to have low levels of toxicity when compared to toxic constituents of spilled oil (Wells 1989), the effects of these dispersants on seabirds are poorly understood. Because the use of these chemicals and spill cleanup activities would be localized and infrequent, potential impacts from spill response activities would largely be short term (e.g., avoidance of the cleanup area).

The specific nature and magnitude of effects of an oil spill on marine and coastal birds of the GOM will depend on the size, location, timing, and duration of the spill and the birds and habitats exposed to the spill. Small spills may be expected to affect relatively small numbers of birds and habitats and would not be expected to cause population-level impacts.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE in the GOM with a volume ranging from 900,000 to 7,200,000 bbl and a duration of 30–90 days (Table 4.4.2-2). In the unlikely event that a CDE were to occur in the GOM, the nature and magnitude of impacts to marine and coastal birds would depend on the location, magnitude, and duration of the event, as well as the species, life stages and habitats exposed to the spill. Exposure to oil from a low-probability CDE would have similar types of impacts on bird populations as spills of other magnitudes; however, the area affected and the number of species and individuals likely affected would increase and the degree of impact would be more severe. A much greater number of birds and habitats could be affected, and population-level impacts for some species could be incurred as CDEs can affect extensive areas of shoreline. For example, the Gulf Coast Least Tern Colony (see Section 3.8.2.1.4) on the Mississippi coast has one of the world's largest colonies of least tern. A CDE reaching this colony site during the nesting season could foul several thousand nests and result in the loss of an entire reproductive season, the effects of which may cause long-term population effects.

Exposure to oil can cause pneumonia, kidney damage, reduced immune system function, and anemia in birds. Even low levels of oil can stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration (MMS 2006b). The GOM acts as an important stopover site for many migratory bird species, and a CDE could impact a bird's ability to consume enough resources to successfully complete its migration. A study of the impact of the 1979 Ixtoc spill on Texas shorebirds found that oil on the beach caused birds to shift their habitat selection to feed in less productive areas (Chapman 1981, 1984). Avoiding oiled habitat may become problematic for species at the edges of their ranges or if a CDE results in widespread oiling of coastlines.

Impact Conclusions.

Routine Operations. The nature and magnitude of effects of routine operations in the GOM on birds would depend on the specific location, the timing, and the nature and magnitude of the operation, as well as the species that would be exposed to the operation. For routine Program activities, the primary effects would be the disturbance of birds (and their normal behaviors) by noise, construction and development equipment, human activity, and habitat loss in areas of infrastructure construction. Birds may also incur injury or mortality as a result of collisions with infrastructure and support vessels.

Birds tend to habituate to human activities and noise, especially in areas like the GOM planning areas, where local bird populations are regularly exposed to noise, construction, and vessel traffic associated with commercial and recreational activities. In most cases, noise disturbances of birds would be short-term or transient, and would be expected to have only minor impacts on marine and coastal birds. Construction of offshore platforms and pipelines could result in short-term avoidance or abandonment of habitats in the immediate area of trenching. However, because of the relatively small amount of habitat that could be disturbed, as well as the limited use of some of the affected habitats (such as deepwater benthic habitat), habitat disturbance or loss is expected to have only minor impacts. Construction of onshore pipelines and landfalls could result in the permanent disturbance of habitat and displacement of individuals within the immediate footprint of the new pipelines and facilities. Because of the relatively small amount of habitat that could be disturbed, habitat disturbance or loss is expected to have only minor impacts on marine and coastal birds. Some mortality may be expected for birds colliding with offshore platforms and, to a lesser extent, with helicopters providing support services to offshore platforms. Impacts from such collisions are anticipated to affect relatively few birds and result in only minor impacts on bird populations, with no population-level effects. Because the discharge of production wastes and other materials generated at offshore platforms and OCS-related vessels is regulated and because permitted production wastes discharged into marine waters would be quickly diluted and dispersed, relatively few birds would be exposed to these waste materials and impacts from such discharges would likely be negligible. The overall impact of all routine operations of the Program is expected to range from negligible to moderate.

Expected Accidental Events and Spills. Accidental oil spills from offshore platforms and pipelines could affect both birds and their habitats. The magnitude and ecological importance of any effects would depend upon the size of the spill, the species and life stages that are exposed, and the size of the local bird population. A shallow water spill in an offshore or nearshore area may impact a greater number of bird species than a deepwater spill, as spills reaching shoreline habitats have the potential to affect shorebirds, wading birds, wetland birds, and migratory birds. Small spills, especially those <50 bbl, would be easily contained and cleaned up. All small spills (≤1,000 bbl) would only impact small areas of habitat and relatively few individuals and are expected to have no more than minor impacts on marine and coastal birds. Large spills (>1,000 bbl), especially those occurring during the fall or spring migrations, may result in lethal and sublethal effects, including reduced reproductive success, on large numbers of birds in both nearshore coastal waters and in coastal habitats. Impacts to marine and coastal birds from a large oil spill in the GOM planning areas are expected to be moderate to major.

An Unexpected Catastrophic Discharge Event. A CDE poses the greatest threat to marine, coastal, and migratory birds, and could affect both birds and their habitats. A CDE would cause similar types of impacts on bird populations as spills of other magnitudes, but the degree of impact would be more severe. Similar to smaller spills, birds that become heavily oiled by direct contact with a spill would likely perish, while lightly oiled birds may experience a variety of lethal or sublethal effects. The GOM acts as an important stopover site for many migratory bird species. An unlikely CDE can foul foraging areas and food resources along extensive areas of shoreline and may impact a bird's ability to refuel for migration. A spill associated with a CDE would affect the greatest number of species, individuals, and habitats, and have the potential to cause moderate to major impacts to affected species.

4.4.7.2.2 Alaska – Cook Inlet.

Impacts of Routine Operations. Oil and gas development that could occur in the Cook Inlet Planning Area following a lease sale under the proposed action would include (1) offshore exploration; (2) construction of offshore platforms and pipelines; (3) construction of onshore pipeline landfalls and pipelines; (4) operations of offshore and onshore facilities; and (5) OCS-related vessel and aircraft traffic (Table 4.4.1-3). While activities supporting this development may be expected to affect marine and coastal birds in the vicinity of the development activities, these impacts would largely be short term, generally affect only a relatively small number of birds at any one time, and not be expected to result in population-level impacts on any species.

Offshore Exploration. Under the proposed action, oil and gas exploration could include the placement of up to 12 exploration and development wells in the Cook Inlet Planning Area. Seismic surveys and placement and operation of the wells could affect some birds. Disturbance of birds during seismic surveys would be limited to the immediate area around survey vessels, be short term, and be largely behavioral (MMS 2005e). For example, noise from airguns and disturbance from survey vessel traffic could displace foraging seabirds in offshore waters, especially if exploration were to occur in areas with high seabird density (such as the open waters adjacent to the Stevenson and Kennedy Entrances to Cook Inlet and off the northwestern coast of Kodiak Island [see Section 3.8.2.2.4]) where seabirds are likely to be encountered. If disturbed, affected birds would likely cease foraging activities and leave the vicinity to feed in other areas. Because the lease sale would occur no closer than 3 NM from shore, offshore exploration activities (including the placement of exploration and development wells) would not be expected to disturb marine or coastal birds or their habitats (such as seabird colonies or wintering grounds) in coastal areas. Thus, normal offshore exploration activities are not expected to result in any population-level effects for local bird populations.

Construction of Offshore Platforms and Pipelines. Under this proposed action, up to three offshore platforms could be constructed in the Cook Inlet Planning Area. These platforms would likely be constructed outside of the planning area and towed to their final location, and marine and coastal birds could be temporarily disturbed during the transportation and placement of the platforms. Disturbance would likely result in affected birds leaving the immediate area of activity (either the platform location or the transportation route). Because of the small number of platforms, the transient nature of their transport and construction, and their offshore locations being well away from coastal habitats and seabird colonies, any impacts on marine and coastal birds may be expected to be short term, affect relatively few birds, and not result in long-term population-level effects for any species.

In addition to the new platforms, up to 241 km (150 mi) of new offshore pipeline could be constructed following leasing under the proposed action. Pipeline trenching could affect birds in nearshore coastal habitats if trenching occurs in or near foraging, overwintering, or staging areas or near seabird colonies. Trenching may also disturb marine species foraging in offshore waters. For many species, disturbance from pipeline trenching would result primarily in a behavioral response, namely, the short-term abandonment or avoidance of habitats in the immediate area of trenching. Pipeline trenching near seabird colonies could cause adults to abandon nests (at least temporarily) and cease incubating eggs or feeding young, and thereby potentially affecting nesting success. If nests are permanently abandoned, some localized population-level effects may be incurred by the affected species if successful nesting habitat is not found elsewhere. Potential impacts could be avoided or minimized by locating pipeline corridors and the landfall away from nesting aggregations (seabird colonies), and by scheduling trenching activities to avoid staging, overwintering, and nesting periods.

Construction of up to 241 km (150 mi) of new offshore pipeline could affect as much as 210 ha (519 ac) of benthic habitat within the Cook Inlet Planning Area and locally affect the availability of foraging habitat for some marine and coastal birds. Because portions of the new pipelines would be in water depths potentially unavailable for most marine and coastal birds, pipeline construction may be expected to have limited effect on the overall availability of foraging habitat for marine and coastal birds. Any impacts on food sources would be localized to the pipeline footprint and are expected to affect relatively few individuals.

Construction of Onshore Pipelines and Landfalls. Under the proposed action, up to 169 km (105 mi) of new pipeline and possibly one new pipeline landfall could be constructed in onshore areas adjacent to the Cook Inlet Planning Area. Construction of new pipelines would likely be located in the general vicinity of existing oil and gas infrastructure, delivering oil to existing refineries in Nikiski and natural gas to existing transmission facilities in the Kenai area (Table 4.4.1-3). Depending on the proximity of the new onshore pipelines or a new pipeline landfall to existing roads, one or more new access roads could be needed to bring in construction equipment and supplies to the construction areas. The construction of new pipelines would result in a long-term loss of a relatively small amount of habitat (about 4.9 ha [12 ac], assuming a 30.5-m [100-ft] construction ROW) along the pipeline routes, while construction camps to support onshore construction activities would affect an additional very small amount of terrestrial habitat. Siting new pipelines and facilities away from coastal areas would reduce the amount of marine or coastal bird habitat that could be affected. Potential habitat impacts could be reduced by locating the new pipelines within existing utility or transportation ROWs. Because there are relatively few nesting colonies along the Kenai Peninsula north of Anchor Point (USGS undated), only a few seabird colonies could be affected by onshore construction activities. The disturbance of birds in these colonies could be reduced or avoided by siting any new onshore infrastructure away from colony sites and by scheduling construction activities to avoid nesting periods. Overall, onshore construction activities are expected to affect only a relatively small number of birds and not to result in population-level effects for any affected species.

Operations of Offshore Facilities. During normal operations, birds may be affected by noise and human activities at onshore and offshore facilities and by the presence of the facilities themselves. Noise and human activities (such as normal maintenance) could affect birds moving through Cook Inlet during spring and fall migration, as well as birds moving into nesting, fall molting, or overwintering habitats in the planning area. Affected birds would likely avoid the platforms and nearby habitats. Although operational noise and human activity may cause birds to avoid areas where platforms are located, affected birds would likely select other suitable areas of the planning area. Because of the small number of new platforms (no more than three), the disturbance of birds in offshore waters by operational noise and human activity would be limited to only a few areas around the platforms and is not expected to adversely affect marine or coastal bird populations.

Offshore platforms may pose a collision hazard to birds, especially during migration and/or periods of low visibility. No information is available regarding bird collisions with platforms and other structures in Cook Inlet or elsewhere in Alaskan waters. However, a reasoned estimate of the potential number of such collisions can be made from information available about potential collisions in the GOM. Annual bird mortality in the northern GOM (a major migratory area with several hundred million migrants estimated to pass through annually) from collisions with offshore platforms has been estimated to average 50 collision deaths per platform per year (Russell 2005). Applying a similar collision mortality rate to development that could occur under the proposed action, about 150 bird collision mortalities might be expected annually for the three new platforms.

Operational Discharges and Wastes. Oil and gas development occurring following a lease sale under the proposed action would result in the generation of drilling fluids and debris (Table 4.4.1-3). Produced water, drilling muds, and drill cuttings generated by development and production wells would be disposed of through down-hole injection. Thus, no impacts on marine and coastal birds from these wastes would be expected under normal operations. In contrast, produced water, drilling muds, and drill cuttings generated by exploration and delineation wells would be discharged at the well sites in compliance with applicable regulations and permits. The discharged materials may contain a variety of constituents (e.g., trace metals, hydrocarbons) that may be toxic to birds. In marine waters, birds could be exposed to these materials by direct contact or through the ingestion of contaminated food items. Birds most likely to be present at well sites are those that forage on invertebrates and fish in offshore waters; these include seabirds such as the alcids (such as the common murre, pigeon guillemot, and ancient murrelet), gulls and terns (such as the mew gull and Arctic tern), and others.

Upon discharge in accordance with permit specifications, production wastes would be rapidly diluted in the water column (i.e., to ambient levels within several thousand meters of discharge [see Section 4.4.3.2.1]) and dispersed by currents, thus greatly reducing the potential for, and the magnitude of, exposure. If constituents of the discharged materials bioaccumulate or biomagnify, there is a potential for some birds to be exposed through their food. Field studies have shown that the concentrations of trace metals, hydrocarbons, or NORM in the tissues of fishes collected around production platforms are within background levels (Continental Shelf Associates 1997).

Normal operations may be expected to generate a variety of operational wastes, such as waste oils, bilge water on support ships, and sanitary wastes. Hazardous waste materials such as lubricating oils, paint, and industrial cleaners would be controlled and disposed of at licensed onshore facilities. Domestic wastewater and sanitary wastes generated on platforms or support vessels would be treated and then discharged to surrounding waters, where they would be quickly diluted (Section 4.4.3.2.1). Many species of marine birds (such as gulls) often follow ships and forage in their wake on fish and other prey injured or disoriented by the passing vessel. Because there would be up to 3 platforms and no more than three weekly vessel trips, only a relatively small volume of operational wastes would be discharged. Any such discharges would be quickly diluted and dispersed and thus not expected to affect marine or coastal birds that could be following the vessels or visiting waters immediately around the production platform.

Marine and coastal birds may become entangled in or ingest floating, submerged, and beached debris (Ryan 1987, 1990). Because the discharge or disposal of solid debris into offshore waters from OCS structures and vessels is prohibited by BOEM (30 CFR 250.40) and the USCG (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]), entanglement in or ingestion of OCS-related trash and debris by marine and coastal birds would not be expected under normal operations.

Vessel and Helicopter Traffic. There could be up to three helicopter trips and three vessel trips each week supporting up to three offshore platforms that could be installed following leasing under the proposed action. Vessel and helicopter traffic could disturb birds in foraging, molting, and staging area habitats as well as in nesting areas (such as seabird colonies) that may occur along the traffic routes. Birds may also be injured as a result of collisions with aircraft. Birds responding to approaching support vessels may be expected to cease normal behaviors and move away from the oncoming vessel; this would have little overall impact on affected birds.

In contrast to ship traffic, helicopter overflights likely have a greater potential for disturbing birds. Both the relatively sudden appearance (compared to an approaching ship) and the noise of helicopter overflights may startle birds, causing them to cease their normal behaviors and flee. The reactions of birds to aircraft overflights will depend on a variety of factors, including the species present, the altitude of the flights, and the frequency of the flights (e.g., see Gladwin et al. 1988; Ellis et al. 1991; Derksen et al. 1992; Miller et al. 1994; Larkin 1996; Delany et al. 1999). Helicopter overflights of open water may startle birds that are resting or foraging on the water surface, causing them to cease normal behavior and possibly try to flee the area. Should birds be disturbed while nesting, nesting success may be affected, especially if the disturbance results in nest abandonment and/or increased nest predation. Alternately, some birds may become habituated to aircraft disturbance. For example, no significant decrease in reproductive success was reported in a thick-billed murre colony located near an airport compared to other thick-billed murres that nested away from the airport (Curry and Murphy 1995). FAA guidelines for helicopter oceanic operations request that pilots maintain a minimum altitude of 213 m (600 ft) while in transit offshore, 305 m (1,000 ft) over unpopulated areas or across coastlines, and 610 m (2,000 ft) over populated areas and sensitive habitats such as wildlife refuges and park properties (FAA 2010).

It is assumed that helicopter support for the new platform would originate from the municipal airport in the Kenai-Nikiski area, north of the Cook Inlet Planning Area, and potential for disturbance of marine and coastal birds would be greatest along the east coast of Cook Inlet in this area and southward into the planning area. This area has several areas that provide important habitat for migrating shorebirds and waterfowl in spring, and some of which provide important overwintering habitat for Steller's eider (Table 3.8.2-2). Although there are no large seabird colonies in this area, small numbers of nesting seabirds could be affected by the overflights. Because of the low amount and transient nature of daily support traffic that might occur under the proposed action, relatively few birds may be expected to be affected by vessel or aircraft traffic. While disturbance of nesting birds has the potential to impact individuals, the number of affected birds would likely be very limited, and if seabird colonies are present, the disturbance of nesting birds could be avoided by using flight paths and vessel routes that avoid the colonies.

Potential Effects on ESA-listed Species in the Cook Inlet Planning Area. Normal operations may affect listed bird species in the same manner as non-listed species (i.e., primarily behavioral disturbance). Compliance with ESA regulations and coordination with the NMFS and USFWS would ensure that lease-specific operations would be conducted in a manner that avoids or greatly minimizes the potential for affecting these species.

The endangered short-tailed albatross, the threatened Steller's eider, and the candidate Kittlitz's murrelet and yellow-billed loon, occur in or near the Cook Inlet Planning Area and thus could be affected by oil and gas development in the area. The short-tailed albatross does not breed in or near the Cook Inlet Planning Area, occurring only as an occasional visitor that forages on the continental shelf edge beyond the southern boundary of the planning area (see Section 3.8.2.2.2). The Steller's eider also does not nest in the Cook Inlet Planning Area, but does overwinter in lower Cook Inlet and in the Shelikof Strait. Thus, normal operations would not be expected to affect nesting habitats or reproductive success of either of these species.

Because of its uncommon occurrence in marine waters in and around the Cook Inlet Planning Area, relatively few short-tailed albatross would be expected to be present in areas where seismic exploration, offshore platform and pipeline construction, or OCS vessel and aircraft traffic is occurring. If present, disturbed individuals would likely move to areas away from the OCS activity and not be adversely affected. While it is possible for a bird to collide with an OCS-related aircraft, the combination of the very low number of short-tailed albatrosses that could be present around platforms or along associated flight lines with the very small amount of aircraft traffic supporting only new platforms means that few, if any, birds would be expected to incur collisions with support aircraft or with a platform. While such collisions would likely result in the mortality of the affected individual, population-level effects would not be expected to result from such collisions.

Overwintering flocks of Steller's eider could be temporarily disturbed by seismic exploration and by the construction of offshore platforms and pipelines, if those activities were to occur in or near areas where the birds are overwintering. Overwintering birds may also be disturbed by OCS-related vessel and aircraft traffic. If affected, birds would be expected to move away from oncoming vessels and would not be adversely affected. Overwintering birds may be startled by helicopter overflights and may or may not take flight and flee the immediate vicinity. Some birds could be killed or injured as a result of collisions with platforms or OCS-related aircraft. Because there would only be no more than three new platforms and three flights per week to the platforms by support aircraft, such collisions are not expected, few if any individuals would be affected, and no population-level effects would be expected.

While Kittlitz's murrelet can be found in the Cook Inlet Planning Area, it is present in a very patchy and clumped distribution, preferring areas of heavy glaciation, high turbidity, and partial ice cover (Day et al. 2000b; Van Pelt and Piatt 2003). This species has been reported to be sensitive to excessive noise and human activity (Day and Nigro 1999). Offshore platform or pipeline construction activities occurring near concentrations of this species could result in the short- or long-term displacement of birds from the construction areas. Construction of onshore pipelines and facilities could disturb nesting birds and affect nest sites, although it is unlikely that more than a few individuals would be affected. This species nests on cliffs and scree slopes, in a terrain typically avoided when pipelines are being sited. Long-term platform operations and daily vessel and aircraft traffic may also result in the long-term displacement of birds from surrounding platform locations and along frequently used flight line locations. In addition, some individuals could collide with OCS-related aircraft. Because of the disjunct distribution of this species, exposure to routine operations would be expected to be infrequent and localized.

Lower Cook Inlet is used by overwintering yellow-billed loons and by immature and possibly nonbreeding adults throughout the year. This species could be temporarily disturbed by seismic exploration and by the construction of offshore platforms and pipelines, if those activities occurred in or near areas where the birds are present. Birds also may be disturbed by OCS-related vessel and aircraft traffic. Birds may be startled by helicopter overflights and may or may not take flight and flee the immediate vicinity. Some birds could be killed or injured as a result of collisions with platforms or OCS-related aircraft; however, there would be no more than three new platforms and three flights per week to the platforms by support aircraft, so no population -level effects would be expected.

Impacts of Expected Accidental Events and Spills. Under the proposed action, no more than one large spill (between 1,700 and 5,000 bbl from either a platform or a pipeline), and as many as 18 small spills (<1,000 bbl) may be expected over the lifetime of the lease. The magnitude and extent of impacts on marine and coastal birds from such spills will be a function of a variety of factors, including (1) the time of year of the spill, (2) the volume of the spill, (3) the habitats exposed to the spill, and (4) the species exposed to the spill or that utilize the impacted habitats. The majority of expected accidental spills would be small (<50 bbl) (see Table 4.4.2-1), would quickly dissipate, and would only have the potential to affect a very small amount of habitat and relatively few individuals. Small spills larger than 50 bbl (≤1,000 bbl) would similarly be relatively easy to contain and would only affect small areas of habitat and few individuals. A large spill (≥1,000 bbl), depending on the season and location, would be more difficult to contain and may result in lethal and sublethal effects on relatively large numbers of birds. Oil spills from onshore pipelines may affect terrestrial habitats and birds. Because of the lower number of species and individual birds that would be present in winter, as well as their more limited winter distribution, a greater number of species and individuals may be expected to be affected by an accidental oil spill during spring and fall migration and during the summer. However, some species overwinter in Cook Inlet, in relatively large numbers, and these could be affected by an accidental spill. Birds in areas near habitats that have been affected by oil may also be disturbed during spill cleanup operations. Spill cleanup activities may displace birds from nearby habitats, which, depending on the nature of those habitats (e.g., nesting, molting, staging), could result in reduced reproductive success or survival. In addition, the duration of cleanup activities may preclude birds from using the area for quite some time.

Exposure of eggs and young and adult birds to oil may result in a variety of lethal and sublethal effects, while oil may foul habitats, reducing habitat quality and contaminating foods; these potential effects apply to both non-listed and listed bird species of the Cook Inlet Planning Area. The short-tailed albatross, Steller's eider, and Kittlitz's murrelet may be directly affected by an accidental oil release in the same manner as described for non-listed birds, namely, via direct contact and through the ingestion of contaminated foods. These three species may also be indirectly affected as a result of spill-related impacts on their habitats, which may also be affected during oil spill cleanup activities. Direct exposure of birds or their habitats could result in a variety of lethal and nonlethal effects that may affect survival and reproductive success, potentially resulting in population-level effects on the exposed species (e.g., see Hartung 1995; Piatt and Anderson 1996; Day et al. 1997a, b; Esler et al. 2000; Lance et al. 2001; Golet et al. 2002; Esler et al. 2002). The types of effects that exposed birds could incur are discussed in Section 4.4.7.1.

During ice-free conditions (i.e., summer), accidental spills (especially small ones) may be expected to be quickly diluted (see Section 4.4.3.2.2). In contrast, spills occurring under ice may persist for a longer period of time and be transported by currents to areas more distant from the site of the accidental spill. Previous modeling of similar size oil spills in Cook Inlet indicate that land segments with the highest chance of contact with an offshore platform or pipeline spill are generally along the western shore of lower Cook Inlet in Kamishak Bay and Shelikof Strait (MMS 2003a). Several areas that provide important habitat to migrating and overwintering birds (see Figure 3.8.2-8 and Table 3.8.2-8), as well as a number of seabird colonies, occur in these areas (USGS undated).

Offshore spills that reach coastal areas may expose species that forage or nest in coastal habitats along Cook Inlet and Shelikof Strait. As discussed in Section 3.8.2.2, these areas support thousands of migrating shorebirds and waterfowl, provide important wintering habitat for Steller's eider, and include numerous seabird colonies. Spills reaching these areas could directly or indirectly expose adults, eggs, young, and food resources. Because of the large number of Steller's eider that overwinter in coastal areas of Cook Inlet (in the vicinity of Homer Spit and Kamishak Bay) (Larned 2005), an accidental spill reaching wintering areas could expose a large number of birds. This species concentrates in shallow, vegetated nearshore habitats, and spills contacting such areas could locally reduce foraging habitat and food resources and contaminate potential prey. The number of birds affected would depend on the size and location of the spill, the number of birds directly exposed to the spill, and the amount of habitat affected.

Offshore spills in marine waters may also expose migrating seabirds and waterfowl, as well as pelagic seabirds that forage in areas such as the offshore marine waters of Cook Inlet near the Barren Islands (Figure 3.8.2.2-1). The short-tailed albatross is considered to be highly vulnerable to the impacts of oil pollution (King and Sanger 1979). Because this species does not breed in the planning area, accidental spills would not be expected to affect nesting colonies. This species is widely dispersed and is only an irregular visitor to the marine waters of the planning area. Few individuals would be expected to be exposed to an accidental spill, and few individuals would be expected to be disturbed during spill cleanup activities. The exposure of a very small number of short-tailed albatross would not be expected to result in population-level impacts on the species. This species forages in open marine waters, and no specific foraging habitat type or location has been identified as being of prime importance for this species. In the event of an accidental spill, members of this species would likely relocate their foraging activities, with no resulting significant impacts expected. Thus, accidental spills would not be expected to adversely affect foraging habitats and associated prey items available to the short-tailed albatross in the Cook Inlet Planning Area.

Spills may also indirectly affect bird populations by reducing food resources and prey availability in affected habitats. These indirect effects could reduce foraging success and energy assimilation, which may affect growth, survival, and reproductive success. Depending on the species affected, these effects could result in population-level effects. Because of the small number and size of spills assumed for routine operations that might occur under the proposed action (Table 4.4.2-1), widespread exposure and impacts such as those observed for the *Exxon Valdez* oil spill in Prince William Sound are not expected for this alternative.

Because of the preference of Kittlitz's murrelet for glacially influenced habitats and its patchy and disjunct distribution among coastal areas, accidental oil spills would generally not be expected to affect more than a few individuals. A moderate to large spill in a high-use area could, however, result in the oiling of a relatively large number of birds. While the chronic effects of long-term exposure of this species are not known, studies on the effects of the *Exxon Valdez* oil spill on marine birds indicate that while murrelets as a whole are especially vulnerable to and adversely affected by large oil spills, this group recovers within a relatively short time following the initial spill and exposure (Day et al. 1997a, b; Murphy et al. 1997). The greatest potential for population-level impacts would be associated with offshore spills occurring in spring and summer and affecting breeding adults. Because this species nests in terrestrial habitats up to 129 km (80 mi) inland (see Section 3.8.2.2.2), nest sites would not be expected to be affected by offshore spills but could be affected by spills from onshore pipelines. However, because this species nests in habitats such as coastal cliffs, scree slopes, and talus above timberline, which are typically considered unsuitable and thus are avoided when a pipeline is being sited, nest sites are unlikely to be affected by an onshore oil spill.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE in the Cook Inlet Planning Area with a volume ranging from 75,000 to 125,000 bbl and with a duration of 50–80 days (Table 4.4.2-2). A low-probability CDE would have similar impacts on bird populations as spills of other magnitudes. However, the area affected would increase and the degree of impact would be more severe depending on the location, magnitude, and timing of the event, climate conditions (winter, ice cover), and on the species, life stages, and habitats exposed to the spill. A much greater number of species, individuals, and habitats could be affected, and population-level impacts for some species could be incurred if the CDE affects extensive areas of shoreline. Such a spill contacting important migratory staging areas for waterfowl and shorebirds could have adverse effects on a variety of species. The Cook Inlet is characterized by the sudden and rapid occurrence of very large numbers of birds in early May as many species of birds use this region as important stopover habitats during their spring migrations. If a CDE were to occur during this time, a larger number of species and individual birds would be impacted by the spill, either by direct mortality or indirectly through loss of habitat or food. Similarly, a CDE reaching wintering areas for waterfowl could have population-level effects, especially with the increased difficulty in addressing spills under winter conditions.

A study of the *Exxon Valdez* oil spill in the Northern Gulf of Alaska reported populations of loons, grebes, cormorants, and sea ducks declining by 44–84% (Piatt et al. 1990). The immediate impact of the spill was a reduction in the size of local breeding populations. Populations may continue to be impacted in the future as both production and recruitment are reduced. In addition to immediate mortality, a CDE can impact bird populations through ingestion of oil or contamination of nest sites (Piatt et al. 1990). Nine years after the *Exxon Valdez* oil spill, most of the diving bird species studied still exhibited negative impacts, while only one surface-feeding species showed a negative effect. The difference in impacts may be due to behavioral differences that result in diving birds spending more time at rest on the water and in contact with any remaining oil on the surface of the water (Irons et al. 2000).

Impact Conclusions.

Routine Operations. The nature and magnitude of effects of routine operations in Cook Inlet on birds would depend on the specific location, the timing, and the nature and magnitude of the operation, as well as the species that would be exposed to the operation. For routine Program activities, the primary effects would be the disturbance of birds (and their normal behaviors) by construction and development equipment and human activity, and habitat loss in areas of infrastructure construction. Birds may also incur injury or mortality as a result of collisions with infrastructure and support vessels.

Offshore exploration activities such as seismic surveys and well placement could displace foraging seabirds. However, activities would occur far enough from shore that only negligible or minor impacts are expected on marine and coastal birds. Construction of offshore platforms and pipelines has the potential to affect the foraging habitat of some marine and coastal birds, but impacts to food sources would be limited to the pipeline footprint, and the overall impact is expected to be no more than negligible or minor. Construction of onshore pipelines and landfalls would result in the long-term disturbance of habitat within the immediate footprint of the new facilities. Because of the relatively small amount of habitat that could be disturbed, only minor impacts are expected on marine and coastal birds. Some mortality may be expected for birds colliding with offshore platforms and, to a lesser extent, with helicopters providing support services to offshore platforms. Impacts from such collisions are anticipated to affect relatively few birds and result in only negligible or minor impacts on bird populations, with no population-level effects. Because the discharge of production wastes and other materials generated at offshore platforms and OCS-related vessels is regulated and because permitted production wastes discharged into marine waters would be quickly diluted and dispersed, relatively few birds would be exposed to these waste materials and impacts from such discharges would likely be negligible. The overall impact of all routine operations for the Program could range from negligible to moderate.

Expected Accidental Events and Spills. Accidental oil spills in the Cook Inlet Planning Area could affect birds through direct contact or through indirect contamination of their food resources and their habitats. The magnitude and ecological importance of any effects would depend upon the size of the spill, the species and life stages that are exposed, the size of the local bird population, and the time of year that the spill occurs. Cook Inlet and Shelikof Strait support large numbers of migrating shorebirds and waterfowl and provide important wintering habitat. Spills reaching these areas could impact large numbers of birds and their habitats. Small spills, especially those <50 bbl, may be expected to quickly dilute during ice-free conditions, but spills occurring under ice may persist. The effects of all small spills (≤1,000 bbl) would be localized and the impacts are expected to be minor. Large spills (>1,000 bbl), especially those occurring under ice and those that reach important wintering habitats, may result in lethal and sublethal effects on large numbers of birds. Impacts to marine and coastal birds from a large spill in the Cook Inlet Planning Area are expected to be moderate to major.

An Unexpected Catastrophic Discharge Event. A CDE poses the greatest threat to marine, coastal, and migratory birds, and could affect both birds and their habitats. A CDE would cause similar types of impacts on bird populations as spills of other magnitudes, but the degree of impact would be more severe. Cook Inlet contains important migratory staging areas for waterfowl and shorebirds. An unexpected CDE occurring in May or winter months would be expected to have a higher impact on bird populations due to the rapid occurrence of large numbers of migratory birds and the difficulties associated with spill cleanup in ice conditions. The impacts of a CDE on coastal and marine birds in the Cook Inlet Planning Area are expected to range from moderate to major.

4.4.7.2.3 Alaska – Arctic.

Impacts of Routine Operations. Under the proposed action, a number of facilities could be constructed and operated in offshore and onshore portions of the Beaufort Sea and Chukchi Sea Planning Areas (Table 4.4.1-4). Under the exploration and development scenarios for these two planning areas, it is assumed that development would be limited to the shelf areas of both planning areas and to water depths less than 91 m (300 ft). Because the shelf is relatively narrow in the Beaufort Sea, ranging from 90 km (about 60 mi) in the west to 50 km (30 mi) in the east, oil and gas activities would occur within 200 km (100 mi) of shore. In contrast, the Chukchi Sea Planning Area has a very wide shelf area with water depths less than 91 m (300 ft), and oil and gas activities may occur in areas 200 km (120 mi) or more from shore. Figure 4.4.1-2 shows the locations of historic lease sales in the Beaufort Sea and Chukchi Sea Planning Areas; future lease sales and development may be expected to occur in similar areas. Thus, coastal birds are more likely to be affected by development in the Beaufort Sea Planning Area than in the Chukchi Sea Planning Area following lease sales under the proposed action. Marine and coastal birds could be affected during routine operations at these locations by (1) offshore exploration, (2) construction of offshore platforms and pipelines, (3) construction of onshore pipelines, (4) operation of offshore platforms, (5) operational discharges and wastes, and (6) vessel and aircraft traffic.

Offshore Exploration. During offshore exploration, seismic surveys conducted in offshore areas could affect primarily seabirds, because these are the species most likely to be foraging or otherwise using pelagic open waters areas of the two planning areas. Potentially affected birds may include puffins, murres, auklets, gulls and terns. Noise from airguns and disturbance from survey vessel traffic could displace birds from nearby habitats. These disturbances would be limited to the immediate area around survey vessels, would be short term, and would not be expected to result in adverse impacts on local bird populations.

Construction of Offshore Platforms and Pipelines. Under the proposed action, one to four offshore platforms could be constructed in the Beaufort Sea Planning Area, and one to five in the Chukchi Sea Planning Area (Table 4.4.1-4). Construction of offshore platforms would likely involve the construction of gravel islands to support drilling operations, and seabirds and waterfowl that utilize offshore waters could be affected by construction of these islands. However, construction of these offshore islands would occur in winter when most species are absent. Thus, construction of offshore platforms would not be expected to affect seabirds or waterfowl.

The exploration and development scenario for the proposed action identifies the construction of many miles of new offshore pipeline in the two planning areas: 48 to 2,422 km (30 to 1,505 mi) for the Beaufort Sea and 40 to 402 km (25 to 250 mi) for the Chukchi Sea. Because pipeline construction would also occur in winter when most species have left the area, few birds would be affected by this construction.

Construction of the offshore gravel islands to support drilling operations would likely use gravel mined from the vicinity of the offshore islands. On the North Slope, gravel is generally extracted from the floodplains of large rivers (Pamplin 1979; BLM 2002). Because the mining of gravel would occur in winter along with other construction activities, gravel mining would not be expected to disturb seabirds, waterfowl, or shorebirds, because these would normally be absent during that time. The winter excavation of gravel could result in the conversion of some riverine floodplain habitats into open water habitats, potentially affecting the local distribution and availability of nesting and foraging habitats for some species arriving the following spring after gravel excavation has occurred.

A variety of waterfowl and shorebird species nest in floodplain habitats along the Arctic coast. The extent to which some of these species could be affected by gravel excavation will depend on the specific habitats excavated, the extent of habitat disturbance, and the level of nesting use that the affected area typically supported. Because gravel excavation would occur in winter, active nests would not be disturbed. Instead, birds arriving in spring searching for suitable nesting habitat would simply search for other nesting locations. Because the relatively small number of offshore facilities that could be constructed under the proposed action (no more than nine platforms total for the two planning areas) would require a relatively limited amount of gravel, excavation activities (and associated habitat impacts) would likely be limited to a few locations.

Although pipeline trenching would also be carried out in winter when most seabird and waterfowl species are not present, seafloor trenching could locally disrupt benthic invertebrate communities that may serve as food sources for waterfowl during other seasons. The extent to which benthic food sources could be affected and the subsequent impact on waterfowl will depend on the type and amount of benthic habitat that would experience long-term disturbance from trenching, the importance of the specific habitats in providing food resources to waterfowl, and the number of waterfowl that could be affected.

Pipeline trenching could disturb as much as 13.5 ha (33 ac) and 567 ha (1,400 ac) of benthic habitat in the Beaufort Sea and Chukchi Sea Planning Areas, respectively. Much of this disturbance would occur in water depths of 30 m (100 ft) or more and thus affect benthic habitats that are largely inaccessible by seabirds and diving ducks. Trenching could, however, affect the egg or larval survival/development (through direct mortality and increased turbidity) of fish species that will eventually become prey for seabirds (SAFMC 2005). The environmental changes caused by trenching would be temporary and would only affect more sensitive prey species. Thus, pipeline trenching is expected to have very limited effects on the overall availability of waterfowl food sources, and any impacts on food sources would be very localized and would not be expected to result in population-level impacts on local seabird and waterfowl populations.

The winter construction would also utilize ice roads to build and access gravel island construction sites during the winter. Ice roads may be constructed over both tundra habitats and frozen ocean habitats. During the construction of ice roads, water from local rivers and lakes would be pumped onto the desired area to build up a rigid surface. Ice roads over frozen ocean habitats would have little effect on most bird species because few species would be present in this season. However, species that do overwinter (such as ptarmigan and snowy owl) may temporarily leave the construction area and move to similar habitats in nearby locations.

Construction of Onshore Pipelines. Under the proposed action, up to 129 km (80 mi) of new onshore pipeline could be constructed in onshore areas adjacent to the Beaufort Sea Planning Area; no onshore pipelines would be constructed in support of new development in the Chukchi Sea Planning Area (Table 4.4.1-4). The construction and operation of up to 129 km (80 mi) of new overland pipelines could disturb coastal and tundra species; it could degrade or eliminate as much as 390 ha (970 acres; assumes 30.5-m [100-ft] pipeline ROW) of potential nesting or post-molting habitat within the footprint of the new pipelines, causing birds to select habitats in other locations. Construction camps to support onshore construction activities would temporarily disturb some areas and limit use by birds; this disturbance would be short- or long-term, depending on the nature and effectiveness of camp abandonment and restoration activities following completion of construction activities. The impacts on potential habitat would be temporary and localized, and birds would likely respond by selecting other areas for nesting or post-molting. Regardless of the duration of the effect, the amount of habitat that would be disturbed would be relatively small and not be expected to affect more than a few birds. Careful pipeline ROW siting to avoid important nesting or post-molting habitats, and avoiding construction during post-molting and staging periods near such habitats, would further reduce the magnitude of any potential effects on local bird populations.

Operations of Offshore Platforms. During normal operations, birds may be affected by noise and human activities at the platforms, as well as by the presence of the platforms themselves. Noise generated during drilling and production activities could affect the use of surrounding waters by birds arriving during spring migration, foraging in surrounding waters during nesting season, and later in the year during fall molting and staging periods. Some species may react by avoiding areas immediately in the vicinity of the platforms, other species may show little avoidance or become acclimated, and still others may be attracted to the offshore platforms. Because of the small number of offshore platforms (no more than nine for both planning areas), the disturbance of birds by operational noise and activity would likely be limited to relatively few individuals and would not be expected to result in population-level effects for any species.

Operational platforms may pose collision threats to migrating and nesting birds alike. Many coastal nesting species travel out to open waters of the shelf to forage, while many species of waterfowl and seabirds migrate along the shelf in spring and summer (Section 3.8.2.3). While little information is available regarding bird collisions with platforms in the Arctic, annual bird mortality from collisions with offshore platforms in the northern GOM has been estimated to average 50 collision deaths per platform per year (Russell 2005). By applying a similar collision mortality rate to the platforms that would be developed in the Beaufort Sea and Chukchi Sea Planning Areas, a total of 200 annual bird collision mortalities might be expected for the four new platforms in the Beaufort Sea Planning Area, and 250 total annual collision mortalities for the five new platforms in the Chukchi Sea Planning Area. The incidence of bird collisions in the GOM may be much greater than the incidence that could occur in the two Arctic planning areas because of the much greater number of migrants in the GOM. However, some Arctic species such as the murres and puffins) are present in very large numbers (Section 3.8.2.3.1) in some locations along the Arctic coast and exhibit daily migrations between coastal nesting areas and foraging areas as far as 80 km (50 mi) or more offshore, which could increase the potential for encountering offshore platforms.

Operational Discharges and Wastes. Produced water, drilling muds, and drill cuttings generated by development and production wells would be disposed of through down-hole injection. Thus, no impacts on marine and coastal birds from these wastes would be expected under routine operations. In contrast, produced water, drilling muds, and drill cuttings generated by exploration and delineation wells would be discharged at the well sites in compliance with applicable regulations and permits. In marine waters, birds could be exposed to these materials by direct contact or through the ingestion of contaminated food items. Birds most likely to be present at well sites are those that forage on invertebrates and fish in offshore waters; these include seabirds such as the murres and puffins, gulls, and jaegers.

Many species of marine birds (especially gulls) often follow ships and forage in their wake on fish and other prey injured or disoriented by the passing vessel. In doing so, these birds may be affected by discharges of waste fluids (such as bilge water) generated by OCS vessels. The discharge of such wastes from OCS service and construction vessels, if allowed, would be regulated under applicable NPDES permits, and any discharged wastes would be quickly diluted and dispersed and thus not be expected to affect marine birds.

Marine and coastal birds may become entangled in or ingest floating, submerged, and beached debris (Heneman and the Center for Environmental Education 1988; Ryan 1987, 1990).

Entanglement may result in strangulation, the injury or loss of limbs, entrapment, or the prevention or hindrance of the ability to fly or swim, and all these effects may be considered lethal. Ingestion of debris may irritate, block, or perforate the digestive tract, suppress appetite, impair digestion of food, reduce growth, or release toxic chemicals (Fry et al. 1985; Dickerman and Goelet 1987; Ryan 1988; Derraik 2002). Because the discharge or disposal of solid debris into offshore waters from OCS structures and vessels is prohibited by BOEM (30 CFR 250.40) and the USCG (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]), entanglement in or ingestion of OCS-related trash and debris by marine and coastal birds would not be expected under routine operations.

Vessel and Aircraft Traffic. Development occurring under the proposed action could include up to 12 weekly vessel and helicopter trips in the Beaufort Sea Planning Area and as many as 15 weekly helicopter and vessel trips in the Chukchi Sea Planning Area. The presence of ships and helicopters, as well as noise associated with their passage, can disturb birds and potentially affect feeding, resting, or nesting behavior, and may cause affected birds to abandon the immediate area. Which birds could be affected, the nature of their response, and the potential consequences of the disturbance will be a function of a variety of factors, including the specific routes, the number of trips per day, the altitude of the flights, the seasonal habitats along the routes, the species using the habitats and the level of their use, and the sensitivity of the birds to vessel and aircraft traffic. Traffic near or over heavily utilized feeding or nesting habitats of sensitive species could result in population-level effects, while impacts from traffic in other areas with less sensitive species would largely be limited to a few individuals and would not result in population-level effects. The use of shipping lanes and aircraft routes avoiding sensitive bird areas would greatly reduce or eliminate the potential for vessel and aircraft traffic to cause population-level effects in marine and coastal birds.

Helicopter overflights are generally conducted at low altitudes and have the potential for disturbing birds in onshore and offshore locations (Ward and Stein 1989; Ward et al. 1994; Miller 1994; Miller et al. 1994). FAA guidelines for helicopter oceanic operations request that pilots maintain a minimum altitude of 213 m (600 ft) while in transit offshore, 305 m (1,000 ft) over unpopulated areas or across coastlines, and 610 m (2,000 ft) over populated areas and sensitive habitats such as wildlife refuges and park properties (FAA 2010). The type of response elicited from the birds and the potential effect on the birds will depend in large part on the time of year for the overflights and the species disturbed. Helicopter overflights during spring breakup of pack ice may disturb marine species feeding in open water leads and waterfowl in open coastal waters, causing birds to leave the area. Similarly, overflights in summer could displace waterfowl and seabirds from preferred foraging areas and from coastal nesting or brood-rearing areas such as seabird colonies and the lagoon systems of the Beaufort and Chukchi Seas. Molting and staging waterfowl may temporarily leave an area experiencing helicopter overflights (Derksen et al. 1992), while geese have been reported to exhibit alert behavior and flight in response to helicopter overflights (Ward and Stein 1989; Ward et al. 1994).

While bird strikes are possible, any such events would affect only an occasional individual and not result in any population-level effects. However, the increased energy demand associated with birds leaving foraging or staging areas for other, potentially less favorable areas could result in a lowered fitness of the affected birds. While birds disturbed from nesting or brood-rearing habitats by occasional overflights would be expected to return, birds experiencing frequent overflights may relocate to less favorable habitats for a longer period of time (MMS 2002b). In addition, the temporary absence of adult birds may increase the potential for predation of unguarded nests and young (NRC 2003a).

Potential Effects on ESA-listed Species in the Arctic Planning Areas. Normal operations may affect listed bird species in the same manner as non-listed species (i.e., primarily behavioral disturbance). Compliance with ESA regulations and coordination with the NMFS and USFWS would ensure that lease-specific operations would be conducted in a manner that avoids or greatly minimizes the potential for affecting these species.

The threatened spectacled eider and Alaska breeding population of the Steller’s eider occur in the Beaufort and Chukchi Seas, while the Federal candidate Kittlitz’s murrelet and yellow-billed loon only occur in the coastal and inland waters of the Chukchi Sea Planning Area. These species could be affected by oil and gas development in the area. None of these species would be disturbed by offshore platform or pipeline construction because these activities would occur in winter when these species have left the area for wintering grounds.

Important molting and staging areas for the spectacled eider occur in both the Beaufort and Chukchi Sea Planning Areas. OCS-related vessel and aircraft traffic may disturb nesting or molting spectacled eiders, as well as those present at staging areas. This species has exhibited noise avoidance behavior during nesting (Anderson et al. 1992). If affected, birds would be expected to move away from oncoming vessels and would not be adversely affected. Some individuals could collide with OCS-related aircraft. Injury or mortality could occur due to the collisions, but the limited traffic that is expected makes collision unlikely and population-level effects are not expected.

Nesting Steller’s eiders may be disturbed by OCS-related vessel and aircraft traffic. If affected, birds would be expected to move away from oncoming vessels and would not be adversely affected. Birds may be startled by helicopter overflights and may or may not take flight and flee the immediate vicinity. Some birds could be killed or injured as a result of collisions with platforms or OCS-related aircraft, but the limited traffic that is expected makes collision unlikely and population-level effects are not expected.

While Kittlitz’s murrelet can be found in the Chukchi Sea Planning Area during the nesting season, it is not believed to nest east of Cape Beaufort because of an absence of suitable habitat (Day et al. 1999). This species has been reported to be sensitive to excessive noise and human activity (Day and Nigro 1999). This species nests on cliffs and scree slopes, in terrain typically avoided when pipelines are being sited. Long-term platform operations and daily vessel and aircraft traffic may result in the long-term displacement of birds from platform locations and along frequently used flight line locations. In addition, some individuals could collide with OCS-related aircraft. Because of the limited distribution of this species, exposure to routine operations would be expected to be infrequent.

During nesting, the yellow-billed loon may be disturbed by OCS-related vessel and aircraft traffic in the Chukchi Sea Planning Area. This species utilizes nearshore and offshore marine waters adjacent to its breeding areas for foraging during the summer. The yellow-billed loon may also be disturbed during migration, which occurs along the coastlines of both the Beaufort and Chukchi Seas. If affected, birds would be expected to move away from oncoming vessels and would not be adversely affected. In addition, some individuals could collide with OCS-related aircraft, but population-level effects are not expected.

Impacts of Expected Accidental Events and Spills. Marine and coastal birds could be affected by accidental oil spills from offshore platforms and pipelines, as well as from onshore processing facilities and pipelines. The magnitude and extent of impacts will be a function of a variety of factors, including (1) the time of year of the spill, (2) the volume of the spill, (3) the habitats exposed to the spill, and (4) the species exposed to the spill or that utilize the exposed habitats. The majority of expected accidental spills would be small (<50 bbl) (see Table 4.4.2-1), would quickly dissipate, and would only have the potential to affect a very small amount of habitat and relatively few individuals. Small spills larger than 50 bbl but ≤1,000 bbl would similarly be relatively easy to contain and would only affect small areas of habitat and few individuals. A large spill (≥1,000 bbl), depending on the season and location, would be more difficult to contain and may result in lethal and sublethal effects on relatively large numbers of birds. Exposure of eggs and young and adult birds to oil may result in a variety of lethal and sublethal effects. Oil moving into coastal and inshore areas may foul habitats, reducing habitat quality and contaminating vegetation and invertebrate foods. Ingestion of contaminated foods may lead to a variety of lethal and sublethal toxic and physiological effects. Finally, oil spill-response activities may disturb birds in nearby habitats that are unaffected by an oil spill.

Certain species of marine and coastal birds may be more susceptible to contact with spilled oil than others, based on their life histories. For example, diving seabirds and underwater swimmers such as loons and diving ducks may be the most susceptible to offshore spills because of their extensive use of such areas and their relatively long exposure time on the sea surface. In contrast, shorebirds and waterfowl may be most susceptible to spills that reach the beach intertidal zone, coastal lagoons, or inshore wetland habitats where these species forage and raise young. The magnitude of the impact will depend on the size of the spill, the species and life stage when exposed, and the size of the local bird population.

Offshore spills in spring that reach coastal barrier islands and mainland coastal wetland areas may expose common eiders, gulls, and other birds that nest in these habitats along the Beaufort and Chukchi Seas. Some of these areas support large nesting colonies, and direct and indirect exposure of adults, eggs, young, and food resources may adversely affect reproductive success and result in population-level effects on some species.

Offshore spills in spring may also expose migrating seabirds and waterfowl. Exposed individuals may experience lethal or sublethal effects from the exposure. Depending on the species, mortality or subsequent impacts on reproduction could result in population-level impacts on some species. Species with naturally low reproductive rates, such as the long-tailed duck and red-throated loon, may be especially vulnerable to population-level impacts. Because these species have a low reproductive rate that limits natural population growth, the loss of comparatively few individuals could result in more substantive population impacts.

Spring spills contacting shoreline areas have the potential to expose thousands of migrating shorebirds, as well as contaminating nesting and foraging habitats and oiling nests and eggs. Exposure of individuals could result in lethal or sublethal effects, while oiling of nests and/or eggs would reduce reproductive success.

Spills occurring in late summer through autumn and that enter coastal lagoons and delta areas could expose large numbers of waterfowl (loons, tundra swans, king eiders, long-tailed duck) that use these habitats for molting and staging, and potentially result in adverse population-level effects. For example, mortality estimates of long-tailed ducks in the central Beaufort Sea from a hypothetical spill ranged as high as 35%, depending on the amount of oil spilled and the number of birds present (MMS 2003a). A winter spill under the ice could contaminate ice leads that develop during spring breakup, exposing eiders and other waterfowl that use these features while migrating.

Oil spills from onshore pipelines would likely be limited to a much smaller area than would a spill in an offshore location. Those birds exposed could incur a variety of lethal or sublethal effects; however, because relatively few individuals or nests would be expected to be exposed, no population-level impacts would be expected. However, an oil spill from an onshore pipeline that reaches an aquatic habitat such as a stream, wetland, or lake on the Arctic coastal plain may have greater impacts on shorebirds and waterfowl. Many such aquatic habitats are used by a variety of waterfowl and shorebirds for brood rearing, molting, and staging. Thus, a terrestrial spill reaching such habitats could expose a much larger number of birds than a spill restricted to a terrestrial environment.

Spill cleanup activities may disturb and displace birds from nearby habitats. Depending on the use of those habitats (e.g., nesting, molting, staging), displaced birds could incur reduced reproductive success or survival. In addition, the duration of cleanup activities may not only displace birds currently present but also preclude birds using the area for quite some time. For example, cleanup activities associated with a large spill may involve hundreds of workers and numerous boats, aircraft, and onshore vehicles, operating in the affected area for a year or more. During this time, migrating birds arriving in spring would be expected to bypass habitats that are near areas undergoing active cleanup operations.

Potential impacts of accidental spills apply to both non-listed and listed bird species of the Beaufort Sea and Chukchi Sea Planning Areas. Because the Kittlitz's murrelet is only present in the Chukchi Sea Planning Area during the nesting season, and because this species nests in terrestrial habitats that are typically considered unsuitable and thus avoided when a pipeline is being sited, this species is unlikely to be affected by an accidental oil spill. Steller's eiders nest in terrestrial environments, but they spend the majority of their time in shallow marine waters and may be impacted by offshore spills in spring that reach mainland coastal habitats. Spectacled eiders may be impacted if offshore spills reach coastal habitats of the Beaufort Sea and Chukchi Sea Planning Areas that are utilized as important molting and staging areas. This species would be impacted by a loss of habitat, as well as ingestion of contaminated food, as it prepares for fall migration. The yellow-billed loon may be more susceptible to contact with spilled oil than other bird species because its diving method of feeding provides a relatively long exposure time on the sea surface.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes CDEs for the Chukchi Sea and Beaufort Sea Planning Areas with volumes ranging from 1,400,000 to 2,200,000 bbl and 1,700,000 to 3,900,000 bbl, and durations of 40 to 75 days and 60 to 300 days, respectively (Table 4.4.2-2). A low-probability CDE would have similar impacts on bird populations as spills of other magnitudes. However, the area affected would increase and the degree of impact would be more severe, and could result in population-level effects depending on the location, magnitude, and timing of the event; climate conditions (winter, ice cover); and on the species, life stages, and habitats exposed to the spill. A much greater number of birds and habitats could be affected, and population-level impacts for some species could be incurred as impacts of CDEs in this region are prolonged by the cold water and cold air temperatures. Many bird species found in Arctic regions are at the edge of their geographic range and may not be as capable of tolerating additional stress from direct oiling or reduction in habitat or resources as species found in more moderate climates (Levy 1980, 1983). A CDE in the harsh environmental conditions of the Arctic may have serious impacts on colonial seabirds of the Arctic (Levy 1980).

A CDE has the potential to affect large numbers of birds due to its toxicity to individuals and their prey and the amount of time birds spend on the surface of marine and coastal waters. Those species that congregate in potentially affected areas are most susceptible to significant impacts. Areas within the Beaufort Sea and Chukchi Sea Planning Areas provide important nesting, molting, and migration habitat to a variety of seabirds, waterfowl, and shorebirds. A CDE during periods of peak use could affect large numbers of marine and coastal birds, seabirds, and waterfowl. If marine and coastal birds come into contact with oil from a CDE, they could experience a loss of thermoregulatory ability, loss of buoyancy, an inability to fly or forage, or organ damage due to ingestion of oil. For example, up to 45% of the estimated Pacific Flyway population of Pacific brant could be affected if an oil spill reaches Kasegaluk Lagoon in the Chukchi Sea Planning Area. Effects could range from direct mortality of approximately 60,000 brant to sublethal effects on an equal or smaller number of brant. The loss of up to 45% of the Pacific Flyway population would have population-level effects. The situation with brant is similar to a wide variety of waterfowl and shorebirds that use similar areas of the Chukchi and Beaufort Seas. Mortality from a CDE could result in population-level effects for most marine and coastal bird species, recovery from which would take more than three generations (BOEM 2011).

Impact Conclusions.

Routine Operations. Routine operations may be expected to affect some birds in each of the Arctic planning areas included in the proposed action. Coastal birds are more likely to be affected by development in the Beaufort Sea Planning Area, because oil and gas activities are more likely to occur closer to shore than in the Chukchi Sea Planning Area. The nature and magnitude of effects on birds would depend on the specific location, the timing, and the nature and magnitude of the operation, as well as the species that would be exposed to the operation. For routine Program activities, the primary effects would be the disturbance of birds (and their normal behaviors) by construction and development equipment, human activity, and habitat loss in areas of infrastructure construction. Birds may also incur injury or mortality as a result of collisions with infrastructure and support vessels.

Offshore exploration activities such as noise from airguns and disturbances from survey vessel traffic may affect seabirds using open water areas of the two planning areas. However, disturbances would be limited to the immediate area around survey vessels and only negligible or minor effects are expected on marine and coastal birds. Construction of offshore platforms and pipelines would involve the construction of gravel islands which could affect seabirds and waterfowl that utilize offshore waters. However, construction would occur in winter when most species are absent, so the impact on marine and coastal birds is expected to be negligible or minor. Construction of onshore pipelines and landfalls would result in the permanent disturbance of habitat within the immediate footprint of the new pipelines and facilities. Because of the relatively small amount of habitat that could be disturbed, habitat disturbance or loss is expected to have only minor impacts on marine and coastal birds. Some mortality may be expected for birds colliding with offshore platforms and, to a lesser extent, with helicopters providing support services to offshore platforms. Impacts from such collisions are anticipated to affect relatively few birds and result in only negligible or minor impacts on bird populations, with no population-level effects. Because the discharge of production wastes and other materials generated at offshore platforms and OCS-related vessels is regulated and because permitted production wastes discharged into marine waters would be quickly diluted and dispersed, relatively few birds would be exposed to these waste materials and impacts from such discharges would likely be negligible. The overall impact of all routine operations for the Program could range from negligible to moderate.

Expected Accidental Events and Spills. Accidental oil spills from offshore platforms and pipelines could affect both birds and their habitats. The magnitude and ecological importance of any effects would depend upon the size of the spill, the species and life stages that are exposed, and the size of the local bird population. A winter spill under ice would increase cleanup difficulties and could result in greater impacts than a spill in ice-free conditions. Small spills, especially those <50 bbl, would be more likely to be contained and cleaned up. All small spills (≤1,000 bbl) would only impact small areas of habitat and relatively few individuals and are expected to have minor impacts on marine and coastal birds. Large spills (>1,000 bbl), especially those that enter coastal lagoons and delta areas, may result in lethal and sublethal effects, including reduced reproductive success, on birds using those habitats for molting and staging. Impacts to marine and coastal birds from a large oil spill in the Arctic planning areas are expected to be moderate to major.

An Unexpected Catastrophic Discharge Event. The Beaufort Sea and Chukchi Sea Planning Areas provide important nesting, molting, and stopover habitat for many species of coastal and marine birds. An unexpected CDE in the Arctic has the potential to affect large numbers of birds that are already at the edge of their geographic range and are sensitive to additional stress. Spill cleanup in ice conditions would be more difficult and the cleanup process itself could displace birds from nearby habitats. Impacts to marine and coastal birds from a CDE in the Arctic planning areas are expected to be moderate to major.

4.4.7.3 Fish

4.4.7.3.1 Gulf of Mexico.

Impacts of Routine Operations. See individual habitat sections for detailed discussions of the impacts of oil and gas activities on fish habitat in the GOM. Potential OCS oil and gas development impacting factors for fish in the GOM are shown by phase in Table 4.4.7-3. Impacting factors common to all phases include platform lighting, increased ship traffic, vessel discharges (bilge and ballast water), and miscellaneous discharges (deck washing, sanitary waste). Impacts from waste discharges would be localized and temporary and are not expected to have population-level impacts on fish populations. Many of these waste streams are disposed of on land, and all vessel and platform wastes that are discharged into surface waters must meet USEPA and/or USCG regulatory requirements. Studies conducted in the northern GOM suggest that platform lighting could alter predator-prey dynamics by enhancing phytoplankton productivity around the platform, potentially improving food availability and the visual foraging environment for fishes (Keenan et al. 2007). Potential impacts from platform lighting would be localized but long term and are expected to have minimal impacts on fish populations.

Exploration and Site Development. During the OCS oil and gas exploration and development phase, fish could be affected by noise from seismic surveys and noise and bottom disturbance from drilling, platform placement, and pipeline trenching and placement activities. Releases of drilling muds and cuttings could also affect fish by contaminating food resources in sediments and surrounding surface waters (Table 4.4.7-3).

All fish species in the GOM are presumed to be able to hear with varying degrees of sensitivity and within the frequency range of sound produced by exploration site development activities. Noises generated during platform and pipeline placement, vessel traffic, and seismic surveys are all potential sources of disturbance to fish communities. Noise could kill or injure fish, induce behavioral alterations, produce generalized stress, and interfere with communication (Smith et al. 2004; Vasconcelos et. al. 2007; see Popper and Hastings 2009 for a recent review). A primary source of noise during exploration and site development would be airguns used during seismic surveys. There is some experimental evidence that noise generated by seismic surveys could kill or injure organisms typically within a few meters of the noise source, but other studies found no injury or mortality even for sensitive, early life stages (Dalen and Knutsen 1986; Holliday et al. 1987; reviewed in NSF and USGS 2010). Several researchers have also documented startle responses or temporary avoidance of areas exposed airgun noise, but these effects are not found consistently (Skalski et al. 1992; Turnpenny and Nedwell 1994; Engås et al. 1996; Wardel et al. 2001; reviewed in Popper and Hastings 2009 and NSF and USGS 2010). Continuous long-term exposure to high-pressure sound waves has been shown to cause damage to the hair cells of the ears of some fishes under some circumstances (Popper 2003). Several studies have found that species with gas bladders, which includes many of the pelagic and demersal fish species in the GOM, are more vulnerable to injury or mortality from explosions than species without gas bladders such as flatfish (MMS 2004a). For adult fishes, continuous exposures to high noise levels is unlikely under natural circumstances as fish could move from the area. However, fish larvae may suffer greater mortality because of their

TABLE 4.4.7-3 Impacting Factors on Fish and Their Habitat in the GOM Planning Areas

	Life Stage Affected[a]		
Development Phase and Impacting Factor	Eggs	Larvae	Adults
Impacting Factors Common to All Phases			
Vessel noise	X	X	X
Vessel traffic	X	X	X
Hazardous materials	X	X	X
Solid wastes	X	X	X
Offshore lighting	X	X	X
Aircraft noise			
Offshore air emissions			
Onshore air emissions			
Aircraft traffic			
Miscellaneous platform discharges	X	X	X
Vessel discharges	X	X	X
Bottom disturbance from vessel anchors	X	X	X
Exploration and Development			
Seismic noise	X	X	X
Noise from drilling and construction	X	X	X
Bottom disturbance from platform placement, drilling, and pipeline placement and trenching	X	X	X
Discharge of drilling muds and cuttings	X	X	X
Production			
Production noise	X	X	X
Produced water discharge	X	X	X
Artificial reef	X	X	X
Decommissioning			
Platform removal (non-explosive)	X	X	X
Platform removal (explosive)	X	X	X

[a] Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

small size and relative lack of mobility, especially within a short distance of the airgun (NSF and USGS 2010). The severity and duration of noise impacts would vary with site and development scenario, but overall the impacts would be temporary and localized. A recent review of seismic survey noise on marine fish concluded that although data were limited, there would be no significant impacts on marine fish populations from seismic surveys (NSF and USGS 2010).

Bottom-disturbing activities such as coring and drilling, platform placement and mooring, and pipeline trenching and placement would displace fish in the vicinity of the activities. Bottom disturbance would result in temporary sedimentation and increased turbidity, which could damage fish gills and bury benthic invertebrate prey resources within some distance of the disturbance. Fish mortality may also be greater if bottom disturbance occurs in areas of high larval and juvenile fish density such as estuaries and nearshore areas. In addition, the physical changes to benthic habitat resulting from drilling could affect food resources for benthic fishes by altering benthic invertebrate community composition. Soft sediment fishes, particularly in shallow water, are subject to frequent bottom disturbance from human activities such as trawling and natural occurrences such as storms and are presumably well adapted to such conditions.

The discharge of drilling muds and cuttings (including synthetic drilling fluids adhering to the cuttings) can affect fish in several ways. Section 4.4.3.1 describes the various categories of drilling fluids. Impacts from turbidity would be similar to those described above and could damage respiratory structures, cause fish to temporarily move from the area, and disrupt food acquisition. Drilling muds and cuttings released near the sediment surface or in shallow water would bury benthic food resources in the release area although conditions would eventually recover. Trace metal and hydrocarbon constituents in drilling fluids can be toxic to all life stages of fishes if exposed to high enough concentrations. Planktonic eggs and larvae that contact the mixing zone would be at greatest risk (e.g., Kingsford 1996), while juveniles and adults passing through a discharge are not likely to be adversely affected. The disturbance would be short, and based on the assumption of a relatively widespread distribution of eggs, larvae, and prey, only a very small proportion of the population of a given fish species is likely to be affected. In addition, all discharges must comply with NPDES permit requirements regarding the discharge amount, rate, and toxicity, which would greatly reduce the impact on fish communities. BOEM-sponsored research on the biological effects of drilling fluids on marine communities in the GOM (Continental Shelf Associates, Inc. 2004a, 2006) found that fish densities were elevated near the platforms compared to control locations and certain classes of benthic invertebrate food sources were also more abundant within 300 m (984 ft) of the well compared to control areas (Continental Shelf Associates, Inc. 2006).

There are several protective measures in place to protect sensitive fish habitat from oil and gas activities. Impacts on hard-bottom areas from bottom-disturbing activities would be minimized by the Topographic Features Stipulation that establishes No Activity Zones, where no operations, anchoring, or structures are allowed. There is also a lease stipulation that requires avoidance of low-relief live-bottom and pinnacle features. In deep water, there are stipulations requiring the avoidance of chemosynthetic communities and deepwater corals.

Based on the discussion above, the site development and exploration represent a short-term disturbance, primarily affecting demersal fishes, with the severity of the impacts generally decreasing dramatically with distance from bottom-disturbing activities. No population-level effects on fish communities would be expected.

Production. Production activities that could affect soft sediment habitat include operational noise, bottom disturbance, and the release of process water. In addition, the platform would replace existing featureless soft sediments and serve as an artificial reef (Table 4.4.7-3).

Chronic bottom disturbance could result from the movement of anchors and chains associated with support vessels and floating platform moorings. Bottom disturbance would affect fish and their food resources in a manner similar to that described above for the exploration and site development phase. Some of the disturbance could be episodic and temporary, but others would last for the lifetime of the platform.

Sessile epifaunal invertebrates requiring hard substrate (i.e., barnacles and corals) as well as small motile invertebrates (amphipods and worms) would colonize fixed or floating platform structures, creating an artificial reef. Pipelines not buried would also provide hard substrate for sessile and structure-oriented fish species. Reef fish and epipelagic fishes such as tunas, dolphin fish, and jacks would be attracted to these platforms in concentrations greater than those of surrounding soft sediments and even natural reefs (Wilson et al. 2003). The platforms could possibly enhance feeding of predators by attracting and concentrating smaller prey species. However, concerns have been expressed that highly migratory species could be diverted from normal migratory routes and consequently from normal spawning or feeding areas because of attraction to structures such as oil platforms (Brickhill et al. 2005). Similarly, platforms may attract reef fish from natural hard-bottom areas. Thus platforms may simply attract fish rather than increasing fish production and at the same time make them easier to harvest by commercial and recreational fisheries (Brickhill et al. 2005). Because of the wide distribution of reef and epipelagic species and the great number and spatial extent of production platforms, such effects could extend to the regional scale. Ultimately, the benefit or detriment of artificial reefs as habitat depends on how fisheries are managed on the reef and the individual life histories and habitat requirements of the species present (Bohnsack 1989; Macreadie et al. 2011).

Produced water contains several toxic elements (Continental Shelf Associates Inc. 1997), and direct and continuous exposure to produced waters can be lethal to all life stages of fishes. Because more chemicals are required to maintain adequate flow in deep waterwells, produced water from deepwater wells is expected to contain more chemical contaminants than wells in shallow water. Direct exposure would occur only in the water column near the discharge point; thus pelagic adults and planktonic eggs and larvae would be most susceptible. Higher impacts would be realized if eggs and larvae were unusually concentrated. Thus, local circulation patterns greatly influence the degree of potential impact. Nevertheless, population-level effects on fishes are not likely, as contaminants are not expected to reach toxic levels in the sediment and water column because of dilution and NPDES permitting requirements regarding discharge rate, contaminant concentration, and toxicity. In studies of the potential long-term ecological effect of oil and gas development, no significant bioaccumulations of hydrocarbons or metals were observed in fish collected near platforms, and histopathological evaluations of fish found no damage to liver tissue (Peterson et al. 1996). In addition, benthic invertebrate food sources collected in sediments near platforms do not appear to bioaccumulate the common contaminants in produced water, and their tissues did not exceed USEPA-specified concentrations considered harmful (Continental Shelf Associates, Inc. 1997). Organisms attached to oil platforms have not been found to accumulate metals, although they have been found to bioaccumulate organic contaminants (Continental Shelf Associates, Inc. 1997). Produced water discharge has also not been found to contribute significantly to hypoxia in the GOM (Rabalais 2005; Bierman et al. 2007). Thus, production activities are expected to result in short-term impacts on fish communities and no population-level effects on fish communities are anticipated.

Decommissioning. Platform removal in general would temporarily affect fish by displacing resident fishes, disturbing sediments, and increasing noise and turbidity for some length of the water column. In addition, it is assumed that up to 275 platforms would be removed using explosives, which could kill or cause sublethal injury to many of the fishes associated with the structures. Small fish and fish with swimbladders are most susceptible to injury and mortality from underwater blasts. In a study of 792 explosive platform removals in the GOM, an average of 567 dead fish were observed floating at the surface, although the actual number dead is likely to be higher (Continental Shelf Associates, Inc. 2004b). Mark and recapture studies conducted at platform removal sites in the central and western GOM (Gitschlag 2000) estimated that between 2,000 and 5,000 fishes greater than 8 cm (3 in.) in length and more than 6,200 fish less than 8 cm (3 in.) were killed during explosive removals in water depths ranging from 14 to 32 m (46 to 105 ft). Sheepshead, spadefish, red snapper, and blue runner accounted for 89% of the mortality estimated by these studies. Mortality estimates of red snapper associated with the platform ranged from 57 to 90%. Assuming 275 explosive removals, a large number of fish could potentially be killed during the Program. Displaced fish would repopulate the area over a short period of time, although the species composition would likely shift to soft sediment species and away from reef and migratory pelagic species of fish. Overall, decommissioning activities are expected to result in short-term impacts on fish communities and no population-level effects are anticipated.

If fixed platforms are toppled and left in place, the platform would continue to serve as an artificial reef, although the density and composition of fish may change. For example, the high vertical relief of the platform is important in attracting fish; thus fish density may decline once the platform is toppled (Wilson et al. 2003). Pipelines not buried, in both shallow and deepwater would provide hard substrate and habitat for structure-oriented fishes. As discussed above, the ability of artificial reefs to enhance fish production is controversial. In addition, artificial reefs may allow the spread of non-native fish species across the GOM, especially as waters warm due to climate change (Hickerson et al. 2008). For example, lionfish (*Pterois volitans*) have spread from the reefs of the West Florida shelf to the central and western GOM, where they are often found associated with oil platforms (http://www.lsu.edu/seagrantfish/biological/invasive/redlionfish.htm). In the future, other species could become established through range expansion or human introductions. Ultimately, the benefit or detriment of artificial reefs as habitat depends on how fisheries are managed on the reef and the individual life histories and habitat requirements of the species present (Bohnsack 1989; Macreadie et al. 2011).

Impacts of Expected Accidental Events and Spills. It is assumed that up to 8 large spills (≥1,000 bbl), up to 70 spills between 50 and 999 bbl, and up to 400 smaller spills between 1 and 50 bbl could occur during the lease period under the proposed action (Table 4.4.2-1). Impacts to individual fish and their habitat would generally increase with the size of the spill. Most spills would be small and are expected to be short-term and affect relatively few individuals. Larger areas and numbers of individuals may be affected by large spills greater than 1,000 bbl. Toxic fractions of PAHs in spilled oil can cause lethal or sublethal effects in adult fishes. Less is known about the impacts of natural gas on fish, but natural gas could have lethal or sublethal impacts as well, depending on concentration. Impacts of hydrocarbons differ among various life stages of fishes. For example, pelagic eggs and larval stages of fish, whose movements are largely controlled by water currents, could be killed if they came into contact with surface oil spills (Patin 1999). Conversely, oil and gas would typically rise above the seafloor, which would limit direct contact with demersal fishes. Evidence also indicates that the majority of adult pelagic fish can likely detect and avoid heavily oiled waters in the open sea, thereby avoiding acute effects (Patin 1999; Roth and Baltz 2009). However, adult fish could still be exposed to sublethal hydrocarbon concentrations through direct contact with gills or through ingestion of spilled oil. In addition, oil could ultimately enter the benthic food web as oil-contaminated pelagic organic matter and biota settled to the seafloor. The size and location of the spill, habitat preference of the fish, and the season in which the spill occurred would be important determinants of the impact magnitude of the spill. Hydrocarbons released during the spill would be diluted and broken down by natural processes.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE in the GOM with a volume of 0.9-7.2 million bbl and a duration of 30–90 days that could result from pipeline ruptures, a loss of well control, and from tanker spills associated with an FPSO system (Table 4.4.2-2). At the population level, hydrocarbon spills could affect fish by causing high mortality of eggs, larvae, juveniles, or adults; triggering abnormal development; impeding the access of migratory fishes to spawning habitat; displacing individuals from preferred habitat; reducing or eliminating prey populations available for consumption; impairing feeding, growth, or reproduction; causing adverse physiological responses; increasing susceptibility to predation, parasitism, diseases, or other environmental perturbations; and increasing or introducing genetic abnormalities. Lethal and sublethal impacts can also result from cleanup methods involving burning, skimming, and dispersants (if used). Dispersant toxicity varies by species and dispersant used, although newer dispersant formulations, such as COREXIT® 2500, do not appear to be more toxic to fish than oil alone (Hemmer et al. 2011). However, few species have been tested; additive toxicity from oil-dispersant mixtures may be significant for some species (Hemmer et al. 2011).

Most of the fishes inhabiting shelf or oceanic waters of the GOM have planktonic eggs and larvae (Ditty et al. 1988; Richards et al. 1993). Catastrophic spills occurring during recruitment periods or spills that affect areas with high larval fish concentrations such as estuaries could result in population-level impacts. Because of the wide dispersal of early life history stages of most fishes in the GOM, it is anticipated that only a relatively small proportion of early life stages present at a given time would be affected by a particular oil spill event, and this would limit the potential for population-level effects. For example, an evaluation of the response of coastal fishes to the DWH event suggests that large-scale losses of 2010 cohorts were largely avoided and that there were no discernible shifts in species composition following the spill (Fodrie et al. 2011). However, the impact magnitude would also depend on the temporal and spatial scope of the oil spill. Since some species of fish spawn in a limited geographic area(s) during a small temporal window, a spill could have population-level impacts if the spill coincided in time and space with spawning activity. In addition, individual fish species that currently have depressed populations and critical spawning grounds in the GOM such as tuna, swordfish, and other billfish could suffer lethal or sublethal effects from the spill.

In addition to effects on individuals and species, impacts to fish can result in ecosystem-level effects if the population impacts are significant. For example, fish in the GOM can occupy a number of trophic levels ranging from herbivore to top-level carnivore. Therefore, fish are critical to energy flow within nearshore and marine food webs. They are also seasonally important food sources to transient carnivores. Consequently, impacts to fish can propagate throughout the food web, affecting sea turtles, birds, and marine mammals. In addition, many GOM fishes migrate between and within marine, estuarine, and freshwater habitats. In doing so, they transfer nutrients and carbon over a broad area, thereby connecting offshore and coastal ecosystems (Deegan et al. 2002; Kneib 2002; Haertel-Borer et al. 2004). Significant impacts to fish populations could reduce this transfer, resulting in local changes in productivity. As with large spills, the size and location of the spill, habitat preference of the fish, and the season in which the spill occurred would be important determinants of the impact magnitude of the spill.

Species Listed under the Endangered Species Act: Gulf Sturgeon.

***Impacts of Routine Operations*.**

Exploration and Site Development. No information is available on the hearing or acoustic biology of Gulf sturgeon from which to assess effects. The only noise sources strong enough to produce impacts other than behavioral disruption are seismic surveys. Since the seismic sources (airguns) are fired in the upper water column, Gulf sturgeon are unlikely to be injured, but the noise could have behavioral effects such as disruption of feeding and movement behaviors. Adult Gulf sturgeon wintering in shelf waters of the GOM may be affected by sounds emanating from working platforms and their attendant operations. However, the most likely effects would be short-term behavioral disruption or avoidance of certain areas.

The placement of bottom-founded structures during the exploratory drilling phase may affect adult Gulf sturgeon and their designated critical habitat (50 CFR 226.214) directly and indirectly. As with all fish, the drilling platform and pipeline placement could injure or displace Gulf sturgeon and reduce or eliminate their benthic food resources. These disturbances could affect adult Gulf sturgeon during cooler months, which is their primary feeding period of the year when they move from coastal rivers into inner shelf waters of the eastern and central GOM (Ross et al. 2009). However, most new oil and gas production activities would not occur in the shallow coastal waters less than 10 m (33 ft) in depth (67 FR 39106–39199) preferred by Gulf sturgeon. Consequently, only a small proportion of the areas of bottom disturbance would potentially be used by Gulf sturgeon.

Drilling muds and cuttings can be released at or near the sea surface or the seafloor. Muds and cuttings are diluted and dispersed rapidly in the ocean; therefore, cuttings released at the surface are unlikely to have measurable impacts on Gulf sturgeon. However, food resources for Gulf sturgeon may be buried by muds and cuttings released near the seafloor or settling in thick accumulations in shallow water. Gulf sturgeon are known not to have an affinity for structured habitat, and they occur in water shallower than that typically used for drill sites. Thus, accumulations of drilling muds and cuttings are not likely to affect Gulf sturgeon or their habitat.

Production. Produced water discharges dilute rapidly in the open ocean, and direct exposure would occur only in the water column near the discharge point where adult sturgeon are not likely to be located. Vulnerable early life stages of Gulf sturgeon exist only in rivers far removed from produced water discharges, making exposure unlikely. The discharge of produced water is not thought to contribute to significantly increasing the size or severity of the hypoxic zone in the GOM (Rabalais 2005). Consequently, it is believed that discharges resulting from the proposed action will not affect dissolved oxygen levels in areas used by Gulf sturgeon.

Decommissioning. Under the proposed action, it is assumed that explosives would be used to remove up to 275 platforms in the entire GOM. Explosive blasts can be lethal to fishes that may be present near the structure (Gitschlag 2000). However, the Gulf sturgeon are known not to have an affinity for offshore structures; thus, they are not likely to be affected.

Impacts of Expected Accidental Events and Spills. Hydrocarbons released by small (1 to 1,000 bbl) and large (>1,000 bbl) accidental spills could affect adult sturgeon by direct contact with gills or via direct ingestion. Adult and juvenile fishes would likely avoid oil from a spill. Fish eggs and larvae could die or become deformed if exposed to certain toxic fractions of spilled oil (Kingsford 1996). However, contact with early life stages of Gulf sturgeon is unlikely because floating oil is not likely to penetrate to the middle reaches of most rivers where eggs are deposited and because oil would float on the freshwater outflow and never reach or settle directly on demersal eggs (Fox et al. 2000).

Impacts of an Unexpected Catastrophic Discharge Event. Although each spill is unique, existing sediment and water quality data collected after the DWH event suggest that even after a CDE, hydrocarbon contamination of the water column would be short-lived and localized (OSAT 2010; OSAT 2 2011). Sediment contamination would also be localized but could be significant in heavily oiled areas (see Sections 4.4.6.1 and 4.4.6.2). Therefore, CDE impacts would be greatest if the spill were to contact critical habitats for Gulf sturgeon; such habitats have been designated in coastal, riverine, and estuarine areas from Louisiana to Florida. Studies of the persistence of hydrocarbons in nearshore habitats following the DWH event are ongoing. All of these habitats are potentially affected by oil spills, depending on the size and location of the spill. See Section 4.4.6.1 for a discussion of the potential impacts of oil spills on coastal habitats.

Species Listed under the Endangered Species Act: Smalltooth Sawfish.

Routine Operations.

Exploration and Site Development. Smalltooth sawfish are considered rare from Texas to the Florida panhandle (NMFS 2009) and are not likely to be present in the Central and Western Planning Areas where exploration and site development, production, and decommissioning activities occur. In addition, smalltooth sawfish are livebearers; therefore sensitive egg and larval life stages are not present in the water column, which makes them less susceptible to impacts from exploration and production activities.

Noise from underwater construction and seismic surveys could produce impacts ranging from lethal to sublethal and behavioral (Popper and Hastings 2009). Since the seismic sources (airguns) are fired in the upper water column, smalltooth sawfish are unlikely to be affected. Juvenile smalltooth sawfish occupy shallow estuaries and nearshore areas away from noise-generating oil and gas exploration and development activities. Adult smalltooth sawfish are found in waters up to 122 m (400 ft) or deeper and could be affected by exploration and production noises. However, the most likely effects would be short-term behavioral disruption or avoidance of certain areas.

The placement of bottom-founded structures during the exploratory drilling phase may affect adult smalltooth sawfish and their designated critical habitat (50 CFR 226.214) directly and indirectly. As with all fish, the drilling platform and pipeline placement could injure or displace smalltooth sawfish and reduce or eliminate their benthic food resources. Small juveniles typically occupy shallow estuarine waters and would not be located in the vicinity of most bottom disturbance. However, most new platform and drilling activity would occur at the depth range occupied by large juveniles and adults. Given their size, most adults would likely be able to swim away from bottom-disturbing activities, thereby avoiding injuries. However, foraging habitat would be temporarily eliminated and food resources in the disturbed area may be reduced.

Drilling muds and cuttings can be released at or near the sea surface or the seafloor. Muds and cuttings are diluted and dispersed rapidly in the ocean; therefore, cuttings released at the surface are unlikely to have measurable impacts on smalltooth sawfish. However, food resources for smalltooth sawfish may be buried by muds and cuttings released near the seafloor or settling in thick accumulations in shallow water. Small juvenile smalltooth sawfish occur in water shallower than that typically used for drill sites and are not likely to be affected.

<u>Production.</u> Vulnerable early life stages of smalltooth sawfish exist only in shallow estuarine areas far removed from produced water discharges, making exposure unlikely. Adults and larger juveniles do occupy coastal waters where produced water discharge would occur. Produced water discharges dilute rapidly in the open ocean, and direct exposure would occur only in the water column near the discharge point where adult sawfish are not likely to be located. The discharge of produced water is not thought to contribute to significantly increasing the size or severity of the hypoxic zone in the GOM (Rabalais 2005). Consequently, it is believed that discharges resulting from the proposed action will not affect dissolved oxygen levels in areas used by smalltooth sawfish.

<u>Decommissioning.</u> Under the proposed action, it is assumed that explosives would be used to remove up to 700 platforms in the entire GOM. Explosive blasts can be lethal to fishes that may be present near the structure (Gitschlag 2000). However, smalltooth sawfish are known not to have an affinity for offshore structures; thus, they are not likely to be affected.

Impacts of Expected Accidental Events and Spills. Smalltooth sawfish are considered rare from Texas to the Florida panhandle and are not likely to be present in the Central and Western Planning Areas where accidental oil spills would occur. Adult and juvenile fishes would likely avoid oil from a spill, although they could be exposed to sublethal concentrations through aqueous or dietary routes. Smalltooth sawfish are livebearers and the exposure of eggs to hydrocarbons would occur only by adult exposure. Contact with small juvenile smalltooth sawfish is unlikely unless oil penetrates shallow estuarine areas. However, actively reproducing populations are thought to exist only in south Florida (NMFS 2009), and therefore small juveniles are not likely to be exposed to oil spills.

Impacts of an Unexpected Catastrophic Discharge Event. Existing sediment and water quality data collected after the DWH event suggest that even after a CDE, hydrocarbon contamination of the water column would be short-lived and localized (OSAT 2010; OSAT 2 2011). Sediment contamination would also be localized but could be significant in heavily oiled areas (see Sections 4.4.6.1 and 4.4.6.2). Studies of the persistence of hydrocarbons in nearshore habitats following the DWH event are ongoing. See Sections 4.4.6.1 and 4.4.6.2 for discussions of the potential impacts of oil spills on coastal habitats. As described above, adults would be able to avoid lethal concentrations of oil and contact with small juvenile smalltooth sawfish is unlikely unless oil penetrates shallow estuarine areas. Actively reproducing smalltooth sawfish populations are thought to exist only in south Florida (NMFS 2009), therefore small juveniles are not likely to be exposed to oil spills.

Impact Conclusions.

Routine Operations. Routine oil and gas activities would be temporary, and no population-level impacts on fish are expected. The primary potential impacts on fish communities from Program activities could result from seismic surveys and bottom-disturbing activities such as drilling, platform placement and mooring, and pipeline trenching and placement, which could displace, injure, or kill fish in the vicinity of the activity. Displaced fish and invertebrate food sources would repopulate the area over a short period of time. Fixed platforms, particularly the large number projected for the GOM, would also serve as artificial reefs that would attract substantial numbers of fish. The effects of drilling muds and produced water discharge on fish would be localized, and no population-level effects are expected. Overall, impacts to fish from routine Program activities are expected to range from negligible to minor, and only negligible impacts on threatened or endangered fish species are expected.

Expected Accidental Events and Spills. Small spills would be localized and are unlikely to affect a substantial number of fish before dilution and weathering would reduce concentrations of toxic fractions to nontoxic levels. Large spills would affect a wider area, with the magnitude of the impacts depending on the location, timing, and volume of spills, distribution and ecology of affected fish species, and other environmental factors. Most adult fish are highly mobile and would likely avoid lethal hydrocarbon exposures, although they may be subjected to sublethal concentrations. Smaller species and egg and larval life stages are more likely to suffer lethal or sublethal exposures from oil contact because of their relative lack of mobility. Overall, impacts to fish (including Gulf sturgeon) from small spills would range from negligible for spill less than 50 bbl, minor for spills up to 1,000 bbl, and from minor to moderate for large spills (≥1,000 bbl). Impacts to smalltooth sawfish are expected to range up to minor.

An Unexpected Catastrophic Discharge Event. Under most circumstances, a CDE would affect only a small proportion of a given fish population; therefore, overall population levels for individual species may not be affected. However, fish species that currently have depressed populations or have critical spawning grounds present in the affected area could experience population-level impacts. In addition, oil contacting shoreline areas used for spawning or providing habitat for early life stages of fish could result in large-scale lethal and long-term sublethal effects on fish. Coastal oiling could measurably depress some fish populations for several years. Overall, the impacts to fish (including Gulf sturgeon) in the case of a CDE could range up to moderate. Impacts to smalltooth sawfish are expected to range up to minor.

4.4.7.3.2 Alaska – Cook Inlet.

Impacts of Routine Operations. Potential OCS oil and gas development impacting factors for fish in the Cook Inlet Planning Area are shown by phase in Table 4.4.7-4. Impacting factors common to all phases include vessel traffic, platform lighting, vessel discharges (bilge and ballast water), and miscellaneous discharges (deck washing, sanitary waste). Impacts from waste discharges would be localized and temporary and are not expected to have population-level impacts on fish populations. Many of these waste streams are disposed of on land, and those that are discharged must meet USEPA and/or USCG regulatory requirements that minimize environmental impacts. Studies of platform lighting suggest the lights could alter predator-prey dynamics by enhancing phytoplankton productivity around the platform, potentially improving food availability and the visual foraging environment for fishes (Keenan et al. 2007). Potential impacts from platform lighting would be localized but long term and expected to have minimal impacts on fish populations.

Exploration and Site Development. During the OCS oil and gas exploration and development phase, fish could be affected by noise from seismic surveys and noise and bottom disturbance from drilling, platform placement, and pipeline trenching and placement activities (Table 4.4.7-4).

Noise disturbance from drilling, construction, and seismic surveys could potentially kill, injure, or displace fish depending on the magnitude of the noise, fish size, and distance from the noise source. Seismic survey data are usually collected by discharging compressed air from arrays of airguns towed behind ships. All fish species in Cook Inlet are presumed to be able to hear, with varying degrees of sensitivity, within the frequency range of sound produced by exploration and site development activities. The effects of airgun discharges on fishes depend on the fish life history stage and biology, distance to and type of the sound source, and the magnitude of the explosion. Noise generated by seismic surveys could kill or injure organisms typically within 1 to 5 m (3 to 16 ft) of the airgun or cause some species to temporarily avoid the area (Turnpenny and Nedwell 1994; Popper and Hastings 2009). Noise might also produce generalized stress (Smith et al. 2004) and interfere with communication (Vasconcelos et al. 2007). Several studies have found that species with gas bladders (e.g., salmonids, coregonids, and gadids) are more vulnerable to injury or mortality from explosions than species without gas bladders such as flatfish (MMS 2004a). The juvenile and adult fish in Cook Inlet likely to be affected by the noise generated from seismic surveys include salmon, cod, whitefishes, and herring. Continuous, long-term exposure to high-pressure sound waves has also been shown to cause damage to the hair cells of the ears of some fishes under some circumstances (Popper and Hastings 2009). For adult fishes, continuous exposures would not exist under natural circumstances, as fish could move from the area. However, fish larvae may suffer greater mortality because of their small size and relative lack of mobility, especially if they are within a few meters of the airgun (NSF and USGS 2010). In a confined area such as Cook Inlet, noise from seismic surveys can also alter fish behavior. For example, disruption of

TABLE 4.4.7-4 Impacting Factors on Fish and Their Habitat in the Cook Inlet Planning Area

	Life Stage Affected[a]		
Development Phase and Impacting Factor	Eggs	Larvae	Adults
Impacting Factors Common to All Phases			
Vessel noise	X	X	X
Vessel traffic	X	X	X
Hazardous materials	X	X	X
Solid wastes	X	X	X
Offshore lighting	X	X	X
Aircraft noise			
Offshore air emissions			
Onshore air emissions			
Aircraft traffic			
Miscellaneous platform discharges	X	X	X
Vessel discharges	X	X	X
Bottom disturbance from vessel anchors	X	X	X
Exploration and Development			
Seismic noise	X	X	X
Noise from drilling and construction	X	X	X
Bottom disturbance from platform placement, drilling, and pipeline placement and trenching	X	X	X
Discharge of drilling muds and cuttings	X	X	X
Production			
Production noise	X	X	X
Produced water discharge	X	X	X
Artificial reef	X	X	X
Decommissioning			
Platform removal (non-explosive)	X	X	X

[a] Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

normal behaviors during critical spawning and feeding periods in spring and summer has the potential to adversely affect survival and reproduction. The severity and duration of noise impacts would vary with site and development scenario, but overall the impacts would be temporary. Recent reviews of seismic survey noise on marine fish concluded that although data were limited, significant impacts on marine fish populations from seismic surveys were not likely (BOEMRE 2010b; NSF and USGS 2010).

Bottom-disturbing activities such as coring and drilling, platform placement and mooring, and pipeline trenching and placement would displace fish in the vicinity of the activities and result in temporary sedimentation and turbidity, which could damage fish gills and bury benthic invertebrate prey resources within some distance of the disturbance. Fish mortality may be greater if bottom disturbance occurred in areas of high larval and juvenile fish density such as estuaries and nearshore areas. The migrations of anadromous species common in Cook Inlet such as Pacific salmon and eulachon could also be disrupted. Soft sediments in Cook Inlet are subject to frequent bottom disturbance from high discharge and storms and Cook Inlet waters are naturally high in suspended sediments. Thus, fish communities in Cook Inlet are presumably well adapted to such conditions.

It is assumed that drilling muds and cuttings would be discharged into Cook Inlet for exploration wells only, while drilling wastes from development and production wells would be reinjected into the wells. The discharge of drilling muds and cuttings (including synthetic drilling fluids adhering to the cuttings) can adversely affect fish in several ways. Impacts from turbidity associated with drilling waste discharge would be similar to those described above and could damage respiratory structures, cause fish to temporarily move from the area, and disrupt food acquisition. Drilling wastes released near the sediment surface or in shallow water would bury benthic food resources in the release area, although conditions would eventually recover. Trace metal and hydrocarbon constituents in drilling fluids can be toxic to fish at all life stages if they are exposed to high enough concentrations. Impacts would be greatest for planktonic eggs and larvae that contact the mixing zone, while juveniles and adults passing through a discharge are not likely to be adversely affected. Based on the assumption of a relatively widespread distribution of eggs, larvae, and prey in Cook Inlet, drilling waste discharge is not likely to alter the population dynamics of fisheries resources in Cook Inlet or the Gulf of Alaska. In addition, drilling discharges must comply with NPDES permit requirements regarding the discharge amount, rate, and toxicity, which would greatly reduce the impact on fish communities.

While an exact route cannot be determined at this time, any onshore pipeline route would be required to comply with various Alaska Coastal Management Program policies. As a consequence, construction activities in sensitive aquatic habitat would be minimized. Specifically, the route for onshore pipeline facilities would be sited inland from shorelines and beaches, and crossings of anadromous fish streams would be minimized and consolidated with other utility and road crossings of such streams. In addition, onshore pipelines would be designed, constructed, and maintained to minimize risk to fish habitats from a spill, pipeline break, or construction activities.

Overall, site development and exploration activities represent temporary disturbance primarily affecting demersal fishes, with the severity of the impacts generally decreasing dramatically with distance from the disturbance. No population-level effects are anticipated.

Production. Production activities that could affect fish communities in Cook Inlet include operational noise, bottom disturbance from anchors and the release of process water. In addition, the platform would replace existing featureless soft sediments and serve as an artificial reef (Table 4.4.7-4).

Chronic disturbance to demersal fish communities could result from the movement of pipelines and anchors and chains associated with support vessels. Bottom disturbance would affect fish in a manner similar to that described above for the exploration and site development phase. The disturbance would be episodic and temporary, but would last for the lifetime of the platform.

Produced water contains metals, hydrocarbons, salts, and radionuclides, and their discharge could contaminate habitat, resulting in lethal and sublethal effects on fish, particularly early life stages. However, NPDES permitting requirements regarding discharge rate, contaminant concentration, and toxicity would greatly reduce the potential for impacts on fish. It is assumed that all produced water would be disposed of by injection into permitted disposal wells. Therefore, the effects of produced water discharges on fish are expected to be minimal.

Platforms would add a hard substrate to the marine environment, providing additional habitat for marine plants and animals (e.g., kelp and mussels) that require a hard substrate. Fish species in Cook Inlet that prefer hard substrate, such as rockfish, may be attracted to platforms. The platform would likely increase shell material and organic matter in the sediments surrounding the platform, potentially resulting in a shift in benthic invertebrate food sources.

A two-year (1997–1998) study of contaminant levels in the sediments of the Shelikof Strait and Cook Inlet provide information on potential effects of oil and gas development in the Cook Inlet Planning Area (MMS 2001a). Samples of sediment from depositional areas (where sediment contamination is expected to be greatest) suggested that metals and PAHs in sediments derived primarily from natural sources rather than past oil and gas developments (MMS 2001a). In addition, sediment concentrations of metals and organic contaminants in outermost Cook Inlet and Shelikof Strait (1) have not increased significantly since offshore oil exploration and production began in Cook Inlet (circa 1963) and (2) posed only a small risk to benthic biota or fish (MMS 2001a).

Decommissioning. No explosive platform removals are anticipated under the proposed action. Nonexplosive removals (e.g., abrasive, mechanical, or diver cutters) would have no long-term impacts to fish populations, although individuals associated with the platform would experience a loss of habitat. Pipelines installed and anchored on the seafloor would be capped and left in place, although there is the potential for chronic sediment disturbance from pipeline movement. If fixed platforms are left in place, the changes to fish communities resulting from the initial platform installation would be long-term.

Impacts of Expected Accidental Events and Spills. It is assumed that 1 to 3 small spills between 50 and 999 bbl and 7 to 15 smaller spills between 1 and <50 bbl, and large spills (≥1,000 bbl) could occur under the proposed action (Table 4.4.2-1). Impacts to individual fish and their habitat would generally increase with the size of the spill. It is anticipated that only a small amount of water column and shoreline would be affected by smaller oil spills and would not, therefore, present a substantial risk to fish populations. Consequently, the effects of small spills on fish and their habitat are expected to be localized, short-term, and affect relatively few individuals. Larger areas and numbers of individuals may be affected by large spills (spills >1,000 bbl). Accidental large hydrocarbon releases in Alaska may have greater ecological consequences than in temperate areas because oil is likely to persist in the environment due to the colder temperatures. Hydrocarbons can have a range of effects on fish depending on the concentration, the length of exposure, and the life history stage of the fish involved

(Starr et al. 1981; Malins 1977). Prolonged exposure to elevated levels of petroleum hydrocarbons can result in lethal or sublethal (reproduction, recruitment, physiology, growth, development, and behavior) impacts at the level of the individual.

Impacts from spills would be greatest if a large spill occurred during a reproductive period or contacted a location important for spawning or growth such as intertidal and nearshore subtidal habitats. Because pelagic species of fishes in Cook Inlet are relatively abundant and widely distributed in waters across much of the central Gulf of Alaska, even a large oil spill is not likely to cause population-level impacts on most fish populations inhabiting the central Gulf of Alaska (i.e., South Alaskan Peninsula, Kodiak Archipelago, Shelikof Strait, Cook Inlet, and Prince William Sound).

An Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE in the Cook inlet Planning Area with a volume of 75-125 thousand bbl and a duration of 50–80 days. The likelihood of oil from a CDE (Table 4.4.2-2) contacting part of the shoreline is relatively high because the Cook Inlet Planning Area is located within a relatively confined estuary. Spilled oil affecting nearshore and intertidal areas would likely result in the greatest impacts on fisheries resources. Oil may persist for years in intertidal areas and could represent a persistent source of exposure for fish such as herrings that generally spawn near shorelines. In addition to impacts to individual fishes, a CDE could result in population-level effects in some cases (Peterson et al. 2003). Fishes most likely to be affected by an oil spill would be those that migrate extensively (e.g., salmon), those with high fidelity to natal streams (e.g., Dolly Varden), and those confined to nearshore environments (e.g. rainbow smelt). Gas and particularly oil releases in Cook Inlet could affect fish populations by causing mortality of eggs, larvae, juveniles, or adults; triggering abnormal development; impeding the access of migratory fishes (e.g., salmon and herring) to spawning habitat; altering behaviors; displacing individuals from preferred habitat; reducing or eliminating prey populations available for consumption; impairing feeding, growth, or reproduction; causing adverse physiological responses; increasing susceptibility to predation, parasitism, diseases or other environmental perturbations; and increasing or introducing genetic abnormalities. It is anticipated that pelagic eggs and larval stages of fish, whose movements are largely controlled by water currents, would be killed if they came into contact with surface oil spills (Patin 1999). Conversely, evidence indicates that the majority of adult pelagic fish can likely detect and avoid heavily oiled waters in the open sea, thereby avoiding acute effects (Patin 1999).

Lethal and sublethal impacts can also result from cleanup methods involving burning, skimming, and dispersants (if used). Dispersant toxicity varies by species and dispersant used, although newer dispersant formulations, such as COREXIT® 2500, do not appear to be more toxic to fish than oil alone (Hemmer et al. 2011). However, few species have been tested; additive toxicity from oil-dispersant mixtures may be significant for some species (Hemmer et al. 2011).

Oil spills in intertidal areas also have the potential to contaminate or alter the composition and abundance of the benthic food resources consumed by fish. For example, evidence from the *Exxon Valdez* oil spill suggests stress-tolerant invertebrates such as polychaetes and snails would not suffer long-term population declines in oiled areas, but clams and mussels could be contaminated and reduced in abundance for several years (*Exxon Valdez* Oil Spill Trustee Council 2010a).

A CDE could result in a decline in local abundances of fish stocks or subpopulations, with recovery potentially requiring multiple generations. Some stocks are already in decline due to non-OCS anthropogenic and natural impact-producing factors (e.g., pollution, habitat loss, and climatic shifts). Impacts to fish can result in ecosystem-level effects if the population impacts are significant. For example, fish can occupy a number of trophic levels ranging from herbivore to top-level carnivore. As such, fish are critical to energy flow within nearshore and marine food webs. They are also seasonally important food sources to transient carnivores. Consequently, impacts to fish can propagate throughout the food web affecting birds and marine mammals. In addition, many Alaskan fishes, particularly salmon, migrate between and within marine, estuarine, and freshwater habitats. In doing so, they transfer nutrients and carbon over a broad area and connect offshore and coastal ecosystems (Naiman et al. 2002). Therefore, significant impacts to fish populations could reduce this transfer resulting in local changes in productivity.

Some of the potential effects that a CDE in Cook Inlet could have on fish resources can be inferred based upon the impacts of the 1989 *Exxon Valdez* oil spill, which released approximately 257,000 bbl of oil into nearby Prince William Sound. The potential effects of the Valdez spill are best known for salmon and Pacific herring. Adult salmon were able to return to natal streams and hatcheries even under very large oil spill conditions (Brannon et al. 1986; Nakatani and Nevissi 1991), as evidenced by the return of pink and sockeye salmon to Prince William Sound and sockeye salmon to Cook Inlet during and after the *Exxon Valdez* oil spill. Population-level effects on salmon were primarily through exposure of eggs and larvae to oil in sediments. Because of their long incubation period in intertidal gravel and because salmon embryos have a large lipid-rich yolk that can accumulate hydrocarbons from low-level exposures, salmon embryos are vulnerable to contamination from oil spills that reach intertidal areas (Peterson et al. 2003). For example, pink salmon embryos in oiled intertidal streams of Prince William Sound continued to show higher mortality than those in non-oiled streams until 1993 (Bue et al. 1998), and from 1989 to 1990, the growth rates of cutthroat trout and Dolly Varden in oiled streams were lower than those in clean streams (Hepler et al. 1993). However, salmonid populations appeared to recover within 15 years. Pink and sockeye salmon populations were considered to have recovered in 1999 and 2002, respectively (*Exxon Valdez* Oil Spill Trustee Council 2010a). Dolly Varden char were considered recovered in 2002, and cutthroat trout are considered to have very likely recovered (*Exxon Valdez* Oil Spill Trustee Council 2010a).

Although the *Exxon Valdez* oil spill occurred a few weeks before Pacific herring spawned in Prince William Sound, adult herring appeared to be relatively unaffected by the spill. About half of the herring egg biomass was deposited within the oil trajectory, and toxicity tests suggested egg-larval mortality in the oiled areas was twice as great as in the non-oiled areas and that larval growth rates in oiled areas were depressed compared to those in areas unaffected by the spill (Brown et al. 1996; McGurk and Brown 1996). After a record harvest in 1992 (following the *Exxon Valdez* spill), the Pacific herring population in Prince William Sound collapsed and has remained depressed, with reduced or no commercial harvest allowed. The Pacific herring stock of Prince William Sound is still classified as “not recovered” from the

Exxon Valdez oil spill (*Exxon Valdez* Oil Spill Trustee Council 2010a). However, because of natural variability in population and confounding environmental factors, there has not been full consensus among researchers that the currently low herring numbers are fully attributable to the effects of spilled oil. Pathogens, rather than lingering effects of the Valdez spill, may be primarily responsible for the lack of recovery (*Exxon Valdez* Oil Spill Trustee Council 2010a).

Although the effects of the spill on rockfish, a common demersal fish in Cook Inlet, were never well understood, their populations and habitat are considered recovered from the *Exxon Valdez* spill (*Exxon Valdez* Oil Spill Trustee Council 2010a). In general, adult demersal fishes are believed to avoid oil slicks, although individuals in coastal shallow waters with slow water exchange could be exposed to sublethal hydrocarbon concentrations (Patin 1999). A large or catastrophic spill could adversely affect hundreds of millions of eggs and juvenile stages, especially spills that reach nearshore areas, which are important to many species of demersal fishes as juveniles (Moles and Norcross 1998). Adult demersal and bentho-pelagic fish, including pollock, sablefish, Pacific cod, eulachon, and Pacific sand lance, would probably not be harmed by spilled oil at the surface. However, many demersal fishes such as walleye pollock, halibut, and cod all have buoyant eggs and larvae that float near the surface where they could be exposed to spilled oil (NPFMC 2010a).

Impact Conclusions.

***Routine Operations*.** The primary potential impacts on fish communities from Program activities could result from seismic surveys and bottom-disturbing activities such as drilling, platform placement and mooring, and pipeline trenching and placement, which could displace, injure, or kill fish in the vicinity of the activity. Displaced fish and invertebrate food sources would repopulate the area over a short period of time. Oil and gas activities would be temporary, and no population-level impacts on fish are expected. The effects of drilling muds and produced water discharge on fish would be localized, and no population-level effects are expected. Drilling waste and produced water discharge would be far less in Alaska because fewer wells would be drilled in Alaska and because it is assumed that drilling muds and cuttings from production wells and all produced water would be reinjected into the wells. Overall, impacts to fish from routine Program activities are expected to range from negligible to minor.

Expected Accidental Events and Spills. Small spills would be localized and are unlikely to affect a substantial number of fish before dilution and weathering would reduce concentrations of toxic fractions to nontoxic levels. Large spills would affect a wider area, with the magnitude of the impacts depending on the location, timing, and volume of spills, distribution and ecology of affected fish species, and other environmental factors. Most adult fish are highly mobile and would likely avoid lethal hydrocarbon exposures, although they may be subjected to sublethal concentrations. Smaller species and egg and larval life stages are more likely to suffer lethal or sublethal exposures from oil contact because of their relative lack of mobility. Overall, impacts from small spills would range from negligible for spill less than 50 bbl, minor for spills up to 1,000 bbl, and from minor to moderate for large spills (≥1,000 bbl).

***An Unexpected Catastrophic Discharge Event*.** A CDE would affect a wider area, with the magnitude of the impacts depending on the location, timing, and volume of spills, distribution and ecology of affected fish species, and other environmental factors. Most adult fish are highly mobile and would likely avoid lethal hydrocarbon exposures, although they may be subjected to sublethal concentrations. Smaller species and egg and larval life stages are more likely to suffer lethal or sublethal exposures from oil contact because of their relative lack of mobility. Under most circumstances, a CDE would affect only a small proportion of a given fish population; therefore, the overall population levels of a given species may not be affected. However, oil contacting shoreline areas used for spawning or providing habitat for early life stages of fish could result in large-scale lethal and long-term sublethal effects on fish. In Alaskan waters, where oil may be slow to break down, coastal oiling could measurably depress some fish populations for several years. Overall, the impacts to fish from a CDE could range up to moderate.

4.4.7.3.3 Alaska – Arctic.

Impacts of Routine Operations. Potential OCS oil and gas development impacting factors for fish are shown by phase in Table 4.4.7-5. Impacting factors common to all phases include vessel traffic, platform lighting, vessel discharges (bilge and ballast water), and miscellaneous discharges (deck washing, sanitary waste). Impacts from waste discharges would be localized and temporary and are not expected to have population-level impacts on fish populations. Many of these waste streams are disposed of on land, and any discharges into surface waters must meet USEPA and/or USCG regulatory requirements before discharge. Studies of platform lighting suggest that the lights could alter predator-prey dynamics by enhancing phytoplankton productivity around the platform, potentially improving food availability and the visual foraging environment for fishes (Keenan et al. 2007). Potential impacts from platform lighting would be localized but long term and are expected to have minimal impacts on fish populations.

Exploration and Site Development. During the OCS oil and gas exploration and development phase, fish could be affected by noise from seismic surveys and noise and bottom disturbance from drilling, subsea well, gravel island and ice road construction, platform placement, and pipeline trenching and placement activities (Table 4.4.7-5). Section 5 of a report recently released by BOEM contains additional information about the sound produced by fish and invertebrates in the Arctic region (Normandeau Associates, Inc. 2012). The effects of these activities on fish communities are described in detail in Section 4.4.7.3.2.

Fish in the Beaufort Sea and Chukchi Sea Planning Areas most likely to be affected by the noise generated from drilling, vessel traffic, and seismic surveys include salmon, cod, whitefishes, and herring. The effect on the overall fish population are not expected to result in population-level impacts since fishes are distributed over wide geographic areas and airgun operations are localized (Section 4.4.7.3.2). While it is anticipated that there would be no long-term population-level effects on managed species from seismic surveys, individual fish, especially egg and larval life stages in close proximity (1 to 5 m [3 to 16 ft]) to airgun arrays (Dalen and Knutsen 1986; Holliday et al. 1987; Turnpenny and Nedwell 1994), could suffer mortality or injury, and adult fishes more distant from the noise could exhibit short-term avoidance and behavioral alteration. A recent review of seismic survey noise on marine

TABLE 4.4.7-5 Impacting Factors on Fish and Their Habitat in the Beaufort Sea and Chukchi Sea Planning Areas

	Life Stage Affected[a]		
Development Phase and Impacting Factor	Eggs	Larvae	Adults
Impacting Factors Common to All Phases			
Vessel noise	X	X	X
Vessel traffic	X	X	X
Hazardous materials	X	X	X
Solid wastes	X	X	X
Offshore lighting	X	X	X
Aircraft noise			
Offshore air emissions			
Onshore air emissions			
Aircraft traffic			
Miscellaneous platform discharges	X	X	X
Vessel discharges	X	X	X
Bottom disturbance from vessel anchors	X	X	X
Exploration and Development			
Seismic noise	X	X	X
Noise from drilling and construction	X	X	X
Bottom disturbance from drilling and placement of subsea wells, platforms, and pipelines	X	X	X
Discharge of drilling muds and cuttings	X	X	X
Production			
Production noise	X	X	X
Produced water discharge	X	X	X
Artificial reef	X	X	X
Decommissioning			
Platform removal (non-explosive)	X	X	X

[a] Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

fish concluded that although data were limited, there would be no significant impacts on marine fish populations from seismic surveys (BOEMRE 2010b; NSF and USGS 2010).

Development and construction activities that could affect fish in the Beaufort and Chukchi Sea Planning Areas include drilling, installation of pipelines and construction of subsea wells, platforms, artificial islands, and ice roads. Bottom disturbance would result in temporary sedimentation and turbidity, which could damage fish gills and bury benthic invertebrate prey resources within some distance of the disturbance. Individual fish would likely temporarily move away from affected areas (Section 4.4.7.3.2). The total area affected by seafloor disturbance under the proposed action would be relatively small compared to the availability of similar seafloor habitat in surrounding areas.

Onshore, up to 129 km (80 mi) of oil pipeline could be constructed. While an exact route cannot be determined at this time, the pipeline route would be required to comply with various Alaska Coastal Management Program policies. As a consequence, construction activities in sensitive aquatic habitats would be minimized. Specifically, the route for onshore pipeline facilities would be sited inland from shorelines and beaches, and crossings of anadromous fish streams would be minimized and consolidated with other utility and road crossings of such streams. In addition, onshore pipelines would be designed, constructed, and maintained to minimize risk to fish habitats from a spill, pipeline break, or construction activities.

Gravel island and ice road construction may affect freshwater fish and fish habitats. Gravel for island construction is mined from river bars, and water for construction of ice roads is pumped from local rivers and lakes to desired areas to build a rigid surface. Removal of gravel could increase turbidity and reduce the water quality in affected rivers. Water withdrawal for ice road construction could potentially remove a large number of fish from the water body and reduce dissolved oxygen concentrations in the remaining lake water (Cott et al. 2008). For ice roads that traverse lakes, long-term impacts to fish populations could result from traffic-related noise disturbance. Truck noise is not expected to be great enough to result in injury to fish even in the vicinity of the road noise (Stewart 2003). However, fish may temporarily avoid the areas of noise and vibrational disturbance (Stewart 2003). The potential for entrainment can be reduced by using mitigative intake screens and by taking water from lakes with groundfast ice; such lakes are less likely to contain significant fish populations. Impacts to water quality can be minimized by avoiding excessive water removal. For example, Cott et al. (2008) found that water withdrawals of 10% of under-ice water volume did not significantly reduce oxygen concentration, while a 20% withdrawal reduced both dissolved oxygen and the amount of suitable fish habitat. Impact to fish will also be reduced by the ADFG, which requires reviews of gravel extraction and water withdrawal activities to assess potential impacts on salmon and other fish species and requires permits to be issued before activities can be initiated.

Artificial islands would increase the diversity of habitats available on an otherwise homogeneous ocean. Specifically, construction of such islands would introduce an artificial hard substrate that opportunistic benthic species, especially those that prefer gravel substrate, could colonize. Fishes may be attracted to the newly formed habitat complex, and fish population numbers in the immediate vicinity of the platforms are likely to be higher than in surrounding waters away from the structures. The overall change in habitat could result in changes in local community assemblage and diversity (NMFS 2011d). The number of platforms projected for the Beaufort Sea and Chukchi Sea Planning Areas under the proposed action (up to nine) would create a small amount of hard substrate habitat and would likely have little effect on overall fish populations.

It is assumed that drilling muds and cuttings would be discharged into the Beaufort and Chukchi Sea Planning Areas for exploration wells only and that drilling wastes from development and production wells would be reinjected into the wells. The discharge of drilling muds and cuttings (including synthetic drilling fluids adhering to the cuttings) can adversely affect fish in several ways. Impacts from turbidity associated with drilling waste discharge would be similar to those described above and could damage respiratory structures, cause fish to temporarily move from the area, and disrupt food acquisition. Drilling wastes released near the sediment surface or in shallow water would bury benthic food resources in the release area, although conditions would eventually recover. Trace metal and hydrocarbon constituents in drilling fluids can be toxic to fish at all life stages if they are exposed to high enough concentrations. Impacts would be greatest for planktonic eggs and larvae that contact the mixing zone, while juveniles and adults passing through a discharge are not likely to be adversely affected. Assuming a relatively widespread distribution of eggs, larvae, and prey in the Beaufort and Chukchi Seas, drilling waste discharge is not likely to alter the population dynamics of fisheries resources. In addition, drilling discharges must comply with NPDES permit requirements regarding the discharge amount, rate, and toxicity, which would greatly reduce the impact on fish communities.

Overall, site development and exploration activities represent temporary disturbance primarily affecting demersal fishes, with the severity of the impacts generally decreasing dramatically with distance from the disturbance. No population-level effects are anticipated.

Production. Production activities that could affect fish communities in the Beaufort and Chukchi Seas include operational noise, bottom disturbance from anchors and the release of process water. In addition, the platform would replace existing featureless soft sediments and serve as an artificial reef (Table 4.4.7-5). Chronic disturbance to demersal fish communities would result from the movement of anchors and chains associated with support vessels. Pipelines not buried would be anchored in place which would minimize their movement and potential to disturb fish habitat. Bottom disturbance would affect similar to that described above for the exploration and site development phase. The disturbance would be episodic and temporary, but would last for the lifetime of the platform.

Produced water contains metals, hydrocarbons, salts, and radionuclides, and their discharge could contaminate habitat, resulting in lethal and sublethal effects on fish, particularly early life stages. It is assumed that all produced water would be disposed of by injection into permitted disposal wells. Therefore, the effects of miscellaneous and produced water discharges on fish communities are expected to be minimal.

The results of the Arctic Nearshore Impacts Monitoring in the Development Area study funded by BOEM provide a good summary of the long-term changes to benthic communities resulting from oil and gas development in the Arctic. Hydrocarbons are primarily derived from river inputs rather than oil and gas development (Brown 2004; Neff & Associates, LLC 2010). Tissue hydrocarbon and metals concentrations in fish and their invertebrate food sources sampled near the Northstar development and Liberty prospect area were similar to or lower than invertebrate tissue levels found elsewhere in the world. No increase in hydrocarbons and metals in fish or invertebrate tissues was attributable to oil and gas production (Neff & Associates, LLC 2010).

Decommissioning. No explosive platform removals are anticipated under the proposed action. Nonexplosive removals (e.g., abrasive, mechanical, or diver cutters) are not expected to have long-term impacts to fish populations, although fish associated with the platform would experience a loss of habitat. Pipelines installed and anchored on the seafloor would be capped and left in place, although there is the potential for chronic sediment disturbance from pipeline movement. Impacts on fish populations associated with decommissioning activities are expected to be temporary.

Impacts of Expected Accidental Events and Spills. It is assumed that large spills (≥1,000 bbl), up to 35 small spills (50 to 999 bbl), and up to 190 smaller spills (>1 and <50 bbl) could occur during the lease period under the proposed action (Table 4.4.2-2). Impacts to individual fish and their habitat would generally increase with the size of the spill. Most accidental hydrocarbon releases would be small and would primarily affect fish in the water column, as most oil and gas would float above the sediment surface. It is anticipated that in most cases only a small amount of the water column and shoreline would be affected by these smaller oil spills and would not, therefore, present a substantial risk to fish populations. Consequently, the effects of small spills on fish and their habitat are expected to be short-term and affect relatively few individuals.

Larger areas and numbers of individuals may be affected by large spills (>1,000 bbl). As described in Section 4.4.7.3.2, accidental hydrocarbon releases in the Beaufort Sea and Chukchi Sea Planning Areas could affect fish populations by causing mortality of eggs, larvae, juveniles, or adults; triggering abnormal development; impeding the access of migratory fishes (e.g., salmon and herring) to spawning habitat; altering behaviors; displacing individuals from preferred habitat; reducing or eliminating prey populations available for consumption; impairing feeding, growth, or reproduction; causing adverse physiological responses; increasing susceptibility to predation, parasitism, diseases, or other environmental perturbations; and increasing or introducing genetic abnormalities. It is anticipated that pelagic eggs and larval stages of fish, whose movements are largely controlled by water currents, would be killed if they came into contact with surface oil spills (Patin 1999; Peterson et al. 2003). Conversely, evidence indicates that the majority of adult pelagic fish can likely detect and avoid heavily oiled waters in the open sea, thereby avoiding acute effects (Patin 1999).

Impacts from large spills would be greatest if a large spill occurred during a reproductive period or contacted a location important for spawning or growth such as intertidal and nearshore subtidal habitats. Because pelagic species of fishes in the Beaufort Sea and Chukchi Sea Planning Areas are widely distributed, even a large oil spill is not likely to cause population-level impacts on most fish populations.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE in the Chukchi Sea Planning Area with a volume of 1.4-2.2 million bbl and a duration of 40–75 days, and a CDE in the Beaufort Sea Planning Area with a volume of 1.7-3.9 million bbl and a duration of 60–300 days (Table 4.4.2-2). See Section 4.4.7.3.2 for a detailed discussion of the effects of oil spills on fish following the catastrophic *Exxon Valdez* spill. A CDE (Table 4.4.2-2) has the potential to affect multiple species in the Arctic Planning Areas. Such spills can have a range of effects on fish depending on the concentration, the length of exposure, and the life history stage of the fish involved (Starr et al. 1981; Malins 1977; NMFS 2011d). During the spill, adult and juvenile fish may be temporarily displaced, which could interfere with movements to feeding, overwintering, or spawning areas. Fish eggs, larvae, and juveniles are the most sensitive life history stages (Section 4.4.7.3.2). Spilled petroleum hydrocarbons may persist for years (NMFS 2011d), especially in sediments of cold waters, making it likely that some fish species would be exposed to low levels of hydrocarbons for an extended time after an oil spill. Similarly, petroleum hydrocarbons could remain available for uptake and bioaccumulation by benthic food sources for years following a spill (NMFS 2011d). Lethal and sublethal impacts can also result from cleanup methods involving burning, skimming, and dispersants (if used). Dispersant toxicity varies by species and dispersant used, although newer dispersant formulations, such as COREXIT® 2500, do not appear to be more toxic to fish than oil alone (Hemmer et al. 2011). However, few species have been tested; additive toxicity from oil-dispersant mixtures may be significant for some species (Hemmer et al. 2011).

Among the most abundant marine fish in the Beaufort Sea and Chukchi Sea Planning Areas are Arctic cod, sculpin, eelpout, pricklebacks, and flatfish. Of these, the Arctic cod may be the most susceptible to spills under ice because they spawn in winter under ice when cleanup would be most difficult. In addition, the larvae are pelagic and most likely to come into contact with oil and gas, which tend to float on the surface. Arctic cod are also susceptible because they are dependent on algal production in open water and under sea ice, which could be affected by oil and gas exposure. Among the most abundant anadromous species are the Arctic and least cisco, broad whitefish, Dolly Varden, and rainbow smelt. Fishes most likely to be affected by an oil spill would be those that migrate extensively (e.g., Arctic cisco), those with high fidelity to natal streams (e.g., Dolly Varden), and those confined to nearshore environments (e.g., broad whitefish and rainbow smelt). Some pelagic species (e.g., Pacific herring; capelin) spawn in intertidal zones where their eggs may be susceptible to oil (Rice et al. 1984). Herring generally spawn near shorelines over 3–4 week periods, and oil driven onshore could contact spawning adults and developing eggs (MMS 1996a). Larval herring are also susceptible after moving into deeper water because they rise diurnally to feed on plankton and could be exposed to surface oil repeatedly if a spill occurs. Demersal fishes such as walleye pollock, halibut, and cod all have buoyant eggs and larvae that float near the surface where they could be exposed to spilled oil (MMS 1996).

A CDE spill could have population-level consequences if vital habitat areas were affected or if it occurred in spawning areas or juvenile feeding grounds when fish populations are highly concentrated (e.g., the Arctic cisco population concentrated near the Colville River). In such cases, catastrophic spills could cause substantial reductions in population levels for one or more years.

In addition to effects on individuals and species, impacts to fish can result in ecosystem-level effects if the population impacts are significant. For example, fish can occupy a number of trophic levels ranging from herbivore to top-level carnivore. Therefore, fish are critical to energy flow within nearshore and marine food webs. They are also seasonally important food sources to transient carnivores. Consequently, impacts to fish can propagate throughout the food web, affecting birds and marine mammals. In addition, many Alaskan fishes, particularly salmonids, migrate between and within marine, estuarine, and freshwater habitats. In doing so, they transfer nutrients and carbon over a broad area and connect offshore and coastal ecosystems (Naiman et al. 2002). Significant impacts to fish populations could reduce this transfer, resulting in local changes in productivity. In addition, Arctic cod are keystone species in the Arctic, and significant impact to this species could have broad ecosystem effects.

Impact Conclusions.

Routine Operations. The primary potential impacts on fish communities from Program activities could result from seismic surveys and bottom-disturbing activities such as drilling, platform placement and mooring, and pipeline trenching and placement, which could displace, injure, or kill fish in the vicinity of the activity. Oil and gas activities would be temporary, and no population-level impacts on fish are expected. Displaced fish and invertebrate food sources would repopulate the area over a short period of time, but certain fish habitat recovery may be long-term. The effects of drilling muds and produced water discharge on fish would be localized, and no population-level effects are expected. Drilling waste and produced water discharge would be far less in Alaska because fewer wells would be drilled in Alaska and because it is assumed that drilling muds and cuttings from production wells and all produced water would be reinjected into the wells. Overall, impacts to fish from routine Program activities are expected to range from negligible to minor, and no impacts on threatened or endangered fish species are expected.

Expected Accidental Events and Spills. Small spills would be localized and are unlikely to affect a substantial number of fish before dilution and weathering would reduce concentrations of toxic fractions to nontoxic levels. Large spills would affect a wider area, with the magnitude of the impacts depending on the location, timing, and volume of spills, distribution and ecology of affected fish species, and other environmental factors. Most adult fish are highly mobile and would likely avoid lethal hydrocarbon exposures, although they may be subjected to sublethal concentrations. Smaller species and egg and larval life stages are more likely to suffer lethal or sublethal exposures from oil contact because of their relative lack of mobility. Overall, impacts from small spills would range from negligible for spill less than 50 bbl, minor for spills up to 1,000 bbl, and from minor to moderate for large spills (≥ 1,000 bbl).

An Unexpected Catastrophic Discharge Event**.** A CDE would affect a wider area, with the magnitude of the impacts depending on the location, timing, and volume of spills, distribution and ecology of affected fish species, and other environmental factors. Most adult fish are highly mobile and would likely avoid lethal hydrocarbon exposures, although they may be subjected to sublethal concentrations. Smaller species and egg and larval life stages are more likely to suffer lethal or sublethal exposures from oil contact because of their relative lack of mobility. Under most circumstances, a CDE would affect only a small proportion of a given fish population; therefore, overall population levels may not be affected. Oil contacting shoreline areas used for spawning or providing habitat for early life stages of fish could result in large-scale lethal and long-term sublethal effects on fish. In Alaskan waters, where oil may be slow to break down, coastal oiling could measurably depress some fish populations for several years. Overall, the impacts to fish from a CDE could range from minor to moderate.

4.4.7.4 Reptiles

Impacts of Routine Operations. The discussion of impacts to reptile species from OCS oil and gas development is primarily focused on sea turtles that may occur throughout the GOM. There is the potential for other reptile species to be affected from a small number of impacting factors related to OCS oil and gas development. Additional reptile species (e.g., American crocodile, Alabama red-belly turtle, and gopher tortoise) will be identified as impacting factors are discussed in this PEIS.

There are five species of sea turtle that may be encountered in the GOM OCS Planning Areas: green, hawksbill, Kemp's ridley, leatherback, and loggerhead. All of these species have the potential to occur throughout the planning areas as hatchlings, juveniles, and adults. All but the hawksbill have been reported to nest on beaches within the GOM Planning Areas, and the number and distribution of nests differ dramatically among these species across bordering States (Section 3.8.3; Figure 3.8.3-1). Sea turtles may be affected in all phases of OCS oil and gas development. Under the proposed action, one or more of the sea turtle life stages could be affected under routine operations due to (1) airborne and underwater noise, (2) offshore structure placement and pipeline trenching, (3) removal of offshore structures, (4) OCS vessel traffic, (5) construction and operation of onshore infrastructure, and (6) exposure to operational discharges and wastes. In addition, reptiles may be affected by unexpected and accidental spills of oil and other contaminants. Table 4.4.7-6 illustrates how each of the various impact factors associated with OCS oil and gas development may affect sea turtles and their habitats in the GOM. Many of these impacting factors could occur during multiple project phases. Conceptual models illustrated in Figures 4.4.7-6 through 4.4.7-10 show how various activities associated with seismic surveys, onshore and offshore construction, normal O&G operations, decommissioning, and accidental oil releases may impact sea turtles. While OCS O&G projects have the potential to affect sea turtles of all life stages, it has been determined that impacts to later life stages (large juveniles and adults) result in greater population-level impacts (Crouse et al. 1987).

As discussed in Section 3.3.1, climate change in the GOM is expected to affect coastal systems through processes such as warming temperatures, changes in precipitation, sea level rise, and more frequent intense storms. Rising water temperatures, increased sea levels, and intense storms may affect the availability and suitability of foraging and nesting habitats for coastal and marine reptiles (Hawkes et al. 2009). For reptiles that rely on temperature to determine the gender of offspring in incubating eggs (referred to as temperature-dependent sex determination), including sea turtles and crocodilians, subtle increases in atmospheric temperatures could skew sex ratios of hatchlings, which could have future population implications (Walther et al. 2002). It is also predicted that global warming and increased precipitation rates associated with climate change will cause sea levels to rise (Church et al. 2001). This phenomenon could alter sea turtle coastal habitat in many areas (Hawkes et al. 2009). For example, a study in Hawaii predicted that as much as 40% of green sea turtle nesting habitat could be affected with a 0.9 m (2.7 ft) sea level rise (Baker et al. 2006).

TABLE 4.4.7-6 Potential OCS Oil and Gas Development Impacting Factors for Reptiles in the GOM

	O&G Impacting Factor								
	Noise								
Resource Receptor Category Potentially Affected	Seismic Exploration	Construction, Operation, and Decommissioning	Collisions with OCS Vessels	Presence of OCS Vessels	Construction and Decommissioning of Onshore and Offshore Infrastructure	Offshore and Onshore Lighting	Produced Water, Drill Cuttings and Mud, Liquid Wastes, Hazardous Materials	Solid Wastes and Debris	Accidental Oil Spills
Sea turtle nest sites – individual nests and nesting beaches	–	–	–	–	Destruction of nests; degradation or loss of nesting beaches	–	–	–	Physical disturbance and reduced quality from fouling
Sea turtle hatchlings	Injury; disruption of normal behavior (feeding, nesting)	Disruption of normal behavior (feeding, nesting)	Injury of mortality from ship strikes	Disruption of normal behavior (feeding, nesting)	Injury; disruption of normal behavior	Attraction of reproductive adults to low quality nesting habitats	Toxicity	Ingestion and/or entanglement	Fouling, toxicity
Sea turtle juveniles					Injury; disruption of normal behavior	Attraction of reproductive adults to low quality nesting habitats			Fouling, toxicity
Sea turtle adults					Injury; disruption of normal behavior	Attraction of reproductive adults to low quality nesting habitats			Fouling, toxicity
Sea turtle migration	Displacement or impediment	Displacement or impediment	–	Displacement or impediment	Displacement or impediment	Attraction of reproductive adults to low quality nesting habitats	–	–	Displacement or impediment
Sea turtle juvenile foraging habitats	–	–	–	–	Temporary habitat disturbance during construction; possible long-term increase in habitat	Attraction of reproductive adults to low quality nesting habitats	Reduced habitat quality	–	Physical disturbance; reduced habitat quality
Sea turtle adult foraging habitats	–	–	–	–	Temporary habitat disturbance during construction; possible long-term increase in habitat	Attraction of reproductive adults to low quality nesting habitats	Reduced habitat quality	–	Physical disturbance; reduced habitat quality

TABLE 4.4.7-6 (Cont.)

	O&G Impacting Factor								
	Noise								
Resource Receptor Category Potentially Affected	Seismic Exploration	Construction, Operation, and Decommissioning	Collisions with OCS Vessels	Presence of OCS Vessels	Construction and Decommissioning of Onshore and Offshore Infrastructure	Offshore and Onshore Lighting	Produced Water, Drill Cuttings and Mud, Liquid Wastes, Hazardous Materials	Solid Wastes and Debris	Accidental Oil Spills
Sea turtle wintering grounds	–	–	–	–	Temporary habitat disturbance; possible long-term increase in habitat	Attraction of reproductive adults to low quality nesting habitats	Reduced quality	–	Physical disturbance; reduced quality
American crocodile nest sites, adults, juveniles, hatchlings, and their habitat	–	–	–	–	Destruction of nests; degradation or loss of nesting or foraging habitat	–	–	–	Fouling, toxicity; physical disturbance; reduced habitat quality
Alabama red-belly turtle nest sites, adults, juveniles, hatchlings, and their habitat	–	–	–	–	Destruction of nests; degradation or loss of nesting or foraging habitat	–	–	–	Fouling, toxicity; physical disturbances; reduced habitat quality
Gopher tortoise nest sites, adults, juveniles, hatchlings, and their habitat	–	–	–	–	Destruction of nests; degradation or loss of nesting or foraging habitat	–	–	–	–

[a] – = No impact anticipated.

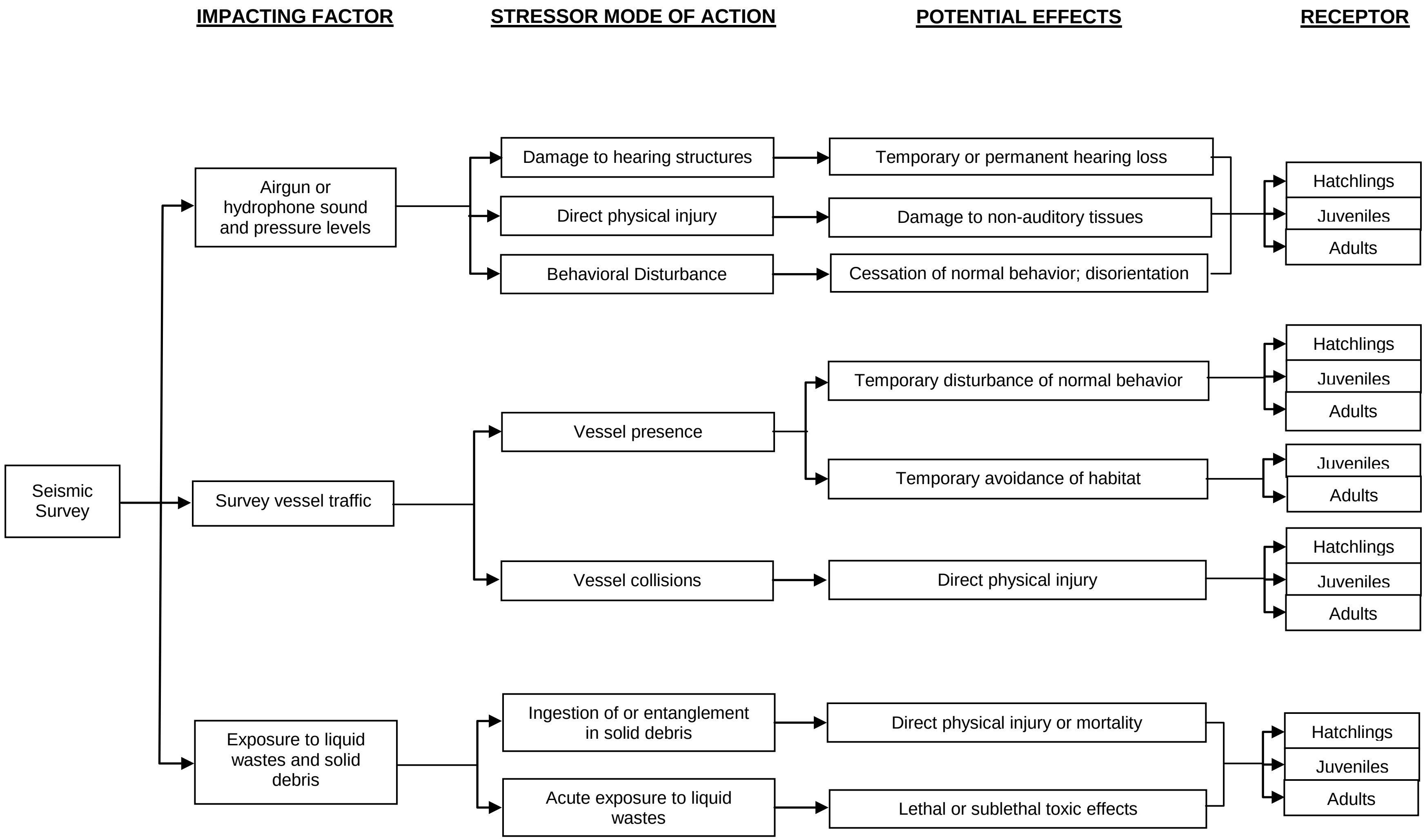

FIGURE 4.4.7-6 Conceptual Model for Potential Effects of Seismic Survey Activities on Turtles in the GOM

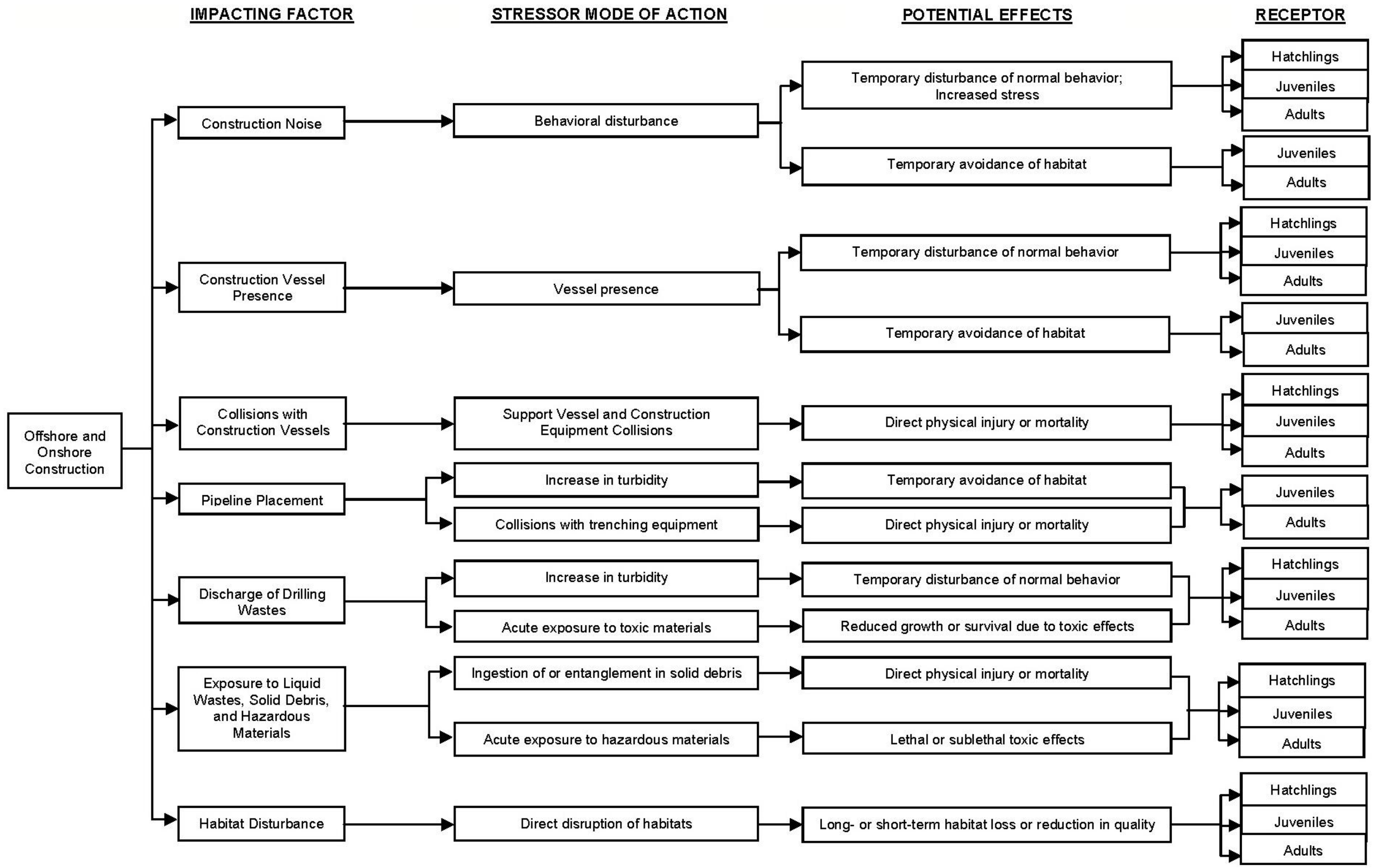

FIGURE 4.4.7-7 Conceptual Model for Potential Effects of OCS-Related Construction Activities on Turtles in the GOM

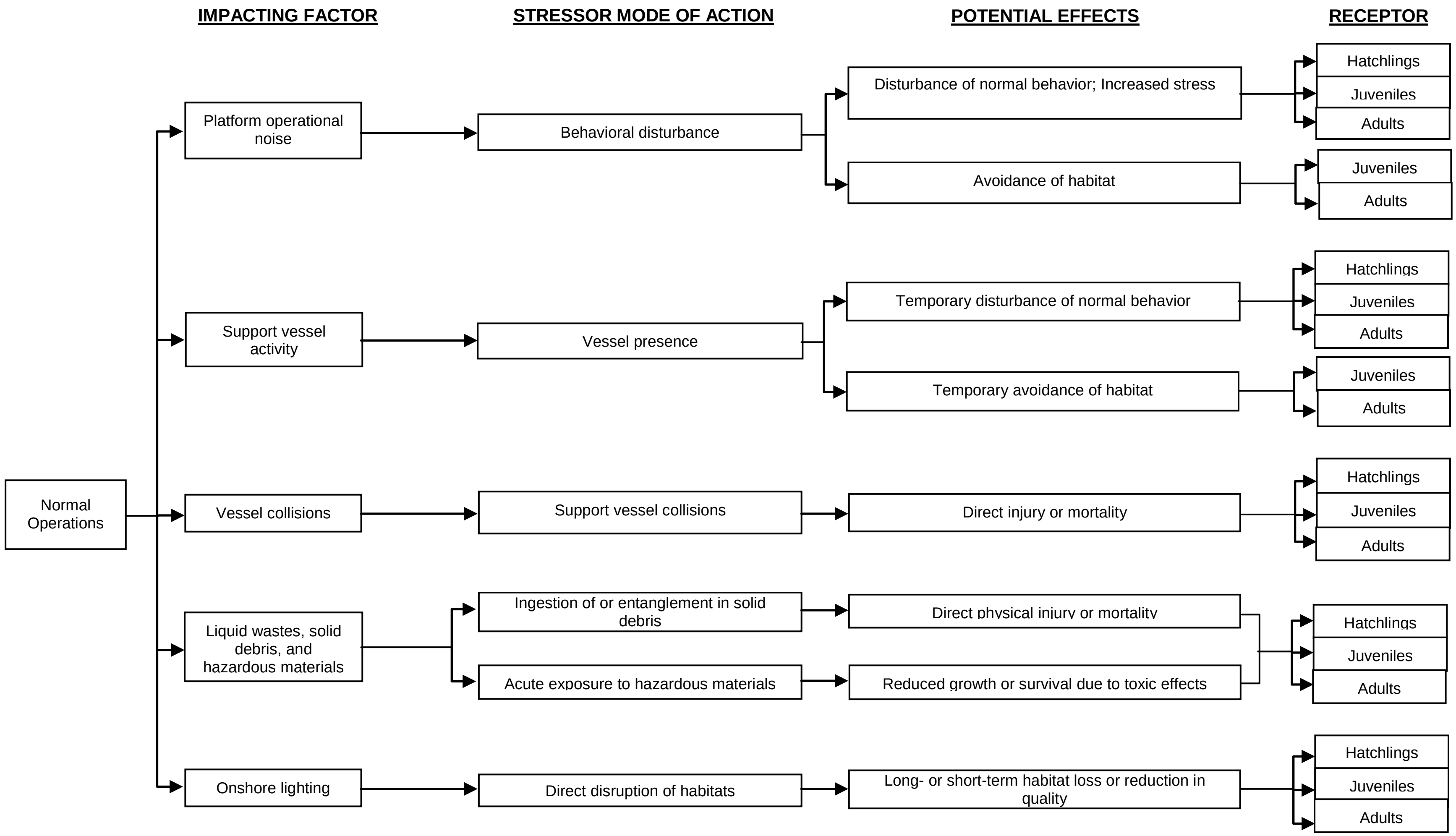

FIGURE 4.4.7-8 Conceptual Model for Potential Effects of OCS Operation on Turtles in the GOM

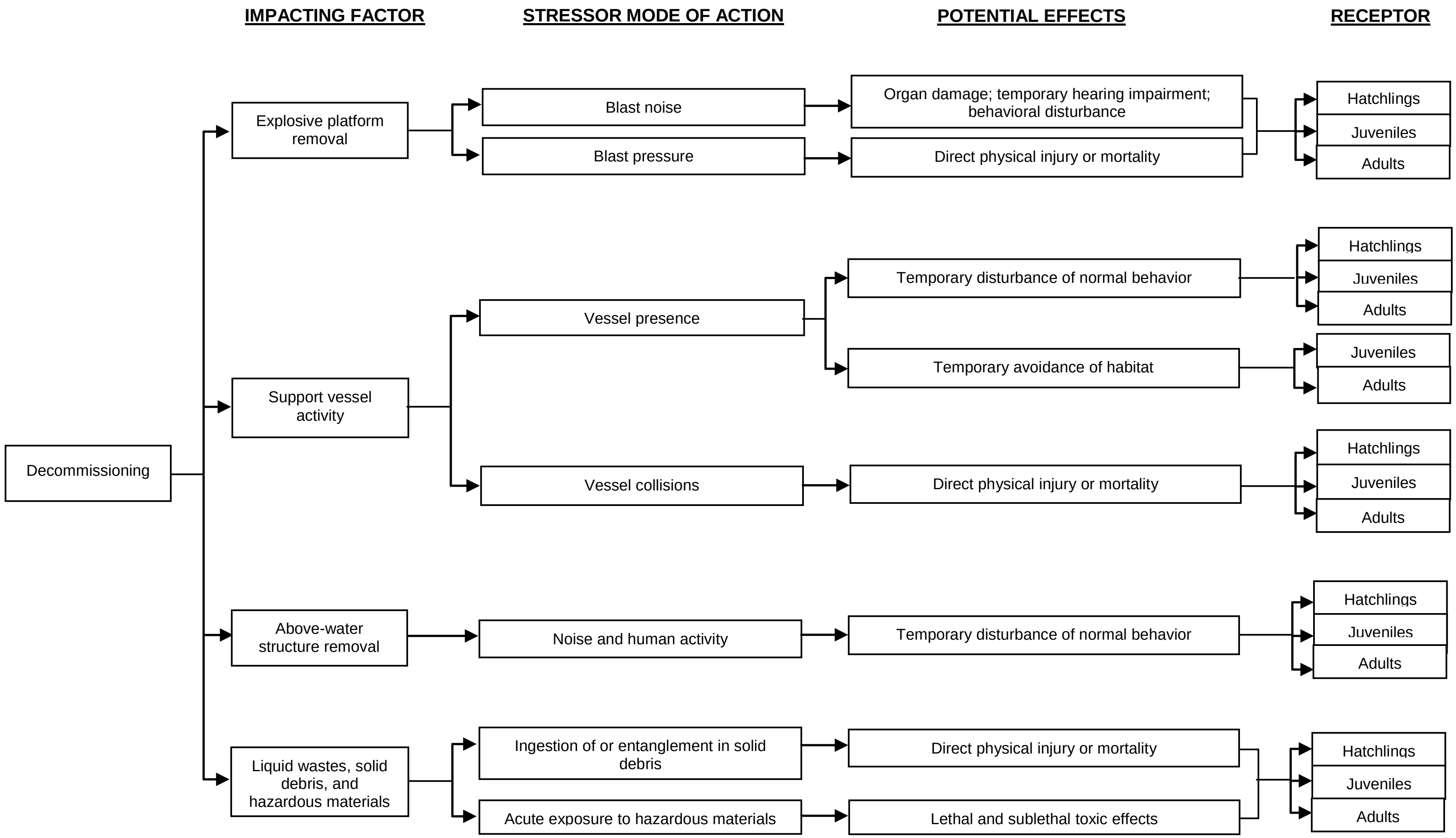

FIGURE 4.4.7-9 Conceptual Model for Potential Effects of Platform Decommissioning on Turtles in the GOM

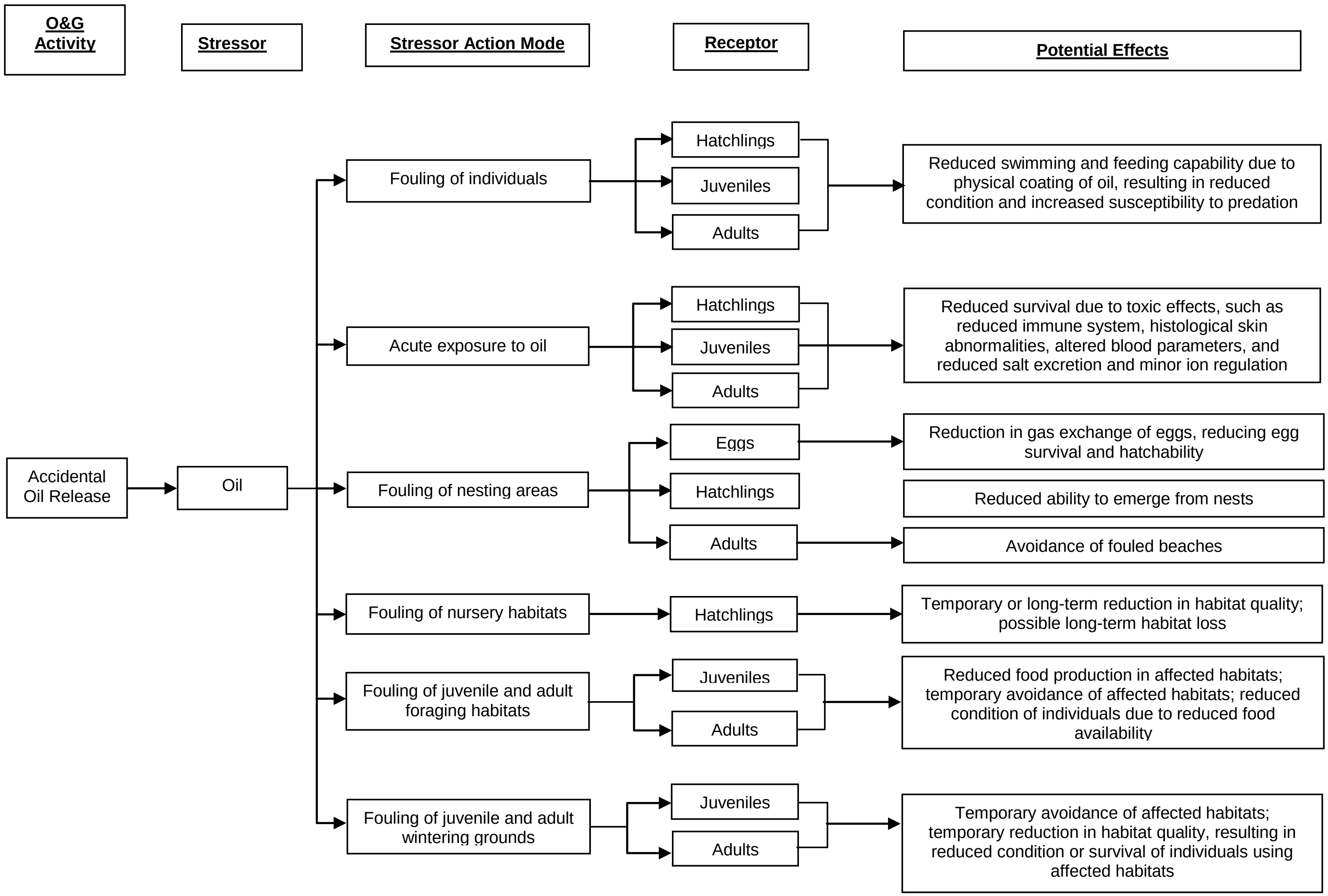

FIGURE 4.4.7-10 Conceptual Model for Potential Effects of Oil Spill on Reptiles in the GOM

Noise. Hearing sensitivity includes the hearing threshold (the minimum sound level that an animal can perceive in the absence of significant background noise) and the hearing bandwidth (the range of frequencies that an animal can hear). There is very little published data on sea turtle hearing sensitivities, but the little available data suggests that sea turtle species exhibit best hearing at low frequencies 200–700 Hz (BOEMRE 2010b), with an upper hearing limit of 1,600 Hz (Dow et al. 2008). Reported hearing thresholds are also of low frequency, estimated to be between 50 and 1,000 Hz (Tech Environmental, Inc. 2006). Threshold detection levels for these species over this frequency range are relatively high (>100 dB referenced to 1 micropascal within 1 meter of the source [dB re 1 µPa-m]) (Tech Environmental, Inc. 2006).

Potential responses to noises generated during normal operations may be expected to be behavioral and may include avoidance of the noise source, disorientation, and disturbance of normal behaviors such as feeding. Evidence suggests that sea turtles may be affected by seismic noises (McCauley et al. 2000; BOEMRE 2010b; NSF and USGS 2010), but it is largely unknown how sea turtles may respond to and be affected by noise generated during structure placement, drilling and production, pipeline trenching, vessel traffic, and explosive structure removal (Geraci and St. Aubin 1987). Because some sea turtles, such as the loggerhead, may be attracted to OCS structures, these may be more susceptible to sounds produced during routine operations.

Noise generated by seismic surveys may affect sea turtles (Figure 4.4.7-6). Seismic surveys generate both high-frequency and low-frequency noise at levels up to 250 dB re 1 µPa-m, with emitted energy levels in the low-frequency range of 10–120 Hz (IACMST 2006). These survey noises are expected to be detected by sea turtles. Table 4.4.7-7 provides a general summary of available information on the effects of exposure to seismic noises (e.g., sonar) on sea turtles. It has been suggested that sound levels above 175 dB re 1 µPa-m induce behavioral reactions in sea turtles. Airguns and pingers typically used in seismic surveys have nominal source outputs ranging from 192 to 265 dB re 1 µPa-m. Therefore, depending on the species of turtle, its age class, and proximity to the acoustic source, there is potential for airgun blasts to affect sea turtle behavior. Currently, the effects of seismic noise on sea turtle physiology are unknown (BOEMRE 2010b; NSF and USGS 2010; Table 4.4.7-7).

Offshore drilling and production structures produce a broad array of sounds at frequencies and levels that may be detected by sea turtles within the area of the installation (Geraci and St. Aubin 1987). These sounds are generally of relatively low frequencies, typically 4.5–30 Hz, and may be generated at sound levels up to 190 dB re 1 µPa-m. Helicopters and service and construction vessels may affect sea turtles due to machinery noise and/or visual disturbances (NRC 1990). The effects of noise generated from construction and operations are illustrated in Figures 4.4.7-7 and 4.4.7-8.

Underwater explosions associated with the explosive removal of offshore facilities may generate noises that disturb sea turtles (Figure 4.4.7-9; MMS 2005d). Underwater explosions associated with the explosive removal of offshore facilities may generate sound levels in excess of 267 dB re 1 µPa-m. Exposure criteria developed by the U.S. Navy (as cited in Frankel and Ellison 2005) to evaluate the potential for impacts of impulsive sounds (i.e., underwater detonations) on marine biota include a sound level of 182 dB re 1 µPa-m. Using this criterion, a

TABLE 4.4.7-7 Summary of Known and Anticipated Effects of Seismic Noise on Sea Turtles in the GOM

Species	Masking	Disturbance	Temporary Hearing Impairment	Injury	Other Physiological Effects	Comments
Green	Unknown	Possible – Short-term	Possible if close to high-energy acoustic source	Unknown	Unknown	Potential for limited adverse effects due to frequency overlap between seismic source and green sea turtle hearing, based on airborne sounds not measured behaviorally (Ridgway et al. 1969; Bartol and Ketten 2006; Dow et al. 2008)
Hawksbill	Unknown	Possible – Short-term	Possible if close to high-energy acoustic source	Unknown	Unknown	No studies available
Kemp's ridley	Unknown	Possible – Short-term	Possible if close to high-energy acoustic source	Unknown	Unknown	Potential for limited adverse effects due to frequency overlap between seismic source and juvenile Kemp's ridley sea turtle hearing (Bartol and Ketten 2006)
Leatherback	Unknown	Possible – Short-term	Possible if close to high-energy acoustic source	Unknown	Unknown	Potential for limited adverse effects due to frequency overlap between seismic source and leatherback vocalizations (Mrosovksy 1972)
Loggerhead	Unknown	Possible – Short-term	Possible if close to high-energy acoustic source	Unknown	Unknown	Potential for limited adverse effects due to frequency of seismic source and a study indicating that loggerheads avoided low-frequency sound (O'Hara and Wilcox 1990)

Source: NSF and USGS 2010.

sea turtle may be affected if exposed to a sound level that exceeds 182 dB re 1 µPa-m. Depending on the size of the charges used in an explosive detonation, the surrounding water depth, and the distance to the nearest sea turtles, individual turtles in the vicinity of the facility undergoing explosive removal may be exposed to sound at or above this level. Based on responses reported for marine mammals, sea turtles exposed to explosive noise may experience temporary hearing loss as well as behavioral changes (NRC 2003c, 2005a). Behavioral responses may include avoidance of the noise source, disorientation, and disturbance of normal behaviors such as resting or feeding. Turtles may also sustain organ or tissue damage when exposed to explosive noise (Klima et al. 1988).

In advance of explosive severance activities, BOEM and NOAA fisheries have implemented protocols to detect the presence of sea turtles within a 1,000-yard radius around decommissioning sites through observer programs operated by vessels, platforms, and helicopters. Since 1987, these observer programs have documented takes of four sea turtles (all loggerheads) in the GOM as a result of explosive severance. Of these four takes, one animal was killed, one stunned, and two injured (MMS 2005d). BOEM continues to require these mitigation measures (see Appendix F of MMS 2005d) and, with compliance, expects these requirements to reduce the potential for negative impacts to sea turtles from explosive removals.

Noise related to exploration, construction vessel passage, and facility removal may be expected to be transient, while noise generated during production may be more long-term. The dominant source of noise from vessels is propeller operation, and the intensity of this noise is largely related to ship size and speed. Vessel noise resulting from O&G activities in the GOM is expected to occur at low levels, generally 150 to 170 dB re 1 µPa-m at frequencies below 1,000 Hz. Vessel noise is transitory and generally does not propagate at great distances from the vessel. Also, available information suggests that sea turtles are not thought to rely on acoustics; the effects to sea turtles from vessel noise are discountable (NMFS 2007).

As few studies on sea turtle hearing sensitivities or noise-induced stress exist, a full understanding of physical and behavioral impacts from sounds generated during exploration, normal operations, and explosive facility removal is not available. Experiments using airguns to try to repel turtles to avoid hopper dredges have been inconclusive (O’Hara and Wilcox 1990; Moein et al. 1995), while sea turtles exposed to an operating seismic source of 166 dB re 1µPa-m were shown to increase their swimming speed in response to the sound (McCauley et al. 2000). In addition, BOEM has implemented mitigation measures for seismic surveys in the GOM requiring ramp-up, protected species observer training, visual monitoring, and reporting for all surveys potentially affecting marine mammals and sea turtles (MMS 2004b). These measures were developed in consultation with NOAA fisheries, and with operator compliance, they are expected to reduce the potential for impacts to sea turtles.

Due to their poor hearing sensitivity, noise impacts related to O&G activities would most likely result in behavioral changes as sea turtles move away from the noise source. These impacts are not expected to result in long-term effects or in population-level impacts. Recovery rates of affected sea turtles are expected to be short-term.

Offshore Structure Placement and Pipeline Trenching. The placement of offshore structures and pipeline trenching may affect hatchling, juvenile, and adult sea turtles in two ways (Figure 4.4.7-7). Individuals coming in contact with construction or trenching equipment may be injured or killed; construction and trenching activities may also temporarily affect habitat use as habitats may experience short-term and long-term changes in abundance and quality.

During placement, pipelines are placed on or in the seafloor to connect offshore platforms with onshore facilities (MMS 2001b). Burial of pipelines using equipment such as jetting sleds physically digs a trench in the bottom sediment and results in a temporary, localized increase in turbidity. This increased turbidity may temporarily affect habitat use by sea turtles, with sea turtles avoiding such areas. Increases in turbidity from trenching at any particular location may be expected to be short-lived, as jet sleds can lay pipe at an average of 1.6 km/day (1 mi/day) (MMS 2001b). While some turtles may alter their use of habitats in the vicinity of a pipeline, affected turtles would likely return to these areas following a return to more normal turbidity levels and experience little adverse affect from any temporary avoidance of the area.

Because hatchlings are not strong swimmers and undergo passive transport by ocean currents, it is unlikely that they would be able to avoid or leave areas where pipeline trenching or structure placement is occurring, and, if present during offshore construction or trenching, they could be injured or killed. In contrast, juvenile and adult sea turtles are active swimmers, and thus may be able to avoid areas where construction or trenching is occurring. Sea turtles have been known to be killed or injured during dredging operations (Dickerson 1990; Dickerson et al. 1992), and thus may also be affected during trenching activities. Juveniles or adults may also be affected if the placement of new structures occurs in foraging or developmental habitats or offshore of nesting beaches (see Section 3.6.4.1 for a discussion of these habitats and areas). Following several years out in open water as growing hatchlings, juvenile sea turtles move into nearshore habitats for further growth and maturation. Adults also utilize nearshore habitats for feeding and may mate in nearshore habitats directly off nesting beaches. In addition, females may become residents in the vicinity of nesting beaches. Offshore construction and trenching may reduce the quality or availability of foraging habitat for juveniles and adults, and may affect adult nesting behavior or access to nest sites. It is assumed that habitats such as seagrass beds and live-bottom areas commonly used by turtles for feeding or resting would be avoided during facility siting and pipeline routing, and that some soft-bottom areas affected by construction or trenching would recover (see Section 4.4.6.2.1).

Based on exploration and development (E&D) scenario estimates (Section 4.4.1.1), up to 2,100 exploration wells and 2,600 production wells may be constructed and up to 12,000 km (7,500 mi) of new pipeline may be installed among the GOM planning areas under the proposed action. At any single location, construction and trenching activities would be of relatively short duration (only until the offshore structure or pipeline is in place). Thus, any impacts incurred from structure placement or trenching would be short-term and localized to the construction area and immediate surroundings and, therefore, would likely affect relatively few juveniles or adults. Because they are passively aggregated by currents, a greater number of hatchlings may be affected if present in a construction or trenching area. However, these effects are not expected to result in population-level impacts.

Removal of Offshore Structures. Sea turtles are known to be attracted to offshore platforms (Lohoefener et al. 1990); therefore, they may be killed or injured during explosive platform removal (Klima et al. 1988; Gitschlag and Herczeg 1994). Even if turtles are not capable of hearing the acoustic properties of an explosion, physiological or behavioral responses (startle) to detonations may still result (MMS 2007c). The effects of blast pressure on sea turtles during explosive platform removal activities are illustrated in Figure 4.4.7-9. Exposure to explosion pressure could result in internal injuries, such as lung hemorrhaging, and individuals may be rendered unconscious by the force of the blasts (Duronslet et al. 1986; Klima et al. 1988). However, evidence of sea turtle mortality or injury from blast pressure is sparse, probably due to the difficulty in observing submerged turtles and because affected turtles may remain submerged rather than float to the surface (NRC 1990). Despite this, the relative importance of oil platform removal to overall sea turtle mortality (from human activities) is considered to be low (NRC 1990; NOAA 2003). Under the proposed action, approximately 150 to 275 existing platforms could be removed from the planning areas using explosives.

Mitigation measures in the form of guidelines for explosive platform removals have been established by BOEM with the cooperation of the National Marine Fisheries Service (NMFS). These guidelines require a mitigation plan that uses qualified observers to monitor the detonation area for protected species prior to and after each detonation. The detection of sea turtles within a predetermined radius from the structure prior to detonation would, without exception, delay structure removal. As long as operators comply with these mitigating measures, it is expected that impacts other than short-term behavioral disturbance would be avoided or greatly reduced, and no population-level effects would occur.

OCS Vessel Traffic. Sea turtles could be disturbed by the presence of OCS project vessels traveling from port locations to the construction area, as well as ships supporting pipeline trenching activities. It is unknown whether or how the presence of passing project vessels might affect nearby sea turtles. Sea turtles exposed to a passing vessel could exhibit short-term cessation of normal behaviors and possibly exhibit behavioral responses such as fleeing (Hazel et al. 2007). Construction vessel traffic would be expected in both offshore and coastal areas, and thus could affect sea turtles in coastal nest staging, foraging, and wintering habitats, as well as in offshore foraging areas and along migration routes. Several studies have reported sea turtles to exhibit strong fidelity to migration corridors, habitat foraging grounds, and nesting areas (e.g., see Morreale et al. 1996; Morreale and Standora 1998; Avens et al. 2003; and Casale et al. 2007). Many important coastal habitats for sea turtles are in areas with high levels of commercial and recreational boat traffic (e.g., see USDOT 2008). In such areas, construction vessel traffic would likely result in only a very small incremental increase in overall vessel traffic in many locations.

Boat collisions are reported to be a major cause of injury and mortality in sea turtles (Lutcavage et al. 1997; TEWG 2007). While juvenile and adult sea turtles may avoid areas with heavy vessel traffic, most species generally exhibit considerable tolerance to ships. Because of their limited swimming abilities, hatchlings would likely not be able to avoid oncoming vessels, and thus may be more susceptible to vessel collisions, especially if aggregated in areas of current convergence or in mats of floating *Sargassum*. To date, there is no direct evidence of OCS vessel collisions with sea turtles (of any life stage) in the GOM from oil and gas activities.

The likelihood of such a collision would vary depending upon species and life stage present, the location of the vessel, its speed, and its visibility. Hatchling turtles, including those aggregated in convergence zones or patches of *Sargassum*, would be difficult to spot from a moving vessel because of their small size and generally cryptic coloration patterns, which blend in with the color and patterns of the *Sargassum*. While adult and juvenile turtles are generally visible at the surface during periods of daylight and clear visibility, they may also be very difficult to spot from a moving vessel when resting below the water surface and during nighttime and periods of inclement weather.

While sea turtles are distributed within nearshore waters and waters of the continental shelf throughout the GOM, they appear to occur in greatest abundance east of Mobile, Alabama, in the Eastern Planning Area (Davis et al. 2000). Only a small portion of the Eastern GOM located greater than 160 km (100 mi) from the Florida coast (Figure 1-2) is being considered for the Program. Service vessels that would go to this area are assumed to originate from bases located in coastal areas adjacent to the Central Planning Area; thus the potential for sea turtle collisions with OCS project boats may be very low for the Eastern Planning Area. In contrast, there may be a greater potential for turtle-vessel collisions in the Western and Central Planning Areas, due to the large number of vessel trips in these areas. Under the proposed action, it is estimated that between 300 and 600 vessel trips would occur per week; most of this activity would occur in the Central and Western Planning Areas.

BOEM has implemented measures for all oil and gas operators in the GOM that require actions to minimize the risk of vessel strikes to protected species, including sea turtles and reporting observations of injured or dead animals (see NTL 2003-G10 [MMS 2003b]). In lieu of a formal observer program, this Notice to Lessees and Operators (NTL) also provides specific guidelines for operators to follow to avoid injury to marine mammals and sea turtles. With compliance, BOEM expects these measures to reduce the potential for negative impacts to sea turtles from vessel collisions.

Construction and Operation of Onshore Infrastructure. Unless existing onshore facilities are available, new platforms and pipelines will require the construction of new onshore infrastructure such as pipeline landfalls. Onshore construction activities along the northern GOM coastline have the potential to disturb nesting adults, hatchlings, and nest sites of all sea turtle species, as well as all life stages and terrestrial habitats of the Alabama red-belly turtle and gopher tortoise.

If present in a construction area, nests containing eggs or emerging hatchlings could be destroyed by site clearing and grading activities. Females ready to nest may avoid disturbed historic nesting beaches or may dig nests in poor quality locations where hatchling success may be greatly reduced. Lighting from construction areas may disorient hatchings emerging from nearby nests, which could increase exposure to predators, cause entanglement in vegetation, or lead hatchlings away from the surf (NRC 1990; Witherington and Martin 1996; Lorne and Salmon 2007). Onshore lighting may also draw hatchlings back out of the surf, as well as disorient adult females seeking to nest on nearby beaches. In addition, terrestrial habitat for the Alabama red-belly turtle and gopher tortoise may be fragmented, degraded, or lost due to the construction and operation of onshore infrastructure.

Although disturbed beaches may undergo restoration activities, such as placement of new sand in disturbed areas, the effectiveness of such actions to restore nesting activity is unknown. Constructed beaches often differ physically from natural beaches and depending on the type of sand used may exhibit sand temperatures quite different from the original pre-disturbed beaches (NMFS and USFWS 2008). Loggerhead nesting activity on restored beaches was found to be reduced the first season following restoration, but much less reduced by the second season, suggesting that nesting activity may return to pre-disturbance levels within a few years (Rumbold et al. 2001). Because nest temperatures affect the sex of hatchlings, restored beach sites with cooler temperatures may skew sex ratios toward males (Milton et al. 1997). Similar impacts could be incurred to the Alabama red-belly turtle, gopher tortoise, and other reptile species that are listed as species of concern by the USFWS (e.g., diamondback terrapin [*Malaclemys terrapin*], gulf salt marsh snake [*Nerodia clarkia*]).

Given the small amount of onshore construction that could occur with a pipeline landfall, it is unlikely that onshore construction would impact more than a few reptile nests, and it is likely that the amount of disturbance to terrestrial habitat for the Alabama red-belly turtle and gopher tortoise would be limited. The implementation of all mitigation measures required by statutes, regulations, and/or lease stipulations that have applied in past lease sales would also greatly limit the potential for impacts to nests and emerging hatchlings. Applicable mitigation measures may include preconstruction surveys for nest sites and delay of construction activities until hatchlings have emerged and moved into open water. In addition, onshore facilities could be located such that known nesting beaches would not be affected by construction and operation of such facilities.

Operational Discharges and Wastes. Normal operations generate a variety of wastes such as produced water, drilling muds and cuttings, sanitary and other waste fluids, and miscellaneous trash and debris. Hatchling, juvenile, and adult sea turtles may be exposed to these wastes by permitted and accidental discharges from onshore and offshore facilities and OCS service and construction vessels. Produced water and drilling muds may contain a variety of constituents, such as trace metals, hydrocarbons, and NORM (Neff 1997), which may be toxic to fish and wildlife, including sea turtles. Exposure to these wastes may occur through direct contact with the wastes in the ocean water and through the ingestion of food contaminated by one or more of the waste constituents. Because produced water and other liquid wastes would be rapidly diluted in the open ocean (i.e., to ambient levels within several thousand meters of the discharge), sea turtles would be expected to experience only very low levels of exposure from the water column. Species such as loggerheads and Kemp’s ridleys that feed at the top of the food chain have been found to have higher tissue levels of bioaccumulative compounds than species feeding at lower trophic levels (Pugh and Becker 2001).

While there is limited information regarding the levels of some contaminants (such as polychlorinated biphenyls [PCBs] and metals) in sea turtle tissues, little is known about what concentrations are within normal ranges of a particular species or what tissue levels may result in acute or chronic effects (Pugh and Becker 2001; NOAA 2003). In loggerhead turtles, chlordane concentrations have been negatively correlated with blood parameters indicative of anemia, and several classes of organic contaminants have been correlated with hepatocellular damage and possible alterations of protein and ion regulation (Keller et al. 2004).

Ingestion of, or entanglement with, discarded solid debris can adversely impact sea turtles. Ingestion of plastic and other nonbiodegradable debris has been reported for almost all sea turtle species and life stages (NOAA 2003). Ingestion of waste debris can result in gut strangulation, reduced nutrient uptake, and increased absorbance of various chemicals in plastics and other debris (NOAA 2003). Sublethal quantities of ingested plastic debris can result in various effects including positive buoyancy, making them more susceptible to collisions with vessels, increasing predation risk, or reducing feeding efficiency (Lutcavage et al. 1997). Some species of adult sea turtles, such as loggerheads, appear to readily ingest appropriately sized plastic debris. In oceanic waters, floating or subsurface translucent plastic material and sheeting may be mistaken for gelatinous prey items such as jellyfish. Entanglement in debris (such as rope and discarded fishing line) can result in reduced mobility, drowning, and constriction of and subsequent damage to limbs (Lutcavage et al. 1997). However, the discharge or disposal of solid debris into offshore waters from OCS structures and vessels is prohibited by BOEM (30 CFR 250.40) and the USCG (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]). Assuming compliance with these regulations and laws and only accidental releases occur, very little exposure of sea turtles to solid debris generated during normal operations is expected.

Produced waters, drilling muds, and drill cuttings are routinely discharged into offshore marine waters and regulated by USEPA NPDES permits and USCG regulations. Compliance with these permits and regulations will greatly limit the exposure of sea turtles to produced water and other wastes generated at offshore facilities and on OCS vessels. Most operational discharges, as regulated, are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API 1989; Kennicut 1995). Any potential for impact on sea turtles from drilling fluids would be indirect, either by impact on prey items or through ingestion via the food chain (API 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate prey species or species lower in the food web. Sea turtles may bioaccumulate chemicals (Sis et al. 1993), which may ultimately reduce fitness characteristics, such as reproductive output.

Impacts of Expected Accidental Events and Spills. The accidental oil spill scenario for the GOM under the proposed action identifies as many as 8 large (≥1,000 bbl) and as many as 470 small (<1,000 bbl) oil spills potentially occurring with development resulting from the lease sales of the proposed action (Table 4.4.2-1). The majority of the expected small accidental spills would be <50 bbl (see Table 4.4.2-1), would quickly dissipate, and would only have the potential to affect a very small amount of reptile habitat and relatively few individuals. Small spills larger than 50 bbl (≤1,000 bbl) would similarly be relatively easy to contain and would only affect small areas of reptile habitat and few individuals. A large spill (≥1,000 bbl), depending on the season and location, could be more difficult to contain and may result in impacts to important habitats (e.g., nesting beaches) and lethal and sublethal effects on a potentially large number of individuals. All sea turtle life stages, as well as nest sites and eggs, may be exposed to accidental oil releases in the GOM planning areas. Although unlikely and not expected to occur under the proposed Program, in extreme catastrophic oil spills, all life stages and habitats of the American crocodile and Alabama red-belly turtle may also be exposed to oil (Table 4.4.7-6). The American crocodile inhabits brackish and freshwater environments and is primarily known to occur in coastal mangrove swamps in southern Florida. The Alabama red-belly turtle is known to occur in coastal brackish environments in Alabama and Mississippi. Depending on location and magnitude, catastrophic oil spills in the GOM have the potential to affect these habitats for the American crocodile and Alabama red-belly turtle.

The effects of accidental oil spills on reptiles are illustrated in Figure 4.4.7-10. Nests may be exposed by oil washing ashore and soaking through overlying soils onto buried eggs, while hatchlings may be exposed as they emerge from nests. Hatchlings, juveniles, and adults may be exposed while swimming through oil on the water surface, through inhalation of petroleum vapors, and through ingestion of contaminated foods and floating tar. Nesting adults (females) may also be exposed while coming ashore on oiled beaches. In addition to direct adverse effects from such exposures, adults and juveniles may also be indirectly affected if an accidental spill reduces the quality or quantity of foraging or nesting habitats. Impacts to nesting habitats could result in population-level effects. Similar impacts could be incurred to more inland reptile species that may occur in brackish environments that are listed as species of concern by the USFWS (e.g., diamondback terrapin [*Malaclemys terrapin*], gulf salt marsh snake [*Nerodia clarkia*]).

Sea turtle behavior may put the turtles at greater risk of oil exposure in the event of an accidental spill. Sea turtles are air breathers and must surface frequently to breathe. Many turtles surface at convergence areas, highly productive areas where ocean currents converge and where spilled oil could be pushed by the ocean currents. These convergence areas also provide food, shelter, and habitat for sea turtles, especially young individuals. Therefore, the accumulation of oil in GOM convergence areas increases the risk of sea turtle exposure to oil (NOAA 2010a).

Sea turtles accidentally exposed to oil or tarballs have been reported to incur a variety of conditions, including inflammatory dermatitis, breathing disturbance, salt gland dysfunction or failure, hematological disturbances, impaired immune responses, and digestive disorders or blockages (Vargo et al. 1986; Lutz and Lutcavage 1989).

Sea turtle nest sites and emerging hatchlings may be exposed to and subsequently affected by oil spills that wash up on nesting beaches and contaminate active nests. Oil may interfere with gas exchange within an oiled nest, may alter hydric conditions of the sand so that it is too wet or too dry for optimal nesting, or may alter nest temperatures by changing the color or thermal conductivity of the overlying sand (NOAA 2003). Adult females may refuse to use oiled beaches (NOAA 2003).

Eggs exposed to freshly oiled sands may incur a significant decrease in hatching success and an increase in developmental abnormalities in hatchlings (Fritts and McGehee 1982). In contrast, eggs exposed to weathered oil did not produce measurable impacts on hatchling survival or development, suggesting that impacts to nest sites would be greatest if the accidental spill occurred during the nesting season. Because most sea turtles nest above the high-tide line and oil washing ashore would be deposited at and just above the high-tide line, oiling of actual nests is unlikely except possibly in the event of exceptionally high tides or storms.

Hatchlings may become oiled while traveling from the nest to water, and a heavy oil layer or tar deposits on the beach may prevent the hatchlings from reaching water. Oiled hatchlings may have difficulty crawling and swimming, increasing the potential for predation. Open-water convergence zones where hatchlings may aggregate are also areas where oil slicks may aggregate. For example, the Sargasso Sea has been estimated to annually entrap 70,000 metric tons of tar (NOAA 2003). Because hatchlings spend more time at the sea surface, they will be more likely to be exposed to surface oil slicks than adults or juveniles. Post-hatchling sea turtles have been collected from convergence zones off Florida with tar in their mouths, esophagi, and stomachs, and tar caking their jaws (Loehefener et al. 1989; Witherington 1994). Ingested tar may result in starvation from gut blockage and decreased food adsorption efficiency, absorption of toxins, local necrosis or ulceration associated with gut blockage, interference with fat metabolism, and buoyancy problems (NOAA 2003).

Sea turtles surfacing and diving in an oil spill may inhale petroleum vapors and aspirate small quantities of oil. While no information is available about the effects of petroleum vapors or aspirated oil on sea turtles, inhalations by mammals of small amounts of oil or petroleum vapors have been shown to result in acute fatal pneumonia, absorption of hydrocarbons in organs and other tissues, and damage to the brain and central nervous system.

Ingested oil, particularly the lighter fractions, could be toxic to sea turtles. Ingested oil may remain within the gastrointestinal tract, irritate and/or destroy epithelial cells in the stomach and intestine, and subsequently be absorbed into the bloodstream (NOAA 2003). Certain constituents of oil, such as aromatic hydrocarbons and PAHs, include some well-known carcinogens. These substances, however, do not show significant biomagnification in food chains and are readily metabolized by many organisms. Hatchling and juvenile turtles feed opportunistically at or near the surface in oceanic waters and may be especially vulnerable and sensitive to spilled oil and oil residues such as floating tar (Lutz and Lutcavage 1989; Lutcavage et al. 1995). Tar found in the mouths of turtles may have been selectively eaten or ingested accidentally while feeding on organisms or vegetation bound by tar (Geraci and St. Aubin 1987; Geraci 1990).

Certain species of sea turtles may be at greater risk of exposure to spilled oil based on their distributions and habitat preferences and also on the timing of a spill. For example, loggerhead and Kemp's ridley sea turtles frequent current-restricted areas such as bays and estuaries. Because oil entering these areas may remain for longer periods of time due to reduced weathering rates and natural dispersion, sea turtles using habitats in these areas may incur longer exposure periods. Spills occurring in coastal waters of the Western Planning Area may affect greater numbers of green, hawksbill, loggerhead, and leatherback sea turtles during summer months when nearshore densities are greater than offshore densities.

Oil spill response activities that may adversely affect sea turtles include artificial lighting at night, machine and human activity and related noise, sand removal and cleaning, and the use of dispersant or coagulant chemicals. Lights used to support nighttime cleanup activities may attract sea turtles to the spill location or disorient hatchlings emerging from nearby nests. Machine and human activity may cause a temporary avoidance of nearby habitats (including nest sites) by sea turtles, produce noise that may disturb sea turtles, and also increase the potential for sea turtle collisions with vessels and onshore vehicles. Onshore activities may also crush existing nests and result in beach compaction, reducing the suitability of existing nest sites for future use. Sand removal may also directly impact nest site habitat quality. While oil dispersants or coagulants contain constituents that are considered to be low in toxicity when compared to many of the constituents of spilled oil (Wells 1989), there are little available data regarding the effects of these chemicals on sea turtles (Tucker & Associates, Inc. 1990).

The magnitude and severity of impacts that could result from accidental spills would depend on the location of the spill, spill size, type of product spilled, weather conditions, the water quality and environmental conditions at the time of the spill, and the species and life stage of the individual exposed to the spill. The magnitude and extent of any adverse effects would also depend on how quickly a spill is contained and how quickly and effectively cleanup is accomplished.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE in the GOM planning areas with a volume of 0.9-7.2 million bbl and a duration of 30–90 days (Table 4.4.2-2). It is important to note that a CDE is unlikely to occur as part of the proposed action. However, should a CDE occur, the impacts discussed below would be reasonably foreseeable. The recent oil spill associated with the DWH event, which occurred in April 2010 approximately 66 km (41 mi) off the Louisiana coast, may have had detrimental consequences to sea turtles that had direct contact with spilled oil. A total of 1,146 sea turtles were recovered from the GOM that had come in contact with or were in the vicinity of spilled oil. The recovered turtles included adults or free-swimming juveniles of four species: green, hawksbill, Kemp's ridley, and loggerhead. However, some recovered sea turtle species could not be identified (Table 3.8.3-3). Of the total number of turtles recovered, approximately 53% were found dead and 47% were found alive. Most of the recovered sea turtles (dead or alive) were Kemp's ridley sea turtles (Table 3.8.3-3). Approximately 85% of the live turtles recovered were visibly oiled; approximately 3% of the dead turtles recovered were visibly oiled (NOAA 2012a). While in the case of the DWH event, the cause of death of the deceased turtles remains unclear, it is possible for turtles to ingest or inhale oil during a CDE that could be potentially fatal without any noticeable external indications.

A CDE also has the potential to affect sea turtle populations by fouling habitats such as seagrass beds and nesting beaches. As discussed in Section 4.4.6.3.1, a CDE could affect a large portion of the pelagic *Sargassum* habitat that supports developing sea turtles, depending on the timing (season), location, and scale (magnitude) of the spill. However, *Sargassum* reproduces every year, so it is expected that the *Sargassum* population will recover if affected by an oil spill.

Oil released from a CDE may also enter coastal and brackish habitats for the American crocodile and Alabama red-belly turtle, where individuals may come in contact with oil. In the case of the DWH event, preliminary reports from the NOAA Natural Resource Damage Assessment Team have indicated that about 1,600 km (1,000 mi) of shoreline along the GOM has tested positive for oil, including salt marshes, beaches, mudflats, and mangroves (NOAA 2010b). The presence of oil in these areas likely affected foraging and nesting habitats for sea turtles, and perhaps the Alabama red-belly turtle, although the true ecological consequences of these effects are not known.

Impact Conclusions.

***Routine Operations*.** Under the proposed action, some routine operations could affect individual reptiles, but population-level impacts are not expected. Noise generated during exploration and production activities and platform removal may result in the temporary disturbance of some sea turtles, while some turtles may be injured or killed during the use of underwater explosives for platform removal. The overall impact of noise related Program activities on reptiles would be minor. Reptiles could also be directly affected by construction of offshore and onshore facilities and pipeline trenching, and also indirectly by short-term and long-term impacts to habitats. The construction and operation of new onshore facilities may impact nest sites, possibly result in eggs being crushed, and disturb hatchling movement from the nest sites to the water. The overall impact of offshore and onshore construction and removal activities on reptiles is expected to be moderate. Sea turtles may also be injured or killed by collisions with OCS vessels. The overall impact of vessel traffic related to Program activities on reptiles is expected to be moderate. Sea turtles may also be exposed to a variety of waste materials which have the potential to cause a variety of lethal and sublethal effects**.** The overall impact of operational discharges and wastes on reptiles is expected to be moderate.

Many of these impacts would be of relatively short duration and localized and would likely affect relatively few individuals in the immediate project area. Existing permit requirements, regulatory stipulations, and BOEM guidelines and mitigation measures, if applied, target many of the routine operations and could limit the potential effects. Overall, impacts to reptiles from routine operations associated with the Program are expected to range from minor to moderate.

***Expected Accidental Events and Spills*.** The majority of the expected small accidental spills would be <50 bbl (see Table 4.4.2-1), would quickly dissipate, and would only have the potential to affect a very small amount of habitat and relatively few individuals. Small spills ≥50 bbl but <1,000 bbl would similarly be relatively easy to contain and would only affect small areas of habitat and few individuals. A large spill (≥1,000 bbl), depending on the season and location, would be more difficult to contain and may result in impacts to important habitats (e.g., nesting beaches) and lethal and sublethal effects on a potentially large number of individuals. Accidental spills have the potential to foul habitats and injure or kill exposed reptiles. An oil spill may result in the exposure of one or more life stages of reptiles to oil or its weathered products. Oil may reduce egg hatching and hatchling survival and may inhibit hatchling access to water. Hatchlings, juveniles, and adults may inhale or ingest oil and oil vapors and may incur any of a variety of physiological impacts. The presence of oil slicks or oiled beaches may alter habitat use and affect nest site access and use. Small spills that may occur under the proposed action are unlikely to affect a large number of reptiles or their habitats and are not expected to have long-term effects on reptile populations in the GOM. The overall impact of small spills (<1,000 bbl) on reptiles is expected to range from negligible to minor. The overall impact of large spills (≥1,000 bbl) on reptiles is expected to range from minor to moderate.

***An Unexpected Catastrophic Discharge Event*.** A CDE is unlikely to occur under the proposed Program. A CDE could affect many individuals and habitats, including nesting beaches, and potentially may incur population-level effects. The magnitude of effects from a CDE would depend on the location, timing, and volume of the spills; the environmental settings of the spills; and the species and life stages of reptiles exposed to the spills. Because 93% of the new oil production that is expected to occur during the Program is assumed to occur far from the coast in deep water (>200 m [656 ft] deep), the likelihood of a large spill occurring close enough to the coastline to affect turtle nesting beaches is expected to be small. However, a CDE occurring in deep water has a greater likelihood of reaching coastal areas, although this will depend on the specific location of the spill and the prevailing currents in that area. The rapid deployment of spill-response teams and implementation of cleanup activities could limit the magnitude of impacts incurred by sea turtles in the event of an accidental spill; however, cleanup operations themselves could also impact sea turtle habitats. In the unlikely event of a CDE, impacts to reptiles would be expected to be major and long-term if multiple individuals and their habitat (especially nesting habitat) are exposed to oil.

4.4.7.5 Invertebrates and Lower Trophic Levels

4.4.7.5.1 Gulf of Mexico.

Impacts of Routine Operations.

Impacting factors common to all phases include vessel discharges (bilge and ballast water), miscellaneous discharges (deck washing, sanitary waste), and offshore lighting. Many of these waste streams are disposed of on land, and all vessel and platform waste streams must meet USEPA and/or USCG regulatory requirements before discharge into surface waters. Impacts on invertebrate populations from waste discharges would be localized and temporary. Studies conducted in the northern GOM suggest that platform lighting could alter predator-prey dynamics by enhancing phytoplankton productivity around the platform, attracting phototaxic pelagic invertebrates, and potentially improving the visual foraging environment for fishes (Keenan et al. 2007). Consequently, increased predation of invertebrates may occur in the vicinity of the platform. Potential impacts from platform lighting would be localized but long-term and are expected to have minimal impacts on invertebrate populations.

Exploration and Site Development. During the OCS oil and gas exploration and development phase, invertebrates could be affected by noise from seismic surveys and noise and bottom disturbance from drilling, platform placement, and pipeline trenching and placement activities. Releases of drilling muds and cuttings could also affect invertebrates by contaminating sediments and surrounding surface waters (Table 4.4.7-8).

Noise from vessel traffic, construction, seismic surveys, and drilling could kill or injure invertebrates close enough to the noise source, as well as reducing habitat suitability, as some species would avoid the area. For example, decapods and cephalopods, two numerically abundant and commercially important groups of invertebrates, are known to detect vibrations from underwater noise and may be sensitive to noise from vessel traffic, seismic surveys, and

TABLE 4.4.7-8 Impacting Factors Potentially Affecting Invertebrates and Their Habitat in the GOM Planning Areas

	Life Stage Affected[a]		
Development Phase and Impacting Factor	Eggs	Larvae	Adults
Impacting Factors Common to All Phases			
Vessel noise	X	X	X
Vessel traffic	X	X	X
Hazardous materials	X	X	X
Solid wastes	X	X	X
Offshore lighting	X	X	X
Aircraft noise			
Offshore air emissions			
Onshore air emissions			
Aircraft traffic			
Miscellaneous platform discharges	X	X	X
Vessel discharges	X	X	X
Bottom disturbance from vessel anchors	X	X	X
Exploration and Development			
Seismic noise	X	X	X
Noise from drilling and construction	X	X	X
Bottom disturbance from platform placement, drilling, and pipeline placement and trenching	X	X	X
Discharge of drilling muds and cuttings	X	X	X
Production			
Production noise	X	X	X
Produced water discharge	X	X	X
Artificial reef	X	X	X
Decommissioning			
Platform removal (non-explosive)	X	X	X
Platform removal (explosive)	X	X	X

[a] colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

drilling (DFO 2004; NSF and USGS 2010). Recent reviews of the impacts of anthropogenic noise on invertebrates indicates that invertebrates exposed to noise could exhibit pathological effects (i.e., injury and mortality), physiological changes (i.e., changes in hormone, protein, and enzyme levels), and/or behavioral changes (such as a startle response) and change swimming and movement patterns (DFO 2004; NSF and USGS 2010). Although data is limited, zooplankton and larvae stages may be injured because of their small size and relative lack of mobility, while noise is often found to have minimal effects on adult invertebrates (reviewed in DFO 2004 and NSF and USGS 2010). The studies typically suggested that injury was limited to within 10 m (33 ft) of the noise source. The numbers of invertebrates that could be affected by noise during the exploration and site development phase make it unlikely that noise impacts would have appreciable effects on invertebrate populations in the Western and Central Planning Areas. A recent review of the effects of seismic survey activities on marine invertebrates concluded that although data were limited, mortality and injury of invertebrates would be limited to organisms located within a few meters of the airgun, and that there would be no significant impacts on marine invertebrate populations from airgun and sonar sounds (NSF and USGS 2010). The severity and duration of noise impacts would vary with site and development scenario, but impacts are expected to be temporary and localized.

Bottom-disturbing activities such as coring and drilling, platform placement and mooring, and pipeline trenching and placement would displace, injure, or kill invertebrates in the vicinity of the activities. The estimated bottom habitat that may be directly disturbed by new pipeline and platform installation ranges from 2,150 to 14,000 ha (5,313 to 34,594 ac) over the entire GOM. In the initial drilling phase before a riser is installed, drilling muds would accumulate around the well and bury benthic invertebrates as well as create a turbidity plume that could impact pelagic invertebrates located near the bottom. Drilling is also expected to increase the amount of sand in sediments surrounding the well for at least 300 m (984 ft) (Continental Shelf Associates, Inc. 2006). This change in grain size could alter community composition and prevent the settlement of some species. In addition, bottom disturbance during platform and pipeline placement would result in sedimentation and turbidity, which could bury benthic infauna and damage the gills of water-column and benthic invertebrates present within some distance of the disturbance. These disturbances would be localized and temporary. Species most likely to be affected are sessile benthic organisms and small zooplankton, which lack the mobility to avoid the direct disturbance and the associated turbidity plumes. An FPSO system may be employed for deepwater wells. Under the FPSO system, oil would be transported from the well to a surface vessel and ultimately to shore. By eliminating the need for pipelines, an FPSO system would greatly reduce bottom disturbance and the chance for disturbing benthic and near-bottom invertebrates and their habitat. Most disturbed areas would be recolonized quickly, but, if grain size is significantly altered, the benthic community may take several years to return to its pre-disturbance composition (Bolam and Rees 2003 and references therein).

The effects of drilling muds and cuttings (including drilling fluids adhering to the cuttings) on invertebrates can be chemical such as toxicity or physical such as gill abrasion, burial, or displacement from turbidity and sedimentation. Impacts from turbidity and sedimentation would be similar to those described above and could damage respiratory structures and disrupt food acquisition at all trophic levels. Drilling wastes released near the sediment surface or in shallow water would bury benthic organisms in the release area. Muds released in deeper water or near the water's surface would be spread over a greater area in a thinner layer and may not result in high mortality, although impacts to water-column invertebrates may be greater under this scenario. The disturbance would be short in duration, with repopulation of the affected area occurring by larval recruitment. In addition, drilling discharges must comply with NPDES permit requirements regarding the discharge amount, rate, and toxicity, which would greatly reduce the impact to invertebrate communities.

The USEPA and BOEM have sponsored research on the biological effects of drilling fluids on benthic invertebrates. In studies conducted on the GOM continental shelf and slope, synthetic drilling fluids in sediments were elevated within 500 m (1,640 ft) of the well (Continental Shelf Associates, Inc. 2004a, 2006). Meiofaunal and macroinvertebrate abundance were typically highest near the well, and were often found to increase with the concentration of drilling fluids in the sediment (Continental Shelf Associates, Inc. 2006). However, the effects of drilling muds appears to be species-dependent. Amphipod, ophiuroid, and ostrocod densities were depressed within 300 m (984 ft) of the well compared to control areas, while copepods, nematodes, and several classes of dominant infauna including worms, clams, and snails were more abundant within 300 m (984 ft) of the well (Continental Shelf Associates, Inc. 2006). Sediments collected near the well were found to be toxic to amphipods, which explains their depressed abundance (Continental Shelf Associates, Inc. 2004a, 2006). The elevated abundance of most infauna may have been due to the high organic matter content of the drilling fluids adhering to the muds and cuttings. Some sites showed particularly high abundance of species tolerant of organic enrichment (Continental Shelf Associates, Inc. 2006). However, the high organic matter content also created anoxic patches along the seafloor that contained very few infauna. The recovery time for benthic communities will depend on impact magnitude and species present, and existing data suggest recovery will begin rapidly but may take years for recovery to pre-disturbance communities (Continental Shelf Associates, Inc. 2004a, 2006).

Production. Production activities that could affect soft sediment habitat include operational noise, bottom disturbance from the movement of mooring anchors, chains, and cables, and the release of process water. In addition, the platform would replace existing featureless soft sediments and potentially serve as an artificial reef (Table 4.4.7-8).

Chronic bottom disturbance would result from the movement of anchors and chains associated with support vessels and floating platform moorings. Bottom disturbance would impact invertebrates in a manner similar that described above for the exploration and site development phase. The disturbance would be episodic and temporary, but would last for the lifetime of the platform.

Sessile epifaunal invertebrates requiring hard substrate (i.e., barnacles and corals) as well as small motile invertebrates (amphipods and worms) would be able to colonize the structure of the platform, resulting in an artificial reef. Unburied pipelines would also provide hard substrate for sessile and structure-oriented invertebrates. Although densities of some zooplankton species were elevated near the platforms in the northern GOM, the effect was not consistent (Keenan and Benfield 2003). The platform would likely increase shell material and organic matter in the surrounding sediments, potentially resulting in a shift in benthic invertebrate community composition. The replacement of soft sediment with artificial reef would only exist during the production phase, unless the platform was permitted to remain in place after decommissioning. Because platforms are spread across a large area of the GOM, they could provide habitat for non-native invertebrate species that prefer hard substrate. Such species could be introduced by a number of mechanisms both natural and anthropogenic (commercial shipping and human introduction). In the deep sea, floating production platforms are used that could create a floating reef habitat at the surface. In deep sea soft sediment, communities may form on mooring structures, but colonization would likely be slow and mooring structures would be completely removed during decommissioning, so impacts, if any, would be temporary.

Produced water contains metals, hydrocarbons, salts, and radionuclides, and its discharge could contaminate habitat resulting in lethal and sublethal effects on invertebrates. Organisms attached to oil platforms have not been found to accumulate metals, although they have been found to bioaccumulate organic contaminants (Neff 2005; Trefry et al. 1995). Produced water from deepwater wells is expected to contain more chemical contaminants to maintain adequate flow. Contaminants from produced water discharges are not expected to reach toxic levels in the sediment and water column due to dilution and NPDES permitting requirements regarding discharge rate, contaminant concentration, and toxicity. Invertebrates collected in sediments near platforms in the GOM do not appear to bioaccumulate the common contaminants in produced water, such as radionuclides, metals, and hydrocarbons, and in most cases, the concentration of these contaminants in their tissues did not exceed USEPA-specified concentrations considered harmful (Continental Shelf Associates, Inc. 1997). Produced water is also not expected to contribute significantly to the creation of hypoxic bottom water conditions (Rabalais 2005; Bierman et al. 2007).

The results of the GOM Offshore Monitoring Experiment, funded by BOEM, provide a good summary of the long-term sublethal impacts of oil and gas development on invertebrates at the individual, population, and community level (Kennicutt et al. 1995). Stations surrounding petroleum wells were sampled in a radial pattern with stations at 30–50, 100, 200, 500, and 3,000 m distances (98–164, 328, 656, 1,640, and 9,842 ft). Elevated sediment concentrations of sand, organic matter, hydrocarbons, and metals were generally restricted to sediments within 200 m (656 ft) of the platforms. Overall, there was no evidence of sublethal physiological stress or change in distribution of epifaunal invertebrates attributable to the presence of the platform. Oil and gas development activities resulted in altered infaunal communities within 100 m (328 ft) of the platform, with reduced density and diversity of crustaceans (primarily amphipods and copepods) near the platform and enhanced density of polychaetes and deposit-feeding nematodes. The patterns in invertebrate density were often attributable to changes in a few species. Differences in abundance between near- and far-field stations were the product of toxic response of sensitive crustacean species and sediment organic enrichment, which increased the density of worms (Kennicutt et al. 1995). Toxicity tests indicated copepod survival, reproduction, and genetic diversity were lower near the platforms due to metal concentrations (Montagna and Harper 1996) or the reef effect of the platform (Montagna et al. 2002).

Decommissioning. Platform removal (potentially using explosives) would temporarily affect benthic and pelagic invertebrates, as described above, by disturbing sediments and increasing noise and turbidity for some length of the water column. Deposition of suspended sediments could bury, smother, or kill some benthic organisms in the vicinity of work sites. Reviews of the effects of underwater blasts on invertebrates suggest they are relatively insensitive to the effects of the pressure wave associated with the blast (Keeving and Hempen 1997). Any mortality should be limited to epifauna within a few meters of the blast (Keevin and Hempen 1997). In addition, the explosive charges typically would be set at 5 m (16 ft) below the seafloor surface, which would significantly attenuate the shock wave as it moved through the seabed. Displaced invertebrate communities would repopulate the area over a short period of time, although a return to the pre-disturbance community may take longer. However, if fixed platforms are toppled and left in place, the changes to invertebrate communities resulting from the initial platform installation would be long-term. Pipelines installed and anchored on the seafloor would be capped and left in place, although there is the potential for chronic sediment disturbance from pipeline movement. Pipelines not buried would also continue to serve as hard substrate for sessile invertebrates and structure oriented invertebrates.

Impacts of Expected Accidental Events and Spills. Accidental hydrocarbon spills can occur at the surface or at the seafloor, potentially affecting pelagic and benthic invertebrates. It is assumed that up to 8 large spills (≥1,000 bbl), up to 70 spills between 50 and 999 bbl, and up to 400 smaller spills between 1 and 50 bbl could occur during the lease period under the proposed action (Table 4.4.2-1). Most oil and gas spills would be small and are expected to primarily affect invertebrates in the water column, as most hydrocarbons would float above the sediment surface. However, even a small spill (<999 bbl) could affect intertidal and subtidal invertebrates if oil were to contact the shoreline. After the spill of 600 bbl of crude oil in Barataria Bay, Louisiana, Roth and Baltz (2009) found a reduction in total number of decapod crustaceans as well as reduction in grass shrimp (*Palaeomonetes pugio*) 3 weeks after the spill occurred. The impact magnitude of these small oil spills on invertebrates is primarily a function of the invertebrate species and habitat affected. It is anticipated that only a small amount of the water column and shoreline would be affected by these smaller oil spills and would not, therefore, present a substantial risk to invertebrate populations. Consequently, the effects of small spills on invertebrates and their habitat are expected to be short-term and affect relatively few individuals.

Larger areas and numbers of individuals may be affected by large spills (>1,000 bbl). Exposure to hydrocarbons can result in lethal or sublethal (reproduction, recruitment, physiology, growth, development, and behavior) impacts at the level of the individual. The invertebrates most likely to be affected are sessile benthic organisms and small zooplankton, which lack the mobility to avoid the oil. Invertebrates differ in their sensitivity to hydrocarbon pollution both by organism class and life stage (Laws 1993). For example, crustaceans appear to be among the taxa most sensitive to oil pollution, while certain species of worms, such as Capitellid polychates, appear to be tolerant of oil pollution (Laws 1993; NRC 2003b). Among meiofauna, nematodes may be less sensitive to oil than copepods. Oil exposure can reduce the abundance of zooplankton in the oiled area, induce narcosis, and bind to feeding appendages (Teal and Howarth 1984). Zooplankton are known to ingest oil, some of which is retained in the gut and some of which is exported to the seafloor in fecal pellets (Teal and Howarth 1984). Impacts from large spills would be greatest if the spill occurred during a reproductive period or contacted a location important for spawning or growth such as intertidal and nearshore subtidal habitats. However, impacts from large spills are expected to be temporary as oil is diluted and broken down by natural chemical and microbial processes.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE in the GOM planning areas with a volume of 0.9-7.2 million bbl and a duration of 30–90 days (Table 4.4.2-2). Spilled oil has been found to affect pelagic and sediment-dwelling invertebrates, as well as dramatically increase the relative abundance of hydrocarbon-consuming bacteria in the sediment and water column (Laws 1993; reviewed in NRC 2003b; Kostka et al. 2011). Hydrocarbon releases at the seafloor would typically rise in the water column, which would limit direct contact with benthic invertebrates but increase the exposure of small zooplankton, which lack the mobility to avoid the oil. Benthic invertebrates could be affected directly by oil reaching intertidal or shallow subtidal habitats or natural deposition of oil-contaminated pelagic organic matter and biota. Benthic and pelagic invertebrates are important trophic links connecting primary producers to higher-trophic-level organisms. Consequently, oil spill contamination on a large scale could result in significant contaminant transfer to higher trophic levels and/or reduce food availability to higher trophic levels if invertebrate populations were severely depressed.

The location of the CDE and the season in which the CDE occurred would be important determinants of the impact magnitude of the spill. For example, catastrophic spills occurring during recruitment periods or spills that affect areas with high larval invertebrate concentrations (i.e., estuaries) would have the greatest impact. In addition, the magnitude of a spill's impacts on invertebrates and their habitat would likely increase with the degree of shoreline oiling, as estuaries have high biological productivity and serve as critical habitat for invertebrates. Oil would persist longer in the environment than gas and oil could be transported to the shoreline where it could reduce local populations of shallow subtidal and intertidal coastal habitat for an extended period of time. However, a spill of this kind is unlikely to occur, and invertebrates typically have short generation times and should recover from even a catastrophic spill.

Some oil spill response activities could adversely affect lower-trophic-level organisms. For example, dispersants could increase oil toxicity, and cleanup techniques, the presence of large numbers of people, or the use of heavy equipment on shorelines could kill some coastal organisms during cleanup responses. Dispersant toxicity varies by species and dispersant used. Newer dispersant formulations, such as COREXIT® 2500, do not appear to be more toxic to invertebrates than oil alone (Hemmer et al. 2011). However, few species and life stages have been tested; additive toxicity from oil dispersant mixtures may be significant for some species (Hemmer et al. 2011). Studies of microbial communities on oiled beaches in Louisiana indicated that the dispersant COREXIT altered microbial communities by reducing the abundance of *Marinobacter* spp. and *Acinetobacter* spp., both hydrocarbon-degrading bacteria, and increasing the relative abundance of *Vibro* spp., a nonhydrocarbon-degrading bacteria (Hamdan and Fulmer 2011). These results indicate that dispersants may inhibit the biodegradation of oil.

Prior studies provide insight into the potential long-term effects of an oil spill on invertebrate populations in the GOM. A large oil spill in Panama affected intertidal and subtidal infauna and epifauna, with the impact magnitude and recovery time varying with the habitat, organism, and degree of oiling (Jackson et al. 1989; Keller and Jackson 1993). Oysters and mussels within mangroves, as well as amphipods, tanaids, and ophiurods in seagrass habitats, displayed long-term (>9 months) reduction in abundance compared to unoiled areas. Corals and associated biota were also affected by the spill, especially at the reef edge that received the heaviest oiling. Although many species recovered within a few months to 2 years, certain crustaceans and oysters had not recovered within 5 years (Keller and Jackson 1993). Guzman et al. (1991) estimated a total recovery time of 10 to 20 years for the same spill. Similarly, surveys of deepwater coral sites following the DWH event revealed that corals and brittle stars showed signs of stress such as mucus secretion, bleaching, abnormal color, and/or attachment posture (White et al. 2012). The 1979 Ixtoc I spill in the Bay of Campeche was not well studied; therefore it is difficult to assess the extent of impacts on invertebrates (ERCO 1982). Most studies of the Ixtoc spill occurred in south Texas far from the spill site. In these studies, sediment contamination was not detected and no strong links between Ixtoc oil and changes in invertebrate communities could be found (ERCO 1982; Laws 1993). In a study of upper Galveston Bay, a site of heavy oil and gas activity with a history of spills, Rozas et al. (2000) found no consistent significant relationships between sediment oil concentration and invertebrate densities, despite testing multiple species. Although sediment contamination did not appear to affect habitat use, sublethal exposure impacts could have been possible.

Species Protected under the Endangered Species Act.

***Elkhorn Coral*.**

Impacts of Routine Operations. The only colonies of elkhorn coral known to exist in the Western and Central Planning Areas are the two colonies in the FGBNMS. As described in Section 4.4.6.2, the Flower Gardens are part of a national sanctuary; no oil and gas exploration or site development will be permitted within the sanctuary. In addition, BOEM instituted a Topographic Features Stipulation establishing No Activity Zones that prohibit structures, drilling rigs, pipelines, and anchoring around the Flower Gardens. Drilling muds can reduce the growth of elkhorn coral (Kendall et al. 1984); however, the Topographic Features Stipulation requires that any discharged drilling muds and cuttings within 4 mi (6.4 km) of the Flower Gardens be shunted to within 10 m (33 ft) of the seafloor (http://www.gomr.mms.gov/homepg/lsesale/topo_features_package.pdf). These protections will limit direct impacts to the elkhorn coral patches from exploration and site development activities.

Impacts on elkhorn coral during the production phase could result from miscellaneous discharges, the movement of vessel anchors and mooring structures, and produced water discharge. However, as described in Section 4.4.6.2, impacts to elkhorn coral would be minimized by an existing stipulation that prohibits exploration and development activities in the vicinity of the FGBNMS. During the production phase, produced water discharges are not likely to impact the FGBNMS because of the Topographic Features Stipulation requiring large buffers between the FGBNMS and oil and gas development activities (Section 4.4.6.2.1).

Impacts of Expected Accidental Events and Spills. Spills at the seafloor would rise in the water column but are not likely to contact the FGBNMS at concentrations toxic to marine life (see Section 4.4.6.2.1). Platform spills and tanker spills at the ocean surface could penetrate the water column to documented depths of 20 m (66 ft) or more, which is within the depth range at which the elkhorn colonies are found in the FGBNMS. However, at these depths, the contaminant concentrations are typically several orders of magnitude lower than those demonstrated to have an effect on marine organisms (MMS 2008a). In addition, no oil and gas infrastructure would be permitted in the vicinity of the FGBNMS, which would allow more time for dilution of the oil before reaching the banks. Therefore, it is likely that only small concentrations of oil from surface spills would reach the FGBNMS (MMS 2008a).

Impacts of an Unexpected Catastrophic Discharge Event. It is possible that a CDE originating from outside the No Activity Zones established by the Topographic Features Stipulation could reach the vicinity of the FGBNMS and potentially affect the two elkhorn coral colonies located therein. The concentration of oil reaching the colonies would depend on the location and characteristics of the CDE. Hydrocarbons have been shown to have lethal and sublethal (reproduction, larval settlement, photosynthesis, and feeding) effects on corals, and as a highly branching species, elkhorn coral may be particularly vulnerable to oil exposure (Guzman et al. 1991). Any impacts associated with a large or catastrophic spill reaching sensitive corals would most likely be sublethal, because of the dilution that would occur as the oil dispersed from the spill site to the Flower Gardens Banks. Corals have the capacity to recover quickly from hydrocarbon exposure (Knap et al. 1985), but larval stages of coral are far more sensitive than adults. Therefore, the impact magnitude of a CDE is partly dependent on whether the spill occurs during a period of coral spawning. For lethal exposures that eliminate the elkhorn colony, recolonization could occur, although recovery may be slow because recruits would have to come from elkhorn coral populations located farther south. Consequently, it is anticipated that the impacts of lethal concentrations of oil reaching coral reef or hard-bottom habitat from a CDE would be long-term. However, impacts to or extirpation of the elkhorn corals in the FGBNMS would not result in overall species-level impacts because this species is primarily located in the southern GOM, Caribbean, and south Florida.

Impact Conclusions.

Routine Operations. The primary impacts of oil and gas activities on invertebrates in the GOM planning areas would be from drilling waste discharges and from bottom-disturbing activities during the exploration and site development phase, which could displace, bury, injure, or kill invertebrates in the vicinity of the activities. Displaced invertebrate communities would generally repopulate the area over a short period of time, although a return to the pre-disturbance community may take longer. Where floating platforms are used, scour from the movement of mooring structures represents a chronic disturbance to benthic invertebrates lasting the life of the production phase. If discharged into open water, the effects of drilling wastes and produced water on invertebrates community structure and function should be restricted to the vicinity of the platform. Impacts to elkhorn coral are expected to be negligible because routine operations are not permitted near the Flower Gardens Banks. Overall impacts to benthic and pelagic invertebrates from routine program activities (exploration and site development, production, and decommissioning phases) would range from negligible to moderate and would primarily affect benthic invertebrates, with the severity of the impacts generally decreasing dramatically with distance from the disturbance. Impacts to Elkhorn coral would be negligible.

Expected Accidental Events and Spills. Small surface or subsurface hydrocarbon spills would be rapidly diluted and would likely result in only small localized, sublethal impacts to invertebrates. Large spills could affect a large number of benthic and pelagic invertebrates and their habitats. The location of the spill and the season in which the spill occurred would be important determinants of the impact magnitude. A large spill could contact shoreline areas, and benthic invertebrates in sensitive intertidal and shallow subtidal habitats could experience large-scale lethal and long-term sublethal effects. Impacts to elkhorn coral are expected to be negligible because of restrictions on oil and gas activities near the Flower Gardens Banks.

Overall, impacts from small spills would range from negligible for spill less than 50 bbl, minor for spills up to 1,000 bbl, and from minor to moderate for large spills (≥1,000 bbl). Impacts to elkhorn coral are expected to be negligible.

An Unexpected Catastrophic Discharge Event. A CDE could affect a wide area, with the magnitude of the impacts depending on factors such as the location, timing, and volume of spills, distribution and ecology of affected invertebrate species. A CDE would likely contact shoreline areas, and benthic invertebrates in sensitive intertidal and shallow subtidal habitats could experience large-scale lethal and long-term sublethal effects. However, a CDE is unlikely to occur, and invertebrates typically have short generation times and should recover. A CDE has the potential to oil the few elkhorn coral colonies present in the Flower Gardens Banks, but no species-level impacts are expected because this species primary range is the southern GOM. Overall, impacts to benthic and pelagic invertebrates (including elkhorn coral) from a CDE could range up to moderate.

4.4.7.5.2 Alaska – Cook Inlet.

Impacts of Routine Operations. Potential OCS oil and gas development impacting factors relevant to invertebrates are shown by phase in Table 4.4.7-9. Impacting factors common to all phases include vessel noise and discharges (bilge and ballast water), miscellaneous discharges (deck washing, sanitary waste), and offshore lighting. Impacts from these activities would be localized and temporary and would range from short-term to long-term. Overall, vessel and miscellaneous discharges are not expected to impact invertebrate communities in the sediment or water column, because many of these waste streams are disposed of on land or must meet USEPA and/or USCG regulatory requirements before being discharged into surface waters. Studies of platform lighting suggest the lights would alter predator-prey dynamics by enhancing phytoplankton productivity around the platform, attracting phototaxic invertebrates and potentially improving the visual foraging environment for fishes (Keenan et al. 2007).

Exploration and Site Development. During the OCS oil and gas exploration and development phase, invertebrates could be affected by noise from seismic surveys and noise and bottom disturbance from drilling, platform placement, and pipeline trenching and placement activities.

Noise from vessel traffic, construction, seismic surveys, and drilling could kill or injure invertebrates close enough to the noise source, as well as reducing habitat suitability, as some species would avoid the area. For example, decapods and cephalopods, two numerically abundant and commercially important groups of invertebrates, are known to detect vibrations from underwater noise and may be sensitive to noise from vessel traffic, seismic surveys, and drilling (DFO 2004; NSF and USGS 2010). Recent reviews of the impacts of anthropogenic noise on invertebrates indicates that invertebrates exposed to noise could exhibit pathological effects (i.e., injury and mortality), physiological changes (i.e., changes in hormone, protein, and enzyme levels), and/or behavioral changes (such as a startle response) and change swimming and movement patterns (DFO 2004; NSF and USGS 2010). Although data is limited, zooplankton and larvae stages may be injured because of their small size and relative lack of mobility, while

TABLE 4.4.7-9 Impacting Factors Potentially Affecting Invertebrates and Their Habitat in the Cook Inlet Planning Area

Development Phase and Impacting Factor	Life Stage Affected[a] Eggs	Larvae	Adults
Impacting Factors Common to All Phases			
Vessel noise	X	X	X
Vessel traffic	X	X	X
Hazardous materials	X	X	X
Solid wastes	X	X	X
Offshore lighting	X	X	X
Aircraft noise			
Offshore air emissions			
Onshore air emissions			
Aircraft traffic			
Miscellaneous platform discharges	X	X	X
Vessel discharges	X	X	X
Bottom disturbance from vessel anchors	X	X	X
Exploration and Development			
Seismic noise	X	X	X
Noise from drilling and construction	X	X	X
Bottom disturbance from platform placement, drilling, and pipeline placement and trenching	X	X	X
Discharge of drilling muds and cuttings	X	X	X
Production			
Production Noise	X	X	X
Produced water discharge	X	X	X
Artificial reef	X	X	X
Decommissioning			
Platform removal (non-explosive)	X	X	X

[a] Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

noise is often found to have minimal effects on adult invertebrates (reviewed in DFO 2004 and NSF and USGS 2010). The studies typically suggested that injury was limited to within 10 m (33 ft) of the noise source. The numbers of invertebrates that could be affected by noise during the exploration and site development phase make it unlikely that noise impacts would have appreciable effects on invertebrate populations in the overall Cook Inlet Planning Area. A recent review of the effects of seismic survey activities on marine invertebrates concluded that although data were limited, mortality and injury to invertebrates would be limited to organisms located within a few meters of the airgun, and that there would be no significant impacts on marine invertebrate populations from airgun and sonar sounds (NSF and USGS 2010). The severity and duration of noise impacts would vary with site and development scenario, but impacts are expected to be temporary and localized.

Bottom-disturbing activities such as coring and drilling, platform placement and mooring, and pipeline trenching and placement would displace, injure, or kill invertebrates in the vicinity of the activities. Exploration would involve semisubmersible or floating drilling rigs, jack-up rigs, and bottom-founded rigs depending on water depth. Production rigs would most likely be fixed platforms. In the initial drilling phase before a riser is installed, drilling muds and cuttings would accumulate around the well and bury benthic invertebrates as well as create a turbidity plume that could adversely impact pelagic invertebrates located near the bottom. This change in grain size could alter community composition and prevent the settlement of some species. In addition, bottom disturbance during platform and pipeline placement would result in sediment resuspension and turbidity, which could bury benthic infauna and damage the gills of water-column and benthic invertebrates present within some distance of the disturbance. Platforms and pipeline placement would disturb 1.5 to 4.5 ha (4 to 11 ac) and 35 to 210 ha (86 to 519 ac) of bottom habitat, respectively. In addition, up to one pipeline landfill may result from the proposed action. Species most likely to be affected by bottom-disturbing activities are sessile and infaunal benthic organisms and small zooplankton that lack the mobility to avoid the direct disturbance and the associated turbidity plumes. Pipelines would be installed and anchored on the surface or buried. Pipelines could crush, injure, or displace invertebrates, as well as shift invertebrate community composition to those species preferring hard substrate. Soft-sediment invertebrates, particularly in shallow water, are subject to frequent bottom disturbance and sediment resuspension due to human activities such as trawling and natural occurrences such as storms. Thus, disturbed areas would likely be recolonized quickly, but, if grain size is greatly altered and slow to recover, the benthic community may take from a few months to several years to return to its pre-disturbance composition (Bolam and Rees 2003 and references therein).

The discharge of drilling muds and cuttings (including synthetic drilling fluids adhering to the cuttings) can adversely affect invertebrates in several ways. The effects of drilling muds and cuttings (including drilling fluids adhering to the cuttings) on invertebrates can be chemical such as toxicity or physical such as gill abrasion, burial, or displacement from turbidity and sedimentation. Impacts from turbidity and sedimentation would be similar to those described above and could damage respiratory structures and disrupt food acquisition at all trophic levels. Drilling wastes released near the sediment surface or in shallow water would bury benthic organisms in the release area. Muds released in deeper water or near the water's surface would be spread over a greater area in a thinner layer and may not result in high mortality, although impacts to water column invertebrates may be greater under this scenario. The disturbance would be short in duration, with repopulation of the affected area occurring by larval recruitment. In addition, drilling discharges must comply with NPDES permit requirements regarding the discharge amount, rate, and toxicity, which would greatly reduce the impact to invertebrate communities.

Production. Production activities that could affect invertebrates in Cook Inlet include operational noise, bottom disturbance from anchors and the release of process water. In addition, the platform would replace existing featureless soft sediments and serve as an artificial reef (Table 4.4.7-9).

Chronic disturbance to benthic invertebrates would result from the movement of pipelines and anchors and chains associated with support vessels. Pipelines not buried would be anchored in place which would minimize their movement and potential to disturb benthic invertebrate communities. Bottom disturbance would impact invertebrates in a manner similar that described above for the exploration and site development phase. The disturbance would be episodic and temporary, but would last for the lifetime of the platform.

Produced water contains metals, hydrocarbons, salts, and radionuclides, and their discharge could contaminate habitat resulting in lethal and sublethal effects on invertebrates, particularly non-mobile benthic infauna. However, NPDES permitting requirements regarding discharge rate, contaminant concentration, and toxicity would greatly reduce the potential for impacts to invertebrates. In addition, it is assumed that all produced water would be disposed of by injection into permitted disposal wells. Therefore, the effects of produced water discharges on invertebrates are expected to be minimal.

Platforms would add a hard substrate to the marine environment, providing additional habitat for marine plants and animals (e.g., kelp and mussels) that require a hard substrate. The platform would likely increase shell material and organic matter in the sediments surrounding the platform, potentially resulting in a shift in benthic invertebrate community composition.

A two-year (1997–1998) study of contaminant levels in the sediments of the Shelikof Strait and Cook Inlet provide information on the overall, long-term potential effects of oil and gas development in the Cook Inlet Planning Area (MMS 2001a). Samples of sediment from depositional areas (where sediment contamination is expected to be greatest) suggested that metals and PAHs in sediments derived primarily from natural sources rather than past oil and gas developments (MMS 2001a). In addition, sediment concentrations of metals and organic contaminants in outermost Cook Inlet and Shelikof Strait (1) have not increased significantly since offshore oil exploration and production began in Cook Inlet (circa 1963) and (2) posed low risk to benthic biota or fish (MMS 2001a).

***Decommissioning*.** No explosive platform removals are anticipated under the proposed action. Nonexplosive removals (e.g., abrasive, mechanical, or diver cutters) would have no long-term impacts to invertebrates, although individuals associated with the platform would experience, injury, mortality, or loss of habitat. Most sediments will recover their normal physical characteristics, ecological functions, and biological communities. Pipelines installed and anchored on the seafloor would be capped and left in place, although there is the potential for chronic sediment disturbance from pipeline movement. If fixed platforms are left in place, the changes to invertebrate communities resulting from the initial platform installation would be long-term.

Impacts of Expected Accidental Events and Spills. It is assumed that 1 to 3 small spills between 50 and 999 bbl, 7 to 15 smaller spills between 1 and <50 bbl, and 1 large spill (≥1,000 bbl) could occur under the proposed action (Table 4.4.2-1). Most oil and gas spills would be small and are expected to primarily affect invertebrates in the water column, as most hydrocarbons would float above the sediment surface. It is anticipated that only a small amount of the water column and shoreline would be affected by these smaller oil spills and would not, therefore, present a substantial risk to invertebrate populations. Consequently, the effects of small spills on invertebrates and their habitat are expected to be short-term and affect relatively few individuals.

Larger areas and numbers of individuals may be affected by large spills (>1,000 bbl). Exposure to hydrocarbons can result in lethal or sublethal (reproduction, recruitment, physiology, growth, development, and behavior) impacts at the level of the individual. The invertebrates most likely to be affected are sessile benthic organisms and small zooplankton, which lack the mobility to avoid the oil. Invertebrates differ in their sensitivity to hydrocarbon pollution both by organism class and life stage (Laws 1993). For example, crustaceans appear to be among the taxa most sensitive to oil pollution, while certain species of worms, such as Capitellid polychates, appear to be tolerant of oil pollution (Laws 1993; NRC 2003b). Among meiofauna, nematodes may be less sensitive to oil than copepods. Oil exposure can reduce the abundance of zooplankton in the oiled area, induce narcosis, and bind to feeding appendages (Teal and Howarth 1984). Zooplankton are also known to ingest oil, some of which is retained in the gut and some of which is exported to the seafloor in fecal pellets (Teal and Howarth 1984). Impacts from large spills would be greatest if the spill occurred during a reproductive period or contacted a location important for spawning or growth such as intertidal and nearshore subtidal habitats. However, impacts from large spills are expected to be temporary as oil is diluted and broken down by natural chemical and microbial processes.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE in the Cook Inlet Planning Area with a volume of 75-125 thousand bbl and a duration of 50–80 days (Table 4.4.2-2). Because the Cook Inlet Planning Area is located within a relatively confined estuary, the likelihood of oil from a catastrophic spill contacting part of the shoreline is relatively high. Site-specific evaluations would have to be conducted to fully evaluate potential spill trajectories from future lease sales. Benthic invertebrates in intertidal and shallow subtidal areas are likely to be contacted by an oil spill. In addition, some oil spill-response activities could adversely affect invertebrates. For example, dispersants could increase oil toxicity, and cleanup techniques, the presence of large numbers of people, or the use of heavy equipment on shorelines could kill some coastal organisms during cleanup responses. Dispersant toxicity varies by species and dispersant used. Newer dispersant formulations, such as COREXIT® 2500, do not appear to be more toxic to invertebrates than oil alone (Hemmer et al. 2011). However, few species and life stages have been tested; additive toxicity from oil dispersant mixtures may be significant for some species (Hemmer et al. 2011). In addition, studies of microbial communities from oiled beaches in Louisiana indicated that the dispersant COREXIT can alter bacterial composition by reducing the abundance of *Marinobacter* spp. and *Acinetobacter* spp., both hydrocarbon-degrading bacteria, and increasing the relative abundance of *Vibro* spp., a nonhydrocarbon-degrading bacteria (Hamdan and Fulmer 2011). These results indicate that dispersants may inhibit biodegradation of oil.

Benthic and pelagic invertebrates are important trophic links connecting primary producers to higher-trophic-level organisms. Consequently, oil spill contamination on a large scale could result in significant contaminant transfer to higher trophic levels and/or reduce food availability to higher trophic levels if invertebrate populations were severely depressed by a CDE. The toxicity of released hydrocarbons would probably decrease rapidly because of evaporation, dispersion, and dilution. Thus, it is concluded that planktonic invertebrates within the area of lethal hydrocarbon concentration could be killed during the first few days of a hydrocarbon spill; after that, the primary effects would be sublethal responses such as reduction in their growth or reproductive rates. Reproduction of copepods is tied to temperature and food availability and is therefore highly seasonal. Oil spills occurring during these reproductive periods could contaminate or reduce the abundance of a critical food source for higher trophic levels. Large-scale changes in overall plankton populations in Cook Inlet are considered unlikely. However, intertidal invertebrates could experience long-term exposures, as oil could persist in intertidal sediments for decades. Thus invertebrate populations could be depressed for a decade or more (Highsmith et al. 2001; Exxon Valdez Oil Spill Trustee Council 2009a).

Studies following the *Exxon Valdez* spill give insight into the impacts of a catastrophic oil spill on invertebrate communities and their subsequent recovery. Amphipods, sea stars, and certain crabs were less abundant in oiled sites compared to areas not affected by the spill (*Exxon Valdez* Oil Spill Trustee Council 2010a). Studies of mussels indicated hydrocarbons accumulated in their tissue in the decade after the spill at sites where oil did not break down. However, by 1999, contaminant levels in mussels from the most heavily oiled beds in Prince William Sound were similar to background levels even though sediment contamination was still present (*Exxon Valdez* Oil Spill Trustee Council 2010a). Stress-tolerant invertebrates like polychaetes and snails did not appear to suffer long-term population declines in oiled areas. As late as 2002, studies of clams indicated differences in population structure between areas affected by the spill and clean areas (*Exxon Valdez* Oil Spill Trustee Council 2010a). However, much of the long-term reduction in clam densities may have been due to the high-pressure beach washing that occurred after the spill (*Exxon Valdez* Oil Spill Trustee Council 2009a). In intertidal areas, the *Exxon Valdez* spill created large density fluctuations in kelp communities that serve as habitat for benthic invertebrates. Intertidal experimental studies have demonstrated that rocky intertidal communities are particularly slow to recover (+10 years) following disturbance (Highsmith et al. 2001). As of 2009, clams, mussels, and intertidal communities are still listed as recovering (*Exxon Valdez* Oil Spill Trustee Council 2009a).

Impact Conclusions.

Routine Operations. The primary impacts of oil and gas activities on invertebrates in the Cook Inlet Planning Area would be from drilling waste discharges and from bottom-disturbing activities during the exploration and site development phase, which could displace, bury, injure, or kill invertebrates in the vicinity of the activities. Displaced invertebrate communities would generally repopulate the area over a short period of time, although a return to the pre-disturbance community may take longer. If discharged into open water, the effects of drilling wastes and invertebrates community structure and function should be restricted to the vicinity of the platform. Overall impacts to benthic and pelagic invertebrates from routine program activities (exploration and site development, production, and decommissioning phases) would range from negligible to moderate, with the severity of the impacts generally decreasing dramatically with distance from the disturbance.

Expected Accidental Events and Spills. Small surface or subsurface hydrocarbon spills would be rapidly diluted and would likely result in only small localized, sublethal impacts to invertebrates. Large spills could affect a large number of benthic and pelagic invertebrates and their habitats. The location of the spill and the season in which the spill occurred would be important determinants of the impact magnitude. A large spill could contact shoreline areas, and benthic invertebrates in sensitive intertidal and shallow subtidal habitats could experience large-scale lethal and long-term sublethal effects. Overall, impacts from small spills would range from negligible for spill less than 50 bbl, minor for spills up to 1,000 bbl, and from minor to moderate for large spills (≥1,000 bbl).

An Unexpected Catastrophic Discharge Event. A CDE could affect a large area, with the magnitude of the impacts depending on factors such as the location, timing, and volume of spills, and distribution and ecology of affected invertebrate species. A CDE would likely contact shoreline areas, and benthic invertebrates in sensitive intertidal and shallow subtidal habitats could experience large-scale lethal and long-term sublethal effects. Local populations of intertidal organisms affected by such large spills could be measurably depressed for several years and oil could persist in shoreline sediments for decades. However, a CDE is not expected to occur and invertebrates typically have short generation times and should recover. Overall, impacts to invertebrates from a CDE could range up to moderate.

4.4.7.5.3 Alaska – Arctic. Impacting factors common to all phases include vessel discharges (bilge and ballast water), miscellaneous discharges (deck washing, sanitary waste), and offshore lighting. Impacts from these activities would be localized and temporary and would range from short-term to long-term. These discharges are expected to have minimal impacts on invertebrate communities in the sediment and water column because many of these waste streams are disposed of on land or must meet USEPA and/or USCG regulatory requirements before being discharged into surface waters. Studies of platform lighting suggest the lights would alter predator-prey dynamics by enhancing phytoplankton productivity around the platform, attracting phototaxic invertebrates, and potentially improving the visual foraging environment for fishes (Keenan et al. 2007).

Impacts of Routine Operations.

Exploration and Site Development. During the OCS oil and gas exploration and development phase, invertebrates could be affected by noise from seismic surveys and noise and bottom disturbance from drilling, subsea well, gravel island, and platform placement, and pipeline trenching and placement activities. See Section 4.4.7.5.2 for a complete discussion of the effects of exploration and site development activities on invertebrates.

Noise from seismic surveys and drilling could kill or injure invertebrates close enough to the noise source and reduce habitat suitability as some species would avoid the area. Noise is expected to have minimal effects on invertebrate populations in the overall Beaufort and Chukchi Planning Areas (see Section 4.4.7.5.2).

Bottom-disturbing activities such as drilling, subsea well and platform placement, and pipeline trenching and placement would displace, injure, or kill invertebrates in the vicinity of the activities, as described in Section 4.4.7.5.2. In addition to burying and displacing benthic communities, the construction of artificial islands would alter sediment composition and shift benthic invertebrate communities to species adapted to coarse gravel substrate. Platform and pipeline placements in the Beaufort and Chukchi Planning Areas would disturb 3 to 13.5 ha (7 to 33 ac) and 77 to 567 ha (190 to 1,401 ac) of bottom habitat, respectively. Pipelines would be installed and anchored on the surface or buried in waters less than 50 m (156 ft) to prevent damage from ice gouges. Pipelines could crush, injure, or displace invertebrates, as well as shift invertebrate community composition to those species preferring hard substrate. Benthic habitats such as the Steffanson Boulder Patch and kelp beds would be protected by stipulations that require surveys for and avoidance of sensitive biological habitat. Although pipeline and platform placement would disturb a large area of the seafloor, it is not expected to have a measurable effect on regional populations. The benthic community in these areas experiences similar naturally occurring disturbances from ice gouging, strudel scour, and severe storms. In the Arctic, recolonization by benthic invertebrates can be slow to begin, and the benthic community may take several years to return to its pre-disturbance composition following bottom-disturbance activities (Conlan and Kvitek 2005).

The discharge of drilling muds and cuttings from exploration wells could adversely affect pelagic and benthic invertebrates (Section 4.4.7.5.2). However, drilling discharges must comply with NPDES permit requirements regarding the discharge amount, rate, and toxicity, which would greatly reduce the impact to invertebrate communities.

Production. Production activities that could affect invertebrates include operational noise, bottom disturbance from the movement of mooring anchors, chains, and cables, and the release of process water. In addition, the platform and gravel islands would replace existing featureless soft sediments and serve as artificial reefs (Table 4.4.7-10).

Chronic disturbance to benthic invertebrates would result from the movement of anchors and chains associated with support vessels. Bottom disturbance would impact invertebrates in a manner similar to that described above for the exploration and site development phase. The disturbance would be episodic and temporary, but would last for the lifetime of the platform.

Produced water contains metals, hydrocarbons, salts, and radionuclides, and its discharge could contaminate habitat resulting in lethal and sublethal effects on invertebrates, particularly nonmobile benthic infauna. However, it is assumed that produced water would be reinjected into the well rather than discharged into the ocean. In addition, produced water discharges must comply with NPDES permit requirements regarding the discharge amount, rate, and toxicity, which would greatly reduce the impact to invertebrate communities (Section 4.4.7.5.2).

The presence of platforms or artificial islands would favor invertebrates requiring or preferring hard substrates, thus shifting community composition in some areas. The platform would likely increase shell material and organic matter in the sediments surrounding the platform, potentially resulting in a shift in benthic invertebrate community composition.

The results of the study Arctic Nearshore Impacts Monitoring in the Development Area funded by BOEM provide a good summary of the long-term changes to benthic communities resulting from oil and gas development in the Arctic. Boehm (2001) determined that

TABLE 4.4.7-10 Impacting Factors Potentially Affecting Invertebrates and Their Habitat in the Beaufort and Chukchi Planning Areas

	Life Stage Affected[a]		
Development Phase and Impacting Factor	Eggs	Larvae	Adults
Impacting Factors Common to All Phases			
Vessel noise	X	X	X
Vessel traffic	X	X	X
Hazardous materials	X	X	X
Solid wastes	X	X	X
Offshore lighting	X	X	X
Aircraft noise			
Offshore air emissions			
Onshore air emissions			
Aircraft traffic			
Miscellaneous platform discharges	X	X	X
Vessel discharges	X	X	X
Bottom disturbance from vessel anchors	X	X	X
Exploration and Development			
Seismic noise	X	X	X
Noise from drilling and construction	X	X	X
Bottom disturbance from drilling and placement of platforms, subsea wells, artificial islands, and pipelines	X	X	X
Discharge of drilling muds and cuttings	X	X	X
Production			
Production noise	X	X	X
Produced water discharge	X	X	X
Artificial reef	X	X	X
Decommissioning			
Platform removal (nonexplosive)	X	X	X

[a] Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

hydrocarbons in sediments (largely attributable to natural sources) were not readily bioavailable to marine filter feeders and deposit-feeders, and concluded that small incremental contaminant additions from future development activities are unlikely to cause immediate ecological harm to organisms in the Beaufort Sea study area. After reviewing tissue samples between 2000 and 2006, hydrocarbon and metals concentrations in invertebrates sampled near the Northstar development and Liberty Prospect area were found to be similar to or lower than invertebrate tissue levels found elsewhere in the world (Neff & Associates, LLC 2010). No increase in hydrocarbons and metals in marine invertebrate tissues was attributable to oil and gas production, even for benthic infauna such as amphipods and clams. Concentrations of metals and hydrocarbons in benthic invertebrates collected in the Boulder Patch were similar to concentrations in invertebrates collected elsewhere in the development area.

Decommissioning. No explosive platform removals are anticipated under the proposed action. Nonexplosive removals (e.g., abrasive, mechanical, or diver cutters) would have no long-term impacts on invertebrates, although individuals associated with the platform would experience injury, mortality, and loss of habitat. Pipelines installed and anchored on the seafloor would be capped and left in place, although there is the potential for chronic sediment disturbance from pipeline movement. The changes to invertebrate communities resulting from the construction of artificial gravel islands would be long-term.

Impacts of Expected Accidental Events and Spills. It is assumed that large spills (≥1,000 bbl), up to 35 small spills (50 to 999 bbl), and up to 190 smaller spills (>1 and <50 bbl) could occur during the lease period under the proposed action (Table 4.4.2-2). Hydrocarbons can cause both lethal and sublethal effects to marine invertebrates. Sublethal effects occur at lower concentrations and include reduced growth and/or fecundity, increased physiological stress, and behavioral changes that may reduce fitness and population size. Most accidental releases would be small, and any impacts would be sublethal except in the immediate vicinity of the spill where lethal concentrations of oil may be present. However, it is anticipated that only a small amount of shoreline would be affected by these smaller oil spills and would not, therefore, present a substantial risk to invertebrate populations. Hydrocarbons released during small spills would be diluted and broken down by natural processes. Consequently, the effects of small spills on invertebrates and their habitat are expected to be short-term and affect relatively few individuals.

Larger areas and numbers of individuals may be affected by large spills (>1,000 bbl). Accidental hydrocarbon releases can occur at the water's surface or at the seafloor, potentially affecting both pelagic and benthic invertebrates. Following an accidental hydrocarbon release, most oil and gas would float above the seafloor, so direct contact with benthic communities in deeper water should be relatively low, while higher exposures would be expected for zooplankton, which lack the mobility to avoid the oil. Oil exposure can reduce the abundance of zooplankton in the oiled area, induce narcosis, and bind to feeding appendages (Teal and Howarth 1984). Zooplankton are known to ingest oil, some of which is retained in the gut and some of which is exported to the seafloor in fecal pellets (Teal and Howarth 1984). The impact magnitude of large oil spills on invertebrates is primarily a function of the invertebrate species and habitat affected. Impacts from spills would be greatest if a large spill occurred during a reproductive period or contacted a location important for spawning or growth such as intertidal and nearshore subtidal habitats. Impacts from large spills are expected to be temporary as oil is diluted and broken down by natural chemical and microbial processes.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE in the Chukchi Sea Planning Area with a volume of 1.4-2.2 million bbl and a duration of 40–75 days, and a CDE in the Beaufort Sea Planning Area with a volume of 1.7-3.9 million bbl and a duration of 60–300 days (Table 4.4.2-2). A CDE could contaminate sediments and the water column for some distance around the leak or rupture. Benthic and pelagic invertebrates are important trophic links connecting primary producers to higher-trophic-level organisms.

Consequently, oil spill contamination on a large scale could result in contaminant transfer to higher trophic levels and/or reduce food availability to higher trophic levels if invertebrate populations were severely depressed by a CDE. Reproduction of copepods is tied to temperature and food availability and is therefore highly seasonal. Thus, a CDE occurring during these reproductive periods could contaminate or reduce the abundance of a critical food source for higher trophic levels. Similarly, catastrophic oil spills could affect euphausiids, which are seasonally abundant in the Beaufort Sea and Chukchi Sea (Berline et al. 2008). Euphausiids are a primary food source for migrating baleen whales. These examples suggest that catastrophic oil spills could result in population-level impacts or contamination of invertebrates, which may, in turn, impact higher trophic levels.

If large quantities of oil from a catastrophic oil spill were to reach intertidal sediments or shallow subtidal sediment, benthic invertebrates in the affected areas could experience high levels of contamination and mortality, and, given the slow rate of oil breakdown in the Arctic, benthic invertebrate populations could be depressed for many years. In addition, some oil spill-response activities could adversely affect invertebrates. For example, dispersants could increase oil toxicity, and cleanup techniques, the presence of large numbers of people, or the use of heavy equipment on shorelines could kill some coastal organisms during cleanup responses. Dispersant toxicity varies by species and dispersant used, although newer dispersant formulations, such as COREXIT 2500, do not appear to be more toxic to invertebrates than oil alone (Hemmer et al. 2011). However, few species and life stages have been tested; additive toxicity from oil dispersant mixtures may be significant for some species (Hemmer et al. 2011). See Section 4.4.7.5.2 for a detailed discussion of oil spills on invertebrates following the catastrophic *Exxon Valdez* spill.

Hydrocarbon releases contacting the hard-bottom kelp communities could have direct impacts on invertebrates inhabiting the area. The magnitude of impacts to the Boulder Patch would depend on the location and severity of the spill. Studies show that the Boulder Patch communities are slow to recolonize (Konar 2007 and references therein). Kelp associated benthic animal communities have also been shown to have major shifts in species composition following exposure to oil (Dean and Jewett 2001). Impacts to kelp habitat from an oil spill could be long-term. *Laminaria* beds oiled by the *Exxon Valdez* spill recovered within 10 years (Dean and Jewett 2001). Planning and permitting procedures requiring no impacts to sensitive biological communities will also minimize spill impacts to the Boulder Patch area.

Oil from a CDE occurring under ice is more difficult to locate and clean than surface spills. Since weathering would be greatly reduced by ice cover, pelagic invertebrates could continue to be harmed or killed as they drift into the trapped oil. In addition, invertebrates living beneath the ice are a crucial food source in the Arctic food web that could be degraded or lost by contact with oil spills. Arctic cod are particularly dependent on sea ice invertebrates.

Impact Conclusions.

Routine Operations. The primary impacts of oil and gas activities on invertebrates in the Arctic planning areas would be from drilling waste discharges and from bottom-disturbing activities during the exploration and site development phase, which could displace, bury, injure, or kill invertebrates in the vicinity of the activities. Bottom-disturbing activities would be temporary and recovery could be short-term to long-term. Displaced invertebrate communities would generally repopulate the area over a short period of time, although a return to the pre-disturbance community may take longer, particularly in the Arctic. If discharged into open water, the effects of drilling wastes on invertebrates community structure and function should be restricted to the vicinity of the platform. Overall impacts to invertebrates from routine program activities (exploration and site development, production, and decommissioning phases) would range from negligible to moderate, with the severity of the impacts generally decreasing dramatically with distance from bottom-disturbing activities.

Expected Accidental Events and Spills. Small surface or subsurface hydrocarbon spills would be rapidly diluted and would likely result in only small localized, sublethal impacts to invertebrates. Large spills could affect a large number of benthic and pelagic invertebrates and their habitats. The location of the spill and the season in which the spill occurred would be important determinants of the impact magnitude of the spills. A large spill could contact shoreline areas, and benthic invertebrates in sensitive intertidal and shallow subtidal habitats could experience large-scale lethal and long-term sublethal effects. Overall, impacts from small spills would range from negligible for spills less than 50 bbl, minor for spills up to 1,000 bbl, and from minor to moderate for large spills (≥1,000 bbl).

An Unexpected Catastrophic Discharge Event. A CDE would likely contact shoreline areas, and benthic invertebrates in sensitive intertidal and shallow subtidal habitats could experience large-scale lethal and long-term sublethal effects. In Alaska, local populations of intertidal organisms affected by such large spills could be measurably depressed for several years and oil could persist in shoreline sediments for decades. However, a CDE is unlikely to occur, and benthic and pelagic invertebrates typically have short generation times and should recover. Invertebrates associated with hard-bottom kelp communities could also be affected and, if so, recovery of the community could be long-term. Oil from a CDE occurring under ice is more difficult to locate and clean than surface spills and may have more persistent effects on water column and sea ice-associated invertebrates. Overall, impacts to invertebrates from a CDE could range up to moderate.

4.4.8 Potential Impacts to Areas of Special Concern

4.4.8.1 Gulf of Mexico

Impacts of Routine Operations.

Marine Protected Areas (MPAs). National System MPAs in the Western and Central Planning Areas consist of the FGBNMS, Jean Lafitte National Historical Park and Preserve, Barataria Preserve, and a number of National Wildlife Refuges (NWRs) (Table 3.9.1-1). MPAs would primarily be affected by pipeline landfalls and potentially by accidental oil spills occurring nearshore as well as large offshore oil spills. Impacts on the FGBNMS and NWRs are described below. *De facto* MPAs are primarily military use areas and are also discussed below.

National Marine Sanctuaries of Texas and Louisiana in the Western Gulf of Mexico Planning Area (Figure 3.9.1-1). Potential impacts on the FGBNMS resulting from site exploration and development activities are discussed in detail in (Section 4.4.6.2.1). Direct impacts on the FGBNMS from bottom disturbance would be prevented by the Topographic Features Stipulation, which prohibits exploration and development activities and the deposition of drilling muds and cuttings in the vicinity of the FGBNMS. During the production phase, produced water discharges are not likely to impact the FGBNMS because of the Topographic Features Stipulation requiring large buffers between the FGBNMS and oil and gas development activities (Section 4.4.6.2.1).

New oil and gas production platforms could act as artificial reef habitat and potentially act as stepping stones allowing the establishment of invasive species in the FGBNMS (Section 4.4.6.2.1). However, there is no conclusive evidence this has occurred historically, and it is more likely that invasive species would establish at the FGBNMS even without the platforms, although the platforms may speed the process.

National Parks, National Seashores, Reserves, and Refuges. See Section 4.4.6.1.1 for a discussion of the potential impacts of the Program on coastal habitats. It is assumed that pipeline landfalls, shore bases, and waste facilities would not be located in National Parks, NWR, or National Estuarine Research Reserves because of their special status and protections. Consequently, impacts to these areas from oil and gas exploration and production activities are not expected to occur.

It is possible that shore bases and waste facilities may be located in one or more estuaries in the Western or Central GOM Planning Area. It is assumed that new shore bases and waste facilities would be constructed in existing developed or upland areas and would not be sited in coastal habitats such as barrier beaches or wetlands. Therefore, impacts on parks, seashores, refuges, and reserves are not likely to occur.

Trash and debris from various sources, including OCS operations, frequently wash up on beaches, which could affect Gulf Shores or Padre Island National Seashore. The discharge or disposal of solid debris from OCS structures and vessels is prohibited, and assuming that operators comply with regulations, most potential impacts would be avoided, although some accidental loss of materials is inevitable.

NPS lands, wildlife refuges, and research reserves could potentially be affected by increased boat and aircraft traffic associated with OCS oil and gas activities. Existing mitigation measures limit vessel speeds in inland waterways and aircraft altitudes over Areas of Special Concern. With these measures in place, most impacts on these Areas of Special Concern due to vessel and aircraft traffic would be avoided.

Military Uses. The Military Areas Stipulation applies to all blocks leased in military areas and requires lessees to coordinate their activities with the relevant military authorities and also states that the U.S. Government is not responsible for any accidents involving military operations. The Military Areas Stipulation reduces use conflicts and improves safety but does not reduce or eliminate the actual physical presence of oil and gas operations. Accidents and use conflicts involving oil and gas and military operations would be minimized or eliminated by adherence to the Military Areas Stipulation. Currently, both activities coexist in the GOM, and there has never been an accident involving the military and oil and gas lessees.

Impacts of Expected Accidental Events and Spills. It is assumed that up to 8 large spills (between 1,700 and 5,300 bbl), up to 70 spills between 50 and 999 bbl, and up to 400 smaller spills between 1 and 50 bbl could occur during the lease period under the proposed action. Small spills at the seafloor would rise in the water column but are not likely to contact the FGBNMS at concentrations toxic to marine life (see Section 4.4.6.2.1). Small platform spills and tanker spills at the ocean surface could penetrate the water column to documented depths of 20 m (66 ft) or more, which is within the depth range of the crests of some coral reefs and topographic features including the FGBNMS. However, at these depths, the contaminant concentrations are typically several orders of magnitude lower than those demonstrated to have an effect on marine organisms (MMS 2008a). Therefore, it is likely that only small concentrations of oil from surface spills would reach the FGBNMS (MMS 2008a).

An oil spill reaching sensitive coastal habitats could impact National Parks, NWRs, National Estuarine Research Reserves, or National Estuary Program sites. Impacts could result from both oiling of the shoreline and mechanical damage during the cleanup process. Small or large spills (>1,000 bbl) would be diluted and degraded by natural processes and, given the small size of most spills, impacts to a significant area of the shoreline are unlikely.

Impacts of an Unexpected Catastrophic Discharge Event. This PEIS analyzes a CDE in the GOM planning areas with a volume of 0.9-7.2 million bbl and a duration of 30–90 days. It is possible that such a spill originating from outside the No Activity Zones established by the Topographic Features Stipulations could reach the vicinity of the FGBNMS. However, because of the tendency for oil components to rise toward the surface and to be diluted as they are transported by water currents, any impacts associated with a CDE reaching sensitive corals would most likely be sublethal. Hydrocarbons have been shown to have lethal and sublethal (reproduction, larval settlement, photosynthesis, and feeding) effects on corals, although no effects on corals following oil spills are also frequently reported (Loya and Rinkevich 1980; Bak 1987; Guzman et al. 1991; Dodge et al. 1995; Haapkyla et al. 2007). Corals have the capacity to recover quickly from hydrocarbon exposure. For example, Knap et al. (1985) found that when *Diploria strigosa*, a common massive brain coral at the Flower Garden Banks, was dosed with oil, it rapidly exhibited sublethal effects but also recovered quickly. However, larval stages of coral are far more sensitive than adults. Therefore, the impact magnitude of a spill is partly dependent on whether the spill occurs during a period of coral spawning. For lethal exposures, the community would likely recover once the area had been cleared of oil, although full recovery could take many years (Haapkvla et al. 2007). Consequently, it is anticipated that impacts of lethal concentrations of oil reaching coral reef or hard-bottom habitat would be long-term but temporary.

A CDE taking place near shore or in deeper water could affect coastal parks, reserves, and refuges if the oil was transported to these areas by currents. Impacts on parks, preserves, and refuges would depend on the size and specific location of the oil spill and the effectiveness of cleanup procedures. If a large volume of heavy oil were to reach these areas, that situation could result in park closure and reduced visitation. In general, oil spills affecting parks, refuges, and reserves would diminish their function by reducing habitat value for wildlife and aquatic biota and interrupting monitoring and research activities.

The impacts of oil spills on parks, preserves, and refuges could include death of wetland vegetation and associated wildlife, oil saturation and trapping by vegetation and sediments (thus causing it to become a chronic source of pollution), and mechanical destruction of the wetland area during cleanup. Spills that damage wetland vegetation protecting canal and waterway banks could accelerate erosion of those banks (see Section 4.4.6.1.1). Some areas may recover completely if proper remedial action was taken. Others may not recover completely. Oil could remain in some coastal substrates for decades, depending on the type of oil spilled, the amount present, sand grain size, the degree of penetration into the subsurface, the exposure to the weathering action of waves, and sand movement onto and off the shore. See Section 4.4.6.1.1 for a discussion of the potential impacts of oil spills on coastal habitats.

Impact Conclusions.

***Routine Operations*.** Overall, impacts on Areas of Special Concern resulting from routine Program activities would be minimized by existing protections and use restrictions applicable to these areas. Routine operations are not expected to conflict with military uses. However, increased vessel and aircraft traffic and the construction of pipelines and platforms could have temporary and localized effects on wildlife and reduce the scenic value of National Parks and NWRs for some visitors. Overall, impacts on Areas of Special Concern resulting from routine Program activities are expected to be negligible to moderate.

***Expected Accidental Events and Spills*.** While most accidental spills would be small and would have relatively small impacts on Areas of Special Concern, large spills that reach coastal National Parks and NWRs could have more persistent impacts and could require remediation. Impacts from large spills could result from both oiling of the shoreline and mechanical damage during the cleanup process. Overall, impacts to Areas of Special Concern from small spills would range from negligible for spill less than 50 bbl, minor for spills up to 1,000 bbl, and from minor to moderate for large spills (≥1,000 bbl).

***An Unexpected Catastrophic Discharge Event*.** The impacts from a CDE would depend on the location and size of the spill, the type of product spilled, weather conditions, the type of area affected, the effectiveness of cleanup operations, and other environmental conditions at the time of the spill. Although unlikely, if oil from a CDE were to reach an Area of Special Concern, coastal habitats and fauna as well as subsistence use, commercial or recreational fisheries, and tourism could be negatively affected. Overall, a CDE could result in up to moderate effects on Areas of Special Concern.

4.4.8.2 Alaska – Cook Inlet

Impacts of Routine Operations.

Marine Protected Areas (MPAs). The Alaska Peninsula unit and Gulf of Alaska unit of the Alaska Maritime NWR are the only Federal MPAs in the vicinity of the Cook Inlet Planning Area. NWRs could primarily be affected by pipeline landfalls and potentially by accidental oil spills, as described below.

National Parks, National Forests, National Seashores, Reserves, and Refuges. Impacts on National Parks, Forests, Reserves, and Refuges could result from facilities developed to support offshore oil drilling and production, and could include effects from pipeline landfall; dredging and construction; and the construction of roads, processing and waste facilities, and onshore pipelines. In addition, subsistence hunting and fishing, which are permitted on all refuges in Alaska, could be affected by oil and gas operations. It is assumed that pipeline landfalls, shore bases, and waste facilities would not be located in National Parks, National Forests, NWRs, or National Estuarine Research Reserves because of the special status and protections afforded these areas. See Section 4.4.6.1.2 for a discussion of the potential impacts of OCS oil and gas activities on coastal habitats.

National Park Service (NPS) lands are potentially susceptible to impacts from activities related to OCS oil and gas development as a consequence of the Program in Cook Inlet. The potentially affected lands include the Lake Clark National Park and Preserve, the Katmai National Park and Preserve, and Aniachak National Monument. Kenai Fjords National Park is east of Cook Inlet on the GOA, but it could be affected by an oil spill associated with OCS activities in Cook Inlet.

Impacts from routine OCS operations could come from facilities developed to support oil drilling and production, and could include effects from pipeline landfalls, dredging, air pollution, and the construction of roads and new facilities. Onshore oil facilities are permissible only on private acreage within each national park land. All of these national parks, monuments, and preserves contain privately held acreage, and development of onshore oil support facilities is possible in these areas. Because of the more confined nature of Cook Inlet, OCS construction of facilities within the Cook Inlet Planning Area could have some negative effects on scenic values for some users of the Lake Clark and Katmai National Parks and Preserves, if the facilities were visible from shore or the air during flightseeing.

Noise and vessel traffic associated with construction activities in offshore areas adjacent to park and refuge boundaries could temporarily disturb some wildlife and could negatively affect recreational values for park users. It is anticipated that noise generated by offshore construction activities would be at low levels, intermittent, and would not occur for more than a few months. Scenic values for some park users could be negatively affected in the long term by the presence of platforms visible from park areas.

National Wildlife Refuges (NWRs) in the vicinity of Cook Inlet are identified in Section 3.9.2.2. NWRs potentially affected by OCS activities in the Cook Inlet Planning Area include the Alaska Peninsula NWR, Becharof NWR, Kodiak NWR, Kenai NWR, and Izembek NWR. Section 22(g) of the Alaska Native Claims Settlement Act of 1971 (ANCSA) requires that new development on National Wildlife Refuge lands must be in accordance with the purpose for which the refuge was formed. Therefore, although development of onshore oil and gas support facilities is technically possible, such projects would be subject to intensive review. The potential effects of routine operations and accidental events on these NWRs are essentially the same as those discussed above for the NPS lands. Noise and vessel traffic associated with construction activities in offshore areas adjacent to park and refuge boundaries could temporarily disturb some wildlife and could negatively affect recreational values for park users. It is anticipated that noise generated by offshore construction activities would be at low levels, intermittent, and would not occur for more than a few months. Scenic values for some park users could be negatively affected in the long term by the presence of platforms visible from park areas. In addition, subsistence hunting and fishing are permitted on all refuges in Alaska and could, therefore, be affected by accidents and routine operations in the immediate vicinity of refuge properties.

The only national forest within the vicinity of the Cook Inlet Planning Area is the Chugach National Forest, which is located mainly on the eastern side of the Kenai Peninsula and portions of Turnagain Arm (Figure 3.9.2-1). Because there would be no OCS-related development, such as pipelines or other onshore facilities, within the Chugach National Forest, it would not be affected by routine OCS activities associated with lease sales in the Cook Inlet Planning Area. The Chugach National Forest also borders Prince William Sound and is close to Valdez. The Chugach National Forest is, therefore, potentially susceptible to effects of routine oil-related operations from transport and tanker loading of oil produced (OCS and non-OCS) in other regions (e.g., the Beaufort Sea Planning Area) and transported by pipeline to the Port of Valdez. Potential effects include increased noise and air pollution from tanker traffic.

***Other Areas of Special Concern*.** There are multiple State parks, refuges, sanctuaries, critical habitat areas, and recreation areas near the Cook Inlet Planning Area, many of which border Cook Inlet or are located in areas that could be contacted by accidental oil spills. Such areas include Captain Cook State Recreation Area, Clam Gulch State Recreation Area, Chugach State Park, Kachemak Bay State Park and State Wilderness Park, and Ninilchik State Recreation Area. In addition, the Kachemak Bay National Estuarine Research Reserve is located in Cook Inlet on the southern end of the Kenai Peninsula. Impacts from OCS activities would be similar to those described above for National Parks and Refuges. Existing protections and restrictions on uses should limit the direct terrestrial impacts from OCS activities on these areas. It is assumed that pipeline landfalls, shore bases, and waste facilities would not be located in the State parks and recreation areas. It is anticipated that noise generated by OCS offshore construction activities would be at low levels, intermittent, and would not persist for more than a few months at any one time. It is considered unlikely that these additional activities would noticeably affect wildlife or park user values compared to current (non-OCS) activities within the considered planning areas. There are no Military Use Areas in the Cook Inlet Planning Area; therefore, no conflicts between OCS activities and the military are expected to occur.

Impacts of Expected Accidental Events and Spills. Accidental oil spills could occur from land-based pipelines and facilities, vessels, and offshore platforms and pipelines. It is assumed that 2 small spills between 50 and 999 bbl and 10 smaller spills between 1 and 50 bbl could occur under the proposed action. It is assumed that one large spill between 1,500 and 7,800 bbl could occur in Cook Inlet. Spills on land are not likely to affect National Parks, Refuges, or National Forests because pipelines and other oil and gas infrastructure would not likely be permitted in these areas. However, there are several NWRs and National Parks along the shorelines of the Cook Inlet Planning Area, as well as one National Estuarine Research Reserve, and all could be affected by a large spill. A section of the Chugach National Forest borders Turnagain Arm and could be affected by spills originating in Cook Inlet as well as tanker spills associated with the Port of Valdez. The Lake Clark National Park and Preserve has approximately 50 km (31 mi) of shoreline along Cook Inlet, including shoreline areas in Tuxedni and Chinitna Bays that are considered to contain sensitive habitats. Katmai National Park and Preserve also contains extensive shoreline in proximity to the Cook Inlet Planning Area and the Shelikof Strait, and it is also adjacent to Katmai Bay, which is considered a sensitive resource area. If a large amount of oil were to contact a National Park, visitation would be likely to decrease or be temporarily prohibited. The several NWRs located in and around Cook Inlet, such as the Kodiak NWR and the Alaska Maritime NWR, could also experience a loss of habitat value if they experienced heavy oiling from offshore spills. Site-specific evaluations would be conducted to fully evaluate potential spill trajectories and spill probabilities in a lease sale EIS.

Several State parks, refuges, sanctuaries, critical habitat areas, wildlife ranges, and recreational areas border Cook Inlet and could be affected by accidental releases of oil spilled from onshore facilities and offshore drilling rigs. An oil spill contacting shoreline habitats could affect subsistence harvests in those parks in which recreation and subsistence hunting and fishing are allowed and could affect the number of park visitors. Impacts would depend primarily on the spill location, size, and time of year.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes the impacts of a CDE in the Cook Inlet Planning Area that has a volume of 75-125 thousand bbl and a duration of 50–80 days (Table 4.4.2-2). If a large volume of oil were to reach the shoreline following a catastrophic spill, NWRs could suffer a reduction in their primary function, which is to support wildlife and aquatic biota. Given the cold temperatures in Alaska, oil could contaminate nearshore refuge habitats for several years to decades and result in lethal and long-term sublethal impacts to refuge biota. Impacts would depend primarily on spill location, spill size, and timing of the spill. In general, directly affected coastal fauna would include marine mammals; fishes that reproduce in, inhabit, or migrate through coastal areas; terrestrial mammals that forage on fish; and marsh and seabirds that use these habitats for nesting and/or foraging. Spilled oil could also affect subsistence harvests in those parks in which subsistence hunting and fishing are allowed. See Sections 4.4.6.1.2 and 4.4.6.1.3 for a description of potential impacts of catastrophic oil spills on coastal areas and biota. Oil could contaminate nearshore habitats for several years to decades and result in lethal and long-term sublethal impacts on refuge biota (Short et al. 2007; Taylor and Reimer 2008; *Exxon Valdez* Oil Spill Trustee Council 2010a). The degree of effects and length of recovery depend on a number of factors such as the type of oil, extent of biota exposure, substrate type, degree of sediment contamination, time of year, and species sensitivity (NOAA 1998; Hayse et al. 1992; Hoff 1995). Sheltered intertidal areas are particularly slow to recover. More than 20 years after the *Exxon Valdez* oil spill, intertidal communities were considered to be recovering, but had not yet fully recovered from the effects of the spill (*Exxon Valdez* Oil Spill Trustee Council 2010a).

Impact Conclusions.

Routine Operations. Overall, impacts on Areas of Special Concern resulting from routine Program activities would be minimized by existing protections and use restrictions applicable to these areas. However, increased vessel and aircraft traffic and the construction of pipelines and platforms could have temporary and localized effects on wildlife and reduce the scenic value of National Parks and NWRs for some visitors. Overall, impacts on Areas of Special Concern resulting from routine Program activities are expected to be negligible to moderate.

Expected Accidental Events and Spills. Impacts on Areas of Special Concern from hydrocarbon spills are unlikely because most spills would be small. Large spills that reach coastal National Parks and NWRs could have more persistent impacts and could require remediation. Impacts from large spills could result from both oiling of the shoreline and mechanical damage during the cleanup process. If a large amount of oil were to contact a National Park, visitation would be likely to decrease or be temporarily prohibited and NWRs could also experience a loss of habitat value to fish and wildlife. Overall, impacts to Areas of Special Concern from small spills would range from negligible for spill less than 50 bbl, minor for spills up to 1,000 bbl, and from minor to moderate for large spills ($\geq$ 1,000 bbl).

An Unexpected Catastrophic Discharge Event. The impacts from a CDE would depend on the location and size of the spill, the type of product spilled, weather conditions, the type of area affected, the effectiveness of cleanup operations, and other environmental conditions at the time of the spill. Although a CDE is unlikely, if oil from a CDE were to reach an Area of Special Concern, coastal habitats and fauna as well as subsistence use, commercial or recreational fisheries, and tourism would be negatively affected. Based on monitoring data following the *Exxon Valdez* spill, oil in some coastal habitats would likely persist for multiple years. Overall, a CDE could result in up to moderate effects on Areas of Special Concern.

4.4.8.3 Alaska – Arctic

Impacts of Routine Operations.

Marine Protected Areas (MPAs). The Arctic National Wildlife Refuge (ANWR) and the Chukchi Sea unit of the Alaska Maritime National Wildlife Refuge are the two Federal system MPAs in or adjacent to the Beaufort and Chukchi Planning Areas, and are described in Section 3.6.5.1. NWRs could primarily be affected by pipeline landfalls and potentially by accidental oil spills, as described below.

National Forests, Parks and Refuges. There are no National Forests in the vicinity of the Beaufort and Chukchi Sea Planning Area; therefore, no impacts on U.S. Forest Service lands are expected. Impacts on NWRs could result from facilities developed to support offshore oil drilling and production, and could include effects from onshore pipelines and pipeline landfalls, dredging and construction, air pollution and the construction of roads, and processing and waste facilities. In addition, subsistence hunting and fishing, which are permitted on all NWRs in Alaska, could be affected by OCS activities. See Section 4.4.6.1.3 for a discussion of the potential impacts of the Program on coastal habitats. Oil facility development currently is prohibited on the ANWR and is discretionary on all other NWRs within Alaska. Although numerous refuge lands have been conveyed to private ownership and Native corporations, Section 22(g) of ANCSA requires that new development on these lands must be in accordance with the purpose for which the refuge was formed. Therefore, development of onshore oil and gas support facilities, though technically possible, would be subject to an exhaustive environmental review process. Therefore, it is currently considered unlikely that onshore oil and gas activities would be developed on refuge lands. Indirect impacts resulting from OCS activities, such as noise pollution or emissions associated with transportation of oil from adjacent planning areas, could occur but would be unlikely to have substantial effects on resources within refuge boundaries.

The Iñupiat Heritage Center, located in Barrow, Alaska, is the only NPS-managed area along the coast of the Beaufort and Chukchi Planning Areas. The area is already urbanized and would not be adversely affected by OCS activities. Although not an NPS land, the National Petroleum Reserve is managed by BLM and has a large shoreline component that borders the Chukchi Sea. Cape Krusenstern National Monument and the Bering Land Bridge National Preserve are south of the Chukchi Planning Area. Although oil transport through the Cape Krusenstern National Monument is permitted under the ANCSA and an existing road is present that could be used to access or create support facilities, such development is considered unlikely under the proposed action. Onshore oil and gas development within the boundaries of the Bering Land Bridge National Preserve is also considered to be unrealistic. Consequently, there are likely to be no effects in either of these National Parks from the proposed action.

Impacts of Expected Accidental Events and Spills. It is assumed that up to 3 large oil spills between 1,700 and 5,100 bbl, up to 35 small spills (50 to 999 bbl) and up to 190 smaller spills (>1 and <50 bbl) could occur during the lease period under the proposed action. Oil spills can occur from offshore drilling platforms, from vessels, or from pipelines located onshore and offshore. OCS infrastructure and activities are not likely to be permitted in NPS lands or in NWRs. Therefore, impacts to these areas from onshore pipeline spills are not likely. While small oil spills would likely only have limited influence on potentially affected resources within these refuges, a large spill could result in more drastic effects on coastal habitats and fauna.

Impacts of an Unexpected Catastrophic Discharge Event. This PEIS analyzes the impacts of a CDE in the Chukchi Sea Planning Area that has a volume of 1.4-2.2 million bbl and a duration of 40–75 days, and a CDE in the Beaufort Sea Planning Area with a volume of 1.7-3.9 million bbl and a duration of 60–300 days (Table 4.4.2-2). A CDE from an offshore pipeline or platform could potentially contact shoreline habitats and communities in NWRs and NPS lands. However, Cape Krusenstern National Monument and the Bering Land Bridge National Preserve are located more than 322 km (200 mi) south of the Chukchi Sea Planning Area and are therefore unlikely to be adversely affected by accidental spills occurring offshore in the Beaufort and Chukchi Seas. The Arctic NWR and the Chukchi Sea unit of the Alaska Maritime NWR would be susceptible to oil spilled from subsea pipelines or drilling platforms.

If a large volume of heavy oil were to reach the shoreline following a CDE, NWRs could suffer a reduction in their primary function which is to support wildlife and aquatic biota. Given the cold temperatures in Alaska, oil could contaminate nearshore refuge habitats for several years to decades and result in lethal and long-term sublethal impacts to refuge biota. Impacts would depend primarily on spill location, spill size, and timing of the spill. In general, directly affected coastal fauna would include marine mammals; fishes that reproduce, inhabit, or migrate through coastal areas; terrestrial mammals that forage on fish also including invertebrate communities that are utilized in subsistence (clams, etc.) and important sources of foraging for marine mammals, fish, and bird populations; and marsh and seabirds that use these habitats for nesting and/or foraging. Spilled oil could also affect subsistence harvests in those parks in which subsistence hunting and fishing are allowed. See Section 4.4.6.1.3 for a description of potential impacts of a CDE on coastal areas and biota.

Impact Conclusions.

***Routine Operations*.** Overall, impacts on Areas of Special Concern resulting from routine Program activities would be minimized by existing protections and use restrictions applicable to these areas. However, increased vessel and aircraft traffic and the construction of pipelines and platforms could have temporary and localized effects on wildlife. Overall, impacts on Areas of Special Concern resulting from routine Program activities are expected to be negligible to moderate.

***Expected Accidental Events and Spills*.** While most accidents would be small and would have relatively small impacts on Areas of Special Concern, large spills that reach coastal NWRs could have more persistent impacts and could require remediation. Impacts from large spills could result from both oiling of the shoreline and mechanical damage during the cleanup process. If a large amount of oil were to contact a NWR, it could experience a loss of habitat value to fish and wildlife. Overall, impacts to Areas of Special Concern from small spills would range from negligible for spill less than 50 bbl, minor for spills up to 1,000 bbl, and from minor to moderate for large spills (≥1,000 bbl).

An Unexpected Catastrophic Discharge Event. Should oil from a CDE reach an Area of Special Concern, the impacts would depend on the location and size of the spill, the type of product spilled, weather conditions, the type of area affected, the effectiveness of cleanup operations, and other environmental conditions at the time of the spill. Although a CDE is unexpected, if oil from a CDE were to reach an Area of Special Concern, coastal habitats and fauna, as well as subsistence use could be negatively affected. Based on monitoring data following the *Exxon Valdez* spill, oil in some coastal habitats would likely persist for multiple years. Overall, a CDE could result in up to moderate effects on Areas of Special Concern.

4.4.9 Potential Impacts on Population, Employment, and Income

4.4.9.1 Gulf of Mexico

Impacts of Routine Operations. Under the proposed action alternative, between 200 and 400 new platforms would be located in the GOM over the 40-year planning period. Using impact estimates provided by the MAG-PLAN Model (see MMS 2005f; BOEM 2011b), Table 4.4.9-1 shows total (direct, indirect, and induced) employment and regional income for Economic Impact Areas (EIAs) in each State in the GOM coast region whose social and economic well-being is directly or indirectly affected by the OCS oil and gas industry (see Section 3.10). Average annual impacts of the proposed action in the GOM coast region would be the addition of between 20,025 and 41,825 jobs, which would amount to less than 1% of total projected GOM coast regional employment in 2015. Between $1,050 million and $2,180 million in income would be produced. The largest employment impacts would be in Texas, ranging from 10,900 to 21,925 additional jobs, with smaller impacts in Louisiana, where the employment created would range from 7,575 to 16,425 jobs. Income impacts in these States would range between $630 million and $1,270 million in Texas and between $350 million and $765 million in Louisiana. Employment impacts are lower in the other GOM coast States; the total number of jobs created would be between 975 and 2,150 in Florida, between 350 and 800 in Alabama, and between 225 and 525 in Mississippi. Although only a small amount of OCS oil and gas activity is proposed for the Eastern Planning Area, economic impacts would occur in Florida associated with expenditures on material and equipment supplied by sectors located in Florida, and the and use of ports and infrastructure for the associated transportation.

The additional jobs would create small but noticeable increases in the population of these regions. Using a historically observed ratio of 2.59 persons per new job (MMS 2006b), population increases of between 28,231 and 56,786 would be expected in Texas on average in each year of the proposed action, with increases of between 19,619 and 42,541 occurring in Louisiana. Smaller increases in population of between 2,525 and 5,569 per new job would occur in Florida, with increases of between 907 and 2,072 in Alabama, and between 583 and 1,360 in Mississippi.

Installation and operation of new offshore oil and gas platforms have the potential to impact property values in coastal areas within viewing distances of offshore activities. The extent of the impact of any given platform would vary according to distance to shore, location within a maximum viewing range, and regional visibility conditions. There are currently 3,679 offshore platforms in the Western and Central Planning Areas in Federal waters in the GOM. Under the proposed action alternative, between 200 and 450 platforms would be added over the 40-year planning period, an average of between five and ten platforms per year. It is also anticipated that between 150 and 275 platforms would be removed over the same period. Although the location of additional offshore platforms is not known, with some new platforms conceivably located in areas of the GOM with relatively little existing oil and gas development, the majority of new platforms are likely to be located in areas already hosting existing platforms.

TABLE 4.4.9-1 Average Annual Impacts of the Proposed Action (Alternative 1) on Coastal Regional Employment and Income[a]

Economic Impact Area	Employment	Income
Alabama		
Low	350	15
High	800	35
Florida		
Low	975	45
High	2,150	95
Louisiana		
Low	7,575	350
High	16,425	765
Mississippi		
Low	225	10
High	525	25
Texas		
Low	10,900	630
High	21,925	1,270
Total GOM		
Low	20,025	1,050
High	41,825	2,180

[a] Totals may not add due to rounding. All estimates are totals of direct, indirect, and induced impacts. Employment estimates are in employee years; personal income estimates are in millions of 2012 dollars.

Source: BOEMRE 2011n.

Impacts of Expected Accidental Events and Spills. Up to 8 large spills greater than 1,000 bbl, between 35 and 70 spills between 50 and 1,000 bbl, and up to 400 small spills less than 50 bbl could occur in the GOM from the proposed action. It is expected that many of these spills will occur in deepwater areas located away from the coast, based on the established trend for greater oil production activity to move into deepwater located for the most part at a substantial distance from the coast.

In previous oil spill analyses, there is a less than 0.5% probability that an oil spill greater than or equal to 1,000 bbl would reach the shores of the majority of coastal counties and parishes in Texas and Louisiana within 10 days of a spill occurring over the 40-yr leasing period in the Western and Central Planning Areas (MMS 2006a). Six counties in Texas and one parish in

Louisiana have a 1–5% chance of an OCS offshore oil spill greater than or equal to 1,000 bbl reaching their shoreline within 10 days. BOEM also estimates that between 5 and 15 chemical spills associated with the OCS program are anticipated each year, with a small percentage of these associated with the proposed action. The majority of spills are expected to be less than 50 bbl in size; a chemical spill of greater than or equal to 1,000 bbl as a result of the proposed action is very unlikely.

The immediate socioeconomic impact of a larger oil spill would include the loss of employment, income, and property value; increased traffic congestion; increased cost of public service provision, and possible shortages of commodities or services. In the short term, the impacts of a spill would be measured in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Longer-term impacts could affect fishing, shrimping, oystering, and/or tourism if these activities were to suffer due to the real or perceived impacts of the spill, and could include substantial changes to the energy industries in the region as a result of the spill.

The employment and regional income impact from an oil spill would likely be greatest in Texas and Florida, with the highest concentration of tourism-related employment occurring in Florida, particularly in the Miami and Tampa-St. Petersburg areas and the Houston-Galveston areas. In the Central GOM Planning Area, the New Orleans area would also be affected due to their high concentration of tourism-related employment. Net employment impacts from a spill are not expected to exceed 1% of baseline employment for any LMA in any given year, even if they are included with employment associated with routine oil and gas development activities associated with the proposed action.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE with an assumed volume of 0.9-7.2 million bbl and a duration of 30–90 days (Table 4.4.2-2). A CDE could result in impacts, which could include the loss of employment, income, and possible shortages of commodities or services in both coastal and inland areas. In coastal areas, losses of property value and increased traffic congestion could also occur, with increases in the cost of public service provision also possible. In the short term, impacts of a CDE would be measured in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Longer-term impacts may include impacts to fishing activities and tourism if these activities were to suffer as a result of the real or perceived impacts of the event, and could include substantial changes to energy industries in the region as a result of the event.

Impact Conclusions.

Routine Operations. Routine Program activities would result in negligible impacts from small increases in population, employment, and income, resulting in increases of less than 1% of baseline levels.

Expected Accidental Events and Spills. Impacts of accidental oil spills could include the short-term loss of employment, income, and property value; increased traffic congestion; increased cost of public service provision; and possible shortages of commodities or services. In the short term, the impacts of a spill would also include projected cleanup expenditures and employment created in cleanup and remediation activities. Longer-term impacts could affect fishing, shrimping, oystering, and/or tourism if these activities were to suffer due to the real or perceived impacts of the spill, and could include substantial changes to the energy industries in the region as a result of the spill. Small spills up to 1,000 bbl would have negligible to minor socioeconomic impacts, while large spills of more than 1,000 bbl would have minor to moderate impacts.

An Unexpected Catastrophic Discharge Event. A CDE could result in the loss of employment, income, and possible shortages of commodities or services in both coastal and inland areas affected by the spill. Losses of property value could also occur in coastal communities, with increased cost of local public service provision also possible. In the short term, impacts of a CDE, measured in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities, would be expected to be large. Longer-term impacts would likely be small, unless recreational activities and tourism suffered as a result of the real or perceived impacts of the event, or if there were substantial changes to energy production in the region as a result of the accidental spill; this would be more likely in the event of a CDE. Overall, the impacts of a CDE would be between minor to moderate.

4.4.9.2 Alaska – Cook Inlet

Impacts of Routine Operations. Under the proposed action alternative, between one and three new platforms would be located in Cook Inlet over the 40-year planning period. Table 4.4.9-2 shows total (direct, indirect, and induced) employment and income in Alaska as a whole. Average annual impacts of the proposed action in the Alaska region would be between 1,372 and 3,792 jobs, which would amount to less than 2% of total projected Alaska employment in 2015. Personal income would increase by between $86.5 million and $255.6 million annually in Alaska as a whole.

Based on current trends, it is assumed that most of the workers directly associated with OCS oil and gas activity will work offshore or onshore in worker enclaves separated from local communities, and that most OCS workers will likely commute to work sites from Alaska's larger population centers or from outside the immediate area. It is also assumed that OCS jobs would be available to the local populations in all areas, but that rural Alaskan employment in the petroleum industry, especially among Alaska Natives, will remain relatively low.

Many workers on oil rigs in the Cook Inlet Planning Area (and onshore oil and gas facilities on the Kenai Peninsula and the North Slope) currently live in Anchorage or on the Kenai Peninsula. The larger populations and more diverse economies of south central Alaska compared to other Alaskan communities will tend to lessen the potential effect of proposed leasing on their economies. As a result, employment generated by OCS activity in the Cook Inlet Planning Area at its peak is only expected to account for less than 5% of total Alaska employment.

TABLE 4.4.9-2 Average Annual Impacts of the Proposed Action (Alternative 1) on Alaska Employment and Income[a]

Area	Employment	Income
Cook Inlet		
Low	1,372	86.5
High	3,792	255.6

[a] All estimates are totals of direct, indirect, and induced impacts. Employment estimates are in employee years; labor income estimates are in millions of 2012 dollars.

Source: BOEMRE 2011o.

Installation and operation of new offshore oil and gas platforms have the potential to impact property values in coastal areas within viewing distances of offshore activities. The extent of the impact of any given platform would vary according to distance from shore, location within a maximum viewing range, and regional visibility conditions. Under the proposed action alternative, between one and three platforms would be added over the 40-yr planning period. It is also anticipated that between one and three platforms would be removed over the same period. Although the location of additional offshore platforms is not known, with some new platforms conceivably being located in areas of the Cook Inlet area, the majority of new platforms are likely to be located in the vicinity of areas already hosting existing platforms.

Impacts of Expected Accidental Events and Spills. One large spill greater than 1,000 bbl, up to 3 spills between 50 bbl and 1,000 bbl, and up to 15 small spills less than 50 bbl could occur in the Cook Inlet Planning Area under the proposed action. Although an oil spill could occur anywhere in the lease sale area, cleanup-related employment would likely occur in the area directly affected, generally in locations remote from communities. The hiring of cleanup workers will likely draw from labor markets in both the region and the rest of Alaska. Oil spills will generate only temporary employment (and population) increases during cleanup operations, because such operations are expected to be of short duration. Employment generated by spills will be a function of the size and frequency of spills.

Impacts of an Unexpected Catastrophic Discharge Event. For the Cook Inlet Planning Area, the PEIS analyzes a CDE with an assumed volume of 75-125 thousand bbl and a duration of 50–80 days (Table 4.4.2-2). The socioeconomic impact of a CDE could result in up to moderate impacts, which could include the loss of employment, income, and possible shortages of commodities or services in both coastal and inland areas. In coastal areas, losses of property value and increased traffic congestion could also occur, with increases in the cost of public service provision also possible. In the short term, impacts of a CDE would be measured in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Longer-term impacts could include fishing and tourism if these activities were to suffer as a result of the real or perceived impacts of the event, and could include substantial changes to energy industries in the region as a result of the event.

Impact Conclusions.

Routine Operations. Routine Program activities would result in minor impacts in the Cook Inlet area, with population, employment, and income increasing by less than 5% of baseline levels in Alaska.

Expected Accidental Events and Spills. Impacts of accidental oil spills could include the short-term loss of employment, income, and property value; increased traffic congestion; increased cost of public service provision; and possible shortages of commodities or services. In the short term, the impacts of a spill would also include projected cleanup expenditures and employment created in cleanup and remediation activities. Longer-term impacts could affect fishing and/or tourism if these activities were to suffer due to the real or perceived impacts of the spill, and could include substantial changes to the energy industries in the region as a result of the spill. Small spills up to 1,000 bbl would have negligible to minor socioeconomic impacts, while large spills of more than 1,000 bbl would have minor to moderate impacts.

An Unexpected Catastrophic Discharge Event. A CDE could result in the loss of loss of employment, income, and possible shortages of commodities or services in both coastal and inland areas affected by the spill. Losses of property value could also occur in coastal communities, with increased cost of local public service provision also possible. In the short term, impacts of a CDE, measured in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities, would be expected to be large. Longer-term impacts would likely be small, unless recreational activities and tourism suffered as a result of the real or perceived impacts of the event, or if there were substantial changes to energy production in the region as a result of the accidental spill; this would be more likely in the event of a CDE. Overall, the impacts of a CDE would be between minor to moderate.

4.4.9.3 Alaska – Arctic

Impacts of Routine Operations. Under the proposed action alternative, between one and five new platforms would be located in the Chukchi Sea and one and four platforms in the Beaufort Sea over the 50-yr planning period. Table 4.4.9-3 shows the potential effects of the proposed action alternative in the Arctic region. Average annual impacts of the proposed action in the Arctic region would be an increase of between 3,457 and 12,665 jobs, which would amount to 5.6% of total projected Alaska employment in 2015. Personal income would increase by between $232.9 million and $904.0 million annually in the Arctic region.

Most of the workers directly associated with OCS oil and gas activity will work offshore or onshore in worker enclaves separated from local communities, and most workers will likely commute to work sites from Alaska's larger population centers, including Anchorage and Fairbanks, or from outside Alaska (MMS 2006b). While OCS jobs would be available to the

TABLE 4.4.9-3 Average Annual Impacts of the Proposed Action (Alternative 1) on Alaska Employment and Income[a]

Area	Employment	Income
Beaufort Sea		
Low	1,581	106.0
High	5,193	364.2
Chukchi Sea		
Low	1,876	126.9
High	7,472	539.9
Total Arctic Region		
Low	3,457	232.9
High	12,665	904.0

[a] All estimates are totals of direct, indirect, and induced impacts. Employment estimates are in employee years; labor income estimates are in millions of 2012 dollars.

Source: BOEMRE 2011o.

local populations in all areas, rural Alaskan employment in the petroleum industry, especially among Alaska Natives, would likely remain relatively low.

Employment in the North Slope oil and gas industry has little direct impact on the communities of the North Slope Borough. While actively working, most North Slope oil and gas workers stay in enclave housing separate from local communities, permanently residing in south central Alaska (Anchorage, the Kenai Peninsula Borough, and the Matanuska-Susitna Borough), or the Fairbanks area, and commute to their homes (or other locations) when not working. As population, employment, and income impacts affect the regional economies in which employees permanently reside, BOEM has not included these impacts in the discussion of impacts of the proposed action in the Arctic region.

The most important benefit of oil and gas development in the Arctic region is revenue from taxation of oil industry facilities. Although jurisdictions in the North Slope Borough and Northwest Arctic Borough are unable to tax offshore OCS facilities, the borough collects property tax revenue from new onshore pipelines and other facilities. Shareholders of the Arctic Slope Regional Corporation, most of whom reside on the North Slope, receive dividends from investments in petroleum service companies many of which are service oil companies on the North Slope and are potential service companies for Chukchi activities. The effects of the proposed action on employment and income in Arctic region communities are likely to be significant, especially when combined with the continued decline in Prudhoe Bay and other North Slope production areas, and continued OCS production would allow jurisdictions in the

Arctic region to maintain revenue collection from onshore facilities associated with continued offshore production.

Impacts of Expected Accidental Events and Spills. Up to 3 large spills greater than 1,000 bbl, 10 and 35 spills between 50 and 1,000 bbl, and up to 190 small spills of less than 50 bbl could occur in the Beaufort and Chukchi Sea area from the proposed action. Although an oil spill could occur anywhere in the lease sale area, cleanup-related employment would likely occur in the area directly affected, generally in locations remote from communities. The hiring of cleanup workers would have a regional and State of Alaska emphasis. Oil spills will generate only temporary employment (and population) increases during cleanup operations, because such operations are expected to be of short duration. Employment generated by spills will be a function of the size and frequency of spills. Large spills of over 1,000 bbl would generate 60 to 90 jobs for up to 6 months and would generate moderate local effects (MMS 2008b).

Impacts of an Unexpected Catastrophic Discharge Event. For the Chukchi Sea Planning Area, the PEIS analyzes a CDE with an assumed volume of 1.4-2.2 million bbl and a duration of 40–75 days; for the Beaufort Sea Planning Area a CDE is assumed to have a volume of 1.7–3.9 million bbl and a duration of 60–300 days (Table 4.4.2-2). The socioeconomic impact of a CDE would result in up to moderate impacts, which could include the loss of employment, income, and possible shortages of commodities or services in both coastal and inland areas. Losses of property value could also occur in coastal communities, with increased cost of local public service provision also possible. In the short term, impacts of a CDE would be measured in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Longer-term impacts could include recreational activities and tourism if these activities suffered as a result of the real or perceived impacts of the event, and may include substantial changes to energy production in the region as a result of the event.

Impact Conclusions.

Routine Operations. Routine operations would result in minor impacts in Alaska with increases in population, employment, and income of less than 5% of baseline levels in Alaska.

Expected Accidental Events and Spills. Impacts of accidental oil spills could include the short-term loss of employment, income, and property value; increased traffic congestion; increased cost of public service provision; and possible shortages of commodities or services. In the short term, the impacts of a spill would also include projected cleanup expenditures and employment created in cleanup and remediation activities. Longer-term impacts could affect fishing and/or tourism if these activities were to suffer due to the real or perceived impacts of the spill, and could include substantial changes to the energy industries in the region as a result of the spill. Small spills up to 1,000 bbl would have negligible to minor socioeconomic impacts, while large spills of more than 1,000 bbl would have minor to moderate impacts.

An Unexpected Catastrophic Discharge Event. CDE could result in the loss of employment, income, and possible shortages of commodities or services in both coastal and inland areas affected by the spill. Losses of property value could also occur in coastal communities, with increased cost of local public service provision also possible. In the short term, impacts of a CDE, measured in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities, would be expected to be large. Longer-term impacts would likely be small, unless recreational activities and tourism suffered as a result of the real or perceived impacts of the event, or if there were substantial changes to energy production in the region as a result of the accidental spill; this would be more likely in the event of a CDE spill. Overall, the impacts of a CDE would be between minor to moderate.

4.4.10 Potential Impacts to Land Use and Infrastructure

The development of oil and gas facilities within the GOM, the Cook Inlet, and the Arctic would have both direct and indirect impacts on existing and future land use, development patterns, and infrastructure. Potential impacts of routine activities of the Proposed Action Alternative are presented below. Routine activities include seismic explorations and exploratory drilling, onshore and offshore construction, normal operations, and decommissioning. Potential impacts of expected accidental spills and an unexpected CDE are also presented. In general, the nature and magnitude of these impacts would depend upon the level and location of new construction, the degree to which the area is already developed, and, in the case of accidental spills or a CDE, the size and location of the spill.

Table 4.4.10-1 provides a summary of the resource receptors that pertain to routine activities. As shown in this table, potential receptors include the following:

- Land use categorization,
- Land use plans and initiatives,
- Development patterns, and
- Onshore infrastructure.

Conceptual models illustrated in Figures 4.4.10-1 through 4.4.10-3 show how various activities associated with seismic surveys, onshore and offshore construction, and normal oil and gas operations may impact land use, development patterns, and infrastructure. These figures are applicable to the GOM, the Cook Inlet, and the Arctic.

As shown in these figures, the potential effects of oil and gas activities typically include the following:

- Incompatibility with local land use/comprehensive planning patterns,
- Incompatibility with existing/planned development,
- Loss of use (intended or perceived) to existing landowners or users, and

TABLE 4.4.10-1 Impacting Factors Associated with Each Phase of Oil and Gas Activities[a]

Resource Receptor Category Potentially Affected	O&G Activities Phase				
	Exploration				
	Seismic Survey	Exploratory Wells	Development/ Construction	Production/ Normal Operations	Decommissioning
Land use categorization	I	I	X	I	X
Land use plans/initiatives	I	I	X	I	X
Development patterns	I	I	X	I	X
Onshore infrastructure	I	I	X	I	X

[a] I = Indirect impacts are anticipated; X = Both direct and indirect impacts are anticipated.

- Potential changes to the physical and/or infrastructural composition of the coast.

Each of these impacts is discussed in the context of seismic explorations, construction of onshore and offshore facilities, normal operations, and decommissioning. A more general discussion of impacts is provided for accidental releases or spills.

For the purpose of this discussion, land use refers to the activity that occurs on a specific area of land and within the structures that occupy it, whereas zoning regulations include such things as requirements for building size, bulk, and density. General land use is assumed to be the primary factor in determining existing and future development decisions. Specific zoning regulations were not evaluated for areas located within the GOM, the Cook Inlet, or the Arctic due to the large scale of the planning areas. Individual environmental assessments generally would account for localized regulations.

In addition, for the purposes of this discussion, intended land use is that prescribed by regulations or formalized land use plans. For instance, if a parcel of land is dedicated as agricultural land, the intended activities likely would include farming, animal husbandry, or a combination of rural activities. The actual use, however, may differ. For the purpose of this evaluation, “actual use” is the manner in which people physically use the land that may or may not be regulated or prescribed by laws or formal plans. Instead, the use may involve traditional practices or activities occurring for long periods of time.

4.4.10.1 Gulf of Mexico

As indicated in Table 4.4.1-1, potentially available oil includes a range of 2.7 to 5.4 billion barrels (Bbbl) within the GOM, along with 12–24 trillion cubic feet (tcf) of natural gas. In order to provide for production of these resources, a number of routine activities are

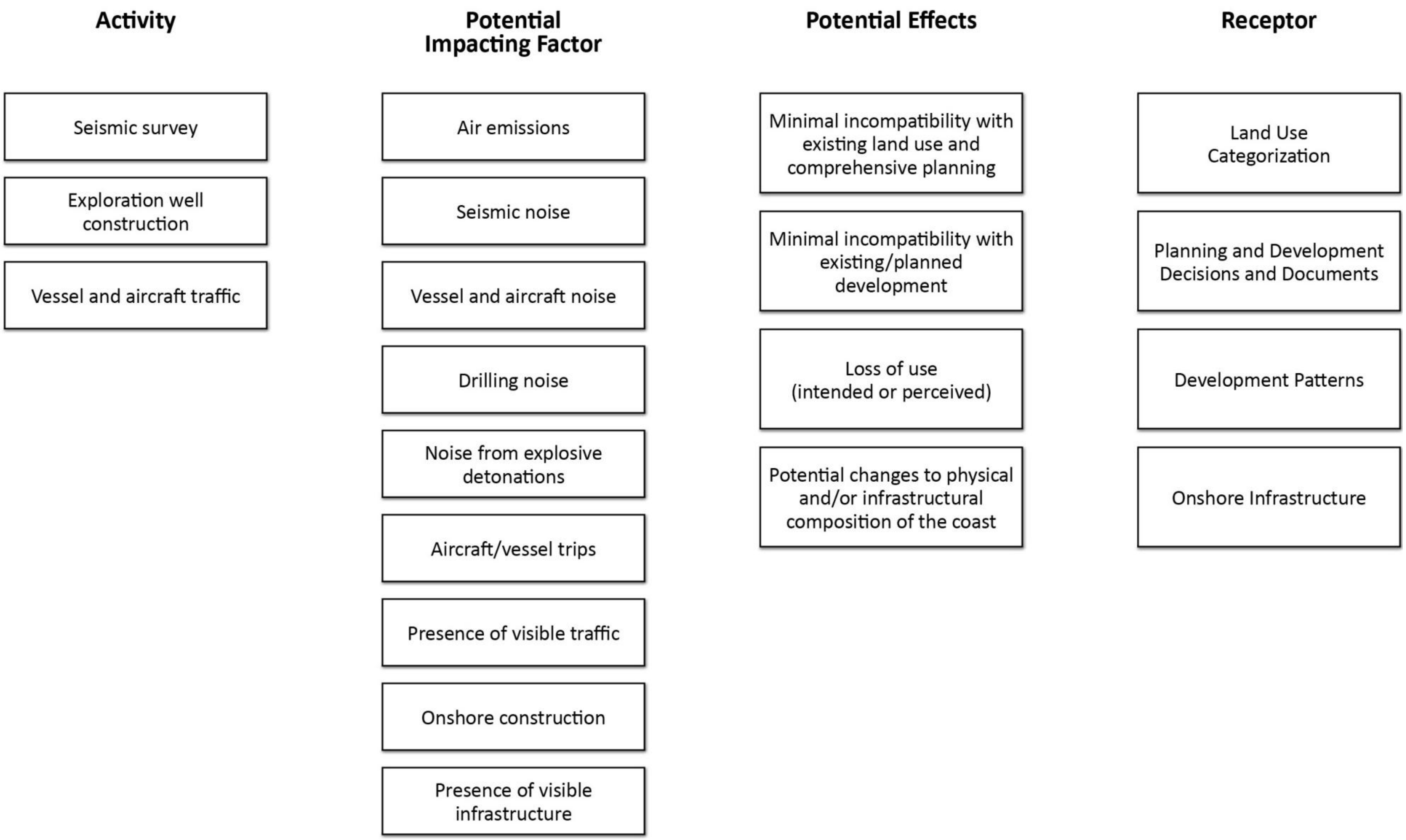

FIGURE 4.4.10-1 Conceptual Model for Potential Direct and Indirect Effects of Seismic Survey Activities on Land Use, Development Patterns, and Infrastructure

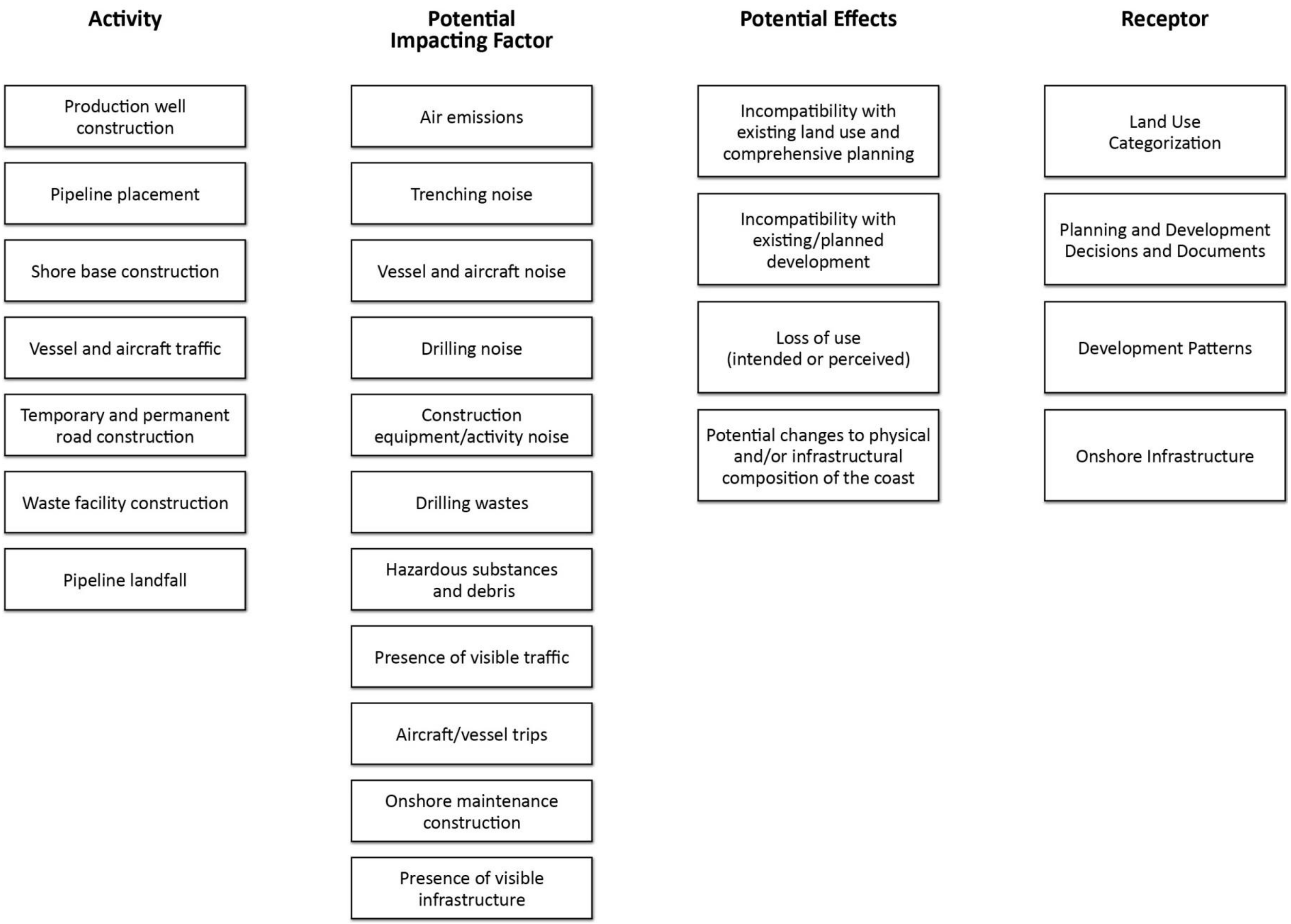

FIGURE 4.4.10-2 Conceptual Model for Potential Direct and Indirect Effects of Onshore/Offshore Construction Activities on Land Use, Development Patterns, and Infrastructure

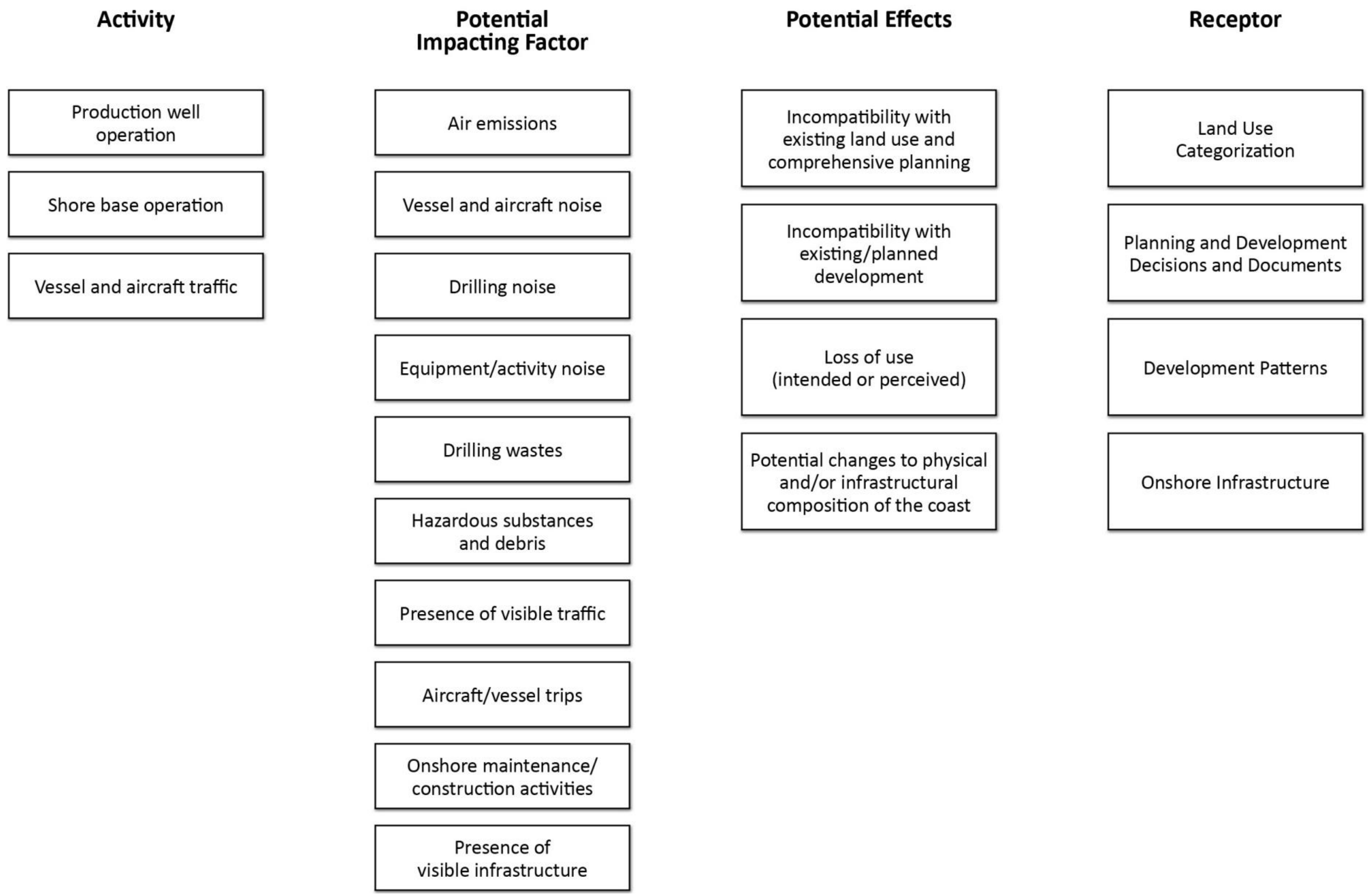

FIGURE 4.4.10-3 Conceptual Model for Potential Direct and Indirect Effects of Normal Operations on Land Use, Development Patterns, and Infrastructure

necessary. As previously indicated, these activities have the potential to impact existing and future land use, development patterns, and infrastructure.

Impacts of Routine Operations.

Seismic Explorations and Exploratory Drilling. Activities associated with exploration typically include a seismic survey, exploratory well construction, and aircraft and vessel traffic (see Figure 4.4.10-1).

Local Land Use/Comprehensive Planning and Development Patterns. Seismic explorations and exploratory drilling would not impact land use, development patterns, and infrastructure directly, as a majority of the activities would be located offshore. In general, existing and future land use categorizations would remain unchanged, along with current development patterns. Existing and planned activities associated with local planning initiatives and plans likely would not be hindered, as the jurisdiction of these plans typically would not extend to the offshore activities. State and Federal planning initiatives, such as the National Coastal Zone Management (CZM) Program, would generally be consistent with seismic surveys and exploratory drilling due to the need for prioritizing coastal-dependent uses (see Section 3.11.1 for more information on this program).

Loss of Use to Existing Landowners or Users. Seismic explorations and exploratory drilling activities would not impact access or use of a particular land area. Some safety-related temporary restrictions on access may be necessary both onshore and offshore; however, these restrictions likely would be temporary, lasting only as long as the exploration activities, with access restrictions lifted afterwards.

In addition, the use of individual properties may be affected indirectly if excessive noise and air emissions generated by survey equipment/vessels and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles) were to occur, or if a small increase in the amount of trash and debris washing ashore were to result from exploration. These occurrences may cause a temporary disturbance or annoyance among particular landholders or users and thereby interfere with their intended or actual use of the land. These impacts would be temporary in nature due to the short time frame of these activities. The level of impact would depend on the specific location of the exploration activities within the GOM.

Physical and/or Infrastructural Composition. While additional infrastructure, such as machinery and staging area improvements, may be needed to accommodate equipment and workers associated with the exploration activities, the increase likely would be negligible at this stage of oil and gas development. In general, existing infrastructure within the GOM would likely be able to accommodate activities associated with exploration (see Section 3.11.1 for further information regarding existing GOM infrastructure).

Onshore and Offshore Construction. Impacts on land use, development patterns, and infrastructure associated with onshore and offshore construction are presented below. As indicated in Figure 4.4.10-2, activities associated with this phase include production well placement, pipeline placement, onshore construction, and aircraft and vessel traffic. Similar to the exploration phase, these activities have the potential to impact local land use and comprehensive planning and existing and planned development; access and use of particular properties; and the physical and infrastructural makeup of the GOM as pertaining to emissions, waste, noise, and traffic; each is discussed below.

Local Land Use/Comprehensive Planning and Development Patterns. As indicated in Section 3.11.1, a number of onshore and offshore facilities are associated with the development of offshore oil and gas. Among these are ports, ship and shipbuilding yards, support and transport, pipelines, pipe coating yards, natural gas processing and storage, refineries, petrochemical plants, and waste management facilities. Current BOEM data suggests that more than 3,900 offshore production facilities are located within the GOM within Federal waters. Most of these facilities are located within the Western and Central Planning Areas.

According to previous government documents, a steady pace of offshore leasing has persisted in the GOM for nearly six decades with the first Federal lease sale in 1954 (MMS undated). Consequently, land use categorizations in the Western and Central Planning Areas often would be able to accommodate this type of industry. Therefore, very little change in land use categorizations (i.e., receptor) are likely to result from the continuation of leasing and subsequent exploration and development activities in the Western and Central GOM Planning Areas. In addition, the development of oil and gas facilities likely would be compatible with existing local land use, zoning, and comprehensive planning in these areas. Land use likely would evolve over time, with most changes occurring as a result of general regional growth rather than specific activities associated with the production of oil and gas (BOEMRE 2011a).

As a result of the DWH event, the overall climate for development of oil and gas has been altered in response to a recent suspension and changes in Federal requirements for drilling safety in the whole of the GOM (BOEMRE 2011a). In some areas of the GOM, for instance, local planning initiatives have been drafted in response to the recent event that could impact the construction of new and/or infill facilities. Some of these initiatives focus on the economic diversification of the GOM coast, rather than upon oil and gas activities, while other strategies focus on the investment of monies for necessary human services (Restore the Gulf 2010b). Perceptions about the spill may influence future decisions regarding the need for oil and gas investments, improvements to existing infrastructure, and the construction of new oil and gas facilities.

Likewise, individual businesses and organizations have adapted to the altered, post-DWH environment. For instance, some companies have removed a portion of their equipment, and a substantial decrease in helicopter flights and servicing of rigs has occurred. Companies have trimmed budgets by cutting hours and salaries of workers; associated support services, such as chemical suppliers and welders, also have been affected by the DWH event.

The effects of this decreased demand have rippled through the various infrastructure categories (e.g., fabrication yards, shipyards, port facilities, pipecoating facilities, gas processing facilities, and waste management facilities) and have affected the oil and gas support sector businesses (e.g., drilling contractors, offshore support vessels, helicopter hubs, and mud/drilling fluid/lubricant suppliers) (BOEMRE 2011a). Land use has been impacted indirectly through various economic incentives, compliance with permitting requirements, and the lack of use of existing facilities. As indicated in a 2011 lease sale, some locations offered a 30% reduction in rental rates in order to keep businesses (BOEMRE 2011a). Actions of this nature influence the overall development pattern. As a consequence, BOEM anticipates monitoring the overall oil and gas development climate as it pertains to the DWH event (BOEMRE 2011a).

If new infrastructure is needed onshore, some developments may be subject to local, State, and/or other Federal permitting and regulations. Within the Western and Central Planning Areas, infill development likely would occur in areas already established for oil and gas development. Specific timelines and requirements would vary by location, as BOEM typically is not the permitting or regulating agency for development activities that occur onshore.

Loss of Use to Existing Landowners or Users. With proper permitting and approvals, onshore and offshore construction generally would not interfere with or prevent use by existing owners or users within areas of immediate development. During construction activities, a temporary loss of access to some areas may be required for safety reasons, with access restored upon completion of the activities. Some users of surrounding land may be inconvenienced by closure or restrictions on access routes, as well. Permanent loss of use is not anticipated. If new land were necessary in order to construct onshore facilities, the acquisition would follow all pertinent local, State, and Federal requirements.

The use of individual properties in the vicinity of the construction activities may be affected indirectly if excessive noise and air emissions generated by the construction equipment and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles) were to occur, or if a small increase in the amount of trash and debris washing ashore were to result from the activities. These occurrences may cause a temporary disturbance or annoyance among particular landholders or users, thereby inhibiting the intended or actual use of a property. The level of impact would depend on the specific location within the GOM.

Physical and/or Infrastructural Composition. Physical land disturbance also would occur in locations where new facilities are needed. As indicated in Table 4.4.1-1, the Western and Central Planning Areas may require up to 12 new pipeline landfalls, four to six new pipe yards, and the potential for up to 12 new natural gas processing facilities. Approximately 3,862–12,070 km (2,400–7,500 mi) of new pipeline could be needed, as well.

The creation of pipeline landfalls could involve such activities as clearing land, preparing a ROW, and digging and backfilling trenches. These activities could alter the physical composition of the landscape, thus potentially limiting the intended use of a parcel unless located in existing utility ROWs. Likewise, the construction of new shore bases and waste facilities could involve, but would not be limited to, the preparation of a site through grading and clearing, excavations, and foundation building. As with a pipeline, these types of activities would alter the existing landscape and, depending on the scale and location, could alter the intended use of a parcel. While these changes would be necessary in some locations within the GOM, the activities associated with the oil and gas construction would not likely cause an extensive change to existing development patterns.

The construction of more permanent facilities could be a positive impact or a negative impact depending on the specific location within the GOM. For instance, where new roads would provide additional routes and capacity for coastline travel, they may be perceived as a positive impact by some stakeholders. However, if the same roadways added large traffic volumes to existing roadways that already were over capacity, the construction could be seen as a negative impact.

Additional indirect impacts include those associated with climate change. Siting of new facilities may account for potential changes resulting from rises in sea level, increased storm frequency and intensity, and temperature changes. Figure 4.4.10-4 provides an illustration of the potential sea rise levels in the GOM.

As noted in the publication, *Oceans and Marine Resources in a Changing Climate: Technical Input to the 2013 National Climate Assessment*, one of the main climate-related effects on the oil and gas industry is the failure of infrastructure that was not designed to withstand new climatic conditions. Some of the existing equipment, such as shallow-water oil platforms in the GOM, were designed to function under climatic conditions typical of 20 to 40 years ago, rather than the conditions of today (Orbach et al. undated). In the past, typical responses to landscape changes associated with a rising sea level included building seawalls and hard structures to hold back the water, raising the land level, replenishing beaches and shorelines, or allowing the water to advance (Twilley et al. 2001).

Today, potential solutions will need to account for these changes in the sea level and may include facility relocation, the construction of seawalls and storm surge barriers, dune reinforcement, and land acquisitions to create buffer areas (IPCC 2007). Advance planning for the potential rise in the sea level due to climate change will help to avoid costly impacts on onshore infrastructure.

Consequently, indirect impacts on land use, development patterns, and infrastructure could include locating facilities further inland and/or strengthening the foundations or building materials of existing facilities. These actions potentially could increase costs associated with development or lead to the construction of new facilities rather than the reuse or expansion of existing properties associated with oil and gas production. These decisions may be influenced by the potential for increased flooding and/or erosion.

***Production Operations*.** Routine operation activities would consist of production well operation, onshore facility operation, and vessel and aircraft traffic, and would also include the transport of oil from offshore to onshore locations using ships or pipelines (see Figure 4.4.10-3).

<u>Local Land Use/Comprehensive Planning and Development Patterns.</u> Once offshore wells are in operation, land use, development patterns, and infrastructure would not be greatly affected by routine operations, because a majority of the activities would be located offshore. As previously indicated, land use likely would evolve over time, with most changes occurring as a result of general regional growth rather than through activities associated with oil and gas production (BOEMRE 2011a). Some regions within the GOM may be impacted to a greater extent than others depending on the site-specific conditions.

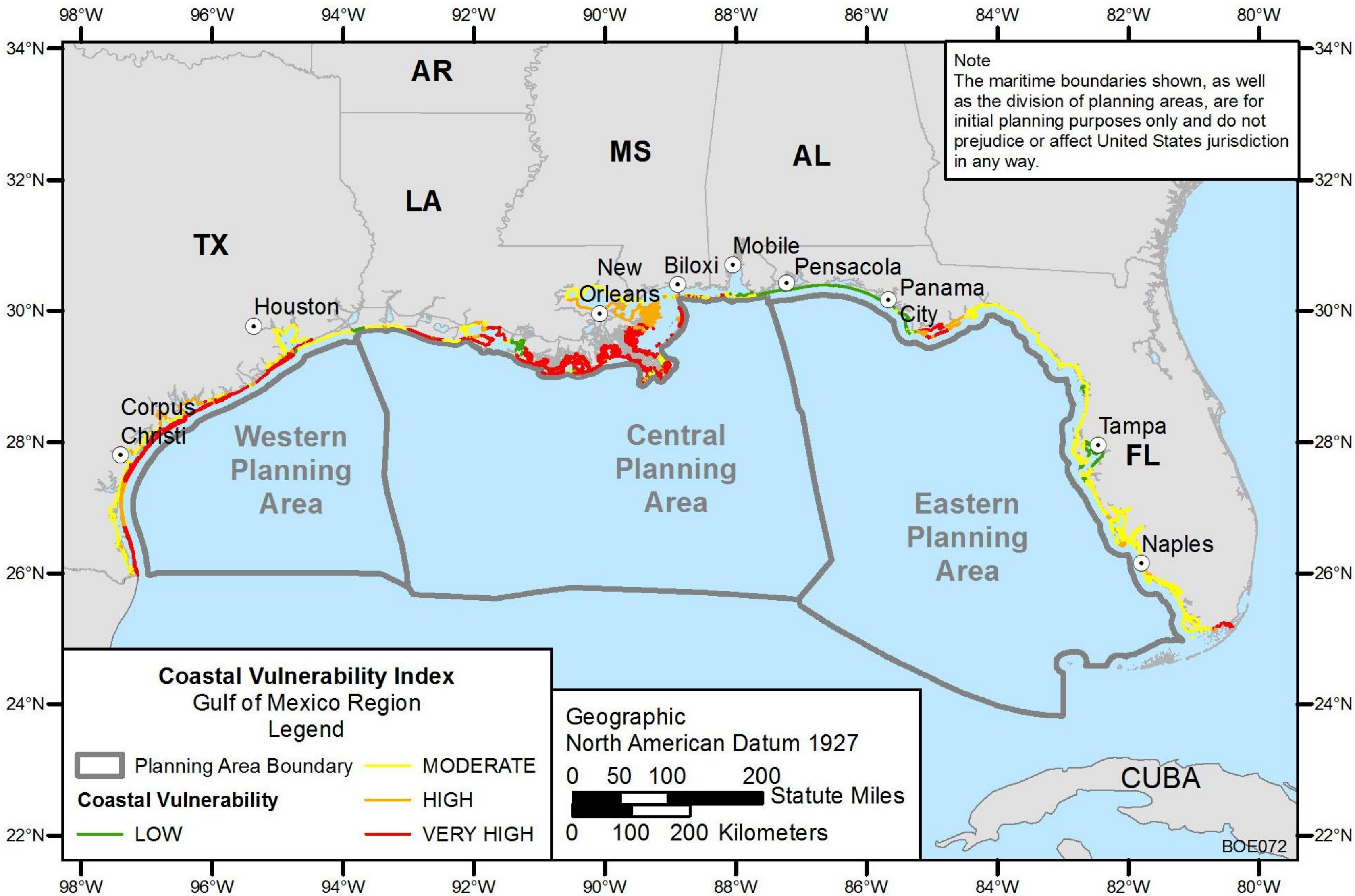

FIGURE 4.4.10-4 Coastal Vulnerability Index

Loss of Use to Existing Landowners or Users. Once the new offshore oil and gas facilities were in operation, temporary or permanent loss of use is not anticipated. As indicated in Section 3.11.1, many facilities already are located within the GOM to support oil and gas development. At times, some access to particular areas may be restricted within surrounding lands to accommodate a brief alteration in normal operations, such as an emergency response. These impacts would be limited and temporary.

Similar to construction, the use of individual properties in the vicinity of the operating platforms may be affected indirectly if excessive noise and air emissions were generated from equipment and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles), or if a small increase in the amount of trash and debris washing ashore were to result from the activities. These occurrences may cause disturbances or annoyance among particular landholders or users, thereby inhibiting the intended or actual use of a property. The level and extent of impact would depend on the specific location within the GOM.

Physical and/or Infrastructural Composition. To the extent possible, existing facilities would be used to support activities under new leases, and new facilities would be built only where necessary, which would tend to limit the potential to create lasting changes to the physical and/or infrastructural makeup of the GOM during operations.

***Decommissioning*.** Typical activities during the decommissioning/reclamation phase could include, but are not limited to, the closure of all wells, removal of access roads (not maintained or intended for other uses) and associated facility sites, and revegetation. These activities have the potential to directly impact land use, development patterns, and infrastructure.

Impacts associated with decommissioning, however, generally would be site-specific. In some cases, a return to pre-exploration and preconstruction conditions may not be feasible.

Local Land Use/Comprehensive Planning and Development Patterns. Depending on the location of the production wells and associated infrastructure, decommissioning activities onshore may be regulated by local land use, zoning, and comprehensive planning initiatives or requirements. The continued use of the facilities after production could impact planned development in a positive manner, either by providing an opportunity for reuse of facilities or allowing for the potential for additional or future oil and gas development.

Loss of Use to Existing Landowners or Users. No permanent loss of use is anticipated to occur during the decommissioning/reclamation phase. Some temporary loss may occur if road or area closures are necessary to accommodate equipment, workers, or specific activities associated with this type of process. Access typically would be restored to its preconstruction or operations state.

In addition, the use of individual properties in the vicinity of the activities may be affected indirectly if excessive noise and air emissions generated by the decommissioning equipment, activities, and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles) were to occur, or if a small increase in the amount of trash and debris washing ashore were to result from the activities. These occurrences may cause a temporary disturbance or annoyance among particular landholders or users, thereby inhibiting the intended or actual use of a property. The level of impact would depend on the specific location within the GOM.

Physical and/or Infrastructural Composition. During decommissioning, potential changes to the physical and infrastructural makeup of the GOM coast could occur. Any equipment added may be removed; defunct equipment also could be removed; however, these activities would not be expected to cause substantial changes to land use, development patterns, and infrastructure. These alterations would be site-specific and their extent would depend on the existing composition of land use and infrastructure.

Impacts of Expected Accidental Events and Spills. Oil spills are a principal accidental impact-causing event. Approximately 8 large spills up to 5,100 bbl, 35–70 small spills of 50 bbl or more but less than 1,000 bbl, and 200–400 small spills of less than 50 bbl are anticipated to occur in the GOM as a result of new development (see Table 4.4.2-1). If oil spills of these sizes and frequencies were to occur and were to contact the coast, overall changes to land uses, development patterns, and existing infrastructure typically would be small. Oil spilled in offshore areas usually is localized and has a low probability of contacting coastal areas, because much of the oil volatilizes or is dispersed by currents (MMS 2008a). In most cases, coastal or nearshore spills would have short-term adverse effects on coastal infrastructure requiring cleanup of any oil or chemicals spilled (MMS 2006a).

Potential impacts on land use and existing infrastructure would likely include "stresses of the spill response on existing infrastructure, direct land-use impact (such as impacts of oil contamination to a recreational area or to agricultural land), and restrictions of access to a particular area, while the cleanup is being conducted" (MMS 2007d). These impacts generally would be temporary and localized, particularly for small spills (and especially ones less than 50 bbl in volume). For large spills ($\geq$ 1,000 bbl), the degree of impact is influenced by many factors including, but not limited to, spill location, spill size, type of material spilled, prevailing wind and current conditions, the vulnerability and sensitivity of the land use and infrastructure, and response capability.

Impacts of An Unexpected Catastrophic Discharge Event. The PEIS analyzes the impacts of an unexpected CDE with a volume of 0.9-7.2 million bbl and a duration of 30–90 days (Table 4.4.2-2). A CDE is considered to be an unexpected, low-probability event unlikely to occur during routine operations (see Sections 4.3.3 and 4.4.2.2 for further discussions on the risks of CDE occurrence). While no direct major land use impacts would be expected following a CDE, response and restoration efforts may result in some immediate and temporary changes to the existing land use and infrastructure in the GOM.

For example, post-spill habitat restoration efforts could result in enhanced barrier islands (e.g., the construction of berms) and wetlands. After the DWH event, for instance, the State of Louisiana requested permission to build six large linear sand berms along the State's barrier islands. The request also included some of the inlets between the barrier islands (USCG 2011a; Martinez et al. 2011). Alabama also had obtained funding for small berm projects, including a barrier for the Katrina Cut (USCG 2011a).

The existing network of pipes and platforms in coastal lands and wetlands of the GOM also could be exposed to potential wreckage and debris from a CDE and its associated response efforts. For instance, more than 40,200 km (24,979 mi) of pipeline rights-of-way are anchored in Louisiana's barrier islands and marshes. Some of the pipelines that were previously buried are now exposed to the surface as a result of erosion and other natural occurrences (Davis 2004). This infrastructure, therefore, is susceptible to changes that occur in the water and on the water surface, such as the presence of oil and vessel traffic that would be associated with a CDE.

In addition, changes in the operation of onshore infrastructure, such as oil pipelines, port facilities, and industrial facilities along the coast, may occur in response to concerns for damage from debris associated with a CDE. For instance, the Nakika crude oil pipeline was shut down as a precautionary measure following the DWH event (Aldy 2011). After this event, temporary waste staging areas and decontamination areas were set up to handle the spill-related waste (BOEM 2011a). In some cases, these facilities created short-term impacts due to changes in use of the land.

A number of indirect effects may also result from a potential CDE, including adaptations in commercial industries, such as fishing and tourism, fluctuating economic patterns, and changes in demographic distributions; all of these impacts could affect land use or development patterns by altering spending patterns of consumers and developers.

Following the DWH event, perceptions regarding emergency planning in the GOM have created a need for future planning and accounting for potential events of greater magnitude than typically anticipated. Trickle-down effects of the DWH event may include more stringent safety protocols in the operation and construction of infrastructure, which may include onshore facilities as well as offshore facilities. Similar types of effects would be anticipated if a catastrophic discharge event were to occur during the life of the Program.

"In the future, the long-term impacts of the DWH event will be clearer as time allows the production of peer-reviewed research and targeted studies that determine those impacts" (BOEM 2012). The oil well erupted on April 20, 2010, and continued until June 15th, thereby lasting a period of 86 days. The DWH event was declared "effectively dead" by the Federal Government on September 19, 2010 (IEM 2010). Due to the cleanup effort, the length of time, and the location, long-term impacts from an event such as this will need to be monitored in future years in order to truly understand its impacts on the GOM, including its impacts on land use and infrastructure (Restore the Gulf 2010b).

As shown by recent events in the GOM, the degree of impact is influenced by many factors including, but not limited to, spill location, spill size, type of material spilled, prevailing wind and current conditions, the vulnerability and sensitivity of the land use and infrastructure, and the response capability. As shown by the response to the DWH event, infrastructure exists in some locations to address this type of event. This would limit the potential for much larger effects to occur. As previously indicated, long-term impacts still are being monitored.

Impact Conclusions.

Routine Operations. Routine operations associated with the addition of new oil and gas leases within the GOM planning areas would result in negligible to minor impacts on land use, development patterns, and infrastructure. In general, the existing infrastructure would be expected to be sufficient to handle exploration and development associated with potential new leases.

Expected Accidental Events and Spills. Expected accidental events and spills could have both direct and indirect effects on land use, depending on the type, size, location, and duration of the incident. If oil spills were to occur and contact the coast, overall impacts on land use and existing infrastructure typically would be minor at most (especially for large spills), and negligible for most small spills (especially those <50 bbl).

An Unexpected Catastrophic Discharge Event. In the unlikely event of a low-probability CDE within the GOM, minor to moderate impacts to land use, development patterns, and infrastructure would be expected. Major impacts would not be expected, in part because existing infrastructure is in place in some locations to be able to address this type of event. This would limit the potential for much larger effects to occur.

4.4.10.2 Alaska – Cook Inlet

New oil and gas production is anticipated in the Cook Inlet, an area previously used for offshore production. As indicated in Table 4.4.1-3, oil production is anticipated to include a range of 0.1 to 0.2 Bbbl within south central Alaska; currently no active Federal leases are located within the Inlet. However, 16 active offshore producing platforms are located within the Cook Inlet in State submerged land. These platforms are served by more than 320 km (200 mi) of undersea gas and oil pipelines, as well as onshore facilities (see Section 3.11.2).

A number of routine activities would be necessary to provide for additional production; these activities have the potential to impact existing and future land use, development patterns, and infrastructure. This analysis of impacts, therefore, focuses solely on new production within the Cook Inlet.

Impacts of Routine Operations.

Seismic Explorations and Exploratory Drilling**.** As previously noted, activities associated with exploration typically include a seismic survey, exploratory well construction, and aircraft and vessel traffic (Figure 4.4.10-1). The impacts resulting from these activities are discussed below.

<u>Local Land Use/Comprehensive Planning and Development Patterns.</u> Seismic explorations and exploratory drilling would not directly impact land use, development patterns, and infrastructure within the Cook Inlet, because a majority of the activities would be located

offshore. During this phase, existing and future land use categorizations would remain largely unchanged, along with current development patterns.

In general, activities to support exploration would be located onshore within existing developments in order to act as staging areas for the seismic surveys and exploratory wells. Temporary onshore service bases could be needed to support offshore exploratory drilling operations. These bases would transfer materials between land and the offshore drilling rigs. In addition, supply vessels and helicopters would be used to shuttle personnel, equipment, and supplies. Existing facilities generally would be used within the Cook Inlet, if they were available in the selected location for exploration; if necessary, new facilities would be built, or prefabricated modules could be moved to the base of the exploration activities (Kenai Peninsula Borough 2008).

<u>Loss of Use to Existing Landowners or Users.</u> Activities associated with seismic explorations and exploratory drilling could affect access or use of a particular land area, to a limited extent. Some temporary onshore and offshore access restrictions could be necessary for safety reasons; however, these restrictions likely would be temporary, lasting only as long as the exploration activities.

The perception of loss of land or use, however, might increase among tribal communities,[19] local inhabitants, and visitors within the Cook Inlet. As offshore exploration includes the temporary siting of large drilling rigs and discharges of drilling muds and cuttings, some people using the coastal area for subsistence hunting and gathering or for recreation and tourism might perceive the effects of the drilling as a disruption to their regular activities (see Sections 4.4.13 and 4.4.14 for a further discussion of subsistence activities, Section 4.4.12 for a discussion of recreation and tourism, and Section 4.4.3.2 for a discussion of water quality). If the perceived disruption or "nuisance" becomes too intense, users may relocate to other parts of the Inlet in order to conduct their regular activities, in anticipation of the new oil and gas activities. Thus, the actual use of the land may be impacted, even if the intended land use designation or categorization is not altered. Within the Cook Inlet, these effects would likely be limited in extent, due to the presence of the existing oil and gas industry.

In addition, the use of individual properties in the vicinity of the exploration activities may be affected indirectly if excessive noise and air emissions generated by the exploratory equipment, activities, and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles) were to occur, or if a small increase in the amount of trash and debris washing ashore were to result from the activities. These occurrences may cause a temporary disturbance or annoyance among particular landholders or users, thereby inhibiting the intended or actual use of a property. The level of impact would depend on the specific location within the Cook Inlet.

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19 Approximately 8.9% of all land within the Kenai Peninsula Borough is owned by Native Village and Regional Corporations. Large tracts of this type of land surround Nanwalek, Port Graham, Tyonek, Ninilchik, Seldovia, and Kenai. Some of the parcels have been used for logging, oil and gas extraction, and mining (Kenai Peninsula Borough 2005).

Physical and/or Infrastructural Composition. As noted in Table 4.4.1.2-1, approximately 4–12 exploration wells would be drilled within south central Alaska. Due to the existing oil and gas infrastructure already present, a minimal amount of additional machinery and staging area improvements would be needed in order to accommodate equipment and workers associated with exploration activities.

Onshore and Offshore Construction. Onshore and offshore construction could impact local land use and comprehensive planning and existing and planned development; access and use of particular properties; the physical and infrastructural composition of the Cook Inlet; and existing conditions as they pertain to emissions, waste, noise, and traffic (see Figure 4.4.10-2).

As indicated in Section 4.1.1-2, construction activities often include production well placement, pipeline placement, onshore construction, and aircraft and vessel traffic. Per the proposed development scenario within south central Alaska, construction of approximately one to three new platforms is anticipated, along with 40–241 km (25–150 mi) of new offshore pipeline and 80–169 km (50–105 mi) of onshore pipeline. Up to one new pipeline landfall also may be needed, as indicated in Table 4.4.1.1-3. Potential impacts of these activities are presented below.

Local Land Use/Comprehensive Planning and Development Patterns. Due to a long history of oil and gas development, existing land use categorizations in Cook Inlet often would be able to accommodate new leases for the proposed development scenario. As indicated in Section 4.4.1.2, existing infrastructure would be used to the extent possible, limiting the need for the acquisition of new sites for development.

Loss of Use to Existing Landowners or Users. Onshore and offshore construction generally would not interfere with or prevent use by existing owners or users within areas already used for oil and gas. As previously indicated, the use of existing facilities generally would be preferred over new construction. However, during construction activities, a temporary loss of access for some users may occur, even within an existing oil and gas development area. Restrictions on access may be put in place for safety reasons or to allow certain activities to occur. Depending on the location of the activities, the restrictions would be lifted after the completion of construction.

Likewise, some users of surrounding land may be inconvenienced by closure or restrictions on access routes or within areas used for subsistence activities. For example, within the Cook Inlet, as in other parts of Alaska, air carriers generally provide a large share of the cargo and passenger service to and within the State. Water transport, especially for large and heavy materials, also is an important component of the transportation network. Activities related to the construction may impact Alaska's air routes, air-terminal facilities, and barge-cargo services, causing delays or changes in scheduling or service (MMS 2002a). Consequently, the perceived impact associated with these restrictions or closures to access routes or land areas may weigh more heavily on permanent communities using surrounding lands or routes for subsistence activities or for daily employment than on temporary visitors or tourists.

While plans for oil and gas development generally would limit the amount of permanent loss of use, especially during construction, some users may be subject to this type of impact dependent on the specific location chosen. A permanent loss of use generally would be associated with land parcels in which land use categorizations were amended to allow for oil and gas construction activities. If new land were necessary in order to construct onshore facilities, such as a new pipeline or landfall, the acquisition process would need to follow all pertinent local, State, and Federal requirements.

In addition, the use of individual properties in the vicinity of the construction activities may be affected indirectly if excessive noise and air emissions generated by the construction equipment and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles) were to occur, or if a small increase in the amount of trash and debris washing ashore were to result from the activities. These occurrences may cause a temporary disturbance or annoyance among particular landholders or users, thereby inhibiting the intended or actual use of a property. The level of impact would depend on the specific location within the Cook Inlet

Physical and/or Infrastructural Composition. The physical and infrastructural composition of south central Alaska would be altered by the expansion and/or improvement of existing facilities, as well as by new construction. The extent of the impacts associated with these activities ultimately would depend on their specific location within the Cook Inlet. For example, this region has an inland network of oil and gas gathering distribution pipelines; one such community is Nikiski, which has existing oil and gas support facilities to account for current leasing (MMS 2007b). The basic onshore support and processing infrastructure that would be necessary to support the anticipated levels of activity are already in place within the Cook Inlet; these transport, loading, and storage capabilities would require expansion to handle an increased volume of produced crude oil rather than extensive construction of new facilities (MMS 2002a, 2007b).

While the oil and gas industry within Cook Inlet was one of the largest sources of high paying jobs within the last decade, natural gas production recently has provided a more stable source of employment. As a result, some of the aging infrastructure associated with offshore drilling is in poor repair, and thus would require updates, expansion, and/or other improvements (Fried and Windisch-Cole 2004). In these locations, new construction could be a more appropriate solution to accommodate offshore oil and gas production.

If new infrastructure were needed, it would be built either as infill within an existing industrial or port area or within an area recently designated for this type of development. A greater impact on the existing physical landscape would be experienced in those areas not already used for oil and gas production. For instance, the construction of the pipeline landfall could involve clearing land, preparing a ROW, and digging and backfilling trenches. Additional clearance could be necessary in order to accommodate the new onshore pipeline, as well. These types of activities or similar ones could alter the physical composition of the landscape, thus potentially limiting the intended, actual, or future use of a parcel. If needed, this type of construction would have extensive impacts in lands used for subsistence hunting or other similar activities.

Additional indirect impacts concern those associated with climate change. The southern half of Alaska has glacial characteristics that are complicated by erodible glacial deposits and high tides, which may impact infrastructure associated with oil and gas development. Cook Inlet already has a 10-m (30-ft) tidal range at its northern extreme and an eroding shoreline of glacially deposited bluffs (Smith and Levasseur 2002).

New facilities may be sited in different locations in response to anticipated rises in sea level, increased storm frequency and intensity, and temperature changes. Other activities that might be undertaken in response to real or potential climate change–induced rises in sea level include facility relocation, the construction of seawalls and storm surge barriers, and land acquisitions to create buffer areas (IPCC 2007).

Consequently, indirect impacts on land use, development patterns, and infrastructure could include locating further inland and/or strengthening foundations or building materials of existing facilities. These actions potentially could increase costs associated with development or force the construction of new facilities rather than the reuse or expansion of existing properties associated with oil and gas production. These decisions may be influenced by the potential for increased flooding and/or erosion, as well. For instance, climate change is expected to add approximately $5–10 billion to the State infrastructure budget depending on the climate change scenario under consideration. In addition, cost estimates for shoreline protection and village relocation continue to rise (CIER 2007). Costs would be largely for maintaining or replacing roads, runways, and water and sewer systems (Larsen et al. 2007).

Production Operations. Routine operations would include production well operation, onshore facility operation, and vessel and aircraft traffic, as well as the transport of oil from offshore to onshore locations using pipelines.

Local Land Use/Comprehensive Planning and Development Patterns. Once offshore oil and gas facilities were in operation,[20] only slight changes to land use, development patterns, and infrastructure would be expected, because a majority of the activities would be located offshore, with some activity occurring within onshore bases and transportation facilities.

In addition, as shown in Table 4.4.1-3, no new shore bases, processing facilities, or waste disposal facilities are associated with the proposed action. Since existing infrastructure would be used to the extent possible, the anticipated use of onshore facilities during normal operations would not be expected to generate noticeable changes to the current setting that would impact the overall land use, development patterns, or infrastructure of Cook Inlet.

Loss of Use to Existing Landowners or Users. Once offshore oil and gas facilities are in operation, a temporary or permanent loss of use would not be anticipated, because a sufficient number of facilities already are located within Cook Inlet to support the increased oil and gas development. At times, some access may be restricted within surrounding lands to accommodate a brief alteration in normal operations (e.g., an emergency response).

[20] For the purposes of this evaluation, normal operations exclude events leading up to the production of offshore oil and gas.

Furthermore, the use of individual properties in the vicinity of the operating platforms may be affected indirectly if excessive noise and air emissions were generated from equipment and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles), or if a small increase in the amount of trash and debris washing ashore were to result from the activities. These occurrences may cause disturbances or annoyance among particular landholders or users, thereby inhibiting the intended or actual use of a property. The level and extent of impact would depend on the specific location within the Cook Inlet.

Physical and/or Infrastructural Composition. To the extent possible, existing facilities would be used and new facilities would be built only where necessary, once initial construction was completed. Since the anticipated new development is modest, large changes to the physical and/or infrastructural composition of Cook Inlet during the operation phase would not be expected.

Decommissioning. When activities for oil and gas become uneconomical to continue production operations or when a lease expires, many of the structures built for production would be dismantled, shut down, or converted to other uses. Typical government regulations require that offshore structures be cut off below the mud line and entirely removed, while pipelines often are left in place due to the high cost of removal. Offshore wells would be cemented in, and sea bottom well sites would be dragged to remove obstructions (Kenai Peninsula Borough 2008). Due to the physical nature of these activities, land use, development patterns, and infrastructure might be impacted directly. These impacts generally would be site-specific. In some cases, a return to pre-exploration and preconstruction conditions might not be feasible.

Local Land Use/Comprehensive Planning and Development Patterns. Depending on the location of the production wells and associated infrastructure, decommissioning activities onshore might be regulated by local land use, zoning, and comprehensive planning initiatives or requirements. In turn, local planning initiatives often account for developments of this nature in future planning. For instance, the continued use of the facilities after production could impact planned development in a positive manner, either by providing an opportunity for reuse of facilities or allowing for additional or future oil and gas activities (MMS 2007c).

Loss of Use to Existing Landowners or Users. No permanent loss of use is anticipated to occur during the decommissioning/reclamation phase. Some temporary loss might occur if road or area closures were necessary to accommodate equipment, workers, or specific deconstruction activities. If feasible, access would be restored to its preconstruction or operations state.

During decommissioning, the use of individual properties in the vicinity of the activities may be affected indirectly if excessive noise and air emissions were generated from equipment and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles), or if a small increase in the amount of trash and debris washing ashore were to result from the activities. These occurrences may cause temporary disturbances or annoyance among particular landholders or users, thereby inhibiting the intended or actual use of a property. The level and extent of impact would depend on the specific location.

Physical and/or Infrastructural Composition. In addition, potential changes to the physical and infrastructural makeup of Cook Inlet could occur. Any equipment added may be removed; other defunct equipment also could be removed. Impacts on land use and infrastructure would be site-specific. Moreover, if any offshore or onshore infrastructure were deemed a visual intrusion within the landscape for the duration of the project, removal of the structure during decommissioning would remove the feature, and thus help to alleviate the impact (MMS 2003a).

Impacts of Expected Accidental Events and Spills. The risk of a spill is present whenever crude oil or petroleum products are handled. Oil spills could be associated with the exploration, development, production, storage, and/or transportation processes and might occur from losses of well control or pipeline or tanker accidents. As shown in Table 4.4.2-1, approximately 1 large spill ≥1,000 bbl, 1 to 3 small spills ≥50 but <1,000 bbl, and 7 to 15 small spills <50 bbl, are anticipated to occur as part of new development within Cook Inlet. From 1999 to 2008, 18 crude oil spills of 380 L (100 gal) or more from pipelines, platforms, onshore production facilities, storage facilities, and marine tankers have occurred in Cook Inlet. Six of these were more than 1,900 L (500 gal) (ADNR 2009b).

Based upon knowledge acquired from previous spills, potential impacts to land use and infrastructure resulting from an oil spill would likely include moderate temporary stresses of the spill response on existing community infrastructure, increased boat and air traffic to respond to the spill and cleanup operations, and restrictions of access to a particular area while the cleanup is conducted (MMS 2007d). These stresses could lead to a temporary loss of use of certain parcels both for their intended and actual uses, but generally no permanent land use categorization changes.

Within Cook Inlet, a geographic response strategy (GRS) has been formulated to account for 17 sites within the central Cook Inlet, 18 sites for the southwest, 21 sites for Kachemak Bay, and 22 sites for the southeast. Strategies within this plan focus on minimizing the environmental damage, using a small response footprint, and selecting sites for equipment deployment that would not cause further harm (ADNR 2009b).

Impacts of an Unexpected Catastrophic Discharge Event. A CDE in the Cook Inlet Planning Area would be an unexpected, low-probability event (see Sections 4.3.3 and 4.4.2.2). The PEIS analyzes the impacts of an unexpected CDE in the Cook Inlet Planning Area that has a volume of 75 to 125 thousand bbl and lasts from 50 to 80 days (Table 4.4.2-2). These events have the potential to impact future development patterns if irreversible changes to the land composition occur within certain areas. For example, one of the largest events of this type occurred in 1989; it consisted of the *Exxon Valdez* discharge. This event led to the closure or disruption of many Cook Inlet businesses, including fisheries (ADNR 2009b).

A CDE would likely be a result of oil transport from a tanker carrying Arctic and Cook Inlet OCS oil from the Valdez terminal to U.S. ports (see Section 4.4.2.1 for additional information). In most cases, a worst-case oil discharge from an exploration facility, production facility, pipeline, or storage facility would be restricted by the maximum tank or vessel storage capacity or by a well's ability to produce oil.

Potential impacts to land use and infrastructure resulting from an unexpected CDE would likely include moderate to high temporary stresses of the spill response on existing community infrastructure and services (e.g., water and sanitation), increased boat and air traffic to respond to the spill and cleanup operations, and restrictions of access to a particular area while the cleanup is conducted (MMS 2007d). A CDE also may indirectly impact land use in the long term, as the local government would need to respond to increased demands for service, disruptions of normal business operations, increased use of municipal facilities, and increased costs associated with response activities (Russell et al. 2001). Some of these impacts may lead to more permanent changes in the way land is used within Cook Inlet, such as closure or disruptions of business as occurred for the *Exxon Valdez* event (ADNR 2009b).

Community impacts surrounding the *Exxon Valdez* event, for instance, included "infrastructure overloads, disruption to economic and occupational structures, and interrupted civic processes" (Gill et al. 2012). Numerous communities within the Cook Inlet region were directly oiled by the discharge (Russell et al. 2001). This has left subsurface oil in a relatively unweathered state, including a presence in recreational and commercial sites. The remaining oil may discourage the future use of some of these locations, as people may wish to avoid known patches of oil, potential locations in which oil may be present, and places where the oil has fully degraded (NOAA 2010e).

Immediately following the *Exxon Valdez* discharge, local communities were faced with initial housing and lodging shortages and excessive demands for services, as cleanup workers inundated the response areas (Gill et al. 2012). These additional stresses were largely a result of the remote nature of the communities affected; in some cases, these communities lacked airstrips, ports, and other support services necessary for conducting a large-scale response (Nuka Research and Planning Group 2007a).

Based on the studies of the *Exxon Valdez* event, the degree of impact on land use and infrastructure is influenced by many factors, including, but not limited to, spill location, spill size, type of material spilled, prevailing wind and current conditions, the vulnerability and sensitivity of the land use and infrastructure, and the response capability. As shown by the response to the *Exxon Valdez* event, some existing infrastructure is in place to be able to address this type of event. This would limit the potential for much larger effects to occur; however, some impacts associated with indirect uses of land still are apparent today from the *Exxon Valdez* event, thereby making the potential impacts associated with a CDE likely greater than one occurring in the GOM.

Impact Conclusions.

Routine Operations. Oil and gas exploration, development, and production activities in the Cook Inlet Planning Area would be a continuation of longstanding activities the area. The proposed action would not introduce new kinds of activities that would alter existing land uses. Routine operations associated with the addition of new oil and gas leases within Cook Inlet would result in negligible to minor impacts on land use, development patterns, and infrastructure. While Cook Inlet currently supports some oil and gas production, some minor impacts on land use, development patterns, and infrastructure would be anticipated to occur as a result of new leases. These impacts would vary in intensity dependent on specific location within the inlet. The existing infrastructure would help to limit the intensity of the impacts.

Expected Accidental Events and Spills. Expected accidental events and spills could have both direct and indirect effects on land use, depending on the type, size, location, and duration of the incident. If oil spills were to occur and were to contact the coast, overall impacts on land use and existing infrastructure typically would be minor (especially for small spills).

An Unexpected Catastrophic Discharge Event. In the unlikely event of a low-probability CDE within Cook Inlet, moderate impacts onland use, development patterns, and infrastructure would be expected. Major impacts would not be expected, in part because infrastructure exists in some locations to address this type of event. This would limit the potential for much larger effects to occur; however, impacts would likely be greater than those expected for the GOM planning areas.

4.4.10.3 Alaska – Arctic

Oil and gas production within the Arctic as a whole is not as developed as that in the GOM and Cook Inlet; however, this region includes the Beaufort Sea Planning Area, which has well-developed oil and gas industry infrastructure on adjacent land and in State waters. For instance, the Prudhoe Bay complex is located adjacent to the Beaufort Sea Planning Area. This is part of a large oil producing field, which contains extensive infrastructure (MMS 2007d).

As indicated in Table 4.4.1-4, oil production is anticipated to include 0.2 to 2.1 Bbbl within the Beaufort Sea and the Chukchi Sea. Therefore, a number of routine activities would be necessary to more fully develop this industry in order to provide for additional production within the Beaufort and Chukchi Seas region. As noted for the other areas, these activities have the potential to impact existing and future land use, development patterns, and infrastructure.

Impacts of Routine Operations. Routine activities include exploration, development, production, and decommissioning. Impacts on land use, development patterns, and infrastructure within the Beaufort and Chukchi Seas regions from each of these activities are presented below.

Seismic Explorations and Exploratory Drilling. Activities associated with exploration typically include a seismic survey, exploratory well construction, and aircraft and vessel traffic.

Local Land Use/Comprehensive Planning and Development Patterns. Seismic explorations and exploratory drilling would not directly impact land use, development patterns, and infrastructure, because a majority of the activities would be located offshore. During this phase, existing and future land use categorizations would remain largely unchanged.

Loss of Use to Existing Landowners or Users. Activities associated with seismic explorations and exploratory drilling could potentially affect access or use of a particular land area, to a limited extent. Some temporary safety-related restrictions on access might be necessary both onshore and offshore; however, these restrictions likely would last only as long as the exploration activities.

For this area of Alaska, a scattered exploration pattern may be necessary due to the lack of existing oil and gas infrastructure. For this type of exploration pattern, more frequent and longer-duration helicopter and support boat trips would be needed than if a clustered pattern of exploration were utilized. For instance, platforms located beyond the landfast ice zone would require substantial helicopter support, especially during the developmental drilling phase, because they would be unreachable by ice roads. In addition, platforms located in the landfast ice zone could be served by vehicles traveling over ice roads (MMS 2007d). Local access to these transportation modes could be affected, to a limited extent, to account for the additional trips and traffic associated with this type of exploration. This would result in a perceived loss of use for some people either living, visiting, or working within the area.

Perceived loss of land or use might also increase among tribal communities, local inhabitants, and visitors within the coastal areas of the Beaufort and Chukchi Seas. Since offshore exploration includes the placement of wells and the production of drilling muds and cuttings, which may be discharged into the marine environment, some people using the coastal area may perceive the effects of the drilling as a disruption to their regular activities. If the perceived disruption or "nuisance" becomes too intense, users may relocate to other parts of the coast in order to conduct their regular activities. Thus, the actual use of the land may be impacted, even if the intended land use designation or categorization is not altered.

For example, as indicated in Section 4.4.13.3, residents of the Chukchi Sea communities have noted a concern over the loss of a subsistence lifestyle and the imposition of additional demands on communities to maintain new infrastructure either directly or indirectly related to oil and gas exploration and eventual production. "Residents of the Chukchi Sea coastal communities have been remarkably consistent in their primary concerns during the more than 20 years of public hearings and meetings on State and Federal oil development on the North Slope" (BOEMRE 2011j). Sections 4.4.13.3.1 and 4.4.14.3.1 provide additional information on the impacts to subsistence and tribal communities within the Arctic region resulting from oil and gas activities.

In addition, the use of individual properties in the vicinity of the exploration activities may be affected indirectly if excessive noise and air emissions were generated from equipment and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles), or if a small increase in the amount of trash and debris washing ashore were to result from the activities. These occurrences may cause disturbances or annoyance among particular landholders or users, thereby inhibiting the intended or actual use of a property. The level and extent of the indirect impacts would depend on the specific location within the Arctic region (BOEMRE 2011j).

<u>Physical and/or Infrastructural Composition.</u> As noted in Table 4.4.1-4, approximately 6–20 exploration and delineation wells and 40–280 development and production wells would be drilled within the Arctic. Machinery and staging area improvements would be needed in order to accommodate equipment and workers associated with these exploration activities. The increase in physical infrastructure likely would be very small at this stage of oil and gas development due

to the temporary nature of the exploration activities and the anticipated use of existing facilities, where available.

Onshore and Offshore Construction. Similar to the exploration phase, onshore and offshore construction have the potential to impact local land use and comprehensive planning and existing and planned development; access and use of particular properties; and the physical and infrastructural composition of the Beaufort and Chukchi Seas.

As indicated in Figure 4.4.10-2, activities associated with this phase often include production well placement, pipeline placement, onshore construction, and aircraft and vessel traffic. Per the proposed development scenario within the Arctic region, approximately 1–5 platforms are anticipated, along with 16–130 km (10–80 mi) of onshore pipeline. No new pipeline landfalls or shore bases are anticipated. This section provides a discussion of impacts associated with land use as they pertain to onshore and offshore construction.

Local Land Use/Comprehensive Planning and Development Patterns. Due to the minimal level of current oil and gas development within the whole of the Beaufort and Chukchi Seas, existing land use plans and designations may not provide for areas that are able to accommodate new leases. Therefore, changes to land use and comprehensive planning decisions, such as a conditional use permit or zoning change, are predicted as a result of the leasing and subsequent development activities, including construction. The need to address existing land use would depend on the specific location selected for onshore construction and on the activity to be conducted (e.g., the construction of onshore pipeline routes or new transportation routes).

For instance, according to the North Slope Borough (NSB) comprehensive plan, five major zoning districts are present, including the Village, Barrow, Conservation, Resource Development, and Transportation Corridor (MMS 2007b). "All areas within the NSB are in the Conservation District, unless they are specifically designated within the limited boundaries of a village or Barrow, a unitized oil field within the Resource Development District, or within the Trans-Alaska Pipeline System (TAPS) corridor" (MMS 2007b). As indicated by this statement, major land uses generally are divided between subsistence use and petroleum-resource extraction (MMS 2007b).

Due to the recognition of oil and gas activities, all of the NSB land management regulations address oil and gas leasing activities, including onshore and offshore (MMS 2007b). Therefore, within the NSB, conditional use permits may be requested that would allow for specific, temporary activities; in some cases, the more permanent development associated with production would require that a master plan be prepared describing anticipated activities. In addition, use of non-Federal land within the NSB may require rezoning from the Conservation District to the Resource Development District or Transportation Corridor (MMS 2007b).

While not a direct cause and effect relationship, if changes to overall land use categorizations or planning initiatives were needed to begin construction and subsequent development of oil and gas facilities, future development patterns could be impacted. If onshore construction were to occur within the Arctic region, various government agencies and jurisdictions would be involved in the change. Land ownership within the North Slope area consists of overlapping ownership interests, at times vague boundary descriptions, and informal or unrecorded land transfers. Surface and subsurface ownership interests are held by the Federal Government, State government, the borough, villages, regional and village Native corporations, and private individuals, including Native allotments. As in many areas, surface and subsurface owners may differ, particularly in communities and Native allotments (URS Corporation 2005).

In addition, if new infrastructure would be needed onshore, some facilities and infrastructure would be subject to other local, State, and/or other Federal permitting and regulations, including provisions for the siting of facilities. Specific timelines and requirements would vary by location, as BOEM typically is not the permitting or regulating agency for development activities that occur onshore.

Loss of Use to Existing Landowners or Users. Onshore and offshore construction generally has the potential to interfere with or prevent use by existing owners or users within areas not already used for oil and gas activities (see Section 4.4.13.3 and 4.4.14.3 regarding impacts on subsistence activities). While the use of existing facilities generally is preferred over new construction, few of these facilities exist within the whole of the Arctic region as compared to the GOM and Cook Inlet. As previously indicated, the Chukchi Sea Planning Area has relatively little established infrastructure, while well-developed oil and gas facilities are located within the Beaufort Sea Planning Area, such as at the Prudhoe Bay complex. Therefore, during construction, a temporary loss of access to some users may occur. Restrictions on access may be put in place as safety precautions or to allow certain activities to occur. Depending on the location of the activities, these restrictions could be lifted after construction was completed.

Users of surrounding lands also may be inconvenienced by closure or restrictions on access routes or within areas used for subsistence activities during construction. For instance, if platforms were constructed in part onshore, some marine subsistence hunters may have to avoid or navigate around them when preparing their crafts from an onshore location. Another example would include the construction of temporary roads for exploration drilling or permanent roads that may be constructed as a result of proposed activities. While roads could increase access to previously inaccessible areas, they also could also create community-development, land use-planning, or fish and game-management problems (ADNR 2009b). Consequently, the perceived impact associated with these restrictions or closures may weigh more heavily on communities using surrounding lands for subsistence activities than recreational users or tourists (see Sections 4.4.13.3.1 and 4.4.14.3.1 for additional information regarding subsistence activities).

In addition, the use of individual properties in the vicinity of the construction activities may be affected indirectly if excessive noise and air emissions were generated from equipment and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles), or if a small increase in the amount of trash and debris washing ashore were to result from the activities. These occurrences may cause disturbances or annoyance among particular landholders or users, thereby inhibiting the intended or actual use of a property. The level and extent of impact would depend on the specific location within the Arctic.

Physical and/or Infrastructural Composition. The physical presence of the shore-based and pipeline infrastructure within the Arctic region would represent an initial industrialization of the area and a long-term and significant change in land use patterns. This would result due to the change from an isolated and often pristine environment to one that supports oil and gas infrastructure. While new technologies and practices tend to be less damaging than those associated with past activities, the addition of these facilities has the potential to permanently alter the land use within the region (AMAP 2010).

In areas already developed with oil and gas infrastructure, such as in the Beaufort Sea Planning Area, the construction of oil and gas infrastructure would represent a continuation of industrial/commercial activity; however, in areas lacking existing infrastructure, it would account for a more substantial change in the industrial/commercial activity and diversity of individual villages (MMS 2007b). The extent of the impacts associated with these activities ultimately would depend on the specific location within the Arctic and the particular community in which facilities would be placed.

Impacts on infrastructural composition also would result from the development of onshore pipeline and a permanent road network in locations that do not already have existing oil and gas facilities. Depending on the location of a pipeline landfall, the path of an associated road to the Trans-Alaska Pipeline System (TAPS) might open up areas not previously reached by permanent roads. The positive benefits of this construction would be to aid future ice road and permanent road construction, as well as providing a connection to the North Slope communities (MMS 2007d). Some of the negative impacts of roadway construction would be the interference with subsistence uses and animal movement and the potential for increased traffic (see Sections 4.4.13.3.1 and 4.4.14.3.1 for more information).

Additional indirect impacts concern those associated with climate change. Much of the infrastructure that would be needed to support oil and gas facilities in the Beaufort and Chukchi Seas likely would cross or be located within the coastal zone, an area vulnerable to climate change impacts (Clow et al. 2011). Siting of new facilities, therefore, may need to account for potential changes resulting from rises in sea level, increased storm frequency and intensity, and temperature changes. Frost heave and thaw settlement also should be accounted for in the development of oil and gas facilities (Instanes 2007).

One of the more noticeable effects would be the thawing of permafrost on land. This can cause erosion, buckled roads, and broken pipelines that could affect the oil and gas industry (Johnston 2010). In the Arctic, facilities often use permafrost as a solid foundation for buildings, pipelines, and roads, and for containing waste materials. The anticipated design lifetime for structures in permafrost regions is typically 30–50 years. Within this time frame, the structure should be able to function as designed with normal maintenance costs, if potential changes to permafrost are considered (Instanes 2003). Warming, for instance, may degrade permafrost, which can harm existing facilities and prevent the use of permafrost in the future (AMAP 2007; MMS 2007d). "Projected climate change is very likely to have a serious effect on existing infrastructure in areas of discontinuous permafrost. Permafrost in these areas is already at temperatures close to thawing, and further temperature increases are very likely to result in extremely serious impacts on infrastructure" (Instanes 2007).

Consequently, indirect impacts on land use, development patterns, and infrastructure can include locating further inland and/or strengthening foundations or building materials of existing facilities. These actions potentially can increase costs associated with development or force the construction of new facilities rather than the reuse or expansion of existing properties associated with oil and gas production. These decisions also may be influenced by the potential for increased flooding and/or erosion.

Production Operations. Routine operation activities would consist of production well operation, onshore facility operation, and vessel and aircraft traffic. It also would include the transport of oil from offshore to onshore locations using ships or pipelines (see Figure 4.4.10-3). As indicated in Section 4.4.1.3, the PEIS assumes that the most likely locations for the occurrence of activities would be in areas that already have been leased in recent sales. One to 15 helicopter trips and 1 to 15 vessel trips would be anticipated.

Local Land Use/Comprehensive Planning and Development Patterns. Once in operation,[21] only very small changes to land use, development patterns, and infrastructure would be expected, since a majority of the activities would be located offshore, and no additional construction would be anticipated. In general, the production of oil and gas would need to be consistent with Federal, State, and local planning initiatives.

Loss of Use to Existing Landowners or Users. Once in operation, an additional loss of use is not anticipated. At times, some access may be restricted within surrounding lands to accommodate a brief alteration in operations or a peak in normal activities, or to conduct maintenance.

During operation, the use of individual properties in the vicinity of the operating platforms may be affected indirectly if excessive noise and air emissions were generated from equipment and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles), or if a small increase in the amount of trash and debris washing ashore were to result from the activities. These occurrences may cause disturbances or annoyance among particular landholders or users, thereby inhibiting the intended or actual use of a property. The level and extent of impact would depend on the specific location within the Arctic. For instance, in locations where subsistence activities occur, the impacts may be more noticeable and have a larger impact on certain communities as compared to other areas of the Arctic; a discussion of these impacts is provided in Sections 4.4.13.3.1 and 4.4.14.3.1.

Physical and/or Infrastructural Composition. To the extent possible, no new facilities would be built during normal operations. Therefore, the potential to create lasting changes to the physical and/or infrastructural composition of the Arctic region during the operation phase would be limited.

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[21] For the purposes of this evaluation, normal operations are considered exclusive of events leading up to the production of offshore oil and gas.

Decommissioning. When activities for oil and gas production operations become uneconomical to continue, or when a lease is expired, many of the structures built for production are dismantled, shut down, or converted to other uses. Decommissioning activities in the Arctic typically involve permanently plugging wells (with cement), removing wellhead equipment, and removing the processing module from the platform. Pipelines also must be decommissioned, which involves cleaning the pipeline, plugging the ends, and leaving it in place, buried within the seabed. Onshore pipelines may be used for other purposes, if not removed (MMS 2008b). All decommissioning activities would abide by Federal regulations. Due to the physical nature of these activities and the length of the leases, land use, development patterns, and infrastructure may be impacted directly. These impacts, however, generally would be site-specific. In some cases, pre-exploration and preconstruction conditions may not be able to be reestablished.

Local Land Use/Comprehensive Planning and Development Patterns. Depending on the location of the production wells and associated infrastructure, decommissioning activities onshore may be regulated by local land use, zoning, and comprehensive planning initiatives or requirements.

In turn, local planning initiatives often account for developments of this nature in future planning due to the length of operation. For instance, the continued use of the facilities after production could impact planned development in a positive manner, either by providing an opportunity for reuse of facilities or by allowing for the potential for additional or future oil and gas development.

Loss of Use to Existing Landowners or Users. No permanent loss of use is anticipated to occur during the decommissioning/reclamation phase. Some temporary loss may occur if road or area closures are necessary to accommodate equipment, workers, or specific activities associated with this type of process. Access to and the physical composition of the industrial/port areas typically would be restored to its preconstruction or operations state to the extent possible.

In addition, the use of individual properties in the vicinity of the decommissioning activities may be affected indirectly if excessive noise and air emissions were generated from equipment and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles), or if a small increase in the amount of trash and debris washing ashore were to result from the activities. These occurrences may cause disturbances or annoyance among particular landholders or users, thereby inhibiting the intended or actual use of a property. The level and extent of impact would depend on the specific location within the Arctic.

Physical and/or Infrastructural Composition. In addition, potential changes to the physical and infrastructural composition of the Beaufort and Chukchi Seas would occur. Any equipment added may be removed; other defunct equipment also could be removed. These alterations would be site-specific. Moreover, if any offshore or onshore infrastructure were deemed a visual intrusion within the landscape for the duration of the project, removal of the structure during decommissioning would remove the feature, and thus alleviate the intrusion (MMS 2003a).

Impacts of Expected Accidental Events and Spills. One anticipated effect of oil and gas development within the Arctic is to extend infrastructure (e.g., landfalls and platforms) and associated activities westward. As a result of this construction, new areas of Alaska adjacent to the Beaufort and Chukchi Seas would be exposed to the potential effects of crude oil spills. Approximately 3 large spills ≥1,000 bbl, 10 to 35 small spills ≥50 bbl but <1,000 bbl, and 50 to 190 small spills <50 bbl, may be expected to occur with proposed development in the Beaufort and Chukchi Sea Planning Areas (Table 4.4.2-1). Consequently, crude oil spill-response equipment and personnel would be needed in those locations (MMS 2007d).

Expected accidental spills of oil or other chemicals are most likely to occur during the transfer of material from one vessel to another or to or from shore. These spills tend to be small and relatively easily contained. Other accidental spills could result from collisions or wrecks made more likely by an increase in marine traffic. The size and severity of such spills depend on the nature and location of the incident. Accidental spills could also result from the loss of well control or damage to pipelines. The effects of an oil spill vary with the size, location, and timing of the spill, along with the type of oil released.

As with other areas of Alaska, potential indirect impacts on land use and infrastructure resulting from small or large spills would likely include moderate temporary stresses from the spill response on existing community infrastructure; oil contamination at a coastal area; increased boat and air traffic to respond to the spill and cleanup operations; and restrictions of access to a particular area while the cleanup is conducted (MMS 2007d). These occurrences could lead to a temporary loss of use of certain parcels for both their intended and actual uses.

Impacts of an Unexpected Catastrophic Discharge Event. A CDE is an unexpected, very-low-probability accident that may occur during oil and gas development on the OCS (see Sections 4.3.3 and 4.4.2). For the Arctic region, the PEIS analyzes unexpected CDEs that range in size from 1.4 to 2.2 million bbl in the Chukchi Sea Planning Area and last 40 to 75 days, and from 1.7 to 3.9 million bbl in the Beaufort Sea Planning Area and that last 60 to 300 days (Table 4.4.2-2).

A CDE would have similar types of effects as spills of other magnitudes; however, the degree of impact would be more severe. For instance, the length of time in which the impacts would be experienced generally would be longer for this type of event (MMS 2007d; BOEMRE 2011j). Likewise, communities that are in close proximity to the event may experience a displacement of existing sociocultural patterns that could affect how they use the land (BOEMRE 2011j). Other changes may include the temporary and/or permanent usurpation of fishing grounds, port congestion/competition for berthing space, increased demand for services and housing, and increased vessel traffic. A CDE also can lead to delays in other infrastructure projects and the use of reserves and investments in local communities to pay for cleanup efforts rather than other planned projects (Picou et al. 2009). In particular, this type of event would have major effects on communities using land for subsistence activities. These impacts are discussed in detail in Section 4.4.13.3.2.

Responses to an unexpected CDE in the Arctic also would be complicated by the region's remote location and limited existing infrastructure (Nuka and Pearson 2010). For example, the closest major port on the U.S. Arctic coastline (i.e., Unalaska in the Aleutian Islands) is approximately 2,407 km (1,496 mi) from Point Barrow. Furthermore, only limited docking facilities are present along the Arctic coast; shallow water depths along the shoreline also make vessel access difficult. In addition, the few communities that are located in the Arctic are not connected to each other or to the rest of the State by onshore roadways. The few major airstrips that could handle cargo aircraft also are not connected to highways or docks (Kelso 2010). According to a Nuka and Pearson (2010) publication, a CDE on the scale of the DWH event likely would cripple the existing infrastructure in the Arctic.

As discussed for the GOM and the Cook Inlet, the degree of impact on land use and infrastructure is influenced by many factors, including, but not limited to, spill location, spill size, type of material spilled, prevailing wind and current conditions, the vulnerability and sensitivity of the land use and infrastructure, and the response capability. Due to the lack of existing spill response infrastructure within parts of the Arctic and the remote nature of the region, the degree of impact on land use and infrastructure within the Arctic likely would be moderate to major, if a CDE were to occur.

Impact Conclusions.

Routine Operations. Within the Arctic, minor to moderate impacts would be anticipated to result from the development of new oil and gas leases within the Beaufort and Chukchi Seas. Existing land use and infrastructure likely would be able to accommodate new leases. In general, land use changes would be needed only in locations where new onshore pipeline routes would be constructed and in areas requiring new transportation networks (MMS 2007b).

Expected Accidental Events and Spills. Expected accidental events and spills could have both direct and indirect effects on land use, depending on the type, size, location, and duration of the incident. If oil spills were to occur and were to contact the coast, overall impacts on land use and existing infrastructure typically would be minor (especially for small spills).

An Unexpected Catastrophic Discharge Event. In the unlikely event of a low-probability CDE within the Arctic, moderate to major impacts to land use, development patterns, and infrastructure would be expected. Impacts would be greater in areas with little infrastructure in place to handle accidents and where a greater reliance is placed on coastal activities for subsistence. There is limited existing infrastructure in place in the Arctic to be able to address this type of event; consequently, impacts of an unexpected CDE to land use would likely be greater in the Arctic than in the GOM and Cook Inlet Planning Areas.

4.4.11 Potential Impacts on Commercial and Recreational Fisheries

4.4.11.1 Gulf of Mexico

Impacts of Routine Operations.

Commercial Fisheries. Routine operations could affect commercial fisheries by causing changes in the distribution or abundance of fishery resources, reducing the catchability of fish or shellfish, precluding fishers from accessing viable fishing areas, or causing losses of or damage to equipment or vessels. Between 200 and 450 new platforms would be established under the proposed action, with up to 2,500 ha (6,177 ac) of seafloor likely to be disturbed by offshore platforms and up to 11,500 ha (28,417 ac) by pipelines. Impacts on commercial fishing activities would vary depending on the nature of a particular structure, the phase of operation, the fishing method or gear, and the target species group. Impacts would be higher for drifting gear such as purse nets, bottom longlines, and pelagic longlines than for trawls and handlines (MMS 2005f). Nevertheless, areas in which commercial fishing would be affected are small relative to the entire fishing area available to surface longlines or purse seiners.

To avoid potential conflicts and to maintain safety at large deepwater structures, a safety zone for vessels longer than 30 m (100 ft) may be established up to 500 m (1,640 ft) around each production platform, which would encompass up to approximately 80 ha (198 ac) of surface area per platform. The Fisherman's Contingency Fund, established under OSCLA, can compensate fisherman for property and economic losses related to obstructions caused by oil and gas development in the OCS. The Fund is composed of assessments paid by offshore oil and gas operations and administered by the NMFS (see www.nmfs.noaa.gov/mb/financial_services/fcf.htm).

Federal regulations (30 CFR 250.702(I)) require that, during decommissioning, all wellheads, casings, pilings, and other obstructions be removed to a depth of at least 5 m (15 ft) below the mud line or to a depth approved by the District Supervisor; the size of the area left untrawlable due to abandoned components would represent only a fraction of the total area excluded by oil and gas operations. Longlining would still be possible following decommissioning and removal because surface waters would not be affected by the presence of the remaining underwater components.

The impact of oil and gas structures on commercial fisheries at various depth ranges can be estimated using data in the Offshore Environmental Cost Model (OECM) (BOEMRE 2010c). The model assumes that there will be buffer zones of up to 0.8 km (0.5 mi) around new oil and gas structures, decreasing the area of ocean available for fishing. Although harvesting levels are not affected by offshore structures and pipelines, as these levels are below federally mandated levels, it is assumed that fishing activity will continue in areas still open for fishing, with existing harvesting levels remaining. Assuming that platforms would be placed in multiple depth ranges, rather than all platforms in a single depth range, OECM indicates that there will be an increase in fishing costs in the majority of depth ranges in each planning area. A platform placed in a depth range that produces decreasing fishing costs means that an additional platform in the depth range would reduce the cost impacts of platforms placed in other depth ranges.

The impacts of oil and gas development on commercial fishing costs would vary considerably by planning region and placement depth (Table 4.4.11-1). In the Western Planning Area, the largest cost increases would occur with structures located in water between 150 and 300 m (492 and 984 ft) deep, with an annual increase of $93 in costs from a single structure; a single structure in each depth range would increase annual costs by $147. In the Central Planning Area, overall increases in costs would be much larger at $1,080 per year, with the largest increase coming with a single structure placed in water between 150 and 300 m (492 and 984 ft). Cost impacts in the Eastern Planning Area would be minimal, at $2 per year with a structure in each depth range. In each of the planning areas, single structures would have relatively insignificant impacts compared to fishery revenues in each depth range.

Under the proposed action alternative, between 44 and 80 platforms would be located in the depth range 0 to 60 m (0 to 197 ft) in the Western Planning Area, with between 122 and 257 such platforms in the Central Planning Area. Offshore oil and gas structures placed within this depth range would increase annual commercial fishing costs by between $1,993 and $3,819 in the Western Planning Area, while reducing costs by between $2,507 and $11,243 in the Central Planning Area. No data is currently available on the placement of offshore platforms in the Eastern Planning Area, and consequently, their impact on commercial fishing costs.

***Recreational Fisheries*.** The level of impacts on recreational fisheries in the GOM due to routine operations under the proposed action would be similar to impacts during the previous lease period. Biological resources that serve as the basis for recreational fisheries in the GOM are expected to be only minimally affected by activities associated with routine operations. Construction activities would primarily affect soft bottom species such as red drum, sand sea trout, and spotted sea trout that are sought by anglers in private or charter/party vessels. Such conflicts would be temporary, however, as fishes would eventually return to disturbed areas. The presence of offshore platforms may have a positive effect on the availability of recreational fishing opportunities. During 1999, for example, approximately 20% of private boat fishing trips, 32% of charter boat fishing trips, and 51% of party boat fishing trips in the western and central GOM (Alabama, Mississippi, Louisiana, and Texas) took recreational fishers within 91 m (300 ft) of oil or gas structures (Hiett and Milon 2002), as the presence of structures is known to aggregate pelagic (e.g., king mackerels, tunas, and cobia) and reef-associated fish species (e.g., red snapper, gray triggerfish, and amberjack) that are targeted by many recreational fishers.

Impacts of Expected Accidental Events and Spills.

***Commercial Fisheries*.** Under the proposed action, up to 8 large spills greater than 1,000 bbl, between 35 and 70 spills between 50 bbl and 1,000 bbl, and up to 400 small spills less than 50 bbl could occur within the northern GOM. Most of the fish species inhabiting shelf or oceanic waters of the GOM have planktonic eggs and larvae (Ditty 1986; Ditty et al. 1988; Richards and Potthoff 1980; Richards et al. 1993). Certain species, such as triggerfishes, deposit demersal eggs but have larvae that take up residence in the water column, meaning that these species would also be affected by oil spills. Depending on the location and timing of particular

TABLE 4.4.11-1 Impacts of a Single Oil and Gas Structure on Commercial Fisheries, by Placement Depth ($2010)

	Western Planning Area		Central Planning Area		Eastern Planning Area	
Placement Depth Range	Fishery Revenue ($m)[a]	Cost Impact ($)	Fishery Revenue ($m)[a]	Cost Impact ($)	Fishery Revenue ($m)[a]	Cost Impact ($)
0 to 60 m	103.4	41.24	153.5	–165.82	64.4	–0.52
60 to 150 m	22.6	16.73	40.4	21.00	17.7	0.24
150 to 300 m	8.3	92.89	26.1	916.09	9.4	–0.92
300 to 1,500 m	74.4	–5.95	180.3	224.17	22.3	2.15
More than 1,500 m	45.4	2.11	402.7	84.91	54.4	0.76
All depths	254.1	147.03	803.1	1,080.40	168.2	1.70

[a] Average harvest values for the period 2006 to 2009.

Source: BOEMRE 2010c.

spills, effects would be greater if local water currents retained planktonic larvae and floating oil within the same water mass for extended periods of time. In deepwater areas, adults of highly migratory fish species, including pelagic species such as tunas, sharks, and billfish, would move away from surface oil spills. Pelagic larvae and neuston would not be able to move away from the spilled oil on the surface and would most likely be killed or injured. However, these impacts are not expected to cause population reductions in most commercially exploited species. In coastal areas, long-term but temporary degradation of estuarine habitat could occur if a large coastal area was oiled following a large or very large oil spill. Although some wetland areas may not recover completely, it is anticipated that spills considered possible as a result of the proposed action are not likely to substantially threaten the overall viability of wetland habitats used by commercially important species. On the basis of the potential level of impacts on coastal habitats including wetlands and submerged seagrass beds under the proposed action, major declines in fish population are not likely to occur.

In general, the level of effects from accidental spills would depend on the location, timing, and volume of spills in addition to other environmental factors. Small spills would be unlikely to affect a large number of fish or commercial fishing before dilution and weathering reduced concentrations; therefore, they would not have long-term effects on commercial fisheries in the GOM. It is anticipated that any single large spill would affect only a small proportion of a given fish population within the GOM and that fish resources would not be affected in the long term. However, localized effects on commercial fishing could result as a consequence of reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods.

Recreational Fisheries. The magnitude of effects from accidental spills would depend on the location, timing, and volume of spills, in addition to other environmental factors. Small spills that may occur under the proposed action are unlikely to affect a large number of fish or have a substantial effect on recreational fishing before dilution and weathering reduced concentrations of oil in the water. Consequently, it is anticipated that small spills would not have substantial or long-term effects on recreational fishing in the GOM. Any single large spill would likely affect only a small proportion of a given fish population within the GOM, and it is unlikely that fish resources would be affected in the long term. However, spills could have localized effects on recreational fishing as a consequence of contamination of fish tissues, degradation of aesthetic values that attract fishers, or temporary closure of fishing areas. On the basis of the number and size of spills assumed for the proposed action, persistent degradation of shorelines and waters are not likely to occur; therefore, impacts on recreational fishing are not expected to be significant. Impacts of spills on subsistence resources are also discussed in Section 4.4.13 and 4.4.14.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE in the GOM planning areas that ranges in size from 0.9-7.2 million bbl and has a duration of 30–90 days (Table 4.4.2-2). The magnitude of effects from a CDE would depend on the location, timing, and volume of the oil associated with the event. Oil from a CDE could contact intertidal habitat and subsequently contaminate or reduce the abundance of commercial and recreational species that depend on nearshore habitat. However, it is likely that an event would only affect a small proportion of fish species population, and it is unlikely that fish resources would be affected in the long term. See Sections 4.4.7.3.1 and 4.4.7.5.1 for a discussion of the potential impacts of a CDE on fish and invertebrate populations in the GOM.

Following a CDE, in the short term there would be local or regional effects on commercial fishing that as a result of reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods, and on recreational fishing as a consequence of contamination of fish tissues, the degradation of aesthetic values that attract fishers, and the likely temporary closure of fishing areas. For example, the DWH event had immediate effects on the GOM fishing industry between April and November 2010, with up to 40% of Federal waters being closed to commercial fishing in June and July (Congressional Research Service 2011) and between 25% and 95% of State waters closed to fishing (Congressional Research Service 2011). The impact of the DWH event on fishery landings is still being investigated (McCrea-Strub et al. 2011). Because consumer perceptions of GOM seafood and seafood products may affect demand, future sales of GOM fisheries' production may be lost (Congressional Research Service 2010). A CDE, such as that followed the DWH accident, could have more noticeable impacts on recreational fishing activity, as well as on individuals and firms that depend on angler spending. Spill effects can be mitigated to some extent through financial compensation and through policies of Federal and State fisheries management agencies.

Impact Conclusions.

Routine operations. Routine operations could affect commercial fisheries by causing temporary changes in the distribution or abundance of fishery resources, by reducing the catchability of fish or shellfish, precluding fishers from accessing viable fishing areas, or causing losses of or damage to equipment or vessels. No population-level effects or long-term loss of fishery resources are expected to result from routine operations in the GOM. Impacts on commercial and recreational fisheries from routine Program activities are expected to be minor.

Expected Accidental Events and Spills. The magnitude of effects from accidental spills would depend on the location, timing, and volume of spills, in addition to other environmental factors. Small spills that may occur under the proposed action are unlikely to affect a large number of fish or have a substantial effect on recreational fishing before dilution and weathering reduced concentrations of oil in the water. Consequently, it is anticipated that small spills would have little effect on commercial and recreational fishing. Any single large spill would likely affect only a small proportion of a given fish population within the GOM, and it is unlikely that fish resources would be affected in the long term. However, large spills could have localized effects on commercial fishing that could result as a consequence of reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods, and on recreational fishing as a consequence of contamination of fish tissues, degradation of aesthetic values that attract fishers, or temporary closure of fishing areas. Oil from large or very large spills could contact intertidal habitat and subsequently contaminate or reduce the abundance of commercial and recreational species that depend on nearshore habitat. Impacts from a large spill could be long-term, but are not expected to result in the long-term loss of fishery resources. Impacts on fisheries from an accidental spill could range up to moderate.

An Unexpected Catastrophic Discharge Event. In the event of a CDE, fishery recoveries could be impacted on a manner similar to that from a large spill. However, a larger proportion of a fish population could be affected, and impacts could be much more long-term in duration. Overall, impacts on commercial and recreational fishing from a CDE are expected to be moderate.

4.4.11.2 Alaska – Cook Inlet

Impacts of Routine Operations.

Commercial Fisheries. With one to three new platforms to be established under the proposed action, up to 4.5 ha (11 ac) of seafloor would be disturbed by offshore platforms, and up to 210 ha (519 ac) by pipelines. Impacts on commercial fishing activities would vary, depending on the nature of a particular structure, the phase of operation, fishing method or gear, and target species group. Routine operations could affect commercial fisheries by causing changes in the distribution or abundance of fishery resources, by reducing the catchability of fish or shellfish, by precluding fishers from accessing viable fishing areas, or by causing losses of or damage to equipment or vessels. It is anticipated that routine operations would not result in detectable effects on overall populations of fishery resources in Cook Inlet. Temporary displacement of fishery resources from localized areas could occur as a consequence of noise and activities associated with construction activities during development; however, these resources would be expected to return once construction disturbances have been terminated. Following platform construction, there could be some highly localized long-term changes in fish densities and species diversity in the vicinity of platforms due to attraction of some invertebrate and fish species.

Some exploration, development, and production activities have a potential to result in space use conflicts with commercial fishing activities. Seismic exploration vessels towing long cables have had a history of conflicts with the commercial fishing industry in Cook Inlet (MMS 2003a), including losses of crab pots, longlines, or other gear. In some cases, commercial fishing vessels could be excluded from normal fishing grounds to avoid the potential for gear loss. In addition, some studies have found a temporary reduction in fisheries' catch during or following seismic surveys (Skalski et al. 1992; Engås et al. 1996; reviewed in Popper and Hastings 2009). Such conflicts can sometimes be avoided by conducting seismic surveys during closed fishing periods or closed seasons. A potential also exists for loss of gear or access to fishing areas when floating drill rigs used for exploration are being moved and during other vessel operations.

Offshore construction of platforms could infringe on commercial fishing activities by excluding commercial fishing from adjacent areas due to safety considerations. It is assumed that up to three production platforms could be constructed as a consequence of leasing in the Cook Inlet Planning Area. If it is assumed that a safety zone of 500 m (1,640 ft) is maintained by larger vessels around each production platform, commercial fishing could be excluded from up to 160 ha (395 ac) of surface area within the planning area. Drilling discharges associated with exploration activities would likely affect only a small area near a drilling platform, and are not expected to interfere with commercial fishing. During development and production phases, potential effects of such discharges would cease because all muds, cuttings, and produced water would be discharged into wells instead of being released to open waters. Potential effects of platform construction and operation are expected to be highly localized.

Construction of pipelines can result in entanglement hazards for some types of fishing gear. The presence of an offshore pipeline would not typically interfere with the use of longlines, purse seines, drift nets (MMS 2004a), or beach seines. However, a bottom trawl, such as those employed by the commercial groundfish industry in Cook Inlet, has a potential to become snagged on exposed pipelines. It is estimated that up to 241 km (150 mi) of additional offshore pipeline could result from lease sales in the Cook Inlet Planning Area, thereby increasing the potential for snagging on pipelines by bottom trawling equipment, unless subsea pipelines are buried in trenches.

It is anticipated that the small increase in vessel activity that could occur as a result of additional lease sales in Cook Inlet under the proposed action (up to six additional trips per week) would not measurably affect commercial fishing opportunities, catchability of fish and shellfish resources, or navigation by commercial fishing vessels.

The impact of oil and gas structures on commercial fisheries at various depth ranges can be estimated using data from the OECM (BOEMRE 2010c). The model assumes that there will be buffer zones of up to 0.8 km (0.5 mi) around new oil and gas structures, decreasing the area of ocean available for fishing. Although harvesting levels are not affected by offshore structures and pipelines, as these levels are below federally mandated levels, it is assumed that fishing activity will continue in areas still open for fishing, with harvesting levels remaining. Assuming that platforms would be placed in multiple depth ranges, rather than all platforms in a single depth range, OECM indicates that there will be an increase in fishing costs in the majority of depth ranges in each planning area. A platform placed in a depth range that produces decreasing fishing costs means that an additional platform in the depth range would reduce the cost impacts of platforms placed in other depth ranges.

The impacts of oil and gas development on commercial fishing costs would vary considerably by placement depth (Table 4.4.11-2). In the Kodiak area, the largest cost increases would occur with structures located in water between 300 and 1,500 m (984 and 4,921 ft) deep, with an annual increase of $34 in costs from a single structure; a single structure in each depth range would increase annual costs by $44. In the Cook Inlet area, the largest increase would come with a single structure placed in water between 150 and 300 m (492 and 984 ft), with an overall increase in costs of $57 per year. In each of the areas, single structures would have relatively insignificant impacts compared to fishery revenues in each depth range.

***Recreational Fisheries*.** In general, routine operations associated with exploration, development, or production activities could affect recreational fisheries by causing changes in the distribution or abundance of fishery resources, by reducing the catchability of fish and shellfish, by precluding fishers from accessing viable fishing areas, or by causing losses of or damage to equipment or vessels. It is anticipated that routine operations would not result in detectable effects on overall populations of fishery resources in Cook Inlet. Temporary displacement of fishery resources from localized areas could occur as a consequence of noise and bottom-disturbing activities associated with routine operations. Following platform construction, there could be long-term localized changes in fish densities and species diversity due to the attraction of some invertebrate and fish species to platforms.

Seismic surveys could temporarily affect the behavior of some targeted species, thereby affecting catch rates in the immediate area of the surveys. Some recreational anglers could decide to avoid areas during seismic surveys due to the potential for loss of fishing gear, due to the increased vessel activity, or because of perceived or actual changes in catchability. It is estimated that new areas in the Cook Inlet Planning Area could be subjected to seismic surveys during the Program. However, given the relatively small proportion of the available Cook Inlet area that would be affected at any particular time, it is not anticipated that seismic surveys would greatly disrupt recreational fishing activities.

Offshore construction of platforms could infringe on some recreational fishing activities by excluding recreational fishing boats from adjacent areas for safety considerations. It is assumed that up to three production platforms could be constructed as a consequence of lease sales in the Cook Inlet Planning Area. However, the area lost to recreational fishing would be limited to the immediate footprint of the platforms plus a small safety zone surrounding each platform; only a very small proportion of available recreational fishing areas in Cook Inlet would be affected. The presence of such platforms could also benefit anglers by aggregating some pelagic or groundfish species.

Vessel traffic to provide support to OCS activities could increase by one to three trips per week. This would constitute a very small increase in overall vessel traffic in Cook Inlet. The potential increase in daily helicopter trips in the Cook Inlet area would not be expected to affect recreational fishing activities. Disturbances of recreational fishing opportunities from other activities associated with routine operations (e.g., pipeline construction) are also expected.

TABLE 4.4.11-2 Impacts of a Single Oil and Gas Structure on Commercial Fisheries, by Placement Depth ($2010)

	Kodiak		Cook Inlet	
Placement Depth Range	Fishery Revenue ($m)[a]	Cost Impact ($)	Fishery Revenue ($m)[a]	Cost Impact ($)
0 to 60 m	15.6	–3.34	7.3	–0.04
60 to 150 m	43.7	9.87	2.6	3.88
150 to 300 m	22.8	3.32	7.0	53.50
300 to 1,500 m	23.4	34.07	0.1	0.0
More than 1,500 m	1.3	0.26	0.0	0.0
All depths	106.9	44.18	17.0	57.35

[a] Average harvest values for the period 2006 to 2009.

Source: BOEMRE 2010c.

Impacts of Unexpected Accidental Events and Spills.

***Commercial Fisheries*.** Fisheries resources could become exposed to oil as a consequence of accidental oil spills. One large spill greater than 1,000 bbl, up to 3 spills between 50 and 1,000 bbl, and up to 15 small spills less than 50 bbl could occur in the Cook Inlet area from the proposed action.

Although pelagic fishes would be less likely to be affected than fishes in shallow subtidal or intertidal areas, oil spills could contaminate gear used for commercial fishing, such as purse seines and or drift nets. A large oil spill before or during the season when such fishing gears are in use could result in closures of some short-period, high-value commercial fisheries in order to protect gears or harvests from potential contamination. Lines from longline fisheries for halibut, Pacific cod, black cod, and other fish species could also be affected by oil. Some lines and buoys fouled with small amounts of oil could be unfit for future use. Although it is unlikely that a trawler would be operating in an oiled area, the trawl catches could be contaminated by oil and rendered unfit for consumption if the trawler did pass through such an area.

The bays and beaches of Cook Inlet have a number of setnet sites where gillnets are anchored to the beach or slightly offshore, and are used to harvest salmon and herring. Oil spills could damage setnet fisheries, as evidenced by the *Exxon Valdez* oil spill in 1989. While only a relatively small volume of weathered oil entered the lower Cook Inlet region as a result of the *Exxon Valdez* spill, the commercial salmon fishery was closed to protect both gear and the harvest from possible contamination.

Multiple small spills or a single large spill could cause declines in subpopulations of some species inhabiting the Cook Inlet Planning Area, although the level of effects would depend on a variety of factors. It is anticipated that there would be no long-term effects on overall fish populations in the central Gulf of Alaska. However, even localized decreases in stocks of fish could have effects on some commercial fisheries by reducing their catch or increasing the amount of effort or the distances that must be traveled to obtain adequate catches. Even if fish stocks are not reduced as a consequence of a spill, specific fisheries could be closed due to actual or perceived contamination of fish or shellfish tissues. Larger spills in Cook Inlet would probably result in the area being temporarily closed to commercial fishing until cleanup operations or natural processes reduced oil concentrations in fishery areas to levels considered safe. The Cook Inlet commercial shellfish industry is likely to be affected by closures because such a spill would be likely to affect shellfish in nearshore subtidal and intertidal areas. Fisheries for shellfish that occur in deeper waters, where oil residues seldom reach, are less likely to be closed. Shellfish from deeper areas could become commercially unacceptable for market due to actual or perceived contamination and tainting.

Closure of Cook Inlet to commercial fishing activities could result in considerable loss of income. Based on analyses conducted by MMS for Cook Inlet oil spills of the same sizes assumed for large spills in this analysis and assumptions about the value of commercial fisheries in Cook Inlet, it was estimated that a large oil spill in lower Cook Inlet could result in economic losses to commercial fisheries for up to 2 yr (MMS 2003a), and, depending on the timing and location of a spill, it was also considered possible that the fishery could be closed for a whole season, resulting in a 100% loss for a given year.

***Recreational Fisheries*.** Recreational fishery resources could be exposed to oil as a consequence of accidental oil spills. Up to 1 large spill greater than 1,000 bbl, up to 2 spills between 50 and 1,000 bbl, and up to 10 small spills less than 50 bbl could occur in the Cook Inlet area from the proposed action.

While it is anticipated that these spills would not affect the overall populations of fishes in the central Gulf of Alaska, some fish stocks in localized areas of Cook Inlet could be affected. Populations of intertidal organisms could be depressed measurably for a year or more in intertidal areas contacted by spilled oil. Oil contacting beaches could affect clam gathering by depressing clam populations or tainting tissues of clams. The magnitude of such effects would depend upon many factors, including the volume of oil spilled, weather conditions, prevailing currents, locations, oil spill response actions, and whether the oil reached sensitive habitats for fishery resources. Declines in localized fish stocks could affect recreational fishing success and businesses associated with providing recreational and sport fishing opportunities.

An oil spill could result in a closure of ports in an effort to protect the ports and vessels from being oiled. Oil spills could potentially cause economic losses for boat owners and anglers by contaminating vessels and fishing gear. Oiled vessels would need to be cleaned and oiled gear either cleaned or replaced; potential individual costs are expected to be relatively small. It is anticipated that many anglers would choose to fish in alternate areas in the event of port closures. Charter operators could be inclined to temporarily avoid going out of port into Cook Inlet to avoid fouling their gear and vessels with oil. Public perception of oil spill damage could temporarily reduce the number of anglers. If so, anglers would likely target alternate fishing areas until they deemed that the quality of the fishing experience in the oil spill area had returned to previous conditions.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE in the Cook Inlet Planning Area that ranges in size from 75 to 125 thousand bbl and has a duration of 50 to 80 days (Table 4.4.2-2). The magnitude of effects from a CDE would depend on the location, timing, and volume of the oil associated with the event. Oil from a CDE could contact intertidal habitat and subsequently contaminate or reduce the abundance of commercial and recreational species that depend on nearshore habitat. Very large oil spills could have greater impacts, especially if the oil reached large areas of intertidal habitat. Studies following the *Exxon Valdez* oil spill suggest that a CDE could have the potential to reduce or contaminate populations of recreationally popular salmon and shellfish in heavily oiled areas for more than 10 years. For example, pink salmon had elevated egg mortality for at least 4 years after the spill (Peterson et al. 2003), and littleneck and butter clam populations were reduced for a decade after the spill, although much of the slow recovery may have resulted from cleanup methods used in intertidal areas (*Exxon Valdez* Oil Spill Trustee Council 2009a). Contamination of shellfish may persist even after populations recover. Species less dependent on intertidal soft sediments, such as rockfish, are less likely to be affected. Impacts of spills on subsistence resources are discussed in Section 4.4.13 and Section 4.4.14.

Following a CDE, in the short term, there would be local or regional effects on commercial fishing that as a result of reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods, and on recreational fishing as a consequence of contamination of fish tissues, the degradation of aesthetic values that attract fishers, and the likely temporary closure of fishing areas. Because consumer perceptions of seafood and seafood products may affect demand, future sales of fisheries' production may be lost following a CDE. A CDE, such as that following the *Exxon Valdez* accident, could have more noticeable impacts on recreational fishing activity, as well as on individuals and firms that depend on angler spending, although studies of recreational visitation in Alaska after the accident indicated that while consumer perceptions of the spill and its impact in visitor surveys were negative, only a small percentage of visits were actually affected (see Section 3.13.6). Spill effects can be mitigated to some extent through financial compensation and through policies of Federal and State fisheries management agencies.

Impact Conclusions.

Routine Operations. Routine operations could affect commercial fisheries by causing changes in the distribution or abundance of fishery resources, by reducing the catchability of fish or shellfish, precluding fishers from accessing viable fishing areas, or causing losses of or damage to equipment or vessels. No population-level effects or long-term loss of fishery resources are expected to result from routine operations in Cook Inlet. Impacts on commercial and recreational fisheries from routine Program activities are expected to be minor.

Expected Accidental Events and Spills. The magnitude of effects from accidental spills would depend on the location, timing, and volume of spills, in addition to other environmental factors. Small spills that may occur under the proposed action are unlikely to affect a large number of fish or have a substantial effect on recreational fishing before dilution and weathering reduced concentrations of oil in the water. Consequently, it is anticipated that small spills would have little effect on commercial and recreational fishing. Any single large spill would likely affect only a small proportion of a given fish population within Cook Inlet, and it is unlikely that fish resources would be affected in the long term. However, large spills could have localized effects on commercial fishing that could result as a consequence of reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods, and on recreational fishing as a consequence of contamination of fish tissues, degradation of aesthetic values that attract fishers, or temporary closure of fishing areas. Oil from large or very large spills could contact intertidal habitat and subsequently contaminate or reduce the abundance of commercial and recreational species that depend on nearshore habitat. Impacts from a large spill could be long-term. Impacts on fisheries from an accidental spill could range up to moderate.

An Unexpected Catastrophic Discharge Event. In the event of a CDE, fishery recoveries could be affected in a manner similar to that from a large spill. However, a larger proportion of a fish population could be affected, and impacts could be much more long-term in duration. Overall, impacts on commercial and recreational fishing from a CDE are expected to be moderate.

4.4.11.3 Alaska – Arctic

Impacts of Routine Operations. There is a relatively small salmon fishery in Kotzebue Sound in Hope Basin, but there are no commercial fisheries in the Chukchi Sea Planning Area where routine operations would occur (MMS 2006b). Consequently, no impacts from routine operations are anticipated. The single commercial fishery in the Beaufort Sea is for cisco and whitefish on the Colville River during the summer and fall months. The potential for negative effects on this fishery would be related to the timing of exploration and development activities and the proximity of those activities to the mouth of the Colville River. Because exploration and development of this area has already occurred, it is considered unlikely that there would be substantial levels of additional development as a result of the proposed action. In addition, impacts would be limited in scope as a result of adherence to mitigation measures and compliance with Federal, State, and local requirements and protective measures. Therefore, impacts on this fishery are also anticipated to be limited in scope. Similarly, impacts on recreational fisheries from routine operations are not anticipated, as little recreational fishing occurs in the Beaufort Sea and Chukchi Sea Planning Areas (NPFMC 2010).

Although commercial fishing is limited in the Beaufort Sea and Chukchi Sea Planning Areas, commercial fishing in the Arctic may become more viable if predicted warming trends continue. There is evidence that commercially harvested species such as snow crab, walleye pollock, and yellowfin sole are expanding northward (NMFS 2009b). If, in the coming decades, commercially viable populations develop in the Arctic and if commercial fishing is permitted in Federal waters, oil and gas developments have the potential to affect these activities, as described in Sections 4.4.11.1.1 and 4.4.11.2.1.

Impacts of Unexpected Accidental Events and Spills. Up to 3 large spills greater than 1,000 bbl, between 10 and 35 spills between 50 and 1,000 bbl, and up to 190 small spills of less than 50 bbl could occur in the Beaufort and Chukchi Sea areas from the proposed action.

Recreational fishing in the Beaufort and Chukchi Sea Planning Areas is very limited and generally occurs only at larger population centers. However, where and when recreational fishing does occur, an oil spill could reduce fishing activity or contaminate fishery resources. Commercial fishing in the Beaufort and Chukchi Sea Planning Areas is restricted to the Colville River. The occurrence of an oil spill near commercial fishing areas during the fishing season could have effects on particular fisheries and the local economies that depend on them. Oil spills typically result in the closure of fishing grounds and reduced or lack of harvest. Even if harvest continues, the perception of a tainted product could reduce the economic value of fish harvested in the vicinity of an oil spill or could even cause fish to be removed from markets.

Spills could foul fishing gear, result in fish contamination and mortality, and potentially close some fishing grounds or entire fisheries for one or more years. A large spill could also increase competition on alternative fishing areas that remain open, resulting in increased costs and/or reduced harvests for individual fishermen. There is a reduced chance of a spill occurring during pulse fisheries of short duration, such as those for salmon, herring, or whitefish, because of the relatively short period of time that such fisheries are open. However, if a spill were to occur during operation of such a fishery, potential impacts would include a total loss of commercial fishing harvest due to the inability to switch to an alternative fishing time or area. Impacts of spills on subsistence resources are discussed in Section 4.4.13 and Section 4.4.14.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE in the Chukchi Sea Planning Area that ranges in size from 1.4-2.2 million bbl and has a duration of 40–75 days, and a CDE in the Beaufort Sea Planning Area with a volume of 1.7-3.9 million bbl and a duration of 60–300 days (Table 4.4.2-2). The magnitude of effects from a CDE would depend on the location, timing, and volume of the oil associated with the event. Oil from a CDE could contact intertidal habitat and subsequently contaminate or reduce the abundance of commercial and recreational species that depend on nearshore habitat. However, it is likely that an event would only affect a small proportion of fish species population. Although commercial and recreational fishing in the Arctic region are of minor economic significance, in the short term, there would be local and regional economic impacts resulting from reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods, and on recreational fishing as a consequence of contamination of fish tissues, the degradation of aesthetic values that attract fishers, and the likely temporary closure of fishing areas.

Because consumer perceptions of seafood and seafood products may affect demand, future sales of fisheries' production may be lost following a CDE. A CDE, such as that following the *Exxon Valdez* accident, could have more noticeable impacts on recreational fishing activity, as well as on individuals and firms that depend on angler spending, although studies of recreational visitation in Alaska after the accident indicated that while consumer perceptions of the spill and its impact in visitor surveys were negative, only a small percentage of visits were actually affected (see Section 3.13.6). Spill effects can be mitigated to some extent through financial compensation and through policies of Federal and State fisheries management agencies.

Impact Conclusions.

Routine Operations. Routine operations could affect commercial fisheries by causing changes in the distribution or abundance of fishery resources, by reducing the catchability of fish or shellfish, precluding fishers from accessing viable fishing areas, or causing losses of or damage to equipment or vessels. Commercial and recreational fisheries in the Beaufort Sea and Chukchi Sea Planning Areas are relatively small and localized. Impacts on these fisheries are unlikely, since OCS activities would not occur in the immediate area near these fisheries. Impacts to commercial and recreational fisheries from routine Program activities are expected to be minor.

Expected Accidental Events and Spills. The magnitude of effects from accidental spills would depend on the location, timing, and volume of spills, in addition to other environmental factors. Small spills that may occur under the proposed action are unlikely to affect a large number of fish or have a substantial effect on recreational fishing before dilution and weathering reduced concentrations of oil in the water. Consequently, it is anticipated that small spills would have little effect on commercial and recreational fishing. Any single large spill would likely affect only a small proportion of a given fish population within the Beaufort and Chukchi Seas. However, large spills could have localized effects on commercial fishing that could result as a consequence of reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods, and on recreational fishing as a consequence of contamination of fish tissues, degradation of aesthetic values that attract fishers, or temporary closure of fishing areas. Oil from large or very large spills could contact intertidal habitat and subsequently contaminate or reduce the abundance of commercial and recreational species that depend on nearshore habitat. Impacts from a large spill could be long-term. Impacts on fisheries from an accidental spill could range from negligible to moderate.

An Unexpected Catastrophic Discharge Event. In the event of a CDE, fisheries recoveries could be impacted on a manner similar to that from a large spill. However, a larger proportion of a fish population could be affected, and impacts could be much more long-term on duration. Overall, impacts on commercial and recreational fishing from a CDE are expected to be moderate.

4.4.12 Potential Impacts to Tourism and Recreation

4.4.12.1 Gulf of Mexico

4.4.12.1.1 Impacts of Routine Operations. In addition to the continuing use of existing onshore support and processing facilities, between 4 and 6 new pipeyards, less than 12 new pipeline landfalls, and as many as 12 new gas processing facilities are projected to be built as a result of the Program. Additional offshore construction could include increased noise and traffic, air and water pollution, impacts on residential property values, and land use changes. As it is likely that onshore facilities would be placed near other commercial areas zoned for such development, certain coastal areas could also be closed temporarily to accommodate the construction of new facilities, while underground pipeline construction could occur near important recreational areas. Routine operations would have limited effects on recreation and tourism, with potential adverse aesthetic impacts on beach recreation and sightseeing and potential positive impacts on diving and recreational fishing.

The proposed action is expected to result in 300 to 600 service-vessel trips and 2,000 to 5,500 helicopter operations weekly. Although service vessels are assumed to use established nearshore traffic lanes and helicopters are assumed to comply with areal clearance restrictions at least 90% of the time, additional helicopter and vessel traffic would add a low level of noise pollution that could affect beach users. Routine OCS traffic can cause disturbances to recreational resources, particularly beaches, through increased levels of noise, debris, and rig visibility. There may also be minor space-use conflicts with recreational fishermen during the initial phases of the proposed action and low-level environmental degradation of fish habitat, which would negatively impact recreational fishing activity. However, these negative effects would likely be outweighed by the beneficial role that oil rigs serve as artificial reefs for fish populations. The degree to which oil platforms will become a part of a particular State's rigs-to-reefs program will be an important determinant of the degree to which the proposed action will impact recreational fishing activity in the long term.

The broader economic implications of the proposed action would be felt primarily on the GOM coast of Texas. The Texas coastline features an important barrier island system that supports a broad range of beach-related activity, and the visual, debris, and noise related issues could impact beach-related activity at these locations.

4.4.12.1.2 Impacts of Expected Accidental Events and Spills. Up to 8 large spills greater than 1,000 bbl, between 35 and 70 spills between 50 and 1,000 bbl, and up to 400 small spills less than 50 bbl could occur in the GOM from the proposed action. It is reasonable to expect that most of these spills will occur in deepwater areas located away from the coast, based on the established trend for oil and gas activity to move into deep waters located for the most part at a substantial distance from the coast.

Temporary impacts would occur if an oil spill reached a beach or other recreational use area. The magnitude of these impacts would depend on factors such as the size and location of the spill, and would likely be greatest if the spill occurred during the peak recreational season. A number of studies (see Section 3.1.3) have shown that there could be a one-time seasonal decline in tourist visits of 5 to 15% associated with a major oil spill.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE with an assumed volume of 0.9-7.2 million bbl and a duration of 30–90 days (Table 4.4.2-2). The effects from a CDE would likely include beach and coastal access restrictions; restrictions on visitation, fishing, or hunting while cleanup is being conducted; and aesthetic impacts associated with the event itself and with cleanup activities. These impacts are expected to be temporary, with the magnitude dependent on the location and size of the event and the effectiveness of cleanup operations. Longer-term impacts may also be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event.

Impact Conclusions.

Routine Operations. Routine operations would have minor, short-term negative effects on recreation and tourism, with potential adverse aesthetic impacts on beach recreation and sightseeing and potential positive impacts on diving and recreational fishing in the GOM coast. Although the proposed action has the potential to directly and indirectly affect recreational resources along the GOM coast, the small scale of OCS activities relative to the scale of the existing oil and gas industry, as well as the distance oil platforms would be from shore, are such that the potential impacts on recreational resources are likely to be minor.

Expected Accidental Events and Spills. Expected accidental spills could have temporary impacts if an oil spill reached a beach or other recreational- or subsistence-use areas in the GOM. The magnitude of these impacts would depend on factors such as the size and location of the spill, and would likely be greatest if the spill occurred during the peak recreational season. Small spills of less than 1,000 bbl could have negligible to minor impacts, while large spills of more than 1,000 bbl could have minor to moderate impacts.

An Unexpected Catastrophic Discharge Event. The effects of an unexpected CDE would likely include beach and coastal access restrictions; restrictions on visitation, fishing, or hunting while cleanup is being conducted; and aesthetic impacts associated with the event itself and with cleanup activities. These impacts are expected to be temporary, with the magnitude dependent on the location and size of the event and the effectiveness of cleanup operations. A CDE could result in minor to moderate impacts. Longer-term impacts may also be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event.

4.4.12.2 Alaska – Cook Inlet

4.4.12.2.1 Impacts of Routine Operations. Although no new pipe yards, pipeline landfalls, or gas processing facilities would be built as a result of the proposed 5-yr program, additional offshore construction could include increased noise and traffic, air and water pollution, impacts on residential property values, and land use changes. Oil and gas development under the proposed action in the south central Alaska region would occur in the vicinity of previous development. The additional development would not alter the character of the area, because similar infrastructure is already present. Effects on scenic quality would be temporary and localized, and would be most noticeable during heavy periods of industrial activity, such as during drilling or pipelaying. Temporary closure of certain areas to recreation would likely be necessary, but would be limited in size and duration. An increase in the amount of trash and debris washing ashore may also occur as a result of the development. The frequency of helicopter and vessel traffic to and from the new platforms would be consistent with that of existing platforms, but would contribute marginally to the impact on scenic quality and add to the industrial noise. The magnitude of these impacts would vary with the distance of these activities from existing parks and wildlife refuges, primary recreational use areas, and cruise line paths. During the short period of construction, the increased workforce could impact lodging accommodations for tourists during peak times; however, impacts would depend on the timing and location of the activities and the availability of a local workforce.

4.4.12.2.2 Impacts of Expected Accidental Events and Spills. One large spill greater than 1,000 bbl, up to 3 spills between 50 and 1,000 bbl, and up to 15 small spills less than 50 bbl could occur in the Cook Inlet area from the proposed action. These oil spills would be responded to primarily by existing response facilities along the coast and existing shore bases according to spill response protocols. Potential impacts on recreation and tourism resulting from an oil spill would likely include direct land use impacts (e.g., from oil contamination at a coastal area), access restrictions to a particular area (e.g., no fishing or hunting while cleanup is conducted), and aesthetic impacts of the spill itself and cleanup operations. These impacts are expected to be temporary, but could last an entire season. However, because of public perceptions resulting from the *Exxon Valdez* oil spill in Prince William Sound, tourism in the region may respond more strongly than would tourism in other regions. The magnitude of the impacts would depend on the location and size of the spill and the effectiveness of cleanup operations.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes an unexpected CDE in the Cook Inlet Planning Area with an assumed volume of 75-125 thousand bbl and a duration of 50–80 days (Table 4.4.2-2). Such a CDE could result in beach and coastal access restrictions; restrictions on visitation, fishing, or hunting while cleanup is being conducted; and aesthetic impacts associated with the event itself and with cleanup activities. These impacts are expected to be temporary, with the magnitude dependent on the location and size of the event and the effectiveness of cleanup operations. Longer-term impacts may also be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event.

Impact Conclusions.

Routine Operations. Routine operations would have minor, short-term negative effects on recreation and tourism, with potential adverse aesthetic impacts on sightseeing, boating, fishing, and hiking activities in the Cook Inlet area.

Expected Accidental Events and Spills. Expected accidental spills could have temporary impacts if an oil spill reached a beach or other recreational- or subsistence-use areas in the Cook Inlet area. The magnitude of these impacts would depend on factors such as the size and location of the spill, and would likely be greatest if the spill occurred during the peak recreational season. Small spills of less than 1,000 bbl could have negligible to minor impacts, while large spills of more than 1,000 bbl could have minor to moderate impacts.

An Unexpected Catastrophic Discharge Event. The effects of an unexpected CDE would likely include beach and coastal access restrictions; restrictions on visitation, fishing, or hunting while cleanup is being conducted; and aesthetic impacts associated with the event itself and with cleanup activities. A CDE could result in minor to moderate impacts. These impacts are expected to be temporary, with the magnitude dependent on the location and size of the event and the effectiveness of cleanup operations. Longer-term impacts may also be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event.

4.4.12.3 Alaska – Arctic

4.4.12.3.1 Impacts of Routine Operations. Although no new pipe yards, pipeline landfalls, or gas processing facilities would be built as a result of the proposed 5-year program, additional offshore construction could include increased noise and traffic, air and water pollution, impacts on residential property values, and land use changes. Oil and gas development activities could result in impacts on recreation and tourism in the Arctic region. The main recreation and tourism activities that could be impacted by routine oil and gas operations would be sightseeing, hiking, and rafting. Fishing in this region is primarily a subsistence activity rather than a recreational activity. Impacts on sightseeing might be viewed as being negative, with adverse aesthetic impacts from offshore platforms and possible increases in construction projects for gas processing facilities and new offshore pipelines to connect to existing onshore pipelines in the Chukchi Sea area. Impacts on these recreational activities would depend on the proximity of the new construction to the recreational use areas (such as whether they are in view of existing parks and refuges).

The additional development would not alter the character of the area, as similar infrastructure is already present. Effects on scenic quality would be temporary and localized, and would be most noticeable during heavy periods of industrial activity, such as during drilling or pipelaying. Temporary closure of certain areas to recreation would likely be necessary, but would be limited in size and duration. An increase in the amount of trash and debris washing ashore may also occur as a result of the development. The frequency of helicopter and vessel traffic to and from the new platforms would be consistent with that of existing platforms, but would contribute marginally to the impact on scenic quality and add to the industrial noise. The magnitude of these impacts would vary with the distance of these activities from existing parks and wildlife refuges and primary recreational use areas. During the short period of construction, the increased workforce could impact lodging accommodations for tourists during peak times; however, impacts would depend on the timing and location of the activities and the availability of a local workforce.

4.4.12.3.2 Impacts of Expected Accidental Events and Spills. Up to 3 large spills greater than 1,000 bbl, up to 35 spills between 50 and 1,000 bbl, and up to 190 small spills of less than 50 bbl could occur in the Beaufort and Chukchi Sea area from the proposed action. These spills would be responded to primarily by existing response facilities along the coast and existing shore bases according to spill response protocols. Potential impacts to recreation and tourism resulting from an oil spill would likely include direct land use impacts (e.g., from oil contamination at a coastal area), access restrictions to a particular area (e.g., no fishing or hunting while cleanup is being conducted), and aesthetic impacts (e.g., view of spill and cleanup activities). These impacts are expected to be temporary, and the magnitude of the impacts would depend on the location and size of the spill and the effectiveness of cleanup operations. The greatest potential impacts would occur from large spills in shallow water. The potential for impact would likely decrease with decreasing spill size and increasing water depth.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE that ranges from 1.9 to 2.2 million bbl in the Chukchi Sea Planning Area, and from 1.7 to 3.9 million bbl on the Beaufort Sea Planning Area (Table 4.4.2-2). A CDE could result in beach and coastal access restrictions; restrictions on visitation, fishing, or hunting while cleanup is being conducted; and aesthetic impacts associated with the event itself and with cleanup activities. These impacts are expected to be temporary, with the magnitude dependent on the location and size of the event and the effectiveness of cleanup operations. Longer-term impacts may also be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event.

Impact Conclusions.

Routine Operations. Routine operations would have minor, short-term negative effects on recreation and tourism, with potential adverse aesthetic impacts on sightseeing, hiking, and rafting activities in the Chukchi Sea and Beaufort Sea Planning Areas.

Expected Accidental Events and Spills. Temporary impacts would occur if an oil spill reached a beach or other recreational- or subsistence-use areas in the Arctic. The magnitude of these impacts would depend on factors such as the size and location of the spill, and would likely be greatest if the spill occurred during the peak recreational season. Small spills of less than 1,000 bbl would have negligible to minor impacts, while large spills of more than 1,000 bbl would have minor to moderate impacts.

An Unexpected Catastrophic Discharge Event. The effects of an unexpected CDE would likely include beach and coastal access restrictions; restrictions on visitation, fishing, or hunting while cleanup is being conducted; and aesthetic impacts associated with the event itself and with cleanup activities. A CDE could result in minor to moderate impacts. These impacts are expected to be temporary, with the magnitude dependent on the location and size of the event and the effectiveness of cleanup operations. Longer-term impacts may also be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event.

4.4.13 Potential Impacts to Sociocultural Systems

4.4.13.1 Gulf of Mexico

As discussed in Section 3.4.1.1, the counties in the GOM coastal commuting zone include a diverse mixture of social classes, cultures, ethnic groups, and communities. They also include a well-established oil and gas industry and support structure focused mainly in Louisiana and Texas. The activities covered under the Program would tend to maintain existing onshore facilities rather than require new ones (MMS 2006a, 2008a). While oil and gas facilities are dispersed along the central and western coast of the GOM, they are not spread evenly. Terrebonne, Plaquemine, and Lafourche parishes in Louisiana are the heart of the oil and gas support industry (MMS 2008a) with Port Fourchon catering to 90% of all GOM deepwater production (BOEMRE 2011a).

4.4.13.1.1 Impacts of Routine Operations. Routine OCS gas and oil operations include exploration, development, operation, and decommissioning. Although tied to the shore by aircraft, supply vessels, and pipelines, these activities occur well offshore and in increasingly deeper water. The global nature of deepwater activities has contributed to cultural heterogeneity among the gas and oil workforce with the importation of migrant workers. A recent study reports that industry employers often hire foreign-born Mexican and Laotian workers in upstream support sectors such as ship and fabrication yards (Hemmerling and Colton 2004). The greater distance of deepwater platforms from coastal communities has resulted in workers being drawn from a wider range of locations in the GOM region, making the ties between local subcultural groups and the offshore industry less consistent. The move farther offshore into deep water has also led to longer offshore work shifts and to more "on call" schedules for many workers, including technical experts and mariners (Austin et al. 2002). In the past, development of infrastructure within coastal wetlands has contributed to the shrinking of wetlands and loss of land in Louisiana, resulting in a loss of both subsistence and commercial wild resource harvesting areas. However, most new production will be able to tie into the existing pipeline system, so it is unlikely that many new pipeline channels will need to be dredged. Current practice is for pipeline channels to be backfilled, reducing wetland erosion and partitioning of habitat (Hemmerling and Colton 2004).

4.4.13.1.2 Impacts of Expected Accidental Spills. Accidental spills, including oil spills, chemical spills, vessel collisions, and loss of well control, are possible under the Program (MMS 2008a) (see Section 4.4.2). Between 200 and 400 spills of 50 bbl or less, 35 to 70 spills between 50 and 1,000 bbl, and 4 to 8 large spills greater than 1,000 bbl are posited for the GOM Program. Most accidental spills on this scale are likely to be short term and localized. Those occurring well offshore are likely to be cleaned up or dissipate before reaching shore, and would thus have little effect on onshore communities (MMS 2006a). Those occurring in coastal waterways involving OCS support vessels or pipelines (BOEMRE 2011a) would have localized effects on wild resources harvested either commercially or for subsistence purposes. Intertidal and estuarine habitats, where shellfish are harvested and the juveniles of harvested species develop, are the most vulnerable (see Sections 4.4.6 and 4.4.7). Most adult fish species seem to be better able to avoid oiled waters. Impacts from small and moderate coastal spills are likely to have localized and short-lived effects. Large spills (over 1,000 bbl), and especially spills of sufficient size to overwhelm cleanup and booming efforts, would have a notable effect on communities dependent on harvesting renewable wild resources either commercially or for subsistence purposes.

Impacts of an Unexpected Catastrophic Discharge Event. A CDE would be considered an unexpected, low-probability event unlikely to occur during routine operations. The PEIS analyzes a CDE that ranges in size from 0.9 to 7.2 million bbl and would last from 30 to 90 days (Table 4.4.2-2). A CDE would have major sociocultural consequences for populations employed in offshore oil and gas production or in commercial fishing and shrimping, along with those engaged in subsistence harvesting, and would result in negative and long-lasting social effects (BOEMRE 2011b). Unlike devastation from hurricanes or other natural disasters that tend to bring communities together to face a common tragedy, oil spills tend to have divisive effects. Technical disasters such as oil spills are perceived as preventable, have a person or organization viewed as primarily responsible, and often can lead to litigation that can last for years (Picou et al. 2009). For example, during the DWH release, large areas of the GOM were closed to all shrimping and fishing (NMFS 2010b, 2011c). Fisheries in Federal waters remained closed from 2 to 11 months (NMFS 2011e), while pockets of Louisiana coastal waters in the Mississippi Delta and Bay Baptiste remain closed (LDWF 2012). The loss of work placed financial stress on workers in that industry. Some, but not all, shrimpers and fishing boats were employed in the cleanup, creating a division between those who received some financial relief through the cleanup effort and those who did not. The loss of income and potential loss of some subsistence sources create emotional stress stemming from financial stress, often resulting in depression and post-traumatic stress disorder in those who depend on the renewable resources of the sea for their livelihood. An increase in sociological disorders such as domestic violence, substance abuse, and suicide was observed in communities affected by the *Exxon Valdez* spill (Picou and Arata 1997). Similar patterns appear to be emerging among populations that are heavily dependent on fishing along the GOM coast (Picou et al. 1999; Picou 2010), especially among fishing communities already hard hit by Hurricane Katrina (Yeoman 2010). Methods for mitigating social stress by creating a therapeutic community based on a model developed for the *Exxon Valdez* spill are being implemented in the GOM (SAMHSA 2010; MASGC 2011).

While only a small portion of those who live along the northern coast of the GOM are engaged in subsistence harvesting, if oil from a CDE were to reach the shore, it could affect the barrier islands and wetlands important to the harvesting of subsistence resources, including waterfowl, fish, shrimp, and shellfish. If coastal fisheries were contaminated or closed, it would have an effect on subsistence harvesting. As a result of the DWH event, close to 30,000 emergency advance payment claims were filed based on the loss of subsistence resources (BOEMRE 2011a). Loss of subsistence resources has economic, nutritional, and cultural consequences. While Federal authorities have declared GOM fish, shrimp, and shellfish from areas contaminated by oil from the DWH event safe to consume (Ylitalo et al. 2012), there is some evidence that populations, such as subsistence fishers, whose diet includes a relatively large amount of seafood, may be at greater risk (Rotkin-Ellman et al. 2012).

Impact Conclusions.

Routine Operations. Few impacts on GOM sociocultural systems are anticipated from the proposed action. The oil and gas industry is well-developed along the coast, and the proposed action is more likely to support the existing industry than to create industry growth. Any expansion of deepwater activities will result in jobs that require longer, unbroken periods of work offshore, specialized skills, and potential in-migration of part of the workforce. Such changes can affect workers, their families, and the communities in which they reside. Impacts on sociocultural systems from routine Program activities in the GOM planning areas are expected to be minor.

Expected Accidental Events and Spills. Small spills are likely to have small, localized, and short-lived effects. Most would occur during transfer of material, such as refueling, or as the result of collisions. Routine transfers are boomed and thus mitigated. Impacts would be minor. Most spills would occur far from shore and would be cleaned up or dissipate before reaching shore, resulting in minor effects. However, small spills in coastal waters could affect localized intertidal resources used by subsistence harvesters. While there would be local impairment of the resource, cleanup should be possible and the resource as a whole should remain viable. Impacts would therefore be moderate.

The impact of a large release from tankers, platforms, or pipelines would depend on its distance from shore, proximity to important fisheries, and the effectiveness of containment and cleanup. Impacts would be moderate to major. Access to fisheries may be temporarily disrupted — a moderate impact. The viability of some resources could be threatened if the spill reached an important estuarine or intertidal area, and impacts would be major.

An Unexpected Catastrophic Discharge Event. In the unlikely event of a low-probability CDE, there would be major economic repercussions for the oil and gas industry, commercial fishers, and subsistence harvesters. If oil from a CDE were to reach the shore, impacts on estuarine and intertidal resources would be unavoidable and could be moderate to major. Long-term closure of fisheries would be likely. These could result in social and cultural stress, leading to possible social pathologies. GOM subsistence harvesters make up a relatively small segment of the coastal population and replacement food resources are more available than for subsistence harvesters in Alaska, so while the impact of the loss of subsistence resources would be moderate for the coastal population as a whole, it would be locally major for populations that depend on subsistence harvesting for a significant proportion of their diet.

4.4.13.2 Alaska – Cook Inlet

Finding and developing oil and gas resources on the Cook Inlet OCS has the potential to create adverse effects on sociocultural systems and subsistence, the severity of which would vary depending on the timing, location, and scale of the activity. Many negative consequences could be minimized through appropriate mitigation procedures. The most central of these is establishing and maintaining communication among local governments, Native villages, oil companies, and appropriate Federal agencies, including both government-to-government consultation in compliance with legal requirements and U.S. Department of the Interior (USDOI) policy (USDOI 2011) and ongoing dialogue leading to adaptive management of adverse effects.

The areas surrounding the Cook Inlet Planning Area are demographically diverse, including isolated subsistence-based Alaska Native villages, towns that rely primarily on commercial fishing, and ethnically and economically diverse cities partly dependent on the oil industry. There have been oil and gas operations in Cook Inlet since the late 1950s, and the surrounding area is home to a well-established gas and oil infrastructure that could accommodate much of any newly developed resource. As discussed in Section 4.4.1.2, under the proposed action, no new shore bases would be constructed, and one new pipeline landfall and possibly one new natural gas processing facility would be built.

Rural communities in the area benefit from oil and gas development throughout the State. However, currently the Federal Government does not share revenues from oil and gas leasing on the OCS with the States, although Alaska has received Federal Coastal Impact Assistance Program (CIAP) funding, because it is an OCS State (Hess 2011; BOEMRE 2011k). Benefits from revenue sharing would only occur if Congress authorizes the sharing of OCS revenues with the OCS States. If such sharing were to occur, OCS activities could be expected to have effects on Alaskan rural communities, through various State programs, proportionate to the percentage of the State budget that relies on revenues from OCS oil and gas production and that is allocated to the affected communities. For the period of the Program, the allocated revenues from OCS oil and gas production would be relatively small.

4.4.13.2.1 Impacts of Routine Operations. Routine operations under the Program would include exploration for oil and gas resources, development of the resources including infrastructure, operation of facilities, and decommissioning of facilities. Each of these phases is characterized by different levels of activity, different extent, and different timing. Because the region as a whole has already undergone oil and gas development, each of these phases can take advantage of and tie into existing infrastructure and can draw on an existing pool of experienced workers (MMS 2003a). The Cook Inlet area has already experienced the impacts of oil and gas development, and would also experience both the positive and negative effects of increased population and employment from the proposed OCS activities. Most area communities are ethnically diverse, with Caucasian majority populations. Alaska Native communities tend to be more remote and more difficult to access than non-Native communities, and would be somewhat buffered from the impacts of the routine operations of the proposed action.

Exploration activities include seismic surveys and the drilling of test wells, activities that are typically conducted from self-contained vessels. Exploration crews would be drawn from an existing pool of trained oil and gas workers in the Cook Inlet area. In-migration for these jobs is expected to be minimal and to have little effect on the current ethnic composition or social structure of the area (MMS 2003a). Exploration activities would likely be supported from existing air and marine facilities on the Kenai Peninsula. No additional facilities would be required. Industrial activities associated with exploration would not be new to the area, but would continue existing operations. There would be very little in-migration for exploration jobs because of the existing trained labor pool and the fact that exploration rig crews are normally contracted with the vessel. Exploration activities are not expected to result in measurable changes in the availability or accessibility of subsistence resources.

Exploration activities could have temporary effects on subsistence harvesting, but are not expected to result in measurable changes in the availability or accessibility of subsistence resources. Cook Inlet personal use and subsistence fisheries are important to all residents of South Central Alaska. Since the Cook Inlet Planning Area lies outside of the Anchorage-Mat-Su-Kenai Peninsula Nonsubsistence Use Area, effects on personal use fishing are not expected. Most of upper Cook Inlet north of Ninilchik is included in the Anchorage-Mat-Su-Kenai Peninsula Nonsubsistence Use Area. While subsistence fishing is not authorized by the Alaska Board of Fisheries in this area, personal use fisheries, open to all Alaska residents who have lived in the State for at least a year, do exist on the Kenai and Kasilof Rivers and Fish Creek that provide an important food source for many families in the Mat-Su-Anchorage-Kenai area (SCADA 2011). More remote subsistence fisheries are accessible to rural communities where customary and traditional uses of fish and wildlife are a principal characteristic of the economy, culture, and way of life. These include Alaska Native communities (ADFG 2011), such as the community of Tyonek, on the west shore of Cook Inlet, and Port Graham and Nanwalek, located on the southern Kenai Peninsula and the Alaska Native communities along the northwestern shore of Kodiak Island.

The effects of exploration on subsistence fishing would be similar to the effects discussed for recreational and commercial fishing in Section 4.4.11.2. Seismic exploration vessels tow long lines that could be entangled with seines, gillnets, long lines, and other gear used by subsistence fishers (MMS 2003a), who may choose to avoid seismic vessels to prevent the loss of gear and thus be kept from their normal fishing grounds. Fishers may also choose to avoid floating exploratory drilling rigs being moved from one location to another for safety reasons and to prevent the loss of gear. Seismic surveys could temporarily affect the behavior of some targeted species, thereby temporarily affecting catch rates in the immediate area of the surveys. Some subsistence fishers could decide to avoid areas during seismic because of perceived or actual changes in catchability. New areas in the Cook Inlet Planning Area could be subjected to seismic surveys during the Program. However, given the relatively small proportion of the available Cook Inlet area that would be affected at any particular time, it is not anticipated that seismic surveys would greatly disrupt subsistence fishing activities. Platform installation activities associated with exploration, including the noise and movement of aircraft, could temporarily displace seals and possibly some whales from installation sites. It is estimated that displaced animals would return to normal behavior and distribution once the operation is complete (MMS 2003a). Effects on subsistence harvesting would vary with the size and duration of the operation.

There would be some direct effects on the subsistence harvest from noise and drilling discharges. Under Federal authority, limited sea mammal harvest and subsistence halibut (and some other non-salmon species) fishing can take place in Cook Inlet. Alaska Natives can hunt marine mammals under the MMPA. Traditionally, beluga whales have been one of the most important marine mammal subsistence resources taken from Cook Inlet at Tyonek. However, this population has experienced a sharp decline and is now endangered. Under current co-management agreements, subsistence harvesting has been suspended to allow the population to recover (Allen and Angliss 2011). After recovery, belugas would once again be available for the village of Tyonek to hunt. Proposed actions should have limited effects upon this potential harvest. While belugas occasionally inhabit areas where exploration noise and disturbance could occur, in recent years their use of such areas appears to have been low. In summer, belugas tend to be concentrated in the extreme upper inlet outside the planning area.

The drilling of exploratory wells would have a limited impact on fish species (see Section 4.4.7.3.2) and subsistence fishers. The estimated volume of drilling discharges from exploration wells would have no effect on fish other than bottom dwellers in the immediate area (within 100 m [328 ft]) of the well at the time of discharge (see Section 4.4.7.1). Drilling muds and cuttings may temporarily limit access of subsistence fishers to some parts of their traditional fishing areas, since the fishers would be required to remain at least 500 m (1,640 ft) away from the drilling platform for safety reasons. Only a very small portion of the available subsistence fishing areas in Cook Inlet would be taken up.

Impacts on marine and coastal birds from exploration activities would be limited to the effects of helicopter flights on nesting or roosting individuals directly or in close proximity to regular flight paths. Effects would be temporary and could include abandonment of roosting or foraging areas, nest abandonment, and lower reproductive success. These effects could last from 1 to 2 years if birds adapt and for the life of the project if they fail to do so (MMS 2003a). Cook Inlet is an important seabird breeding area. All Alaska Native communities surrounding the Cook Inlet Planning Area report the harvesting of seabird eggs and marine and coastal birds including migratory waterfowl (Table 3.14.2-2). This localized, probably temporary, displacement of bird populations from traditional subsistence harvest areas would affect subsistence bird and egg harvesters by reducing the availability of the resource and/or requiring harvesters to extend their harvesting range. It is not expected that any resource would become unavailable or that there would be an overall population decrease (MMS 2003a).

Sociocultural effects could result from development and production phases, if the resulting employment were to cause a migration into the area that is beyond the capacity of existing sociocultural systems to absorb, or if subsistence harvest patterns were changed. Although new development is likely to create jobs, many of these jobs could be filled from the reservoir of skilled petroleum industry workers in the Cook Inlet area (particularly on the Kenai Peninsula) or filled by others who would commute from outside the area and return home at the end of their shifts or contracted work assignments (MMS 2003a). The characteristics of any new population segment are likely to be compatible with the towns and cities in which they choose to reside. It is not likely that they will choose to reside in isolated Alaska Native villages, unless they are of Alaska Native heritage. Any in-migration should do little to change existing sociocultural patterns.

Because oil and gas industry infrastructure already exists in and around Cook Inlet, new construction would be limited to tying new production wells to the existing system. This could entail the construction of new offshore platforms, offshore and onshore pipelines, and a new landfall. Increased turbidity from the construction of platforms and pipelines could disturb pelagic fish important to subsistence fishers and commercial fishers alike, and displacing the fish from their preferred habitat and decreasing their catchability by subsistence fishers. However, disturbance or displacement should be short term — limited to the time of construction and a few hours or days thereafter. The drilling structures themselves may result in changes in species distribution as offshore structures attract and protect some species (MMS 2003a). Cuttings and fluids from production wells would be treated and disposed of in the well. Longlines and hand-held trolls used for bottom fishing and gear such as beach and purse seines could snag on submerged pipelines, causing some loss of gear for subsistence fishers.

A small increase in vessel activity to support platforms (up to six additional trips per week) is anticipated. This small increase should not measurably affect subsistence harvesting opportunities, catchability of fish and shellfish resources, or navigation by subsistence fishers.

Noise associated with drilling rig and support vessel traffic, helicopter flights, platform construction and operation, pipeline construction, and vessel traffic to and from drilling platforms could temporarily disturb belugas, particularly in the winter when they are more often in the lower inlet. While the beluga population in the inlet is in decline and the Cook Inlet stock is endangered, routine industry activities have not been found to contribute significantly to this decline (MMS 2003a). The effects of increased routine industry activity on beluga populations are assessed in Section 4.4.7.1.1.

Effects on marine and coastal birds important to subsistence harvesters would result from helicopter flights and would be similar to those described above for exploration activities.

Airborne and underwater noise would be the main sources of disturbance for marine mammals harvested by Alaska Native communities. Noise and disturbance would come from flights and vessel traffic to platforms, offshore pipelaying, platform installation, and very local costal habitat modification at the pipeline landfall. There would also be brief temporary displacement of terrestrial mammals harvested by some communities (see Table 3.14.2-2) (e.g., brown bears and moose) on the Kenai Peninsula from helicopter flights and supply vessel traffic between platforms and onshore facilities.

Effects from well abandonment and decommissioning on wildlife important to subsistence harvesters would be similar to those from construction.

4.4.13.2.2 Impacts of Expected Accidental Events and Spills. The activities associated with the proposed action are susceptible to oil spills and natural gas releases. While developers are required to submit oil spill response plans, the *Exxon Valdez* oil spill has shown that a very large discharge event can overwhelm existing plans and cause damage to resources important to subsistence harvesters, affect fish populations important to commercial fishers, and have sociological impacts in affected communities.

Accidental spills of oil or other chemicals are most likely to occur during the transfer of material from one vessel to another or to or from shore. These spills tend to be small and more easily contained. Other accidental spills could result from collisions or wrecks. The size and severity of such spills depend on the nature and location of the incident. Accidental spills could also result from the loss of well control or damage to pipelines.

It is assumed that as many as 15 very small oil spills (50 bbl or less), 3 small oil spills between 50 and 1,000 bbl, and 1 large spill greater than 1,000 bbl could occur under the Program (see Section 4.4.2). While most small spills are likely to be contained, even small spills may have effects on subsistence resources. Because small amounts of oil spread out rapidly over the ocean surface, forming a thin sheen, and tend to break up into small patches and streamers, an oil spill has to be at least several barrels, perhaps as many as 50, before birds important to subsistence hunters would be at risk. A limited number of birds would be lost. Small oil spills would have some effects on mammals sought by subsistence hunters, such as harbor seals, other marine mammals, and terrestrial mammals, with perhaps the loss of a few individuals to oiling and small amounts of transient and local contamination. Subsistence harvesters would consider animals from an oiled context to be tainted and would be less likely to harvest them. Recovery from small spills would probably require no more than a year (MMS 2003a). Effects would vary, depending on the location and timing of the spill.

One large spill (over 1,000 bbl but less than 75,000 bbl) is assumed here. Effects would vary depending on the timing and location of the spill. Effects of a large spill are likely to be greatest in parts of the Cook Inlet Planning Area that are relatively confined, since oil is more likely to reach the shore and affect important intertidal zones that support the young of many fish species as well as shellfish that form a part of the subsistence harvest. Fishes most likely to be affected by large spills include many that are important to subsistence fishers. They include those that migrate extensively, such as the Arctic cisco; those with strong ties to the streams where they were spawned, such as the Dolly Varden; and those tied to nearshore environments (see Section 4.4.7.2.2). Because pelagic species of fishes in Cook Inlet are relatively abundant and widely distributed in waters across much of the central Gulf of Alaska, even a large oil spill (up to 4,600 bbl) is not likely to cause population-level impacts on most fish populations inhabiting the central Gulf of Alaska (i.e., South Alaskan Peninsula, Kodiak Archipelago, Shelikof Strait, Cook Inlet, and Prince William Sound).

A pipeline or platform spill in Cook Inlet could affect subsistence activities on the Kenai Peninsula, Kodiak Island, and the Alaska Peninsula. If a natural gas loss of well control occurred below or on the water surface, with possible explosion and fire, subsistence resources such as fish, birds, and beluga whales in the immediate vicinity of the loss of well control could be killed. Natural gas and gas condensates that did not burn would be hazardous to any organism exposed to high concentrations. Natural gas vapors and condensates disperse rapidly and would not likely affect subsistence resources beyond the immediate area. High concentrations would not occur if the loss of well control occurred on the top of a platform where dispersal would occur more rapidly. Effects from losses of natural gas well control are likely to be short-term and local, lasting a year or less and extending for about 1.6 km (1 mi) (MMS 2003a).

Impacts of an Unexpected Catastrophic Discharge Event. A CDE in the Cook Inlet Planning Area would be a possible, but low-probability event under the 5-year plan. The PEIS analyzes an unexpected CDE in the Cook Inlet Planning Area that ranges from 75 to 125 thousand bbl and lasts from 50 to 80 days (Table 4.4.2-2). A CDE in the waters of south central Alaska and the resulting cleanup are likely to have consequences for sociocultural systems and could have long-lasting social and psychological repercussions. The sociocultural impacts would include effects upon resources that are used in some way by local residents (i.e., subsistence, tourism, recreation, and elements of quality of life) and economic losses for commercial fishers and support businesses. In past very large spills, the loss of livelihood for both commercial and subsistence fishers resulted in depression and an increase in suicide and other pathological behavior, as did participation in protracted litigation resulting from the spill (Picou et al. 2009; Fall 2009; Fall et al. 2009).

Cleanup efforts resulting from a CDE would result in short-term increases in population and economic opportunities, as well as increased demand on community services and increased stress to smaller communities. In communities based on commercial fishing, the increased demand on community services would coincide with a decrease in tax revenues as income from commercial fishing declines. Competition for employment in the cleanup process would create division within communities (Picou et al. 2009).

It is likely that a CDE would damage resources important to subsistence harvesters and affect fish populations important to commercial fishers. It would reduce the availability and/or accessibility of subsistence resources. Resources subject to such impacts include those that are most significant for the area — fish and shellfish — as well as marine mammals and, to some extent, terrestrial mammals. Birds and marine plants (seaweed) would also be at-risk resources that are used locally. Alaska Native subsistence harvesters would consider marine mammals from an oiled context to be tainted and would be less likely to harvest them. Since the waters of the Cook Inlet Planning Area are relatively confined, oil from a CDE is likely to reach the shore and affect important intertidal zones that support the young of many fish species as well as shellfish that form a part of the subsistence harvest. Fishes most likely to be affected by a CDE include many that are important to subsistence fishers. They include those that migrate extensively, such as the Arctic cisco; those with strong ties to the streams where they were spawned, such as the Dolly Varden; and those tied to nearshore environments. Impacts on fish can propagate throughout the food web, affecting birds and marine mammals.

A CDE has the potential for long-lasting effects on subsistence-based Native villages and communities. However, Native communities have proven to be flexible and adaptive, mitigating to some extent immediate losses of subsistence harvest resources. Of great concern to Native wild food harvesters regarding oil spills is the contamination of the natural environment. After the *Exxon Valdez* spill, Alaska Natives were fearful that marine and nearshore resources had been tainted, placing more trust in traditional environmental knowledge than government agencies. Harvesting of traditional resources dropped off and Alaska Natives relied on stored foods from previous seasons, augmented by relief supplies of traditional foods supplied by unaffected villages with whom they had traditional ties and exchange relationships. Nonetheless, over time, social ties appear to have weakened. In the years following the spill, harvesting slowly rebounded, but the composition of the harvest changed, attributed both to long-term loss of resources and continuing fears of tainting (Fall 2009). Nanwalek Native Tom Evans reported in 2003 that "our resources have not recovered" (MMS 2003c). Other sociocultural effects included changes in wild food preferences; changes in traditional roles and status in the communities; disruption of the instruction of children in traditional subsistence knowledge and practices; and thus, the disruption of the transmission of Alaska Native culture and conflicts with outsiders (MMS 2003a).

Cleanup efforts would also affect subsistence resources. While cleanup strategies would reduce the amount of spilled oil in the environment, thus mitigating negative effects to some extent, disturbance and displacement of subsistence resources would increase from cleanup activities such as offshore skimmers, workboats, barges, aircraft overflights, and *in situ* burning. Deflection of resources resulting from the combination of a CDE and cleanup efforts could persist beyond one season, perhaps lasting several years. As a result, subsistence harvests and subsistence users would suffer nutritional and cultural impacts (MMS 2003a). In addition to effects on subsistence, during the *Exxon Valdez* cleanup, archaeological resources important to Alaska Native cultures were damaged or stolen (Picou et al. 2009).

As is evident from the *Exxon Valdez* event, cleanup efforts can be quite disruptive socially, psychologically, and economically for an extended period of time. While the magnitude of impacts declines rapidly in the first year or two after a large spill, long-term effects continue to be evident. Technological disasters, such as oil spills, have been shown to have more divisive community effects than natural disasters (Picou et al. 2009). Such effects can be reduced by the early implementation of coping and mitigation measures (Picou et al. 1999). One important coping measure is the establishment of, and local participation in, an effective spill-response effort that has been formulated into an explicit spill-response plan. Such local programs do have a number of benefits. They provide local employment, a sense of local empowerment, and a means for local resident/oil industry communication. Another coping measure is the establishment of intervention programs such as peer listening programs based on community participation (MMS 2003a; Picou et al. 1999, 2009; Picou 2010).

Impact Conclusions.

Routine Operations. Oil and gas exploration, development, and production activities in the Cook Inlet Planning Area would be a continuation of long-standing economic characteristics of the area. The proposed action would not introduce new kinds of activities that would alter existing socioeconomic systems. The relatively small number of new residents that would come into the area because of the proposed action should likewise not alter existing sociocultural systems. These activities are not likely to affect commercial fishing (see Section 4.4.11.2); however, they may periodically result in temporary and localized displacement of subsistence resources or limit access by subsistence hunters, making the subsistence harvest more difficult, but no resource would experience an overall decrease in population, and no harvest would be curtailed for part of the harvest season. Impacts on sociocultural systems from routine Program activities in the Cook Inlet Planning Area are expected to be minor.

Expected Accidental Events and Spills. Because portions of the Cook Inlet Planning Area are relatively confined, spills from accidents are more likely to reach the shore, potentially contaminating important intertidal and estuarine zones. The impacts of small spills would vary from minor to moderate depending on the size, location, and timing of the spill. Impacts from small spills could be mitigated with prompt cleanup. Populations of resources important to subsistence harvesters that lose some individuals to local oiling are likely to recover in less than a year.

A large oil spill could contact areas where important subsistence resources are present and have moderate to major impacts. Some harvest areas and resources in these locations would be too contaminated to harvest. Some subsistence resource populations could be reduced, although pelagic fish species would not be expected to suffer population-level loses. As a result of tainting, an even larger array of resources could be rendered unavailable for use by Alaska Natives. Tainting concerns in communities nearest the spill could seriously curtail traditional practices for harvesting, sharing, and processing resources and threaten pivotal practices of traditional Alaska Native cultures. Harvesting, sharing, and processing of subsistence resources would continue but would be hampered to the degree these resources were contaminated. In the case of contamination, harvests would cease until such time as local subsistence hunters perceived resources to be safe.

An Unexpected Catastrophic Discharge Event. In the event of an unexpected, low-probability CDE, there would be unavoidable impacts on commercial and subsistence harvesting of marine resources leading to community divisions and sociopathic behavior. There would be major and long-lasting impacts on the affected communities. Loss of resources important to subsistence harvesters, including intertidal resources, migrating fishes, and fishes with strong ties to the shore, would be affected. Oil spill cleanup would increase overall effects by displacing subsistence species, altering or reducing subsistence hunter access, and altering or extending the length of time required for subsistence harvesting.

4.4.13.3 Alaska – Arctic

As was the case for Cook Inlet, finding and developing oil and gas resources on the Arctic OCS has the potential for creating adverse effects on sociocultural systems and subsistence. Such effects would be similar in nature but would vary in magnitude depending on the timing, location, and scale of the event or activity. Many of the subsistence use areas are discussed or identified in Sections 3.14, 4.3.2, and 4.6.1. Many negative consequences could be minimized through appropriate mitigation procedures. The most central of these would be establishing and maintaining communication among Native villages, oil companies, and appropriate Federal agencies, including both government-to-government consultation in compliance with legal requirements and USDOI policy (USDOI 2011) and ongoing dialogue leading to adaptive management of adverse effects.

As discussed in Section 3.14.3.1, the northern and northwestern coasts of Alaska are the home of indigenous Iñupiaq communities confronted with increasing industrialization tied to mineral extraction. While it is clear that industrialization in northern Alaska has had important economic and social effects, until now, the industrial workforce building and operating the expanding oil and gas extraction facilities has been largely non-local and transient, residing in self-sufficient enclaves far removed from Alaska Native villages and, for the most part, placing little strain on village government resources. However, as expressed by Alaska Natives in scoping meetings (BOEMRE 2011c–f), as oil and gas production infrastructure expands both onshore and onto the OCS, the indigenous villagers feel their traditional subsistence-based lifeway is being constrained and their cultural values threatened. Commenters on the Draft PEIS recalled the loss of former hunting grounds around Prudhoe Bay.

As expressed by Carla Sims Kayotuk in the 2011 Kaktovik scoping meetings: "I do not want to see that [sociocultural] change for our community. It has changed some, but I don't want to see any more negative changes happen. And I strongly believe that if offshore development, even onshore development [continues], that's going to happen and our community will never be the same again. And I know change happens. Culture changes, traditions change, but I think it's going to be a very negative impact on us" (BOEMRE 2011c).

The Iñupiat, like other coastal Alaska Natives, are closely tied to the land and the sea. Subsistence harvesting and the distribution of the subsistence harvest through kin and social networks based on cultural ideals of community and sharing are core values of Iñupiaq culture. To the extent that oil and gas activities in or close to Alaska Native villages adversely affect the subsistence harvest or limit cultural continuity, they have a negative impact on Iñupiaq sociocultural systems. In addition, new development may result in an influx of outsiders who do not share Iñupiaq values and mores, resulting in stress on indigenous sociocultural systems. For example, all Iñupiaq villages on the North Slope are "dry," and in some of them the importation of alcohol is illegal. These values may not be shared by oil workers coming from outside Iñupiaq communities.

The Iñupiat harvest a wide range of wild animal and plant resources including bowhead and beluga whales, seals, walrus, polar bears, fish, waterfowl, and caribou (see Section 3.14.3.1). For coastal communities, the most iconic harvests are the bowhead and beluga whale hunts. These lie at the heart of Iñupiaq social system and sense of cultural identity.

"If you ever see this young kid as a young man [become] a whaler, it's like an individual that lives in [the city], has a dream of becoming a pilot or [having] a career of some sort. But when you are a Native, it's always been being a provider to the community, be a hunter. That's the culture of Iñupiat. Pass on the traditions that's been passed on to us for thousands of years," said Isaac Nukapigak from the village of Nuiqsut (BOEMRE 2011d).

Native Alaskans often refer to the Chukchi and Beaufort Seas as the Iñupiaq garden or Garden of Eden and are extremely concerned about loss of resources from oil spills and pollution, and from changes in patterns of wildlife migration resulting from industrial activities. In the words of Raymond Aguvluk, a local resident, at the 2011 Wainwright scoping meeting for this PEIS "We eat from out there, you know. And [are] you guys going to send us chicken or steak? No way. We love our garden out there" (BOEMRE 2011e).

Marine mammals and fish are the resources of most concern, as they constitute a major part of the subsistence harvest and typically are the resources most likely to be directly affected by oil and gas activities on the OCS. Land mammals, particularly caribou, are also important subsistence resources. In most cases, they would be affected most by transportation pipelines and other support infrastructure tied to OCS development. However, if oil and gas activities on the OCS resulted in a loss of, the tainting of, or prevented access to, marine subsistence resources, subsistence hunters would likely turn to terrestrial sources, increasing pressure on caribou, moose, other land mammals, freshwater fishes, and waterfowl. Oil spills that have occurred elsewhere in Alaska have resulted in negative consequences for subsistence resources and activities, but routine exploration, development, and operation could also potentially result in negative effects.

4.4.13.3.1 Impacts of Routine Operations. Routine oil and gas operations may be divided into four categories or phases: exploration, development, operations, and decommissioning. Exploration on the OCS, whether using seismic surveys or test wells, is done from largely self-contained ocean-going vessels, and in the past has had little direct impact on the infrastructure of local communities (MMS 2007b; MMS 2008b). However, exploration ships do require onshore support facilities. Exploration in the Beaufort Sea using existing facilities at Prudhoe Bay/Deadhorse and Barrow would result in little new impact. Conversely, exploration plans filed for the Chukchi Sea include development of an onshore base in Wainwright that would use some village infrastructure and services. With a staff of 22 to 64 individuals, it would include a helipad, fuel storage, lift and hoist facilities near existing boat ramps, and temporary housing for vessel crews weathered in while being changed (Shell 2009a, b). In anticipation, the local village corporation has built crew quarters (Burwell 2011; Anchorage Daily News 2010). Having a shore base in a village would likely increase interaction between transient workers and Alaska Natives in Wainwright, , with the potential for changing cultural dynamics, including conflicts arising from differing behavioral norms and the adoption of Western cultural traits by indigenous communities. The presence of the onshore base would also provide some employment opportunities for Alaska Natives (Shell 2009b). Cultural conflicts may be minimized through cultural awareness orientation stipulated in lease contracts so in-migrant workers are made aware of Alaska Native cultural values including the importance of the subsistence harvest to local communities. Lease stipulations would require developers to submit plans that orient new in-migrant workers to the local Alaska Native culture, including subsistence, in advance (MMS 2007b).

Of great concern to local populations is the noise created by seismic survey airguns and test drilling rigs during exploration and their potential for disturbing or driving away the migratory sea mammals upon which subsistence communities depend. Iñupiat whalers generally agree that whales and other marine mammals are more sensitive to noise than Western scientific studies suggest and will avoid noise sources, and that they have been disturbed from their normal patterns of behavior by past seismic and drilling activities. According to Kaktovik whaling captain George Kaleak, Sr., "The sound can go over 50 miles, and whales can hear it" (BOEMRE 2011c). Noise and other associated activities can make whales less predictable and more dangerous to those who hunt them. They can be deflected from their usual migration routes into deeper, more dangerous waters, where they are more difficult to take and bring home successfully. Deflection of whales from their migratory paths not only makes whaling more difficult, it makes it more expensive. The added distance that must be traveled to and from a successful hunt is likely to result in added fuel costs, and has the potential for lost wages, resulting in time taken away from regular jobs (NMFS 2011f). Whalers from Barrow, Nuiqsut, and Kaktovik have been especially vocal on this issue, as they are most likely to be directly affected by such activities during the fall open water season.

Isaac Nukapigak, a Nuiqsut whaling captain explained at scoping meetings held in 2011: "At one point, I remember us being out there for 7 weeks and didn't meet our quota because of [oil and gas exploration] activities and weather prediction where our subsistence hunt and the whales were disrupted because of this heavy activity going on in the Beaufort. We had to go 30 miles north. That's where we finally were able to see whales because there was so much activity east of Cross Island. And that time we had no choice because a whale was got 35 miles north of Cross Island because of … safety [in] these small boats that we go out in to harvest, weather prediction got bad on us. We had no choice but to let go of the whale even though we didn't want to. And that year was so harsh because we didn't meet our quota. It was very noticeable in this community. There was no whale meat stored in our cellars. People were hurting" (BOEMRE 2011d).

According to Tom Albert, a former non-Iñupiat senior scientist for the North Slope Borough Department of Wildlife Management, "When a captain came in to talk to me, I knew he was going to say that the whales are displaced [by noise] farther than you scientists think they are. But some of them would also talk about 'spookiness,' when the whales were displaced out there and when the whaler would get near them, they were harder to approach and harder to catch" (MMS 1997a).

That marine mammals are sensitive to noise disturbance is clear, although thresholds in terms of signal characteristics and distance have not been established for all species and can vary within a species depending on the nature of the sound, the age of the individual, its prior experience with the noise, and its current activity. The sounds of seismic airguns can be detected as far as 97 km (60 mi) away in deep water. Feeding bowhead whales tend to show less avoidance of sound sources than do migrating bowheads. Studies have shown that deflection from usual bowhead migration routes may start as far as 35 km (22 mi) from the noise source and persist for from 40 to 48 km (25 to 30 mi). Iñupiaq whaling captains report that bowhead pods divert from their migratory path at distances of 56 km (35 mi) from an active seismic operation and are displaced from the path by as much as 48 km (30 mi). Belugas are more sensitive to noise and are thought by Iñupiaq whalers to remember areas of past noise disturbance and avoid them (NMFS 2011f). Generally, such effects would be confined to the vicinity of the seismic vessel and to the actual time of operation. Seismic surveys would occur after July 1 in the open water season, and would thus not affect the spring whale hunt. Deferral of leasing from a corridor along the coast provides a sea mammal migration corridor in the Chukchi Sea. Villagers along the Beaufort coast have requested a similar deferral corridor (BOEMRE 2011d, f). Without mitigation in place, seismic surveys could affect the more important fall hunt and cause subsistence resources to be unavailable and have a major effect on subsistence harvesting. Lease stipulations for whaler-oil industry conflict avoidance agreements (CAAs) and other "non-disturbance" agreements have minimized such problems in the recent past so that noise and disturbance effects of single actions have been, and are expected to be, effectively mitigated. However, such agreements become more difficult to implement if multiple vessels are surveying at the same time. It is expected that required adaptive mitigation and management plans (AMMPs), the requirements of National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) incidental take authorizations, and required consultation with local communities would ensure that impacts on marine mammals would be minimal. Typical requirements include monitoring for the presence of sea mammals and ensuring that supply aircraft routinely fly above elevations that would disturb sea mammals (MMS 2007b; MMS 2008b). Impacts from noise generated during the exploration phase would be greatest along the north coast in the Chukchi Sea and Beaufort Sea Planning Areas and would only affect the northwest coast if whales remain deflected and do not resume their normal migratory paths.

Development would involve the construction of onshore and offshore infrastructure including gravel drilling pads, onshore and offshore pipelines, landfalls, pumping stations, roads, and additional facilities to house an influx of construction workers. While construction has the potential of providing additional local employment, the noise and human presence associated with construction activities are likely to have temporary and localized effects on some subsistence resources and, depending on the location of construction worker enclaves, place stress on the infrastructure of local communities. Operation of the facilities may require fewer workers than construction, many of whom are likely to be transient shift-workers based in other parts of Alaska. The sociocultural impact of these transient workers would depend on the location of new shore-based facilities, and associated enclaves. When a shore-based facility for Chukchi Sea exploration and development is established at Wainwright, it is likely to expand beyond that required for exploration, further increasing the interaction between transient workers and the previously relatively isolated Alaska Native population.

The potential direct and indirect effects of development in the Arctic would result from noise, and visual disturbances from the construction of pipelines and other offshore and shore-based facilities. Construction activities, including the delivery of fuel and supplies, are limited in time and space and can be scheduled to minimize impacts to subsistence resources. In the past, they have been effectively limited in specified areas during critical periods on subsistence use through industry/subsistence user cooperation (MMS 2008b). The need to install additional platforms in the Arctic could increase the areas and times where either industry or subsistence activities are restricted. This would increase the possibility for moderate to major harvest disruption. Disruption would be made worse if construction and production activities were concentrated in critical subsistence-use areas, which may include cabins and camps. Potential cumulative effects of multiple projects are discussed in Section 4.6.5.3. Increased traffic from supply ships would result in increased noise that sea mammals would avoid and an increased potential for ship-marine mammal strikes, since supply ships would have to travel through the same relatively confined passage as whales. The impact from harm done to whales or the deflection of whales would be felt in whaling communities all along the whale migration routes and in the inland communities that regularly exchange part of their inland subsistence harvest for marine products from coastal communities.

Onshore pipeline effects on subsistence would occur during a 1- or 2-year construction period. The major onshore pipeline to be constructed for the proposed action would connect Chukchi Sea oil production with the TAPS, affecting North Slope Borough communities, or to a possible deepwater port at Kotzebue, affecting subsistence harvesting in the Northwest Arctic Borough. Offshore pipeline effects on subsistence would generally be confined to the period of construction and could be mitigated through lease stipulations that would restrict industry activities during critical subsistence-use periods.

The potential disturbance effects of production operations may be more difficult to mitigate, because such activities would be longer term and operate year round. As with construction, the potential direct and indirect effects of routine OCS operations in the Arctic regions derive from noise, visual, and traffic disturbances from the operation of pipelines and other shore-based facilities.

Even when construction is complete, new infrastructure such as roads and pipelines could serve to restrict the movement of land mammals and the access by indigenous populations to onshore subsistence resources such as caribou herds. For example, a pipeline connecting the Chukchi Sea Planning Area with the TAPS would cross a large area that is currently undeveloped except for isolated and relatively small airstrips. This could restrict access by Nuiqsut subsistence hunters, who already could be restricted by oil and gas development in the Colville River delta the westward expansion of the Prudhoe Bay facilities, and the potential for development to their west in the National Petroleum Reserve in Alaska (BOEMRE 2011d). The potential impact of the pipeline on subsistence resource-use patterns, while unavoidable, can be at least partially mitigated and minimized with proper pipeline design, location, and routing. Potential effects of a pipeline on subsistence users (perceptions of areas they wish to avoid or that are difficult for them to access for hunting) can be addressed with design considerations (for instance, by elevating or burying segments of the pipeline) and by including subsistence users early in the consultation process. The most difficult potential onshore pipeline effects to mitigate would be those related to pipeline servicing and access. If a service road is constructed for this purpose, it would greatly increase impacts on caribou movement and access to subsistence resources on the western part of the North Slope (MMS 2007b). This effect would be greater if such a road were eventually opened to public access, on the model of the Dalton Highway. Roads are also reported to impose substantial maintenance costs on subsistence equipment (snow machines and sleds) and to present some safety issues (Impact Assessment, Inc. 1990). Current practices aim to minimize the construction of new roads. If pipeline servicing was conducted using aircraft, and perhaps ice roads or other ground transport in winter, such potential access effects would be minimized. Increased aircraft traffic in the summer could have a moderate effect on subsistence uses, but such impacts could be reduced through coordination with subsistence users.

The potential effect of pipelines on subsistence resources themselves (in terms of population and behavior) are discussed in Section 4.4.7.13. With regard to caribou, onshore facilities and activities associated with the proposed offshore development program in northern Alaska should have temporary impacts on individual caribou but almost no effects on caribou herds, although development may change their migration patterns and make them less accessible or less desirable. Caribou habituation to gravel pads and oil field infrastructure alters the value of the caribou to subsistence users, who view these habituated caribou as contaminated and not behaving correctly. Frank Long, Jr., stated in the Nuiqsut Alpine Satellite Development Project scoping meeting: “We will have the same problem we did in the Prudhoe Bay and the Kuparuk area with our caribou. Right now, I call our caribou that are existing around here that don’t go nowhere our ‘industrial dope addict caribou.’ They are already sick and nobody’s doing anything about them” (MMS 2007b).

Fish are another important subsistence resource. Most OCS petroleum industry activities would occur far from the freshwater or nearshore locations where subsistence harvests are concentrated. However, the construction of gravel causeways has the potential to affect fish migration routes. This can be mitigated by including culverts that allow the fish to pass through. Other effects would include potential reductions in fish populations (or health effects), which have been evaluated in Section 4.4.7.3.3.

Many Iñupiaq villagers take the long view of their presence in Arctic Alaska. The Iñupiat lived as subsistence hunters for centuries before the arrival of oil development and expect to remain after the oil and gas reserves have been depleted. They are concerned with decommissioning. The impacts of decommissioning are expected to be similar to those of the construction process. Likewise short-lived and spatially restricted, impacts of noise and traffic on subsistence resources may be mitigated through consultation and scheduling.

The principal sociocultural systems impacts of the proposed action in the Arctic would be due to developing a shore base within an Alaska Native community. Additional significant effects would be in the area of subsistence harvesting, with implications for health, population, and the economy. All of these topics, except for health, are discussed in other sections (see Sections 4.4.9, 4.4.10, and 4.4.14). Potential OCS activity would support these established trends. Activity under the proposed program could exert sociocultural effects at the Statewide, regional, and local levels. Income related to OCS development could be expected to support many of the preexisting State programs. At a regional level, OCS activity would constitute one component of continued economic development — primarily onshore and related to the Prudhoe Bay “oil patch” — which has become the prime source of support for most of the infrastructure and local economic development in the North Slope Borough. At a local level, communities might experience adverse sociocultural impacts if development leads to the establishment of shore based facilities, new onshore access routes into the communities, an influx of oil industry personnel into local communities, or local economic benefits from increased local employment opportunities.

Social systems and cultures are seldom, if ever, static. Many changes viewed as sociocultural concerns could also be seen as adaptive change. What is often perceived as the “erosion of cultural values” may only be a transformation or change in the behavioral expression of those values (modes of sharing, expressions of respect). On the other hand, some behavioral changes are more important indicators of cultural and value change than others. That is perhaps why public testimony on the impacts of petroleum development in Arctic Alaska — especially that of Alaska Native Elders — has focused on subsistence resources and practices, the relationship of people to the land and its resources, health, increased social pathologies, and the use (and loss) of Native languages. While OCS activity from the proposed action would only contribute incrementally to these effects, it should be recognized that these activities would occur within this context.

Some of the vectors of sociocultural change that have been commonly noted in studies of Arctic Alaska, lease sale documents, or testimony during the lease sale process can be briefly summarized as follows (see MMS 2008b, p. 4-327, and references therein):

- Changes in community and family organization (availability of wage-labor opportunities locally or regionally, ethnic composition, factionalism, household size);

- Institutional dislocation and continuity (introduction of new institutions, "loss" or de-emphasis of older or more traditional ones, and adaptation of new forms to old content or values, and vice versa);

- Changes in the patterns of overall subsistence activities (time allocation, access, effort, equipment, and monetary needs) and the potential disruption of subsistence harvest activities by industrial development;

- Changes in health measures (a combination of increased access to health care, changes in diet, increased exposure to disease, substance use and abuse, concern over possible exposure to contaminants of various sorts, and other factors);

- Perceived erosion of cultural values and accompanying behaviors (increased social pathologies such as substance abuse, suicide, and crime/delinquency in general; decreased fluency in Native languages; decreased respect for elders; less sharing); and

- Cultural "revitalization" efforts such as dance groups, Native language programs, and official and regular traditional celebrations (such as the reestablishment of *Kivgiq* [the Messenger Feast], for example, in the North Slope Borough and the Northwest Arctic Borough).

While these are all in some sense generalizations and "analytical constructs," all are also supported by specific testimony of Native residents of the region. These dynamics are not generally viewed as specific to oil and gas development (let alone OCS), but rather as the overall context within which Iñupiat culture must continue to exist (MMS 2008b).

4.4.13.3.2 Impacts of Expected Accidental Events and Spills. The high degree of dependence of Arctic Alaska Native communities on the Beaufort and Chukchi Seas for their subsistence is reflected in the frequency and urgency with which they expressed their concerns over oil spills in the Arctic at public meetings. They are aware of the long-lasting consequences of the *Exxon Valdez* oil spill and of the scale of the effort that was required to cap and clean up after the DWH event in the GOM.

Oil spills have the most potential for adverse effects attributable to the proposed action. Negative effects on specific subsistence species, as well as on the more general patterns of subsistence resource use, persisted in Prince William Sound for years after the *Exxon Valdez* oil spill and the subsequent cleanup effort (Fall 2009).

Expected accidental spills of oil or other chemicals are most likely to occur during the transfer of material from one vessel to another or to or from shore. These spills tend to be small and relatively easily contained. Other accidental spills could result from collisions or wrecks made more likely by an increase in marine traffic. The size and severity of such spills depend on the nature and location of the incident. Accidental spills could also result from the loss of well control or damage to pipelines. The effects of an oil spill vary with the size, location, and timing of the spill, along with the type of oil released.

The Arctic environment is particularly vulnerable to the effects of both large and small oil releases, which are expected to persist longer in the environment because of the colder temperatures. An oil spill of more than 1,000 bbl could, depending on the time and location of the spill event, affect the subsistence use of marine mammals in the region where it occurs. In 1978, Thomas P. Bower, Sr., a whaler from Barrow, reported the results of a 1944 oil spill when a Liberty Ship, the *S.S. Jonathan Harrington*, ran aground southeast of Barrow and dumped fuel oil into the sea to lighten the ship:

According to Bower, about 25,000 gallons of oil were deliberately spilled into the Beaufort Sea in this operation. In the cold, Arctic water, the oil formed a mass several inches thick on top of the water. Both sides of the barrier islands in that area — the Plover Islands — became covered with oil. "That first year … I observed how seals and birds who swam in the water would be blinded and suffocated by contact with the oil. It took approximately 4 years for the oil to finally disappear.… I observed that for 4 years after that oil spill, the whales made a wide detour out to sea from these islands" (MMS 2007b).

Although this episode shows that a species can recover after 4 years without cleanup, those years are remembered by subsistence harvesters as a time when subsistence harvest was severely reduced.

It is assumed that as many as 190 very small oil spills (50 bbl or less) and between 35 and 70 small oil spills (more than 50 bbl but no greater than 1,000 bbl) would be associated with the Program in the Arctic (see Section 4.4.2). While most small spills are likely to be contained, small spills may have local effects on subsistence resources. Because small amounts of oil spread out rapidly over the ocean surface, forming a thin sheen, and tend to break up into small patches and streamers, an oil spill has to be at least several barrels, perhaps as many as 50, before birds important to subsistence hunters would be at risk. A limited number of birds would be lost. Small oil spills are estimated to have minor effects on mammals sought by subsistence hunters, such as harbor seals, other marine mammals, and terrestrial mammals, with perhaps the loss of a few individuals to oiling and some minor, transient, and local contamination. Subsistence harvesters would consider animals from an oiled context to be tainted and would be less likely to harvest them. Recovery from small spills would probably require no more than a year (MMS 2003a). Loss of a subsistence resource for a year would increase the stress on local communities, which would have to import more expensive foods to compensate (Fall et al. 2001), and could affect the stocks of terrestrial animals and freshwater fish as coastal hunters and fishers turn inland for subsistence food. The effects of prolonged exposure to elevated levels of petroleum hydrocarbons on fish are discussed in Section 4.4.7.3.3. The effects can be lethal or sublethal and have the greatest effect on eggs, larvae, and juveniles, particularly in intertidal zones.

As many as three large spills (over 1,000 bbl) could occur in the Beaufort Sea and Chukchi Sea Planning Areas under the proposed action. As the result of a large spill, the bowhead whale hunt could be disrupted, as could the beluga harvest and the more general and longer hunt for walrus. Animals could be directly oiled, or oil could contaminate the ice floes or onshore haulouts they use on their northern migration. Such animals could be more difficult to hunt because of the physical conditions. Animals could be "spooked" and/or wary, either because of the spill itself or because of the "hazing" of marine mammals, which is a standard spill-response technique in order to encourage them to leave the area affected by a spill. Oiled animals are likely to be considered tainted by subsistence hunters and would not be harvested, as occurred after the *Exxon Valdez* spill. This would also apply to terrestrial animals, such as bears that scavenge oiled birds and animals along the shore, or caribous that seasonally spend time along the shore or on barrier islands seeking relief from insects. Loss or tainting of marine mammals occurring off the north coast would affect subsistence communities all along the migration routes of the marine mammals, including Northwest Arctic Borough communities and whaling communities on islands in the Bering Sea. There would be a considerable ripple effect from losses in these communities, since coastal communities are tied into exchange networks that stretch inland as far as Anchorage.

Although developers must submit oil spill response plans and have spill response vessels available, there has been little experience with under-ice or broken-ice oil spills (Arctic Council 2009). While the concern is most typically phrased in terms of the potential effects of oil spills on whales and whaling, it can be generalized to a concern for marine mammals and ocean resources in general. Fishes most likely to be affected by large spills include many that are important to subsistence fishers. They include those that migrate extensively, such as the Arctic cisco; those with strong ties to the streams where they were spawned, such as the Dolly Varden; and those tied to nearshore environments, such as broad whitefish (see Section 4.4.7.3.3). Marine mammals and fish typically comprise 60% of a coastal Alaska Native community's diet. Pipeline and platform spills could also impact migrating anadromous fish in the river deltas, as well as species that use oiled coastal and nearshore habitat, such as nesting birds, breeding caribou, and the like. Overall, the impacts of oil spills on subsistence practices and resources would be variable, ranging from minor to major, depending on the size, location, and timing of the spill. As shown by the results of the *Exxon Valdez* spill, subsistence harvesters in unaffected areas are likely to share resources with impacted villages through established social networks. While local ties are regularly strengthened through mutual exchange, they can weaken when there is less to exchange (Picou et al. 2009).

Cleaning up a large spill is likely to have negative consequences as well. Cleanup activities and increased human presence could displace subsistence species from their usual harvesting locations. There are relatively few vessels on the northern and northwestern coasts of Alaska that could participate in the cleanup of a large spill. It is likely that whaling boats and their crews would be diverted for this purpose. Depending on the timing of the spill, this would make them unavailable for the whale hunt. While local villagers would be employed in the cleanup, it is likely that many additional workers would be necessary, placing stress on village facilities. An influx of outsiders is likely to result in some cultural conflict, stressing the local sociocultural systems.

As is evident from the *Exxon Valdez* oil spill event, such cleanup efforts can be disruptive socially, psychologically, and economically for an extended period of time. While the magnitude of impacts declines rapidly in the first year or two after a large spill, long-term effects continue to be evident (Picou et al. 2009). Such effects can be reduced by the early implementation of coping and mitigation measures (Picou et al. 1999). One important coping measure is the establishment of, and local participation in, an effective spill-response effort that has been formulated into an explicit spill-response plan. Such local programs do have a number of benefits. They provide local employment, a sense of local empowerment, and a means for local resident–oil industry communication. Another possible coping measure would be the establishment of intervention programs, such as peer listening programs based on community participation (MMS 2003a; Picou et al. 1999, 2009; Picou 2010).

A recent Oil Spill Risk Analysis (OSRA) that modeled the oil spill trajectory for spills in the Chukchi Planning Area suggests that the major impacts of an oil spill would be along the northern coast of Alaska and on the Russian coasts. Due to the predominantly southwesterly flow of ocean currents, the probability of an oil spill in the Chukchi Sea Planning Area reaching Kavilina, Kotzebue, or Shisharef is extremely low (BOEMRE 2011j).

Impacts of an Unexpected Catastrophic Discharge Event. A CDE is an unexpected, very-low-probability accident that may occur during oil and gas development on the OCS (see Sections 4.3.3 and 4.4.2). The PEIS analyzes unexpected CDEs that range in size from 1.4 to 2.2 million bbl in the Chukchi Sea Planning Area and last 40 to 75 days, and for 1.7 to 3.9 million bbl in the Beaufort Sea Planning Area and last 60 to 300 days (Table 4.4.2-2). Alaska Natives all along the northern and northwest coasts and whaling communities on islands in the Bering Sea have grave concerns about the possibility of a CDE. They are concerned that oil from such an event would spread quickly in the shallow Arctic waters, that oil companies lack the technology to clean up a spill in ice and lack an understanding of how dispersants would act in Arctic waters, and that there is not enough equipment nearby and insufficient infrastructure such as harbors and airports to handle the influx of people and material needed to clean up a CDE. They are particularly concerned about the effects of a spill in the whale migration path and the resulting loss and/or contamination of a major food source. The loss of whales as subsistence resources would be a blow to Alaska Native whaling communities. This loss could not be easily replaced by other resources and would have serious cultural ramifications as well (BOEMRE 2011j). In the words of Waska Williams at the 2011 Barrow scoping meetings, "In the event that a major spill happens, our way of life is in jeopardy" (BOEMRE 2011f).

Depending on the time and place it occurred, an unexpected CDE could have major effects on the marine mammals, fishes, migratory birds, and terrestrial mammals upon which Alaska Native subsistence harvesters depend. Oil is more likely to persist in the Arctic environment due to the colder temperatures prolonging the effects of such an event. A CDE could affect the subsistence harvest by altering the overall subsistence round (annual pattern of subsistence harvest activities) through displacement, real or perceived tainting, increased wariness of the harvested species, or increased risk and cost due to the necessity of traveling greater distances during the hunt. Direct contact with oil on barrier islands and coastal shorelines would create toxic environments for traditional subsistence resources. Onshore contact and spill response and cleanup have the greatest potential for disrupting the subsistence round. The instantaneous nature and magnitude of an unexpected CDE makes it difficult to "stock up" on subsistence resources in advance (BOEMRE 2011j).

A recent analysis of the potential effects of a CDE in the Chukchi Sea Planning Area suggests that a CDE may be divided into five phases: the initial event; offshore oil; onshore contact; spill response and cleanup; and long-term recovery (see BOEMRE 2011j and references therein). The initial event is likely to have localized direct impacts; however, there would probably be indirect impacts on subsistence harvest patterns resulting from images and news of the event causing distress to subsistence harvesters throughout the region, who would likely fear reduced or contaminated resources, contaminated habitats and harvest areas, reduction in the ability to harvest, and generally unsafe food.

Offshore resources could come into direct contact with released oil, and pollution from the spill may contaminate environmental resources. There could be a serious curtailment of subsistence if offshore oil contacted migrating or resident marine mammals. Seabirds and waterfowl that congregate in dense flocks and spend much of their time on the sea surface would be at greatest risk. Marine mammals such as seals, walrus, and polar bears would not likely be in the vicinity of an active drilling operation. The number of bowhead whales contacting spilled oil would depend on the duration, location, and timing of the spill and whales' ability or inclination to avoid contact. If oil were to get into leads or ice-free areas frequented by migrating bowheads, some portion of the population would be exposed to fresh oil. Prolonged exposure could kill some whales. The effects of a CDE on beluga whales, seals, and walrus could result from oiling of skin and fur, inhaling hydrocarbon vapors, ingesting oil-contaminated prey, losing food sources, and temporary displacement from some feeding areas. Any nearshore CDE would cause injury or death to these sea mammals, potentially cause them to move off their normal course, and make them unavailable for harvest. Any nearshore contact near Point Lay would disrupt beluga migration and deprive Point Lay of its primary subsistence hunt. If a large amount of oil contacted a large group of aggregating belugas, some deaths would occur (BOEMRE 2011j). If there is a serious reduction in the whale stock, the International Whaling Commission (IWC) could reduce or eliminate the quota of whales that can be taken by Alaska Native subsistence harvesters. This would have major effects throughout the Alaska Native communities that either harvest marine subsistence resources or trade with the communities that do. An oil spill affecting any part of the migration routes of the bowhead whale and other marine mammals could taint resources that are culturally pivotal to the subsistence way of life. Even if whales were available for the spring and fall hunt, fears of tainting would make bowheads less desirable and alter or halt the subsistence hunt.

Onshore contact would be even more serious. An oil spill contacting a coastal haul-out area would have a significant impact on walrus populations; a spill contacting denning polar bears would have a significant impact on polar bear populations. Oil could cause injury or death of these animals or cause them to alter their normal behavior, making them unavailable for harvest. Marine and coastal birds in the Pacific Flyway could potentially face substantial impacts if oil were to contact important bird habitats such as Kasegaluk Lagoon, Peard Bay, the barrier islands, the spring open-water lead system, or seabird nesting colonies at Cape Lisburne and Cape Thompson during periods of peak use. There could be significant mortality and sublethal effects to large numbers of birds. The loss of waterfowl populations to oil spills would cause harvest disruptions that would be significant to subsistence hunters who regard the spring waterfowl hunt to be of primary importance. Oil reaching intertidal or estuarine spawning and rearing habitats could result in significant adverse effects to some local breeding populations, which would require up to three generations to recover. Anadromous fish would be particularly hard hit if oil reached the mouths and deltas of anadromous streams and rivers. Local fish stocks would not be available to subsistence harvesters for years to come. Oiled shores would also have negative impacts on some terrestrial mammals, particularly scavengers ingesting oiled carcasses of seabirds on the shore and caribou exposed to oil when they seasonally seek relief from insect harassment on the shores and on barrier islands (BOEMRE 2011j).

An unexpected CDE originating in the Beaufort or Chukchi Sea region would produce impacts felt by communities remote from these planning areas and far removed from the spill. The same concerns about the integrity of subsistence resources, subsistence harvests, and subsistence food consumption would be shared by all the Iñupiat and Yup'ik communities in the North Slope Borough, the Northwest Arctic Borough, and the Bering Sea area; and by indigenous peoples on the Russian Chukchi Sea coast adjacent to the migratory corridor used by whales and other migrating species such as salmon stocks breeding in the Bering Sea region (BOEMRE 2011j).

> "Tainting concerns could seriously curtail the harvesting, sharing, and processing of subsistence resources, and these practices would be hampered to the degree these resources were contaminated. All areas directly oiled, areas to some extent surrounding them, and areas used for staging and transportation corridors for oil-spill response would not be used by subsistence hunters for some time following a spill. Oil contamination of beaches would have a profound impact on whaling because, even if bowhead whales were not contaminated, Iñupiat subsistence whalers would not be able to bring them ashore and butcher them on a contaminated shoreline. In the case of extreme contamination, harvests could cease until such time as resources were perceived as safe by local subsistence hunters. Because all communities would share concerns over the safety of these subsistence foods and the health of the whale stock, social stress would occur from the reduction or loss of preferred foods harvested in the traditional fashion and threaten a pivotal element of indigenous Alaska culture. The duration of avoidance by subsistence users would vary depending on the volume of the spill, the persistence of oil in the environment, the degree of impact on resources, the time necessary for recovery, and the confidence in assurances that resources were safe to eat. Such oil-spill effects would be considered significant." (BOEMRE 2011j)

The loss of subsistence harvest resources, particularly marine mammals, would adversely affect Alaska Native culture and society. As shown by the results of the *Exxon Valdez* spill (Picou et al. 2009; Fall et al. 2001), subsistence harvesters in unaffected areas are likely to share resources with impacted villages through established social networks. While local ties are regularly strengthened through mutual exchange, they can weaken when there is less to exchange.

Cleaning up a CDE would have negative consequences as well. Cleanup activities and increased human presence could displace subsistence species from their usual harvesting locations. There are relatively few vessels on the northern and northwestern coasts that could participate in the cleanup of a CDE. It is likely that whaling boats and their crews would be diverted for this purpose. Depending on the timing of the spill, this could make them unavailable for the whale hunt. During the *Exxon Valdez* cleanup, higher wages offered to cleanup workers resulted in local labor shortages (Fall et al. 1999). While local villagers would be employed in the cleanup, it is likely that many additional workers would be necessary, placing stress on village facilities. An influx of outsiders is likely to result in some cultural conflict, stressing the local sociocultural systems. As is evident from the *Exxon Valdez* oil spill event, such cleanup efforts can be disruptive socially, psychologically, and economically for an extended period of time.

The cleanup process itself could alter the behavior of animals important to subsistence harvesting. Disturbance to bowhead and beluga whales, seals, polar bears, caribou, fishes, and birds could increase. Offshore, skimmers, workboats, barges, aircraft overflights, relief-well-drilling activities, and *in-situ* burning during cleanup could cause whales to temporarily alter their paths. They could cause some animals, including seals in ice-covered or broken-ice conditions, to avoid areas where they are normally harvested or to become wary or more difficult to harvest. On and near shore, workers, boats, heavy equipment, and intentional hazing or capture of animals could disturb coastal resource habitat, displace species, or alter or restrict subsistence hunter access to these species and alter or extend the normal subsistence hunt. "Overall, oil-spill-cleanup activities…should be viewed as an additional impact, potentially causing displacement of subsistence resources and subsistence hunters" (BOEMRE 2011j).

After a CDE, it is likely that considerable stress and anxiety would occur over the loss of subsistence resources, contamination of habitat and subsistence resources, fear of the health effects of eating contaminated wild foods, fear of changes to harvest quotas, and the need to depend on the knowledge of others regarding environmental contamination. Individuals and communities would be increasingly stressed during the time it would take to modify subsistence-harvest patterns by selectively changing harvest areas (if such areas were even available), and there would be increased costs and risks associated with travel and hunting in unfamiliar areas. Associated cultural activities, such as the organization of subsistence activities among kinship groups and the relationships among those who customarily process and share subsistence harvests, would also be modified or would decline (BOEMRE 2011j).

> "Multiyear disruptions of subsistence-harvest patterns, especially to the bowhead whale, a pivotal subsistence resource to the Iñupiat culture, could disrupt sharing networks, subsistence task groups, and crew structures and would cause disruptions of the central Iñupiat cultural value: subsistence as a way of life. These disruptions also could cause a breakdown in sharing patterns, family ties, and the community's sense of well-being and could damage sharing linkages with other communities. Other effects might be a decreasing emphasis on subsistence as a livelihood, with an increased emphasis on wage employment, individualism, and entrepreneurism." (BOEMRE 2011j)

Impact Conclusions.

Routine Operations. Finding and developing oil and gas resources on the Arctic OCS has the potential to create adverse impacts on sociocultural systems and subsistence in the Arctic Planning Areas. Such impacts would range from minor to moderate for the routine Program activities, depending on the nature, timing, location, and scale of the activity. Many potential effects are expected to be limited or mitigable. Of greatest concern to the Alaska Natives who inhabit the area are threats to their subsistence base and way of life. Not only does subsistence harvesting provide them with a substantial portion of their food supply, but subsistence-related activities are central to their cultural identity. For many, the most iconic subsistence activity is the whale hunt.

Lease sales on the Arctic OCS are likely to result in the search for and development of oil and gas resources. These activities could have direct and indirect effects on Alaska Native subsistence practices and culture. Noise from seismic surveys and exploratory drilling has the potential to deflect whales and other marine mammals from their accustomed migration routes, making them more difficult to harvest. Effects can be reduced through cooperative scheduling and exploration design based on dialogue among the villages, oil companies, and Federal and State agencies. The noise and increased human presence resulting from the construction and operation of drilling pads, pipelines, and shore base facilities has the potential to disturb subsistence species, causing minor to moderate impacts. The increased presence of non-Natives in and around previously isolated villages increases the chance of cross-cultural misunderstanding and could result in financial and cultural stress on Native communities. Lease stipulations requiring conflict avoidance agreements between oil developers and Native villages, along with training of in-migrating work force, will reduce negative impacts. Impacts on freshwater fish and terrestrial subsistence species such as caribou from onshore pipelines can be ameliorated by cooperative planning efforts that take subsistence needs into account. Effects are likely to be compounded by concern over cumulative effects, which are discussed in Section 4.6.5.3.

Expected Accidental Events and Spills. Of greatest concern to the villagers are the effects of any oil spill. Potential impacts on sociocultural systems from accidents under the proposed action could vary from minor to major, depending on the size, location, and timing of a spill

Depending on their location, weather conditions, and the time of year, small spills would be more likely to be contained and cleaned up. Small spills are likely to have minor impacts on marine mammals. It is likely that some birds would be lost, but resources should recover in less than a year. Depending on its location, the loss of a resource for a year could be a major impact; however, in general, the impacts of a small spill are likely to be minor to moderate.

Depending on timing and location, a large spill could disrupt the beluga, bowhead, and walrus harvests. Animals could be oiled or spooked by hazing. Any major disruption of the sea mammal harvest would have major impacts. Important fish species could also be affected, as could seabirds, waterfowl, and land mammals that scavenge oiled individuals. Impacts could be major if intertidal zones, lagoons, and estuaries were oiled. Events occurring in the northern planning areas would be felt all along the migration routes of animals important to subsistence harvesters including harvesters of the Northwest Arctic Borough and those on offshore islands.

An Unexpected Catastrophic Discharge Event. The greatest impacts would occur in the unlikely event of a low-probability CDE. The impacts of a CDE would be most serious if the release occurred during a whale migration and affected the migration route. Contact with oil could result in the deaths of some individual animals. Native harvesters would perceive surviving oiled whales as tainted and would be hesitant to harvest them. A reduction in whale stock could result in the IWC reducing or eliminating whale quotas in the entire Alaska Arctic. The deaths of a large number of birds is possible and, if breeding populations were affected, could result in a serious reduction of the availability of waterfowl to subsistence harvesters all along the Pacific Flyway. Intertidal breeding populations could be decimated, resulting in a long recovery period. Anadromous fishes could be hard hit. In general, the impacts of such an unlikely spill would be major not only for the villages along the northern coast, but for all communities that depend on the sea mammals, fish, and birds that migrate to or through the Chukchi and Beaufort Seas and their shores.

An unexpected CDE would prove challenging for existing response capacity and capability, especially if the spill were under ice or in broken ice. The cleanup process itself has the potential to cause displacement of subsistence resources and subsistence hunters, and would have major impacts in the short term depending on the timing and duration of the displacement. The associated influx of cleanup workers is likely to overwhelm the resources of local communities and could result in cross-cultural conflicts.

4.4.14 Potential Impacts on Environmental Justice

4.4.14.1 Gulf of Mexico

4.4.14.1.1 Impacts of Routine Operations. In addition to the continuing use of existing onshore support and processing facilities, between 4 and 6 new pipe yards, up to 12 new pipeline landfalls, and as many as 12 new gas processing facilities are projected to be built as a result of the proposed 5-year Program. Impacts of new onshore construction impacts could include increased noise and traffic, air and water pollution, impacts on residential property values, and land use changes. Air emissions from onshore facilities and helicopter and vessel traffic traversing coastal areas will be highest in the areas containing the greatest amounts of infrastructure, which again will be Texas and Louisiana. Lesser amounts will occur in Mississippi and Alabama. No onshore infrastructure supporting OCS operations currently exists in Florida, and none will be built as a result of the proposed program.

It is assumed that 75% of the activity from the proposed 5-yr program will occur in deep and ultra-deep waters, with offshore air emissions greatest in the coastal areas of Texas and Louisiana, the areas with the greatest amounts of oil and gas activity, and lesser amounts in occurring in Mississippi and Alabama. The coastal areas of Florida are located so far from OCS activities that no environmental justice issues from offshore air emissions are expected to impact the coastal parts of the State.

The effects of the OCS program on air quality have been analyzed in Section 4.4.4. This analysis concluded that routine operations associated with the proposed 5-yr program would result in NO_2, SO_2, PM_{10}, and CO levels that are well within the National Ambient Air Quality Standards (NAAQS). Coastal effects from offshore activities are expected to be small, based on the established and increasing trend toward movement of oil and gas activities into deeper waters of the GOM.

The proposed 5-yr program will result in levels of infrastructure use and construction similar to that which has occurred in the GOM coast region during previous programs. These activities are not expected to expose residents to notably higher risks than currently occur. While the distribution of offshore-related activities and infrastructure indicates that some places and populations in the GOM region will continue to be of environmental justice concern, the incremental contribution of the proposed OCS program is not expected to affect those places and populations.

4.4.14.1.2 Impacts of Expected Accidental Events and Spills. Up to 8 large spills greater than 1,000 bbl, between 35 and 70 spills between 50 and 1,000 bbl, and between 200 and 400 small spills less than 50 bbl could occur in the GOM from the proposed action. It is reasonable to expect that most of these spills will occur in deepwater areas located away from the coast, based on the established trend for oil and gas activity to move into deep waters located for the most part at a substantial distance from the coast. However, according to MMS (2002b), the probability of an offshore oil spill occurring and impacting coastal populations is low. While the location of possible oil spills cannot be determined and while low-income and minority populations reside in some areas of the coast, in general the coasts are home to more affluent groups. Low-income and minority groups are not more likely to bear more negative impacts than other groups.

Chemical and drilling-fluid spills may be associated with exploration, production, or transportation activities that result from the proposed action. Low-income and minority populations might be more sensitive to oil spills in coastal waters than is the general population because of their dietary reliance on wild coastal resources, their reliance on these resources for other subsistence purposes such as sharing and bartering, their limited flexibility in substituting wild resources with those purchased, and their likelihood of participating in cleanup efforts and other mitigating activities. With the exception of a catastrophic accidental event, such as that which occurred following the DWH accident, the impacts of oil spills, vessel collisions, and chemical/drilling fluid spills are not likely to be of sufficient duration to have adverse and disproportionate long-term effects for low-income and minority communities in the analysis area.

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE that ranges in size from 0.9 to 7.2 million bbl and has a duration of 30–90 days (Table 4.4.2-2). In the GOM, a CDE could have impacts on low-income and minority communities, although the magnitude of impacts of a CDE would partly depend on the location, size, and timing of the event, and many of the long-term impacts of a CDE on low-income and minority communities are unknown. As studies of past oil spills have highlighted, different cultural groups would likely possess varying capacities to cope with catastrophic events (Palinkas et al. 1992), with some low-income and/or minority groups more reliant on subsistence resources and/or less equipped to substitute contaminated or inaccessible subsistence resources with those purchased in the marketplace. Because lower income and/or minority communities may live near and be directly involved with CDE cleanup efforts, the vectors of exposure can be higher for them than for the general population, increasing the potential risks of long-term health effects. To date, there have been no longitudinal epidemiological studies of possible long-term health effects for oil-spill cleanup workers. While the economic impacts of the DWH event have been partially mitigated by employers retaining employees for delayed maintenance or through the Gulf Coast Claims Facility (GCCF) program's emergency funds, the physical and mental health effects on both children and adults within these communities could potentially unfold for many years.

Impact Conclusions.

Routine Operations. The Program would result in levels of infrastructure use and construction similar to those that have already occurred along the GOM coast during previous programs. Routine Program operations are not expected to expose residents to notably higher risks than currently occur. While the distribution of offshore Program activities and infrastructure indicates that some places and populations in the GOM region will continue to be of environmental justice concern, the incremental contribution of the Program is not expected to affect those places and populations. Air emissions from the proposed program are not expected to result in air quality impacts on minority or low-income populations, with emissions from the proposed program not being expected to exceed the NAAQS in any affected area. Impacts on environmental justice from routine Program activities in the GOM Planning Areas are expected to be negligible.

Expected Accidental Events and Spills. Impacts from accidental oil spills expected in the GOM would not raise additional environmental justice concerns because of the movement of oil and gas activities farther away from coastal areas and the demographic pattern of more affluent groups (and fewer low-income and minority populations) living in coastal areas. Small spills less than 1,000 bbl would have negligible to minor impacts, while large spills (≥1,000 bbl) would have minor to moderate impacts.

An Unexpected Catastrophic Discharge Event. A CDE could have moderate to major impacts on low-income and minority communities, although the magnitude of impacts of a CDE would partly depend on the location, size, and timing of the event, and many of the long-term impacts of a CDE on low-income and minority communities are unknown.

4.4.14.2 Alaska – Cook Inlet

4.4.14.2.1 Impacts of Routine Operations. Although only one pipeline landfall and no new pipe yards or gas processing facilities would be built as a result of the Program, additional offshore construction could include increased noise and traffic, air and water pollution, impacts on residential property values, and land use changes. Much of the Alaska Native population resides in the coastal areas of Alaska. New offshore infrastructure resulting from this program could be located near areas where subsistence hunting occurs. The Program will result in levels of infrastructure use and construction similar to that which has occurred in the south central Alaska region during previous programs, and, in many of the same locations. These activities are not expected to expose residents to notably higher risks than those that currently occur.

Any adverse environmental impacts on fish and mammal subsistence resources from installation of infrastructure and routine operations of these facilities could have disproportionately higher health or environmental impacts on Alaska Native populations, particularly with regard to air quality impacts and impacts on animal species used for subsistence purposes.

Air emissions from onshore facilities and helicopter and vessel traffic traversing coastal areas will be highest in areas containing the greatest amounts of infrastructure. It is assumed that the majority of the activity from the Program will occur in deep and ultra-deep waters, with offshore air emissions greatest in the coastal areas with the greatest amounts of oil and gas activity, and lesser amounts occurring elsewhere. The effects of the OCS program on air quality have been analyzed in Section 4.4.4. This analysis concluded that routine operations associated with the proposed 5-yr program would result in NO_2, SO_2, PM_{10}, and CO levels that are well within the NAAQS. Coastal effects from offshore activities are expected to be small, based on the established and increasing trend toward movement of oil and gas activities into deeper waters.

Critical subsistence species that are most likely to be disturbed by noise-producing activities include bowhead and beluga whales, seals, fish, caribou, and birds. Noise disturbance would be associated with aircraft and vessel support of modifications to platform facilities, installation of oil and gas pipelines from platforms to shore, and the expansion of shore facilities. While OCS oil and gas activities are not expected to appreciably reduce any populations of subsistence species, it is possible that disturbance caused by these activities could alter the local availability of these resources to harvesters. These impacts would be considered short term and localized, and would not rise to the level of significant adverse effects.

4.4.14.2.2 Impacts of Expected Accidental Events and Spills. One large spill greater than 1,000 bbl, between 1 and 3 spills between 50 and 1,000 bbl, and up to 15 small spills less than 50 bbl could occur in the Cook Inlet area from the proposed action. It is reasonable to expect that most of these spills will occur in deepwater areas located away from the coast, based on the established trend for oil and gas activity to move into deep waters located for the most part at a substantial distance from the coast. The magnitude of impacts from such spills cannot be predicted, should they contact the coast, and depends on their location, size, and timing. However, according to MMS (2002b), the probability of an offshore oil spill occurring and impacting coastal populations is low. While the location of possible oil spills cannot be determined and while low-income and minority populations are resident in some areas of the coast, in general the coasts are home to more affluent groups. Low-income and minority groups are not more likely to bear more negative impacts than are other groups.

Subsistence activities of Alaska Native communities could be affected by accidental oil spills, with the potential health effects of oil spill contamination on subsistence foods being the main concern (Stephen Brand and Associates 2009). After the 1989 *Exxon Valdez* spill, testing of subsistence foods for hydrocarbon contamination between 1989 and 1994 revealed very low concentrations of petroleum hydrocarbons in most subsistence foods, and the U.S. Food and Drug Administration concluded that eating food with such low levels of hydrocarbons posed no significant risk to human health (Hom et al. 1999). Human health risks can be reduced through timely warnings about spills, forecasts about which areas may be affected, and even evacuating people and avoiding marine and terrestrial foods that may be affected. Avoidance of shellfish, which accumulate hydrocarbons, would be recommended, and Federal and State agencies with health care responsibilities would have to sample the food sources and test for possible contamination.

Whether subsistence users will use potentially tainted foods would depend on the cultural "confidence" in the purity of these foods. Based on surveys and findings in studies of the *Exxon Valdez* spill, Natives in affected communities largely avoided subsistence foods as long as the oil remained in the environment. Perceptions of food tainting and avoiding use lingered in Native communities after the *Exxon Valdez* spill, even when agency testing maintained that consumption posed no risk to human health (MMS 2006b).

The assessment and communication of the contamination risks of consuming subsistence resources following an oil spill is a continuing challenge to health and natural resource managers. After the *Exxon Valdez* spill, analytical testing and rigorous reporting procedures failed to convince many subsistence consumers because test results were often inconsistent with Native perceptions about environmental health. Any effective discussion of subsistence resource contamination must understand the conflicting scientific paradigms of Western science and traditional knowledge in addition to the vocabulary of the social sciences in reference to observations throughout the collection, evaluation, and reporting processes. True restoration of environmental damage, according to Picou and Gill (1996), "must include the re-establishment of a social equilibrium between the bio-physical environment and the human community" (Field et al. 1999; Nighswander and Peacock 1999; Fall et al. 1999). Since 1995, subsistence restoration resulting from the *Exxon Valdez* oil spill has improved by taking a more comprehensive approach by partnering with local communities and by linking scientific methodologies with traditional knowledge (Fall et al. 1999; Fall and Utermohle 1999).

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE that ranges in size from 75 to 125 thousand bbl and has a duration of 50–80 days (Table 4.4.2-20). In Cook Inlet, a CDE could have impacts on low-income and minority communities, although the magnitude of impacts of a CDE would partly depend on the location, size, and timing of the event, and many of the long-term impacts of a CDE on low-income and minority communities are unknown. As studies of past oil spills have highlighted, different cultural groups would likely possess varying capacities to cope with catastrophic events (Palinkas et al. 1992), with some low-income and/or minority groups more reliant on subsistence resources and/or less equipped to substitute contaminated or inaccessible subsistence resources with those purchased in the marketplace. Because lower income and/or minority communities may live near and be directly involved with catastrophic discharge event cleanup efforts, the vectors of exposure can be higher for them than for the general population, increasing the potential risks of long-term health effects. To date, there have been no longitudinal epidemiological studies of possible long-term health effects for oil spill cleanup workers.

Impact Conclusions.

Routine Operations. Much of the Alaska Native population in the Cook Inlet region resides in the coastal areas, and any new onshore and offshore infrastructure occurring under the Program could be located near these populations or near areas where subsistence hunting occurs. Any adverse environmental impacts on fish and mammal subsistence resources from Program infrastructure and routine operations could result in health or environmental justice impacts on Alaska Native populations, although impacts are expected to be minor.

Expected Accidental Events and Spills. Small spills up to 1,000 bbl would have negligible to minor impacts, while large spills (≥1,000 bbl) that affect subsistence resources could have moderate to major impacts on the Alaska Native population, particularly if the subsistence resources were diminished or tainted as a result of the spill.

An Unexpected Catastrophic Discharge Event. A CDE could have moderate to major impacts on low-income and minority communities, although the magnitude of impacts of a CDE would depend partly on the location, size, and timing of the event, and many of the long-term impacts of a CDE on low-income and minority communities are unknown. Long-term impacts on subsistence resources may be expected, however, and these may lead to longer and greater environmental justice impacts. Mitigation measures, cooperative agreements between Native and industry groups, and government-to-government consultations are designed to limit the effects from oil spills and routine operations.

4.4.14.3 Alaska – Arctic

4.4.14.3.1 Impacts of Routine Operations. Although only one pipeline landfall and no new pipe yards or gas processing facilities would be built as a result of the Program, additional offshore construction could include increased noise and traffic, air and water pollution, impacts on residential property values, and land use changes. Much of the Alaska Native population resides in the coastal areas of Alaska. Any new onshore and offshore infrastructure resulting from this program could be located near these populations or near areas where subsistence hunting occurs. The Program will result in levels of infrastructure use and construction similar to what has occurred in the Arctic region during previous programs. These activities are not expected to expose residents to notably higher risks than currently occur.

Air emissions from onshore facilities and helicopter and vessel traffic traversing coastal areas will be highest in the areas containing the greatest amount of infrastructure. It is assumed that the majority of the activity from the Program will occur in deep and ultra-deep waters, with offshore air emissions greatest in the coastal areas with the greatest amounts of oil and gas activity, and lesser amounts in occurring elsewhere. The effects of the OCS program on air quality have been analyzed in Section 4.4.4. This analysis concluded that routine operations associated with the Program would result in NO_2, SO_2, PM_{10}, and CO levels that are well within the NAAQS.

Any adverse environmental impacts on fish and mammal subsistence resources from installation of infrastructure and routine operations of these facilities could have disproportionately higher health or environmental impacts on Alaska Native populations, particularly with regard to air quality impacts and impacts on animal species used for subsistence purposes.

The NSB Municipal Code defines subsistence as "an activity performed in support of the basic beliefs and nutritional needs of the residents of the borough and includes hunting, whaling, fishing, trapping, camping, food gathering, and other traditional and cultural activities" (ADNR 1997). While this is, at best, a partial view of the significance of these activities to the Iñupiat (and more generally to Alaskan Natives) as individuals, culturally it stresses subsistence as a primary cultural and nutritional set of activities upon which Alaskan Natives depend.

Critical subsistence species that are most likely to be disturbed by noise-producing activities include bowhead and beluga whales, seals, fish, caribou, and birds. Noise disturbance would be associated with aircraft and vessel support of modifications to platform facilities, installation of oil and gas pipelines from platforms to shore, and the expansion of shore facilities. While natural gas development and production are not expected to appreciably reduce any populations of subsistence species, it is possible that disturbance caused by these activities could alter the local availability of these resources to harvesters. These impacts would be considered short term and localized, and would not rise to the level of significant adverse effects.

4.4.14.3.2 Impacts of Expected Accidental Events and Spills. Up to 3 large spills greater than 1,000 bbl, between 10 and 35 spills between 50 and 1,000 bbl, and up to 190 small spills of less than 50 bbl could occur in the Beaufort and Chukchi Sea area from the proposed action. The magnitude of impacts from such spills cannot be predicted, should they contact the coast, and depends on their location, size, and timing. However, according to MMS (2002b), the probability of an offshore oil spill occurring and impacting coastal populations is low. While the location of possible oil spills cannot be determined, and while low-income and minority populations are resident in some areas of the coast, low-income and minority groups are not more likely to bear more negative impacts than are other groups.

Subsistence activities of Native communities could be affected by accidental oil spills, with the potential health effects of oil spill contamination of subsistence foods being the main concern (Stephen Brand and Associates 2009). After the 1989 *Exxon Valdez* spill, testing of subsistence foods for hydrocarbon contamination between 1989 and 1994 revealed very low concentrations of petroleum hydrocarbons in most subsistence foods, and the U.S. Food and Drug Administration concluded that eating food with such low levels of hydrocarbons posed no significant risk to human health (Hom et al. 1999). Human health risks can be reduced through timely warnings about spills, forecasts about which areas may be affected, and even evacuating people and avoiding marine and terrestrial foods that may be affected. Avoidance of shellfish, which accumulate hydrocarbons, would be recommended, and Federal and State agencies with health care responsibilities would have to sample the food sources and test for possible contamination.

Whether subsistence users will use potentially tainted foods would depend on the cultural "confidence" in the purity of these foods. Based on surveys and findings in studies of the *Exxon Valdez* spill, Natives in affected communities largely avoided subsistence foods as long as the oil remained in the environment. Perceptions of food tainting and avoiding use lingered in Native communities after the *Exxon Valdez* spill, even when agency testing maintained that consumption posed no risk to human health (MMS 2006b).

The assessment and communication of the contamination risks of consuming subsistence resources following an oil spill is a continuing challenge to health and natural resource managers. After the *Exxon Valdez* spill, analytical testing and rigorous reporting procedures failed to convince many subsistence consumers, because test results were often inconsistent with Native perceptions about environmental health. Any effective discussion of subsistence resource contamination must understand the conflicting scientific paradigms of Western science and traditional knowledge in addition to the vocabulary of the social sciences in reference to observations throughout the collection, evaluation, and reporting processes. True restoration of environmental damage, according to Picou and Gill (1996), "must include the re-establishment of a social equilibrium between the bio-physical environment and the human community" (Field et al. 1999; Nighswander and Peacock 1999; Fall et al. 1999). Since 1995, subsistence restoration resulting from the *Exxon Valdez* oil spill has improved by taking a more comprehensive approach by partnering with local communities and by linking scientific methodologies with traditional knowledge (Fall et al. 1999; Fall and Utermohle 1999).

Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE in the Chukchi Sea Planning Area that ranges in size from 1.4 to 2.2 million bbl and has a duration of 40–75 days, and a CDE in the Beaufort Sea Planning Area with an assumed volume of 1.7-3.9 million bbl and duration of 60–300 days (Table 4.4.2-2). In the Arctic, a CDE could have impacts on low-income and minority communities, although the magnitude of impacts of a CDE would partly depend on the location, size, and timing of the event, and many of the long-term impacts of a CDE on low-income and minority communities are unknown. As studies of past oil spills have highlighted, different cultural groups would likely possess varying capacities to cope with catastrophic events, with some low-income and/or minority groups more reliant on subsistence resources and/or less equipped to substitute contaminated or inaccessible subsistence resources with those purchased in the marketplace. Because lower income and/or minority communities may live near and be directly involved with catastrophic discharge event cleanup efforts, the vectors of exposure can be higher for them than for the general population, increasing the potential risks of long-term health effects. To date, there have been no longitudinal epidemiological studies of possible long-term health effects for oil-spill cleanup workers.

Impact Conclusions.

Routine Operations. Much of the Alaska Native population in the Arctic region resides in the coastal areas. Any new onshore and offshore infrastructure occurring under the Program could be located near these populations or near areas where subsistence hunting occurs. Any adverse environmental impacts on fish and mammal subsistence resources from Program infrastructure and routine operations could result in health or environmental justice impacts on Alaska Native populations although impacts are expected to be minor.

Expected Accidental Events and Spills. Small spills up to 1,000 bbl would have negligible to minor impacts, while large spills (≥1,000 bbl) that affect subsistence resources could also have moderate to major impacts on the Alaska Native population, particularly if the subsistence resources were diminished or tainted as a result of the spill.

An Unexpected Catastrophic Discharge Event. A CDE could have moderate to major impacts on low-income and minority communities, although the magnitude of impacts of a CDE would depend partly on the location, size, and timing of the event, and many of the long-term impacts of a CDE on low-income and minority communities are unknown. Long-term impacts on subsistence resources may be expected, however, and these may lead to longer and greater environmental justice impacts. Mitigation measures, cooperative agreements between Native and industry groups, and government-to-government consultations are designed to limit the effects from oil spills and routine operations.

4.4.15 Potential Impacts to Archeological and Historic Resources

4.4.15.1 Gulf of Mexico

Archaeological resources in the GOM region that may be impacted by the proposed action include historic shipwrecks and inundated prehistoric sites offshore as well as historic and prehistoric sites onshore. Historic shipwrecks tend to concentrate in the shallow, nearshore waters of the GOM (CEI 1977; Garrison et al. 1989; Pearson et al. 2003); however, numerous recent discoveries of well-preserved historic shipwrecks in deepwater areas of the GOM have increased understanding of shipwreck potential on the OCS (Atauz et al. 2006; Church and Warren 2008; Church et al. 2004; Ford et al. 2008). BOEM has expanded its archaeological survey requirements to ensure the detection of these deepwater shipwrecks prior to approving bottom-disturbing activities in areas where it has reason to believe that archaeological resources might exist. Inundated prehistoric sites may exist on the continental shelf shoreward of about the 50-m (164-ft) isobath. The depth may increase as our understanding of the timing for the peopling of North America is pushed ever earlier.

Onshore historic properties include sites, structures, and objects such as historic buildings, forts, lighthouses, homesteads, cemeteries, and battlefields. Onshore prehistoric archaeological resources include sites, structures, and objects such as shell middens, earth middens, campsites, kill sites, tool manufacturing areas, ceremonial complexes, and earthworks.

Adverse effects on historic properties require mitigation. The appropriate mitigation would be developed through consultation among BOEM, the appropriate SHPO, and any Native American tribes who have an interest in the resources.

All archaeological sites identified through surveys conducted for BOEM permitting activities require avoidance or evaluation for listing on the NRHP. Only archaeological and historic resources that are determined eligible for listing on the NRHP require consideration during Federal undertakings (36 CFR Part 800).

4.4.15.1.1 Impacts of Routine Operations. Routine operations associated with offshore oil and gas fall into four stages: exploration, development, operations, and decontamination and decommissioning. Impacts can occur on archaeological and historic resources during any stage but would be most likely during the exploration and development stages when the seafloor is first altered by an activity. It is assumed that operations and decontamination and decommissioning would affect seafloor that had been previously altered by the earlier activities. The potential for impacting a cultural resource is dependent upon the specific activity and whether a cultural resource is present within the area of potential effect for that activity.

Routine activities associated with exploration and development that are likely to affect archaeological and historic resources include drilling wells, platform installation, and pipeline installation and anchoring, as well as onshore facility and pipeline construction projects. While the source of potential impacts will vary with the specific location and nature of the routine operation, the goal of archaeological resource management remains the protection and/or retrieval of unique information contained in intact archaeological deposits.

Direct impacts occur when permitted activities physically alter significant archaeological or historic resources. The result of direct impacts on shipwrecks would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, as well as loss of information on maritime cultures for the time period from which the ship dates. Other indirect impacts can result from the visual intrusion resulting from oil and gas development on the OCS and its effect on onshore historic properties. An indirect effect of oil and gas development on archaeological and historic resources is that metal debris from a permitted activity could settle near a shipwreck and could mask magnetic signatures of significant historic archaeological resources, making them more difficult to detect with magnetometers. Direct impacts from a routine activity on a prehistoric archaeological site could include destruction of artifacts or site features, as well as disturbance of the stratigraphic context of the site. This would result in the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for North America, Central America, South America, and the Caribbean.

Regulations in 30 CFR 550.194 allow the BOEM Regional Director to require that an archaeological report based on geophysical data be prepared, if there are indications that a significant archaeological resource may exist within a lease area. For historic resources, this decision can be based on whether a lease block falls within an area assessed as having a high potential for shipwreck occurrence, such as the entrances to historic ports and harbors, or on the

Regional Director's determination that a survey is warranted. For prehistoric resources, a survey is required if there is the potential for landforms to be present that could contain prehistoric material. If the survey finds evidence of a possible archaeological resource within the lease area, the lessee must either move the proposed activity to avoid the possible resource or conduct further investigations to determine whether an archaeological resource actually exists at the location. If an archaeological resource is present at the location of proposed activity and cannot be avoided, BOEM procedures require consultation with the State Historic Preservation Office to develop mitigating measures prior to any exploration or development.

BOEM has used predictive models based on various parameters to determine when and where archaeological surveys should be required. Studies conducted between 2006 and 2008 suggest that the models used in the past are not adequate (Church and Warren 2008; Ford et al. 2008; Atauz et al. 2006). These studies document significant effects on shipwrecks resulting from routine activities that occurred in areas where wrecks were not anticipated. As a result of these discoveries, BOEM may require surveys in all areas outside those already identified as having the potential for archaeology that could be affected by a project.

Federal, State, and local laws and ordinances, including the National Historic Preservation Act provide a process to facilitate the consideration of known sites and as-yet-unidentified archaeological resources in the planning phases of a proposed project. Where there is reason to believe that an archaeological resource might exist in a lease area, regulations require archaeological surveys to be conducted prior to permitting any activity that might disturb a significant archaeological site. When required, these archaeological surveys have been found to be effective in locating most archaeological resources prior to any construction on the OCS; however, even with surveys, there is the potential that a shipwreck or an inundated terrestrial site could be missed due to sedimentation on the wreck or other factors, resulting in a routine activity contacting a shipwreck or site. Such an event could result in the disturbance or destruction of unique or significant historic archaeological information.

4.4.15.1.2 Impacts of Expected Accidental Events and Spills. Impacts on archaeological and historical resources from an accidental oil spill can result from either direct contact of crude oil with archaeological material or from effects caused by cleanup workers and their equipment (i.e., anchor drags, dredging of contaminated soils, or unauthorized collecting by cleanup workers). The following are discussions of the potential effects from an accidental oil spill on various resource types based on location and water depth.

Shipwrecks in shallow waters and coastal historic and prehistoric archeological sites could be impacted by an accidental oil spill. Archaeological resource protection during an oil spill requires specific knowledge of the resource's location, condition, nature, and extent prior to impact; however, the GOM coastline has not been systematically surveyed for archaeological sites. Existing information indicates that, in coastal areas of the GOM, prehistoric sites occur frequently along the barrier islands and mainland coast and the margins of bays and bayous. Thus, any spill that contacted the land would involve a potential impact on a prehistoric site.

Shipwrecks can be affected by contact with crude oil. Shallow water shipwrecks often serve as artificial reefs when they are covered by corals and other organisms. The organisms that attach to the wreck protect the wood from deterioration. An oil spill could destabilize a balanced ecosystem covering the wreck, thus potentially increasing deterioration of the wreck until the wreck comes into equilibrium with its new environment. Some terrestrial studies have suggested that, while oil contamination of wood initially restricts deterioration, it can later increase deterioration (Ejechi 2003). It is not known how this situation would be altered in a marine environment. It is also not known whether dispersants used to break up concentrations of oil have any effect on shipwrecks or the ecosystem that forms on the wrecks (BOEMRE 2011a).

Should an oil spill contact a coastal historic site, such as a fort or a lighthouse, the major impact would be visual due to oil contamination of the site and its environment. Any effects from contact with oil to historic materials could be mitigated through cleaning of the historic material. The visual impact would most likely be temporary, lasting up to several weeks depending on the time required for cleanup. Gross crude oil contamination of shorelines is a potential direct impact that may affect archaeological site recognition. Heavy oiling conditions could conceal intertidal sites that may not be recognized until they are inadvertently damaged during cleanup (Whitney 1994). Crude oil may also contaminate organic material used in ^{14}C dating, and, although there are methods for cleaning contaminated ^{14}C samples, greater expense is incurred (Dekin et al. 1993; Brown 2011). An Alaskan study examining the effects of the 1989 *Exxon Valdez* oil spill on archaeological deposits revealed that oil in the intertidal zone had not penetrated the subsoil, apparently due to hydrostatic pressure (Dekin et al. 1993); however, because of the different environments, these results should not be translated into the GOM coastal environment without further study.

Spill Response and Cleanup. Cleanup activities have the potential to alter archaeological sites and shipwrecks. Inadvertent damage from anchors can greatly impact archaeological sites and shipwrecks (Church and Warren 2008). The potential amount of damage depends on several factors including the presence and density of shipwrecks and archaeological material in the area of activity, the number of vessels being employed in the cleanup activities, and whether offshore decontamination stations were needed and where these facilities were established. These types of impacts could be avoided or minimized if wreck locations are known. In 2007, 2,100 shipwrecks were reported to have been lost in the GOM; however, specific location information is known for only 233 of these wrecks (BOEMRE 2011a). This issue makes it difficult to avoid wrecks that are suspected to be in the area, but whose presence as yet remains unverified.

Another source of potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup activities implemented by untrained volunteers and heavy equipment operators (Borrell 2010). Unmonitored booming, cleanup activities involving vehicle and foot traffic, mechanized cleanup involving heavy equipment, and high-pressure washing on or near archaeological sites pose risks to the resources. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. As Bittner (1996) described in her summary of the *Exxon Valdez* oil spill, "Damage assessment revealed no contamination of the sites by oil, but considerable damage resulted from vandalism associated with cleanup activities and lesser amounts were caused by the cleanup process itself."

The National Response Team's *Programmatic Agreement on Protection of Historic Properties during Emergency Response under the National Oil and Hazardous Substances Pollution Contingency Plan* clarifies interagency and regulatory aspects of archaeological site protection during oil spill response. The agreement was followed during the DWH event and it is assumed that the agreement was effective; however, no reports on the utility of the agreement for that event are currently available.

4.4.15.1.3 Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE that ranges in size from 0.9-7.2 million bbl with a duration of 30–90 days (Table 4.4.2-2). A CDE could result in minor to major impacts on a large number of archaeological and historic resources. Due to the large area affected by a catastrophic event, some resources such as coastal historic sites that are sensitive to prolonged contact with oil could be more heavily impacted. Cleanup crews would be needed in a greater number of locations. This could allow oil to be in contact with resources for a significant amount of time before cleanup efforts could be applied, which could result in impacts to these resources. A greater threat to archaeological and historic resources during a catastrophic discharge event would result from the larger number of response crews being employed. Historically most impacts to archaeological and historic resources during a spill response were the result of vandalism or physical damage from spill response activities (Bittner 1996; Reger et al. 2000). A CDE would result in major impacts to numerous archaeological and historic resources from response activities. The number of sites potentially susceptible to injury from a CDE is quite large. Given the number of resources to be considered and personnel limitations, timely monitoring of affected sites may not be possible (Reger et al. 2000).

Cleanup activities for a CDE may involve the use of chemical substances. These substances, depending on what chemicals are actually employed, may affect archaeological sites. For example, cleanup techniques for the DWH event included application of chemical agents. The full effect of the agents on archaeological sites and shipwrecks is unknown. However, some evidence exists that the use of these substances may result in the contamination of any carbon-14 samples, making the dating of sites difficult (Borrell 2010).

A CDE also may release large amounts of hazardous air pollutants (HAPS), such as benzene, toluene, and xylene, which are found in oil/water mixtures, emulsions called "mousse," or in fresh oil. While HAPs evaporate over time, they may result in indirect effects on historic structures. In addition, "crude oil also contains polyaromatic hydrocarbons (PAHs) that are highly toxic and, if they have penetrated building materials, can persist for long periods of time" (Chin 2010). Contamination of a structure with HAPS or PAHs could limit access to the resource until levels are reduced.

In addition, a CDE also has the potential to indirectly affect future archaeological and historic preservation efforts, due to the depletion of public funds that were redirected to cleanup activities. A CDE, such as the DWH event, typically covers a broad region and requires a short-term and intense effort to clean up and limit the immediate effects of the spill. Significant expenditure of public funds is required to cover upfront costs of these efforts, which ultimately could inhibit future planning and budgets for cultural resource management activities. In Louisiana, for instance, the Office of Cultural Development has indicated that "the Gulf oil spill has stretched resources thin and a discouraging budget climate that has already reduced the overall reach and effectiveness of State government now threatens to carve further into public services" (Louisiana Office of Cultural Development 2011).

The Programmatic Agreement on Protection of Historic Properties during Emergency Response under the National Oil and Hazardous Substances Pollution Contingency Plan would be followed during the response to a CDE. As mentioned above, it is assumed that the process identified in the agreement would be effective; however, no assessments of the agreement's application during the DWH event are available.

Impact Conclusions.

Routine Operations. Assuming compliance with existing Federal, State, and local archaeological regulations and policies, most impacts on archaeological resources resulting from routine activities under the proposed action should be avoided. BOEM may alter its requirements for archaeological surveys because currently, BOEM does not require the submission of archaeological reports based on high-resolution geophysical survey data in all lease-sale areas. Without the data analysis included in the archaeological reports, it is impossible to assess whether a proposed activity may affect an unknown cultural resource in the area of potential effect. When required, archaeological reports based on high-resolution geophysical data are believed to provide the information needed by BOEM to develop appropriate avoidance or mitigation strategies to protect cultural resources within the area of potential effect from impacts associated with oil and gas activities on the OCS. Impacts on archeological and historic resources from routine Program activities are expected to range from negligible to major.

Expected Accidental Events and Spills. In the case of expected accidental events and spills, some impacts on coastal historic and prehistoric archaeological resources could occur. The magnitude of the impacts would depend on the number of resources affected and on the significance and uniqueness of the information lost. Impacts can result from both direct contact with oil and from cleanup operations. Some impacts from direct contact with oil are expected when resources are present, and additional impacts are expected during cleanup activities. Impacts from small spills (<50 bbl) could range from negligible to major depending on the location of the spill in relation to sensitive resources. A similar situation is encountered with small spills up to 1,000 bbl. These spills could result in impacts ranging from negligible to major, depending on the location the spill in relation to sensitive resources. Large spills (≥1,000 bbl) could result in negligible to major impacts. As the size of the spill increases, the likelihood that a sensitive resource could be affected increases. However, given the irreplaceable nature of the resource, even the smallest spill, if occurring in close proximity to a sensitive resource, could result in major impacts. The difference between the scenarios is one of magnitude. Smaller spills are more likely to affect a single resource, whereas larger spills are more likely to affect numerous resources.

An Unexpected Catastrophic Discharge Event. In the event of a CDE which is not expected, some impacts on coastal historic and prehistoric archaeological resources could occur. Although it is not possible to predict the precise numbers or types of sites that would be affected, contact with archaeological sites would probably be unavoidable, and the resulting loss of information would be irretrievable. The magnitude of the impacts would depend on the number of resources affected and on the significance and uniqueness of the information lost. Impacts can result from both direct contact with oil and from cleanup operations. Some impacts from direct contact with oil from a CDE may be expected, and additional impacts may be expected during cleanup activities. Response actions associated with a CDE have the greatest potential for adversely affecting archeological and historic resources. Impacts from a CDE could range from minor to major. In the event of a CDE, many resources would likely be affected. There is a greater likelihood that more of the resources would be affected at a major level during a CDE.

4.4.15.2 Alaska – Cook Inlet

Archaeological and historic resources in the Alaska region include historic shipwrecks, submerged aircraft, inundated prehistoric sites offshore, and historic and prehistoric sites onshore. These resources have the potential to be affected by the proposed action. The locations of most of the cultural resources in Cook Inlet are currently unknown, but if any are discovered during OCS oil and gas activities, they would be subject to archaeological surveys, and other activities and mitigations required by applicable laws and BOEM policies. There is no current archaeological baseline study for Alaska on which to base decisions concerning where cultural resources should be present. An archaeological baseline study was done for Alaska in the mid-1980s (Dixon et al. 1986); however, this research was never updated and should be assessed for its validity when compared with current research and scientific findings. Some research attempting to identify landforms that may contain archaeological remains has been done in the Beaufort and Chukchi Seas, but no new studies have been conducted in Cook Inlet. Research on historic shipwrecks has identified 108 shipwrecks in Cook Inlet (Tornfelt and Burwell 1992). As discussed in Section 3.16.2, portions of Cook Inlet are subject to high-energy tidal movements (MMS 2003a). This high-energy environment may have destroyed some of the archaeological evidence that once existed in Cook Inlet, but this can only be verified through science-based methods of inquiry.

4.4.15.2.1 Impacts of Routine Operations. Routine activities associated with the proposed action that could affect cultural resources include well drilling, platform installation, pipeline installation, and onshore facility and pipeline construction projects that involve ground disturbance. Effects on cultural resources can be determined only on a case-by-case basis. Only through project-specific surveys can cultural resources be identified. The determination that a survey is required depends on several factors including the potential for landforms to exist that may contain archaeological sites (i.e., submerged coastlines) or archival records suggesting that shipwrecks could be present.

As previously discussed, regulations at 30 CFR 550.194 allow the BOEM Regional Director to require that an archaeological report based on geophysical data be prepared, if there are indications that a significant archaeological resource may exist within a lease area. For historic resources, this decision is based on whether a historic shipwreck is reported to exist within or adjacent to a lease area. For prehistoric resources, an analysis is completed prior to each lease sale to consider the relative sea level history, the depth of burial of the late Wisconsinan land surface (i.e., lands that could contain archaeological sites), the type and thickness of sediments burying the old land surface, and the severity of ice gouging at the present seafloor. Lease areas that are shown by this analysis to have the potential for prehistoric archaeological resources are required to have an archaeological survey prior to initiating exploration and development activities. If the survey finds evidence of a possible archaeological resource within the lease area, the lessee must either move the proposed activity to avoid the possible resource or conduct further investigations to determine whether an archaeological resource actually exists at the location. If an archaeological resource is present at the location of proposed activity and cannot be avoided, BOEM procedures require consultation with the State Historic Preservation Office to develop mitigation measures prior to any exploration or development.

Federal, State, and local laws and ordinances, including the National Historic Preservation Act and the Alaska Historic Preservation Act, provide a process to facilitate the consideration of known sites and as-yet-unidentified archaeological resources both onshore and offshore. Where there is reason to believe that an archaeological resource might exist in a lease area, regulations require archaeological surveys to be conducted prior to permitting any activity that might disturb a significant archaeological site. When required, these surveys have been found to be effective in locating most archaeological resources prior to any construction or offshore bottom-disturbing activity on the OCS. However, even with surveys there is the potential that a shipwreck or an inundated terrestrial site could be missed due to sedimentation on the wreck or other factors, resulting in a routine activity contacting a shipwreck or site. Such an event could result in the disturbance or destruction of unique or significant historic archaeological information. However, regulations in 30 CFR 550.194(c) require that if any archaeological resource is discovered, operations must be immediately halted in the area of the discovery and a report of the discovery must be made so that further investigation may determine the significance of the resource.

4.4.15.2.2 Impacts of Expected Accidental Events and Spills. Oil spills and their subsequent cleanup could impact the archaeological resources of the Alaska region directly and/or indirectly. The geologic history of specific shorelines generally affects the presence or absence, condition, and age of archaeological sites on or near Alaska region shorelines. However, some types of archaeological resources are present on or adjacent to nearly all Alaska region shorelines. Existing data indicate that archaeological resources are particularly abundant along Gulf of Alaska shorelines (Mobley et al. 1990).

Archaeological resource protection during an oil spill requires specific knowledge of the resource's location, condition, nature, and extent prior to impact. However, large portions of the Cook Inlet coastline have not been systematically surveyed for archaeological sites. While some response groups have compiled known archaeological site data in a form useful for mitigation during an emergency response (Wooley et al. 1997), these data have not been compiled for all areas of the Alaska region.

Gross crude oil contamination of shorelines is a potential direct impact that may affect archaeological site recognition. Heavy oiling conditions (Whitney 1994) could conceal intertidal sites that may not be recognized until they are inadvertently damaged during cleanup. Crude oil may also contaminate organic material used in ^{14}C dating, and, although there are methods for cleaning contaminated ^{14}C samples, greater expense is incurred (Dekin et al. 1993). However, many other anthropogenic sources of hydrocarbons and other possible contaminants also exist, so caution should always be taken when analyzing radiocarbon samples from coastal Alaska (see Reger et al. 1992). A study examining the effects of the 1989 *Exxon Valdez* oil spill on archaeological deposits revealed that oil in the intertidal zone had not penetrated the subsoil, apparently due to hydrostatic pressure (Dekin et al. 1993).

Spill Response and Cleanup. The major source of potential impact from oil spills resulting from the proposed action is the harm that could result from unmonitored shoreline cleanup activities implemented by untrained volunteers and heavy equipment operators (Borrell 2010). Cleanup activities could impact beached shipwrecks, or shipwrecks in shallow waters, as well as coastal historic and prehistoric archaeological sites. Unmonitored booming, cleanup activities involving vehicle and foot traffic, mechanized cleanup involving heavy equipment, and high-pressure washing on or near archaeological sites pose risks to the resources. Inadvertent damage from anchors can greatly alter archaeological sites and shipwrecks (Church and Warren 2008). The potential amount of damage depends on several factors including the presence and density of shipwrecks and archaeological material in the area of activity, the number of vessels being employed in the cleanup activities, and whether offshore decontamination stations were needed and where these facilities were established. These types of impacts could be avoided or minimized if wreck locations are known. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. As Bittner (1996) described in her summary of the 1989 *Exxon Valdez* oil spill, “Damage assessment revealed no contamination of the sites by oil, but considerable damage resulted from vandalism associated with cleanup activities, and lesser amounts were caused by the cleanup process itself.”

The National Response Team’s *Programmatic Agreement on Protection of Historic Properties during Emergency Response under the National Oil and Hazardous Substances Pollution Contingency Plan* clarifies interagency and regulatory aspects of archaeological site protection during oil spill response. The agreement also outlines the Federal On-Scene Coordinator’s role in protecting archaeological resources, the type of expertise needed for site protection, and the appropriate process for identifying and protecting archaeological sites during an emergency response. The agreement was followed during the DWH event, and it is assumed that the agreement was effective; however, no reports on the utility of the agreement for that event are currently available.

4.4.15.2.3 Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE that ranges in size from 75-125 thousand bbl with a duration of 50–80 days (Table 4.4.2-2). A CDE could result in minor to major impacts on a large number of archaeological and historic resources. Due to the large area affected by a catastrophic event some resources such as coastal historic sites that are sensitive to prolonged contact with oil could be more heavily impacted. Cleanup crews would be needed in a greater number of locations. This could allow oil to be in contact with resources for a significant amount of time before cleanup efforts could be applied, which could result in impacts to these resources. A greater threat to archaeological and historic resources during a catastrophic discharge event would result from the larger number of response crews being employed. Historically most impacts to archaeological and historic resources during a spill response were the result of vandalism or physical damage from spill response activities (Bittner 1996; Reger et al. 2000). A catastrophic discharge event would result in major impacts to numerous archaeological and historic resources from response activities.

The number of sites potentially susceptible to injury from a CDE is quite large. Given the number of resources to be considered and personnel limitations, timely monitoring of affected sites may not be possible (Reger et al. 2000). Following the *Exxon Valdez* event, for instance, the oil-spill area likely contained more than 3,000 sites of archaeological and historic significance. Among these, at least 24 archaeological sites on public lands were known to have been adversely affected by cleanup activities, looting, or vandalism, all linked to the spill (*Exxon Valdez* Oil Spill Trustee Council undated). Other examples include reports from the Kodiak Island mayor’s office, in which vandalism occurred almost immediately following the release from the *Exxon Valdez*. Cleanup crews that were hired to clean up the oil were found digging up artifacts and destroying remnants of the past inhabitants (Mason 2008).

Cleanup activities for a CDE may involve the use of chemical substances. These substances, depending on what chemicals are actually employed, may affect archaeological sites. For example, cleanup techniques for the DWH event included application of chemical agents. The full effect of the agents on archaeological sites and shipwrecks is unknown. However, some evidence exists that the use of these substances may result in the contamination of any carbon-14 samples, making the dating of sites difficult (Borrell 2010).

A CDE also may release large amounts of HAPs, such as benzene, toluene, and xylene, which are found in oil/water mixtures, emulsions called “mousse,” or in fresh oil. While HAPs evaporate over time, they may result in indirect effects on historic structures. In addition, “crude oil also contains polyaromatic hydrocarbons (PAHs) that are highly toxic and, if they have penetrated building materials, can persist for long periods of time” (Chin 2010). Contamination of a structure with HAPS or PAHs could limit access to the resource until levels are reduced.

In addition, a CDE also has the potential to indirectly affect future archaeological and historic preservation efforts, due to the depletion of public funds that were redirected to cleanup activities. A CDE, such as the DWH event, typically covers a broad region and requires a short-term and intense effort to clean up and limit the immediate effects of the spill. Significant expenditure of public funds is required to cover upfront costs of these efforts, which ultimately could inhibit future planning and budgets for cultural resource management activities. In

Louisiana, for instance, the Office of Cultural Development has indicated that "the Gulf oil spill has stretched resources thin and a discouraging budget climate that has already reduced the overall reach and effectiveness of State government now threatens to carve further into public services" (Louisiana Office of Cultural Development 2011).

The *Programmatic Agreement on Protection of Historic Properties during Emergency Response under the National Oil and Hazardous Substances Pollution Contingency Plan* would be followed during the response to a CDE. As mentioned above, it is assumed that the process identified in the agreement would be effective; however, no assessments of the agreement's application during the DWH event are available.

Impact Conclusions.

Routine Operations. Assuming compliance with existing Federal, State, and local archaeological regulations and policies, most impacts on archaeological resources resulting from routine activities under the proposed action should be avoided. BOEM may alter its requirements for archaeological surveys because currently, BOEM does not require the submission of archaeological reports based on high-resolution geophysical survey data in all lease-sale areas. Without the data analysis included in the archaeological reports, it is impossible to assess whether a proposed activity may affect an unknown cultural resource in the area of potential effect. When required, archaeological reports based on high-resolution geophysical data are believed to provide the information needed by BOEM to develop appropriate avoidance or mitigation strategies to protect cultural resources within the area of potential effect from impacts associated with oil and gas activities on the OCS. Impacts on archeological and historic resources from routine Program activities are expected to range from negligible to major.

Expected Accidental Events and Spills. In the case of expected accidental events and spills, some impacts on coastal historic and prehistoric archaeological resources could occur. The magnitude of the impacts would depend on the number of resources affected and on the significance and uniqueness of the information lost. Impacts can result from both direct contact with oil and from cleanup operations. Some impacts from direct contact with oil are expected when resources are present, and additional impacts are expected during cleanup activities. Impacts from small spills (<50 bbl) could range from negligible to major depending on the location of the spill in relation to sensitive resources. A similar situation is encountered with small spills up to 1,000 bbl. These spills could result in impacts ranging from negligible to major depending on the location the spill in relation to sensitive resources. Large spills (≥1,000 bbl) could also result in negligible to major impacts as well. As the size of the spill increases, the likelihood that a sensitive resource could be affected increases. However, given the irreplaceable nature of the resource, even the smallest spill could result in major impacts if it occurred in close proximity to a sensitive resource. The difference between the scenarios is one of magnitude. Smaller spills are more likely to affect a single resource, whereas larger spills are more likely to affect numerous resources.

An Unexpected Catastrophic Discharge Event. In the event of a CDE which is not expected, some impacts on coastal historic and prehistoric archaeological resources could occur . Although it is not possible to predict the precise numbers or types of sites that would be affected, contact with archaeological sites would probably be unavoidable, and the resulting loss of information would be irretrievable. The magnitude of the impacts would depend on the number of resources affected and on the significance and uniqueness of the information lost. Impacts can result from both direct contact with oil and from cleanup operations. Based on experience gained from the *Exxon Valdez* oil spill, some impacts from direct contact with oil from even a CDE are expected, and additional impacts are expected during cleanup activities. Response actions associated with a CDE have the greatest potential for adversely affecting archeological and historic resources. Impacts from a CDE could range from minor to major. In the event of a CDE, many resources would likely be affected. There is a greater likelihood that more of the resources would be affected at a major level during a CDE.

4.4.15.3 Alaska – Arctic

Archaeological and historic resources in the Alaska region include historic shipwrecks, submerged aircraft, inundated prehistoric sites offshore, and historic and prehistoric sites onshore. These resources have the potential to be affected by the proposed action. Several factors must be considered when assessing any potential impacts on offshore resources in Alaska. First, the locations of most of the cultural resources in the Arctic are currently unknown; this is especially true of submerged cultural resources. If any are discovered during OCS oil and gas activities, they would be subject to archaeological surveys and other activities and mitigations required by applicable laws and BOEM policies. The goal of much of the archaeological research being done in the Arctic is to identify locations and landforms that have the potential to contain archaeological and historic resources. The focus on submerged prehistoric resources in Alaska is due to the theory that North America was first populated by nomadic hunters following game across the submerged land mass known as Beringia that once linked Asia with North America (Hoffecker and Elias 2003). A second factor is that, unlike the GOM region, there is no current archaeological baseline study for Alaska on which to base decisions concerning where cultural resources should be present. A third factor is that sea levels have risen over the last 13,000 years. Human activity tends to concentrate on coasts. Regions that were once coastal are now submerged. The coastline that existed 13,000 years ago is now found at roughly the 50-m (164-ft) bathymetry line (Darigo et al. 2007). It is thought that people first came to North America approximately 13,000 years ago. A fourth factor is that natural processes such as ice gouging may have modified much of the ocean bottom to the extent that many cultural resources no longer exist. Studies conducted in 2007 suggest some nearshore locations may remain intact due to shorefast ice, which kept the ice which normally would scrape the sea floor away from the coast. Other factors such as the amount of sediment that has collected on a location may improve the potential for some resources to remain intact.

4.4.15.3.1 Impacts of Routine Operations. Routine activities associated with the proposal that could affect cultural resources include well drilling, platform installation, pipeline installation, and onshore facility and pipeline construction projects that involve ground disturbance. Effects on cultural resources can be determined only on a case-by-case basis. Only through project-specific surveys can cultural resources be identified. The determination that a survey is required depends on several factors, including the potential for landforms to exist that may contain archaeological sites (i.e., submerged coastlines) or archival records suggesting that shipwrecks could be present.

Regulations at 30 CFR 550.194 allow the BOEM Regional Director to require that an archaeological report based on geophysical data be prepared if there are indications that a significant archaeological resource may exist within a lease area. For historic resources, this decision is based on whether an historic shipwreck is reported to exist within or adjacent to a lease area. For prehistoric resources, an analysis is completed prior to each lease sale to consider the relative sea level history, the depth of burial of the late Wisconsinan land surface (i.e., lands that could contain archaeological sites), the type and thickness of sediments burying the old land surface, and the severity of ice gouging at the present seafloor. Lease areas that are shown by this analysis to have the potential for prehistoric archaeological resources are required to have an archaeological survey prior to initiating exploration and development activities. If the survey finds evidence of a possible archaeological resource within the lease area, the lessee must either move the proposed activity to avoid the possible resource or conduct further investigations to determine whether an archaeological resource actually exists at the location. If an archaeological resource is present at the location of proposed activity and cannot be avoided, BOEM procedures require consultation with the State Historic Preservation Office to develop mitigation measures prior to any exploration or development.

Federal, State, and local laws and ordinances, including the National Historic Preservation Act and the Alaska Historic Preservation Act provide a process to facilitate the consideration of known sites and as-yet-unidentified archaeological resources both onshore and offshore. Where there is reason to believe that an archaeological resource might exist in a lease area, existing regulations require archaeological surveys to be conducted prior to permitting any activity that might disturb a significant archaeological site. When required, these archaeological surveys have been found to be effective in locating most archaeological resources prior to any onshore construction project or offshore bottom-disturbing activity; however, even with surveys there is the potential that a shipwreck or an inundated terrestrial site could be missed due to sedimentation on the wreck or other factors, resulting in a routine activity contacting a shipwreck or site. Such an event could result in the disturbance or destruction of unique or significant historic archaeological information.

4.4.15.3.2 Impacts of Expected Accidental Events and Spills. Oil spills and their subsequent cleanup could impact the archaeological resources of the Alaska region directly and/or indirectly. The geologic history of specific shorelines generally affects the presence or absence, condition, and age of archaeological sites on or near Alaska region shorelines; however, some type of archaeological resource is present on or adjacent to nearly all Alaska region shorelines. Existing data indicate that archaeological resources are particularly abundant along Gulf of Alaska shorelines (Mobley et al. 1990).

Archaeological resource protection during an oil spill requires specific knowledge of the resource's location, condition, nature, and extent prior to impact; however, large portions of the Alaska region coastline have not been systematically surveyed for archaeological sites. While some response groups have compiled known archaeological site data in a form useful for mitigation during an emergency response (Wooley et al. 1997), these data have not been compiled for all areas of the Alaska region.

Gross crude oil contamination of shorelines is a potential direct impact that may affect archaeological site recognition. Heavy oiling conditions (Whitney 1994) could conceal intertidal sites that may not be recognized until they are inadvertently damaged during cleanup. Crude oil may also contaminate organic material used in ^{14}C dating, and, although there are methods for cleaning contaminated ^{14}C samples, greater expense is incurred (Dekin et al. 1993). Many other anthropogenic sources of hydrocarbons and other possible contaminants also exist, so caution should always be taken when analyzing radiocarbon samples from coastal Alaska (see Reger et al. 1992). A study examining the effects of the 1989 *Exxon Valdez* oil spill on archaeological deposits revealed that oil in the intertidal zone had not penetrated the subsoil, apparently due to hydrostatic pressure (Dekin et al. 1993).

Spill Response and Cleanup. The major source of potential impact from oil spills resulting from the proposed action is the harm that could result from unmonitored shoreline cleanup activities implemented by untrained volunteers and heavy equipment operators (Borrell 2010). Cleanup activities could impact beached shipwrecks, or shipwrecks in shallow waters, as well as coastal historic and prehistoric archaeological sites. Unmonitored booming, cleanup activities involving vehicle and foot traffic, mechanized cleanup involving heavy equipment, and high-pressure washing on or near archaeological sites pose risks to the resource. Inadvertent damage from anchors can greatly alter archaeological sites and shipwrecks (Church and Warren 2008). The potential amount of damage depends on several factors, including the presence and density of shipwrecks and archaeological material in the area of activity, the number of vessels being employed in the cleanup activities, and whether offshore decontamination stations were needed and where these facilities were established. These types of impacts could be avoided or minimized if wreck locations are known. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. As Bittner (1996) described in her summary of the 1989 *Exxon Valdez* oil spill, “Damage assessment revealed no contamination of the sites by oil, but considerable damage resulted from vandalism associated with cleanup activities, and lesser amounts were caused by the cleanup process itself.”

The National Response Team’s *Programmatic Agreement on Protection of Historic Properties during Emergency Response under the National Oil and Hazardous Substances Pollution Contingency Plan* clarifies interagency and regulatory aspects of archaeological site protection during oil spill response. The agreement also outlines the Federal On-Scene Coordinator’s role in protecting archaeological resources, the type of expertise needed for site protection, and the appropriate process for identifying and protecting archaeological sites during an emergency response. The agreement was followed during the DWH event, and it is assumed the agreement was effective; however, no reports on the utility of the agreement for that event are currently available.

4.4.15.3.3 Impacts of an Unexpected Catastrophic Discharge Event. The PEIS analyzes a CDE in the Chukchi Sea Planning Area with an assumed volume of 1.4-2.2 million bbl and a duration of 40–75 days, and a CDE in the Beaufort Sea Planning Area with an assumed volume of 1.7–3.9 million bbl and a duration of 60–300 days (Table 4.4.2-2). A CDE could result in minor to major impacts on a large number of archaeological and historic resources. Due to the large area affected by a catastrophic event some resources such as coastal historic sites that are sensitive to prolonged contact with oil could be more heavily impacted. Cleanup crews would be needed in a greater number of locations. This could allow oil to be in contact with resources for a significant amount of time before cleanup efforts could be applied, which could result in impacts to these resources. A greater threat to archaeological and historic resources during a catastrophic discharge event would result from the larger number of response crews being employed. Historically most impacts to archaeological and historic resources during a spill response were the result of vandalism or physical damage from spill response activities (Bittner 1996; Reger et. al. 2000). A catastrophic discharge event would result in large impacts to numerous archaeological and historic resources from response activities. The number of sites potentially susceptible to injury from a CDE is quite large. Given the number of resources to be considered and personnel limitations, timely monitoring of affected sites may not be possible (Reger et al. 2000).

Cleanup activities for a CDE may involve the use of chemical substances. These substances, depending on what chemicals are actually employed, may affect archaeological sites. For example, cleanup techniques for the DWH event included application of chemical agents. The full effect of the agents on archaeological sites and shipwrecks is unknown. However, some evidence exists that the use of these substances may result in the contamination of any carbon-14 samples, making the dating of sites difficult (Borrell 2010).

A CDE also may release large amounts of HAPs, such as benzene, toluene, and xylene, which are found in oil/water mixtures, emulsions called “mousse,” or in fresh oil. While HAPs evaporate over time, they may result in indirect effects on historic structures. In addition, “crude oil also contains polyaromatic hydrocarbons (PAHs) that are highly toxic and, if they have penetrated building materials, can persist for long periods of time” (Chin 2010). Contamination of a structure with HAPs or PAHs could limit access to the resource until levels are reduced.

In addition, a CDE also has the potential to indirectly affect future archaeological and historic preservation efforts, due to the depletion of public funds that were redirected to cleanup activities. A CDE, such as the DWH event, typically covers a broad region and requires a short-term and intense effort to cleanup and limit the immediate effects of the spill. Significant expenditure of public funds is required to cover upfront costs of these efforts, which ultimately could inhibit future planning and budgets for cultural resource management activities. In Louisiana, for instance, the Office of Cultural Development has indicated that “the Gulf oil spill has stretched resources thin and a discouraging budget climate that has already reduced the overall reach and effectiveness of State government now threatens to carve further into public services” (Louisiana Office of Cultural Development 2011).

The Programmatic Agreement on Protection of Historic Properties during Emergency Response under the National Oil and Hazardous Substances Pollution Contingency Plan would be followed during the response to a CDE. As mentioned above, it is assumed that the process identified in the agreement would be effective; however, no assessments of the agreement's application during the DWH event are available.

Impact Conclusions.

Routine Operations. Assuming compliance with existing Federal, State, and local archaeological regulations and policies, most impacts on archaeological resources resulting from routine activities under the proposed action should be avoided. BOEM may alter its requirements for archaeological surveys because currently, BOEM does not require the submission of archaeological reports based on high-resolution geophysical survey data in all lease-sale areas. Without the data analysis included in the archaeological reports, it is impossible to assess whether a proposed activity may affect an unknown cultural resource in the area of potential effect. When required, archaeological reports based on high-resolution geophysical data are believed to provide the information needed by BOEM to develop appropriate avoidance or mitigation strategies to protect cultural resources within the area of potential effect from impacts associated with oil and gas activities on the OCS. Impacts on archeological and historic resources from routine Program activities are expected to range from negligible to major.

***Expected Accidental Events and Spills*.** In the case of expected accidental events and spills, some impacts could occur on coastal historic and prehistoric archaeological resources. The magnitude of the impacts would depend on the number of resources affected and on the significance and uniqueness of the information lost. Impacts can result from both direct contact with oil and from cleanup operations. Some impacts from direct contact with oil are expected when resources are present, and additional impacts are expected during cleanup activities. Impacts from small spills (<50 bbl) could range from negligible to major depending on the location of the spill in relation to sensitive resources. A similar situation is encountered with small spills up to 1,000 bbl. These spills could result in impacts ranging from negligible to major depending on the location the spill in relation to sensitive resources. Large spills (≥1,000 bbl) could also result in negligible to major impacts as well. As the size of the spill increases, the likelihood that a sensitive resource could be affected increases. However, given the irreplaceable nature of the resource, even the smallest spill if occurring in close proximity to a sensitive resource could result in major impacts. The difference between the scenarios is one of magnitude. Smaller spills are more likely to affect a single resource, whereas larger spills are more likely to affect numerous resources.

***An Unexpected Catastrophic Discharge Event*.** In the event of a CDE that is not expected, some impacts could occur on coastal historic and prehistoric archaeological resources. Although it is not possible to predict the precise numbers or types of sites that would be affected, contact with archaeological sites would probably be unavoidable, and the resulting loss of information would be irretrievable. The magnitude of the impacts would depend on the number of resources affected and on the significance and uniqueness of the information lost. Impacts can result from both direct contact with oil and from cleanup operations. Based on experience gained from the *Exxon Valdez* oil spill, some impacts from direct contact with oil from even a CDE are expected, and additional impacts are expected during cleanup activities. Response actions associated with a CDE have the greatest potential for adversely affecting archeological and historic resources. Impacts from a CDE could range from minor to major. In the event of a CDE, many resources would likely be affected. There is a greater likelihood that more of the resources would be affected at a major level during a CDE.

4.5 OTHER ALTERNATIVES

Besides the proposed action (Alternative 1), six additional "action" alternatives are considered in this PEIS. These action alternatives are essentially identical to the proposed action except that each excludes a different, particular planning area that is included in the proposed action. For example, Alternatives 1 and 2 are identical except that Alternative 2 excludes lease sales under the Program from the Eastern Planning Area. Because of the similarity in planning areas included among the action alternatives, the types of impacts that could be incurred under each of the alternatives would be similar, but would not be expected to occur in the excluded planning area. Under all of the alternatives (including no action), oil and gas development activities would remain and continue in the excluded areas of the Program, but only on acreage that is currently under active lease at the start of the 2012-2017 Program (i.e., areas leased under previous 5-year leasing programs). Alternatives 2 to 7, which each exclude one of the planning areas, may, in part, contribute to beneficial environmental effects relative to the proposed action through avoided adverse effects which may otherwise stress environmental resources and sensitive ecosystems. This is only true if the alternative actually contributes to lesser OCS exploration and development activity levels at some point in the future (see Section 4.4.1 and Figure 4.4.1-2).

Under any of the alternatives, the types of impacts that could be incurred under any new leasing and development, or under development in currently active leases, would be the largely the same as those identified under Alternative 1. However, under Alternatives 2 through 7 (with only a single planning area excluded) or combination thereof, there is a potential for incrementally greater oil and gas development in non-excluded planning areas compared to levels anticipated under the proposed action. This potential increase in oil and gas development may result if industry reallocates its oil and gas development resources from the excluded planning area to any of the other planning areas that would remain available for leasing.

For example, under Alternative 4, leasing would be excluded in the Central GOM Planning Area, while potential leasing would be available in the Western GOM. Under this alternative, industry may modify its lease acquisition strategy and re-prioritize prospects slated for Central GOM exploration, in favor of the Western GOM Planning Area. Industry may also perceive the exclusion of the Central GOM Planning Area in the 2012-2017 Program as a sign of future access restrictions in that area and may react by increasing its bidding activity on tracts in other planning areas that would be available for leasing under the Program. However, opportunities for industry to compete in global markets combined with reduced access on the OCS may offset these incremental increases as companies consider the attractiveness of international prospects.

Under the exclusion of either or both the Chukchi and Beaufort Sea Planning Areas, the active lease inventory in these areas from previous 5-year programs will likely continue to experience lead-times to exploration and development in excess of 5 years. Therefore, the adoption of short-term (2012-2017) exclusions in these "frontier" areas would likely have little to no effect on OCS activities as industry strives to make progress to actively explore and subsequently build the infrastructure necessary to develop resources underlying its currently leased acreage. The exclusion of the Cook Inlet Planning Area (Alternative 7) may have little or no noticeable effect on exploration and development activities in other planning areas in the short term and beyond, as there are no leases currently active in this planning area, and any planning for a lease sale would not begin until industry expresses an interest in holding a sale.

Regardless of the alternative being considered, it is speculative to predict how industry may respond to the exclusion of one of the planning areas and associated lease sales. While it is also speculative to suggest how impact levels may change in other planning areas with an industry response to an exclusion, the types of impacts may be expected to be similar in nature to the types of impacts identified under the proposed action for the non-excluded areas. In addition, it is reasonable to assume that the mitigation and monitoring that would be required in the non-excluded areas would also apply to any new industry actions in the non-excluded planning areas, as would any such requirements from previous 5-year leasing programs, thereby reducing the potential for any large increases in impacts from additional industry activity.

4.5.1 Alternative 2 – Exclude the Eastern Planning Area for the Duration of the 2012-2017 Program

4.5.1.1 Description of Alternative 2

Under Alternative 2, no sales would be held in the Eastern GOM Planning Area under the Program, and there would be no change from the proposed action for the other planning areas. Under Alternative 2, the following would take place:

- Five area-wide lease sales in the Central GOM Planning Area;
- Five area-wide lease sales in the Western GOM Planning Area;
- One lease sale with a whaling deferral in the Beaufort Sea Planning Area;
- One lease sale with a 40-km (25-mi) buffer in the Chukchi Sea Planning Area; and
- One lease sale in Cook Inlet.

4.5.1.2 Summary of Impacts

Excluding the Eastern GOM Planning Area from the Program would reduce the number of potential lease sales in the GOM from 12 to 10, and there would be no offshore and onshore oil and gas development activities in the Eastern GOM Planning Area. As a result, none of the localized impacts (short or long term) on water quality, air quality, marine and coastal biota and habitats, or archeological or historic resources that would be associated with development in the Eastern GOM Planning Area would be expected to occur. Even under this alternative, there is still the potential for some of the Eastern GOM Planning Area resources to be affected by OCS activities in the 2012-2017 Program window since OCS exploration and development activities could be pursued under past lease sales. However, water and air quality, as well as marine and coastal biota and habitats, in some portions of the Eastern GOM Planning Area could be affected by oil and gas leasing and development in the eastern portions of the Central GOM Planning Area.

Because of the relatively small amount of development that would occur in the Eastern GOM Planning Area under the proposed action (no more than 1 installed platform, no more than 17 wells), the population, employment, and income impacts identified for the GOM under the proposed action would be only slightly reduced, and would remain largely unchanged in the other planning areas (see the cost-benefit analysis of the alternatives presented in Section 2.12). In addition, none of the net economic benefits of the proposed action to the Eastern GOM Planning Area (see Table 2.12.4-1) would be expected to occur.

Under Alternative 2, it is possible that industry may reallocate assets planned for the Eastern GOM Planning Area (where no more than two lease sales would be held under the proposed action) to the other GOM planning areas. This would either increase bidding activity on new leases or increase exploration and development activities on currently active leases. In such an event, the other GOM planning areas may see a short-term, incremental increase in oil and gas activities and associated impacts over the impacts identified for the proposed action. However, it is speculative to predict how industry may respond to the exclusion of the Eastern GOM Planning Area, and therefore equally speculative to identify environmental impacts associated with any industry response, although the pathways and nature of any such impacts would be similar to those identified for the proposed action. Given the small amount of oil and gas development (compared to the level of ongoing and potential future development in the other GOM planning areas) that may be relocated, any small incremental increases in oil and gas activities may be expected to have a similarly small incremental increase in environmental impacts, and the magnitude of the impacts would likely not differ from impacts under the proposed action. In addition, it is reasonable to assume that the mitigation and monitoring that would be required under this alternative would also apply to any new industry actions in the Central or Western GOM Planning Areas, as would any such requirements from previous 5-year leasing programs, thereby reducing the potential for any large increases in impacts from additional industry activity.

Under Alternative 2, potential impacts on natural, physical, and socioeconomic resources in Alaska would be similar in nature and general magnitude as those identified from the proposed action.

Under Alternative 2, no oil spills from oil and gas development activities under the Program would occur directly in the Eastern GOM Planning Area. However, spills from development in the other planning areas (especially a large or very large spill in the Central

Planning Area) could be carried by currents into the Eastern GOM Planning Area and affect marine and coastal resources, tourism and recreation, commercial fisheries, and local economies. Oil spills from oil and gas exploration and development activities associated with past lease sales in the Eastern GOM Planning Area could also occur. The nature and magnitude of any such impacts on those resources (as described in earlier sections of this chapter) will depend on the location, size, and duration of a spill in the other GOM planning areas.

4.5.2 Alternative 3 – Exclude the Western Planning Area for the Duration of the 2012-2017 Program

4.5.2.1 Description of Alternative 3

Under Alternative 3, no lease sales would be held in the Western Planning Area under the Program, and there would be no change from the proposed action for the other planning areas. Under Alternative 3, the following would take place:

- Five area-wide lease sales in the Central GOM Planning Area;
- One or two lease sales in the extreme western portion of the Eastern GOM Planning Area;
- One lease sale with a whaling deferral in the Beaufort Sea Planning Area;
- One lease sale with a 40-km (25-mi) buffer in the Chukchi Sea Planning Area; and
- One lease sale in Cook Inlet.

4.5.2.2 Summary of Impacts

Excluding the Western GOM Planning Area from the Program would reduce the number of potential lease sales in the GOM from 12 to 7. Under the proposed action, there could be as many as 96 platforms and 534 wells (and associated pipelines, landfalls, and onshore processing facilities) developed in the Western GOM Planning Area. Under Alternative 3, this development would not occur, and as a result none of the short- or long-term localized impacts identified for the proposed action on water quality, air quality, marine and coastal biota and habitats, archeological or historic resources, or land use and infrastructure that would be associated with development and operation of this infrastructure and support activities (such as support vessel and helicopter traffic) in the Western GOM Planning Area would be expected to occur. Even under this alternative, there is still the potential for some of the Western GOM Planning Area resources to be affected by OCS activities during the 2012-2017 Program window from OCS exploration and development activities that could be pursued under past lease sales. Under Alternative 3, a marginal decrease in new activity, relative to the proposed action, may contribute to improved ecosystem condition as a result of avoided adverse effects from potentially fewer routine activities or accidental spills. However, water and air quality, as well as marine and coastal biota and habitats, in some portions of the Western GOM Planning Area could still be affected by oil and gas leasing and development in the western portions of the Central GOM Planning Area, especially if that development uses existing commercial infrastructure (such as shipyards, support centers, processing facilities) and shipping lanes in coastal areas of the Western GOM Planning Area.

Even though a relatively large amount of development would occur in the Western GOM Planning Area under the proposed action, the increases in population, employment, and income identified to occur under the proposed action would be only slightly reduced under Alternative 3, and economic activity could increase in the other planning areas (see cost-benefit analysis of the alternatives presented in Section 2.12). In addition, none of the net economic benefits of the proposed action to the Western GOM Planning Area (see Table 2.12.4-1) would be expected to occur.

Under Alternative 3, it is possible that industry may reallocate assets planned for the Western GOM Planning Area to the other GOM planning areas and either increase bidding activity on new leases or increase exploration and development activities on currently active leases (i.e., Central GOM Planning Area is highest likelihood). If so, the other GOM planning areas may see a short-term incremental increase in oil and gas activities and associated impacts over those identified for the proposed action. However, it is somewhat speculative to predict how industry would respond to the exclusion of the Western GOM Planning Area for 5 years. Therefore, it is difficult to identify the exact environmental impacts that may occur elsewhere given any industry response, but the nature of any such impacts would be similar to those identified for the proposed action. In addition, it is reasonable to assume that the mitigation and monitoring that would be required under this alternative would also apply to any relocated industry actions in the Central or Eastern GOM Planning Areas, as would any requirements from previous 5-year leasing programs, thereby reducing the potential for any large increases in impacts from additional industry activity.

Under Alternative 3, potential impacts on natural, physical, and socioeconomic resources in Alaska would be similar in nature and general magnitude as those identified for the Alaska planning areas from the proposed action.

Under Alternative 3, no oil spills from oil and gas development activities would occur directly in the Western GOM Planning Area under the Program. However, spills that may occur under Alternative 3 from development in the other planning areas (especially large or very large spills in the Central GOM Planning Area or Eastern GOM Planning Area) could be carried by currents into the Western GOM Planning Area and affect marine and coastal resources, tourism and recreation, commercial fisheries, and local economies. Oil spills from oil and gas exploration and development activities associated with past lease sales could also occur. The nature and magnitude of any such impacts on those resources (as described in earlier sections of this chapter) will depend on the location, size, and duration of any spills in the other GOM Planning Areas.

4.5.3 Alternative 4 – Exclude the Central Planning Area for the Duration of the 2012-2017 Program

4.5.3.1 Description of Alternative 4

Under Alternative 4, no lease sales would be held in the Central Planning Area under the Program, and there would be no change from the proposed action for the other planning areas. Under Alternative 4, the following would take place:

- Five area-wide lease sales in the Western GOM Planning Area;
- One or two lease sales in the extreme western portion of the Eastern GOM Planning Area;
- One lease sale with a whaling deferral in the Beaufort Sea Planning Area;
- One lease sale with a 40-km (25-mi) buffer in the Chukchi Sea Planning Area; and
- One lease sale in Cook Inlet.

4.5.3.2 Summary of Impacts

Excluding the Central GOM Planning Area from the Program would reduce the number of potential lease sales in the GOM from 12 to 7. Under the proposed action, the greatest amount of oil and gas development in the GOM would occur in the Central GOM Planning Area, with as many as 316 platforms and 749 wells (and associated pipelines, landfalls, and onshore processing facilities). Under Alternative 4, this development would not occur, and as a result none of the localized impacts (short or long term) on water quality, air quality, marine and coastal biota and habitats, archeological or historic resources, or land use and infrastructure that would be associated with development and operation of this infrastructure and support activities (such as support vessel and helicopter traffic) in the Central GOM Planning Area would be expected to occur. Even under this alternative, there is still the potential for the same Central GOM Planning Area resources to be affected by OCS activities in the 2012-2017 Program window since OCS exploration and development activities could be pursued under past lease sales. Under this alternative, a marginal decrease in new activity, relative to the proposed action, may contribute to improved ecosystem condition as a result of avoided adverse effects from potentially fewer routine activities or accidental spills. However, water and air quality, as well as marine and coastal biota and habitats could still be affected in some portions of the Central Planning Area by oil and gas activities in portions of the Western and Eastern GOM Planning Areas that abut the Central GOM Planning Area, especially if those activities use existing commercial infrastructure (such as shipyards, support centers, processing facilities) that are located in the Central GOM Planning Area. Under this alternative, a marginal decrease in new activity, relative to the proposed action, could contribute to improved ecosystem condition as a result of avoided adverse effects from potentially fewer routine operations and accidental spills. While this alternative does not eliminate the risk of an oil spill occurring in the Central GOM during the time frame under consideration, the risk may be reduced because it effectively limits industry exploration and development to existing leases and, potentially at some point in the future, reduces overall activity levels. This could be an important consideration as environmental resources in the Central GOM recover from any persistent effects or stress caused by the DWH event. However, the potential decline in OCS activity levels would not occur immediately and may not even occur until much later in the Program window.

Under Alternative 4, potential impacts on natural, physical, and socioeconomic resources in Alaska would be similar in nature and general magnitude as identified from the proposed action.

Even with the large amount of development that could occur in the Central GOM Planning Area under the proposed action, under Alternative 4 the increases in population, employment, and income likely to occur under the proposed action would be only slightly reduced, and economic activity could increase in the other planning areas (see cost-benefit analysis of the alternatives presented in Section 2.12). In addition, none of the net economic benefits of the proposed action to the Central GOM Planning Area (see Table 2.12.4-1) would be expected to occur.

Under Alternative 4, it is possible that industry may reallocate assets planned for the Central GOM Planning Area to the other GOM planning areas where it may either increase bidding activity on new leases or increase exploration and development activities on currently active leases (Western GOM Planning Area only). In such an event, there may be a short-term incremental increase in oil and gas activities and associated impacts in the other planning areas. However, it is somewhat speculative to predict how industry would respond to the exclusion of the Central GOM Planning Area for 5 years. Therefore, it is difficult to identify the exact environmental impacts that may occur elsewhere given industry's response, but the pathways and nature of any such impacts would be similar to those identified for the proposed action. In addition, it is reasonable to assume that the mitigation and monitoring that would be required under this alternative would also apply to any new industry actions in the Western or Eastern GOM Planning Areas, as would any such requirements from previous 5-year leasing programs, thereby reducing the potential for any large increases in impacts from additional industry activity.

Under Alternative 4, no oil spills from oil and gas development activities associated with this Program would occur directly in the Central GOM Planning Area. However, spills from development in the Western or Eastern GOM Planning Areas could be carried by currents into the Central GOM Planning Area and affect marine and coastal resources, tourism and recreation, commercial fisheries, and local economies. Oil spills from oil and gas exploration and development activities associated with past lease sales could also occur. The nature and magnitude of any such impacts on those resources (as described in earlier sections of this chapter) will depend on the location, size, and duration of any spills in the other GOM planning areas.

4.5.4 Alternative 5 – Exclude the Beaufort Sea Planning Area for the Duration of the 2012-2017 Program

4.5.4.1 Description of Alternative 5

Under Alternative 5, no lease sales would be held in the Beaufort Sea Planning Area under the Program, and there would be no change from the proposed action for the other planning areas. Under Alternative 5, there would be:

- Five area-wide lease sales in the Western GOM Planning Area;
- Five area-wide lease sales in the Central GOM Planning Area;
- One or two lease sales in the extreme western portion of the Eastern GOM Planning Area;
- One lease sale with a 40-km (25-mi) buffer in the Chukchi Sea Planning Area; and
- One lease sale in Cook Inlet.

4.5.4.2 Summary of Impacts

Excluding the Beaufort Sea Planning Area from the Program would reduce the number of potential lease sales in the Arctic from 2 to 1. Under the proposed action, there could be as many as 4 platforms, 136 wells, 249 km (155 mi) of offshore pipeline, and 129 km (80 mi) of onshore pipeline developed in the Beaufort Sea Planning Area and adjacent coastal areas. Under Alternative 5 this development would not occur, and as a result none of the localized impacts (short or long term) on water quality, air quality, marine and coastal biota and habitats, archeological or historic resources, or land use and infrastructure that would be associated with development and operation of this infrastructure and any supporting activities (such as support vessel and helicopter traffic) in the Beaufort Sea Planning Area would be expected to occur. Even under this alternative, there is still the potential for the same Beaufort Sea Planning Area resources to be affected by OCS activities during the 2012-2017 Program window since OCS exploration and development activities could be pursued under past lease sales. Under this alternative, a marginal decrease in new activity, relative to the proposed action, may contribute to improved ecosystem condition as a result of avoided adverse effects from potentially fewer routine activities or accidental spills. Water quality, as well as marine and coastal biota and habitats in some portions of the Beaufort Sea Planning Area and adjacent coastal areas, could still be affected by oil and gas leasing and development in the eastern portions of the Chukchi Sea Planning Area. Any adverse impact on migrating marine mammals occurring in the Chukchi Sea Planning Area could affect not only these resources but also the success of subsistence hunters in the Beaufort Sea that rely on these resources. Under this alternative, a marginal decrease in activity, relative to the proposed action, could contribute to improved ecosystem condition as a result of avoided adverse effects to sensitive or keystone biological resources from potentially fewer routine operations or accidental spills. While this alternative does not eliminate the risk of an oil spill occurring in the Beaufort Sea during the time frame under consideration, the risk may be reduced because it effectively limits industry exploration and development to existing leases and, potentially at some point in the future, reduces overall activity levels. Similarly, this alternative may reduce the space- and time-use conflicts anticipated with subsistence activities. These are important considerations as environmental resources and human cultures in the Arctic adapt to changing climate and environmental conditions.

Under Alternative 5, the increases in population, employment, and income likely to occur under the proposed action would be only slightly reduced, and economic activity could increase in the other planning areas (see cost-benefit analysis of the alternatives presented in Section 2.12). In addition, none of the net economic benefits of the proposed action to the Beaufort Sea Planning Area (see Table 2.12.4-1) would be expected to occur.

Under Alternative 5, potential impacts on natural, physical, and socioeconomic resources in the GOM planning areas would be similar in nature and general magnitude as those identified from the proposed action.

Under Alternative 5, it is possible that industry may reallocate assets planned for the Beaufort Sea Planning Area (where a single lease sale would be held under the proposed action) to the other planning areas (and especially the Chukchi Sea Planning Area) and possibly increase bidding activity on new leases or increase exploration and development activities on currently active leases. However, it is somewhat speculative to predict how industry may respond to the exclusion of the Beaufort Sea Planning Area, making it difficult to identify environmental impacts that may occur with a given industry response. However, the pathways and nature of any such impacts would be similar to those identified for the proposed action. In addition, it is reasonable to assume that the mitigation and monitoring that would be required under this alternative for the non-deferred planning areas would also apply to any new industry actions associated with response to the exclusion of the Beaufort Sea Planning Area, as would any such requirements from previous 5-year leasing programs, thereby reducing the potential for any large increases in impacts from additional industry activity.

Under Alternative 5, no oil spills from oil and gas development activities associated with the Program would occur directly in the Beaufort Sea Planning Area. However, a spill that may occur under this alternative in the Chukchi Sea Planning Area could be carried by coastal currents into the Beaufort Sea Planning Area and affect marine and coastal resources, subsistence whaling, tourism and recreation, and local economies and communities. Oil spills from oil and gas exploration and development activities associated with past lease sales could also occur. The nature and magnitude of any such impacts on those resources (as described in earlier sections of this chapter) will depend on the location, size, and duration of a spill in the Chukchi Sea Planning Area.

4.5.5 Alternative 6 – Exclude the Chukchi Sea Planning Area for the Duration of the 2012-2017 Program

4.5.5.1 Description of Alternative 6

Under Alternative 6, no lease sales would be held in the Chukchi Sea Planning Area under the Program, and there would be no change from the proposed action for the other planning areas. Under Alternative 6, the following would take place:

- Five area-wide lease sales in the Western GOM Planning Area;
- Five area-wide lease sales in the Central GOM Planning Area;
- One or two lease sales in the extreme western portion of the Eastern GOM Planning Area;
- One lease sale with a whaling deferral in the Beaufort Sea Planning Area; and
- One lease sale in Cook Inlet.

4.5.5.2 Summary of Impacts

Excluding the Chukchi Sea Planning Area from the Program would reduce the number of potential lease sales in the Arctic from 2 to 1. Under the proposed action, there could be as many as 5 platforms, 300 wells, and 402 km (250 mi) of offshore pipeline developed in the Chukchi Sea Planning Area. Under Alternative 6, this development would not occur, and as a result none of the localized impacts (short or long term) on water quality, air quality, marine and coastal biota and habitats, archeological or historic resources, or land use and infrastructure that would be associated with development and operation of this infrastructure and any supporting activities (such as support vessel and helicopter traffic) in the Chukchi Sea Planning Area would be expected to occur. Even under this alternative, there is still the potential for the same Chukchi Sea Planning Area resources to be affected by OCS activities during the 2012-2017 Program window since OCS exploration and development activities could be pursued under past lease sales. Under this alternative, a marginal decrease in new activity, relative to the proposed action, may contribute to improved ecosystem condition as a result of avoided adverse effects from potentially fewer routine activities or accidental spills. Water quality, as well as marine and coastal biota and habitats, and land use and infrastructure in some portions of the Chukchi Sea Planning Area and adjacent coastal areas, could still be affected by oil and gas leasing and development in the western portions of the Beaufort Sea Planning Area. Any adverse impact on migrating marine mammals occurring in the Beaufort Sea Planning Area could affect not only these resources but also the success of subsistence hunters in the Chukchi Sea that rely on these resources. Under this alternative, a marginal decrease in activity, relative to the proposed action, could contribute to improved ecosystem condition as a result of avoided adverse effects to sensitive or keystone biological resources from potentially fewer routine operations or accidental spills. While this alternative does not eliminate the risk of an oil spill occurring in the Chukchi Sea during the time frame under consideration, the risk may be reduced because it effectively limits industry exploration and development to existing leases and, potentially at some point in the future, reduces overall activity levels. Similarly, this alternative may reduce the space- and time-use conflicts anticipated with subsistence activities. These are important considerations as environmental resources and human cultures in the Arctic adapt to changing climate and environmental conditions.

Under Alternative 6, the increases in population, employment, and income likely to occur under the proposed action would be only slightly reduced, and economic activity could increase in the other planning areas (see cost-benefit analysis of the alternatives presented in Section 2.12). In addition, none of the net economic benefits of the proposed action to the Chukchi Sea Planning Area (see Table 2.12.4-1) would be expected to occur.

Under Alternative 6, potential impacts on natural, physical, and socioeconomic resources in the other planning areas would be similar in nature and general magnitude as those identified from the proposed action.

Under Alternative 6, it is possible that industry may reallocate assets planned for the Chukchi Sea Planning Area (where a single lease sale would be held under the proposed action) to the other planning areas (and especially the Beaufort Sea Planning Area) and possibly increase bidding activity on new leases or increase exploration and development activities on currently active leases. However, it is speculative to predict how industry may respond to the deferral of the Chukchi Sea Planning Area, and equally speculative to identify environmental impacts associated with any industry response, although the nature of any such impacts would be similar to those identified for the proposed action. In addition, it is reasonable to assume that the mitigation and monitoring that would be required under this alternative for the non-deferred planning areas would also apply to any new industry actions associated with response to the exclusion of the Chukchi Sea Planning Area, as would any such requirements from previous 5-year leasing programs, thereby reducing the potential for any large increases in impacts from additional industry activity.

Under Alternative 6, no oil spills from oil and gas development activities under the Program would occur directly in the Chukchi Sea Planning Area. However, spills from development in the Beaufort Sea Planning Area could be carried by coastal currents into the Chukchi Sea Planning Area and affect marine and coastal resources, subsistence whaling, tourism and recreation, and local economies and communities. Oil spills from oil and gas exploration and development activities associated with past lease sales could also occur. The nature and magnitude of any such impacts on those resources (as described in earlier sections of this chapter) will depend on the location, size, and duration of a spill in the Beaufort Sea Planning Area.

4.5.6 Alternative 7 – Exclude the Cook Inlet Planning Area for the Duration of the 2012-2017 Program

4.5.6.1 Description of Alternative 7

Under Alternative 7, no lease sales would be held in the Cook Inlet Planning Area during the Program, and there would be no change from the proposed action for the other planning areas. Under Alternative 7, the following leasing activities could take place:

- Five area-wide lease sales in the Western GOM Planning Area;
- Five area-wide lease sales in the Central GOM Planning Area;
- One or two lease sales in the extreme western portion of the Eastern GOM Planning Area;
- One lease sale with a whaling deferral in the Beaufort Sea Planning Area; and
- One lease sale with a coastal deferral in the Chukchi Sea Planning Area.

4.5.6.2 Summary of Impacts

Excluding the Cook Inlet Planning Area could result in one less potential lease sale in the Alaska Region. All offshore and onshore oil and gas activities and production associated with this sale would not occur. The small amount of oil assumed to be developed under Alternative 1 in Cook Inlet would be compensated for by imported oil. It is unlikely that the additional amount of imported oil that could occur under Alternative 7 will measurably affect the number of tanker oil spills that occur in other offshore areas in the United States.

The analyses of impacts of Alternative 1, the Proposed Action, in Cook Inlet showed in almost all cases temporary and localized impacts. Any disturbance to existing environmental conditions associated with routine operations or an oil spill would be expected to be ameliorated on a time scale of days to a year or two. Under Alternative 7, these short-term localized impacts would not occur. Under the Proposed Action, no population-level impacts were predicted for biological resources, although several endangered and/or threatened bird species would be vulnerable to mortality from oil spills. A moderate to large oil spill could affect a relatively large number of Steller’s eiders, which overwinter in Cook Inlet. However, because the eider does not breed in Cook Inlet, the breeding populations would not be directly affected, although the number of eiders that arrive in the Arctic for breeding could be reduced. The endangered short-tailed albatross occurs uncommonly in Cook Inlet, so large numbers of this species would not be affected by a spill. Furthermore, the albatross breeds outside Cook Inlet, so the breeding population would not be affected during the breeding season. Kittlitz’s murrelets, a candidate for listing under the Endangered Species Act, also occur in Cook Inlet and could come in contact with spilled oil while foraging, depending on the timing and location of any spill that occurred.

Impacts on these species under Alternative 1 would be contained within the Cook Inlet area and would not extend to other planning areas in Alaska where these species also occur during different life stages or seasons. Under Alternative 7, none of these localized impacts on protected species would occur from OCS activity.

While no long-term population-level impacts on terrestrial mammals in the Cook Inlet area are expected under Alternative 1, increased mortality of brown and black bears could occur if previously remote areas were converted to industrial use, resulting in increased conflict between bears and humans. A large oil spill that affected intertidal areas could lead to significant mortality of eggs and juvenile fish of pelagic species, such as the salmon, leading to reduced adult survival. The overall fish populations in south central Alaska, however, would not be affected. A large spill could temporarily affect fisheries in the area that were contacted by the spill. While no long-term impacts on the fish populations are expected, economic impacts on commercial and recreational fisheries could result as a result of loss of gear, closings of affected areas, and unavailability of fishing areas during cleanup operations. These temporary and localized impacts in Cook Inlet, which are unlikely given the small amount of activity expected under Alternative 1, would be precluded under Alternative 7.

Impacts on air and water quality under Alternative 1 in Cook Inlet are expected to be short-term and localized because of the small amount of activity anticipated and the largely pristine quality of the air and water environments there. Therefore, Alternative 7 will not result in a major difference from Alternative 1 for these resources.

The analysis of archaeological resources indicated that existing BOEM requirements for archaeological surveys would be expected to eliminate most of the possible impacts on historic and prehistoric resources. Impacts were possible from cleanup operations after an oil spill. Given the small amount of liquid hydrocarbons expected to be produced under Alternative 1 in Cook Inlet, compounded with the requirement that the spill would have to contact areas with historic or prehistoric resources for impacts to occur, Alternative 7 is not expected to result in a significant difference from Alternative 1 with regard to the potential for archaeological resource impacts.

The population, employment, and income impacts anticipated under Alternative 1 in the Cook Inlet area would not occur under Alternative 7. Table 4.4.9-2 shows estimates of 4,520 jobs and $152 million in income resulting from Alternative 1 in the Cook Inlet area during the life of the Program. See Section 2.12 for a discussion of a cost-benefit analysis of the alternatives. In addition, none of the net economic benefits of the proposed action to the Cook Inlet Planning Area (see Table 2.12.4-1) would be expected to occur.

Under Alternative 7, it is possible that industry may reallocate assets planned for the Cook Inlet Planning Area (where a single lease sale would be held under the proposed action but only at industry request) to the other planning areas and possibly increase bidding activity on new leases or increase exploration and development activities on currently active leases. However, it is speculative to predict how industry may respond to the exclusion of the Cook Inlet Planning Area, making it difficult to identify environmental impacts associated with any industry response. However, the pathways and nature of any such impacts would be similar to those identified for the proposed action. In addition, it is reasonable to assume that the mitigation and monitoring that would be required under this alternative for the non-deferred planning areas would also apply to any new industry actions associated with response to the exclusion of the Cook Inlet Planning Area, as would any such requirements from previous 5-year leasing programs, thereby reducing the potential for any large increases in impacts from additional industry activity.

4.5.7 Alternative 8 – No Action

The National Environmental Policy Act requires consideration of a No Action Alternative to every major Federal action that could result in significant impacts on the environment. In the context of the Program, the No Action Alternative is defined as the scenario in which BOEM holds no OCS oil and gas lease sales during the Program. Under this scenario, none of the potential environmental impacts associated with oil and gas related activities under the proposed action that have been evaluated in Section 4.4 would occur. These precluded impacts would include both the anticipated effects under the proposed action of routine operations and accidental discharges on ecological conditions and the effects of leasing on regional employment, regional income, and sociocultural stability. In addition, the oil and natural gas that would have been produced as a consequence of sales over the 5-yr program period would not be available to consumers, who would therefore need to obtain energy from other sources. The energy substitutes needed to replace the lost OCS production would be associated with their own potential environmental effects that could occur throughout the United States or the world depending on the mix of specific energy substitutes that would be used. The analysis that follows considers these factors to evaluate the overall effects of implementing the No Action Alternative. Information is first presented on the various uses of energy in the economy and on the current and projected uses of oil and gas compared to other fuel or alternate energy sources in each economic sector. Substantial discussions of the current status and projected developments in alternate energy sources for each sector of the economy are provided. A scenario of energy substitutes is then developed that projects the mix of energy substitutes that would be used to replace lost OCS production during the life of the program. This scenario is used to evaluate the anticipated broad effects of implementing the No Action Alternative in each program area as well as in other areas that could be affected by the energy substitutes used to replace lost OCS production.

4.5.7.1 Oil and Gas Uses and Alternatives

The information in this section has been taken from BOEM's Energy Alternatives and Environment report. The Energy Alternatives and Environment report was updated since the publication of the Draft PEIS and includes discussions of near and long-term outlooks for various potential energy substitutes. Part of the report has been inserted into this section as the basis for the discussion of outlooks for energy in the Final PEIS. The full report is available for download from the BOEM Web site.

4.5.7.1.1 Transportation Sector. Total energy use in the transportation sector has grown by an average of just over 1 percent per year over the last 20 years. As of 2010, the transportation sector accounted for an estimated 28 percent of all energy consumption in the United States, a proportion that has been slowly rising since the 1960s. The vast majority of this energy has come from oil. Nearly three fourths of all petroleum consumed in the United States in 2010, was used for transportation, with natural gas, electricity, and other alternatives playing much smaller roles (EIA 2010d). In this section, we discuss recent trends in the use of oil and gas in the transportation sector and the near- and long-term potential for substitutes to these energy sources. These discussions provide a current snapshot of the various Federal policies and technological advancements that are likely to affect future fuel consumption trends in the United States. BOEM welcomes comments and feedback from the other Federal agencies on our discussions of their programs and policies.

Current Use of Oil and Gas.

Ground Travel. Oil is the dominant energy source for ground travel, which consumed approximately 136 billion gallons of motor gasoline and 42 billion gallons of diesel fuel in 2010. Growth in consumption was slow but steady during the mid-2000s economic expansion, averaging about one percent per year from 2003 to 2007 (EIA 2007a). However, motor gasoline use fell by about three percent from 2007 to 2008, the first time that total annual consumption has fallen since the 1988 to 1991 period. Consumption remained flat from 2008 to 2010 (EIA 2010e).

This mid-2000s growth trend was attributable to several factors. Growth in the U.S. population, averaging just under one percent per year, resulted in approximately three million potential new vehicle drivers annually (USCB 2009). Meanwhile, the number of highway vehicles grew even faster, at a rate of nearly four million vehicles per year from 2003 to 2007. At the end of 2007, 254 million registered highway vehicles were in use in the United States, one for every 1.19 people. The growth in the number of vehicles has been realized entirely in the light truck segment, as the number of passenger cars has remained more or less constant (USDOT 2009b). The subsequent flat growth in fuel consumption follows the general trend of fuel consumption declining during periods of economic recession and/or high gasoline prices.

After 20 years of steady increase, the average number of miles driven per vehicle peaked at 12,211 per year in 1998 and stayed more or less at that level until 2007 when it began to decline (EIA 2010f). The average fuel efficiency of all vehicles on the road improved only minimally over that time period. The trend towards increased efficiency will accelerate in the future, as the fuel efficiency of *new* vehicles has been increasing in recent years. New fuel efficiency and greenhouse gas pollution standards, announced in July 2011, will increase the minimum fleetwide average for manufacturers of cars and light trucks to 54.5 miles per gallon (MPG) for model years 2017 through 2025, which is expected to reduce oil consumption by almost 34 billion gallons per year by 2025 (USEPA 2011t). In addition, the new Heavy-Duty National Program, recently announced by the U.S. Environmental Protection Agency (USEPA) and Department of Transportation (USDOT) will reduce fuel consumption by large trucks and buses, further reducing overall ground transportation fuel use (USEPA 2011u).

The use of natural gas as a vehicle fuel in both compressed and liquid forms has increased in recent years, with an average annual growth rate of 8.3 percent from 2006 to 2010 (EIA 2010g). However, natural gas still represents a small fraction of total vehicle fuel consumption, at just over 225 million gallons of gasoline-equivalent in 2009, or slightly more than one percent of total vehicle fuel use (EIA 2011d). In 2009, approximately 117,000 natural gas-fueled vehicles were in use, many of which were buses and other fleet vehicles (EIA 2011d).

Ethanol, as a gasoline additive, makes up the majority of alternative fuel currently in use; consumption increased from 2.8 billion gallons gasoline-equivalent in 2005 to 7.3 billion gallons in 2009. As a primary fuel (i.e., in a blend that is at least 85 percent ethanol), ethanol consumption increased from 38 million gallons of gasoline-equivalent in 2005 to just over 71 million gallons in 2009. Biodiesel use rose even more quickly over that period, but remains relatively modest overall at 325 million gasoline-equivalent gallons. Electricity, hydrogen, and other fuels contributed very little; electricity use for vehicle transportation actually declined slightly over this period (EIA 2011d).

Table 4.5.7-1 summarizes the trends in the consumption of vehicle fuels and in the number of alternative fuel vehicles in recent years.

Air Travel. Certificated U.S. air carriers used 17.3 billion gallons of fuel in 2010, 6.4 percent of the total energy consumed by the U.S. transportation sector (USDOT 2011d). Until 2007, fuel use for air travel was rising faster than use for ground travel. Total consumption rose by 4.6 percent per year from 2003 to 2007 before falling in 2008 through 2010 (USDOT 2011d), indicating a strong linkage to larger economic factors. Petroleum-derived, kerosene-style jet fuel accounts for nearly all of the fuel used for air travel.

TABLE 4.5.7-1 Estimated Consumption of Vehicle Fuels and Number of Alternative Fueled Vehicles in the United States, 2009

	Consumption (1,000 gasoline-equivalent gallons)			
Fuel	2005	2009	Percent Annual Growth	Alternative-Fuel Vehicles, 2009
Ethanol in gasohol	2,765,663	7,343,133	27.65	
Biodiesel	93,281	325,102	36.63	
Natural gas (CNG and LNG)	189,287	225,175	4.44	117,446
Ethanol, 85% (E85)	38,074	71,213	16.95	504,297
Electricity	5,219	4,956	–1.28	57,185
Hydrogen	25	140	53.83	
Total Alternative Fuels	3,091,549	7,969,719	26.71	

Source: EIA 2011d.

Marine Travel. Marine travel accounts for a relatively small proportion of total oil consumption in the transportation sector and, as with air travel, does not consume any natural gas. Total fuel consumption for marine travel was about 997 trillion Btu in 2009, roughly three-fifths the amount used by air travel and four percent of the total for the sector. Marine travel employs a mix of fuels. Residual fuel oil makes up about 70 percent of oil use, while distillate/diesel fuel oil and gasoline each account for about 15 percent. This mix has remained generally consistent over time (USDOT 2011e).

As summarized in Table 4.5.7-2, total oil consumption for marine travel has shown no clear trend over time, with periods of sharp declines following years of growth, and vice versa. After dropping by nearly 30 percent from 2000 to 2003, fuel use increased nearly as dramatically to reach comparable levels by 2007. Consumption decreased from 2007 to 2009. Like other fuels, general consumption trends follow the general economic trend.

Rail Travel. Similar to marine travel, rail travel comprises a small proportion of total oil consumption and virtually no natural gas consumption. Total oil use was 454 trillion Btu in 2009. The overwhelming majority of this was for freight, rather than passenger, transport. Distillate and diesel are the primary fuels used with electricity accounting for only two trillion Btu out of the total (USDOT 2011e). Following a low of 414 trillion Btu in 1990, oil consumption for rail transportation grew steadily to 594 trillion Btu in 2006, before falling to 454 trillion Btu in 2009 (USDOT 2011e).

Near-Term Market Analysis of Substitutes. This section analyzes the near-term potential for substitution away from oil and gas in the transportation sector, either through efficiency measures or through the use of alternative fuel sources. Due to the nature of the equipment involved, the focus is solely on ground transportation. Options for oil and gas substitutes in air travel will be discussed in the longer-term analysis in Section 3.3. Due to their relatively small contributions to oil and gas consumption, we do not consider substitution in the marine or rail travel sectors, except insofar as rail-based mass transit could provide a substitute for automobiles in the long run.

With the exception of flex-fuel vehicles, which operate using either gasoline or ethanol without any modifications, and the capacity of diesel vehicles to use biodiesel with relatively modest engine adjustments, most automobiles are locked into using the single fuel type for which they were originally designed. This means that, barring a major shift in driving patterns, the potential for changes in oil and gas consumption for transportation will be determined by changes in the composition of the vehicle fleet. Based on sales and registration data, the average lifespan of a passenger vehicle is approximately 14 years. Recent data suggest this may be on an upward trend, but since new vehicle sales are generally tied to the health of the overall economy, these data are not sufficient to indicate a long-term trend (USDOT 2009b,c). With a 14-year average lifespan, we can expect roughly 82 million vehicles, mostly from the late 1990s and early 2000s, to be retired in the next five years, with around 83.7 million new vehicles replacing them, assuming population growth and vehicle ownership per capita trends continue. We will use these rough estimates to establish the magnitude of the impact of various oil and gas substituting technologies below. It is important to note that in the following section and throughout this analysis, efficiency is considered a ‘substitute’ energy source; thus, much of the

TABLE 4.5.7-2 Energy Consumption for Marine Travel, 1980-2009 (trillion Btu)

	1980	1985	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Residual fuel oil	1,340	687	947	881	960	810	726	580	702	775	861	947	758	680
Distillate/diesel fuel oil	205	236	286	324	314	284	288	307	297	278	264	267	165	176
Gasoline	132	132	163	133	141	124	135	138	126	158	155	153	142	141
Total	1,677	1,054	1,396	1,338	1,415	1,218	1,149	1,025	1,125	1,211	1,280	1,367	1,065	997
Percent annual change	14.52	–8.86	5.77	–0.84	5.05	–13.92	–5.67	–10.79	9.76	7.64	5.70	6.80	–22.09	–6.38

Source: USDOT 2011e.

potential for a shift away from oil and gas use relies on technologies that continue to use these fuels, albeit in smaller quantities per vehicle mile traveled.

More Efficient Vehicles. Based on recent trends, it is possible to develop a rough estimate of the number of new vehicles expected to come into use over the next five years. Since 2000, the U.S. population has grown by an average of just under one percent per year. Over that timeframe, passenger cars and light trucks per capita has fallen by 0.7 percent annually. Considering these forces together, one can expect a net addition of 1.7 million new cars and trucks from 2011 to 2015. However, this does not tell the whole story. After accounting for 82 million vehicle retirements over that time, assuming an average lifespan of 14 years, we can assume that 83.7 million new cars and trucks will be purchased over that time, of which about half will be trucks and half passenger cars.

In the near term, the efficiency of the U.S. vehicle fleet is likely to be determined more by stricter regulatory requirements than by a demand pull from consumers for yet-more efficient vehicles. The corporate average fuel economy (CAFE) standards through model year 2010 stood at 27.5 MPG for passenger cars and 23.1 MPG for light trucks. Building on requirements in the 2007 Energy Policy Act, USEPA and USDOT have jointly established stricter targets, setting a schedule that steadily raises the requirements to an end point equivalent to of 35.7 MPG for cars and 28.6 MPG for light trucks for model year 2012-2016 vehicles. The new vehicles subject to these limits will replace older, retired vehicles manufactured in the late 1990s and early 2000s, whose fuel efficiency was about eight MPG lower on average. This is equivalent to a 23 percent savings in fuel use for passenger cars, or a 28 percent savings for light trucks. If we hold the number of miles driven per vehicle steady at the relatively high 2007 levels, we can expect to be close to an upper bound of expected total savings of 12.3 billion gallons of gasoline per year by 2015, as a result of the stricter vehicle standards. Recently announced stricter fuel efficiency and greenhouse gas pollution standards for model years 2017-2025 require 54.5 MPG fleetwide average and have been estimated to reduce oil consumption by 2.2 million barrels per day or approximately 33 billion gallons per year by 2025 (USEPA 2011t).

Hybrid Vehicles. Hybrid-electric vehicles are by now a familiar presence on U.S. roads. Powered by gasoline, hybrid vehicles can produce significant efficiency gains by using "regenerative braking" (recapturing the energy given off when a car brakes by charging a supplemental electric battery). However, by 2010, following the economic downturn that began in 2008, the sale of hybrids into the U.S. market had dropped by more than 20 percent from its 2007 peak (USDOT 2011f). Plug-in hybrids, whose batteries can be charged through electrical grid connections, entered the U.S. passenger vehicle market in 2010.

Hybrids attract attention because of their high fuel efficiency. However, it is important to note, that these gains are not necessarily additional to the savings noted above under fuel efficiency and greenhouse gas pollution standards, since hybrids would constitute a portion of the efficiency gains required under those regulations. Hybrids may be a promising technology for manufacturers to achieve fuel efficiency and greenhouse gas pollution standards. For instance, the Toyota Prius, by far the most popular hybrid in the United States, gets an estimated average 50 MPG. This compares favorably to a number of important benchmarks, including the 2008 average passenger car efficiency of 22.6 MPG, the average new car efficiency of 32.6, and the 2010 CAFE standard of 27.5 MPG (USDOT 2011g). Of course, not all hybrids match the Prius for fuel efficiency, particularly some of the hybrid sport utility vehicles on the market. Perhaps a more useful point of comparison would be the Toyota Camry hybrid, which, at 41 MPG, represents a 46 percent improvement over the conventional Camry (USDOE 2012a). Projecting this 46 percent improvement to all hybrid vehicles implies an upper bound for total oil savings of about 240 gallons per vehicle per year, based on 2008 average consumption of 522 gallons per passenger vehicle (EIA 2011e).

Electric and Plug-in Hybrid Vehicles. All-electric vehicles, rather than using gasoline, typically run on batteries, which need to be charged on a regular basis. Most users charge electric cars every night through a connection to the electric grid or an off-grid power source. Instead of an internal combustion engine, such vehicles make use of an electric motor. Many of the mechanical parts of a conventional engine are thus eliminated or replaced with electronic components. On a daily basis, the operating cost of an electric vehicle is generally lower than a typical vehicle, due to reduced fuel and maintenance costs. At present, however, the adoption of such vehicles is hindered by their limited range and by the current state of battery technology, among other factors. Many electric vehicles can travel only 50 to 100 miles on a single charge and the batteries used are heavy, expensive, and need to be replaced every few years. Plug-in hybrids, which do not face the same range limitations, are more likely to be widely adopted by consumers over the near term, especially as battery technology improves and costs decrease.

President Obama has proposed aggressive policies to promote electric cars in the U.S. with the goal of one million electric vehicles by 2015 (USDOE 2011a). Certain automakers are investing heavily in electric cars. In particular, Nissan began selling its first all-electric car, the Leaf, in late 2010 in the United States, Japan and Europe. Chevrolet also released the Volt in late 2010, which is an all-electric car with a range-extending gasoline generator. Ford will begin selling an electric version of the Focus starting in 2012, with initial production goals of 5,000 to 10,000 vehicles per year (Motavalli 2010a). The electric sports car manufacturer, Tesla, is planning greater production capacity for its new Model S, projecting 20,000 vehicles per year in 2012 (Nauman 2008). Other manufacturers have all-electric vehicles in the development phase, or for sale in other countries but not in the United States.

President Obama's objective of at least one million electric vehicles by 2015 would represent approximately 0.7 percent of the total U.S. vehicle fleet. If this goal is met, then electric cars will comprise about 0.7 percent of the total fleet. Consequently, the near-term impact of all-electric vehicles on oil consumption may be modest, especially since the early adopters of these vehicles are likely to be drivers who travel relatively short distances (USDOT 2011h). As in the case of pure hybrid gains, the efficiency gains may not necessarily be greater than the fuel efficiency and greenhouse gas pollution standards, but electric cars may be the technology chosen to achieve the fuel efficiency and greenhouse gas pollution standards.

It is important to note the environmental consequences of shifting from gasoline to electricity as a fuel source for vehicles. In simple terms of energy used, due to efficiency gains allowed by design differences, electric vehicles represent a significant improvement over gasoline vehicles. The Nissan Leaf, with a 24-kWh battery, can travel 73 mi on a single charge, with a fuel economy equivalent to 99 MPG of gasoline (USDOE 2012b). Electric vehicles, therefore, produce environmental benefits by eliminating fossil fuel combustion and the associated tailpipe emissions of SO_2, NO_x, particulate matter, and greenhouse gases. However, these benefits are offset by increased emissions from electricity generation at power plants. The extent of these offsetting impacts will be determined by the electricity fuel sources used, which varies in different regions across the country. In the Pacific Northwest, which has a high proportion of hydropower, the net impact of electric vehicles may be positive. However, in areas where coal (which is more greenhouse gas-intensive than oil and can emit high levels of SO_2, NO_x, and particulate matter) is the dominant fuel source, the overall effect may be modestly beneficial or harmful. Areas in the immediate vicinity of coal-fired power plants may incur substantially worse air and water quality. Similarly, replacing oil fuel in cars with electricity from nuclear power plants could lead to increased production of radioactive waste, which if improperly transported or disposed could pose serious health hazards. The substitution of renewable energy as a source of baseload power (e.g., through the development of utility-scale wind, solar, biomass, and geothermal resources), would mitigate the negative impact of increased reliance on electric vehicles.

Ethanol Vehicles. Ethanol is a form of alcohol, of the type found in alcoholic beverages. As a hydrocarbon, it can also be used as an energy carrier and it has been used as a fuel source or additive for vehicles for several years. Most ethanol used for fuel in the United States is derived from corn, although in other countries, such as Brazil, sugar cane is a more popular and more efficient feedstock.

In the United States, ethanol is used primarily as an additive to gasoline. Several States mandate or subsidize ethanol blends in the range of 5 to 15 percent. Less frequently, ethanol is used as the primary fuel, either as an 85/15 blend with gasoline or in pure (neat) form. While all gasoline-powered vehicles can use ethanol in small amounts, higher concentrations require modifications. Flex-fuel vehicles can use any mixture of gasoline and ethanol or, in some cases, natural gas. Nearly eight million flex-fuel vehicles are currently in use in the United States; however, many owners may be unaware that their vehicle has this capability (USDOE 2010).

In the near term, ethanol use is likely to be determined largely by policy requirements. Most notably, the Renewable Fuel Standard, as revised through the Energy Independence and Security Act of 2007, requires an increase from nine billion gallons of ethanol and other renewable fuels in 2008 to 36 billion in 2022. USEPA has established interim targets of 12.95 billion gallons in 2010 and 20.5 billion gallons in 2015 (USEPA 2010a), more than 10% of 2008 levels of total oil consumption for transportation. Assuming this goal remains in force, the 7.5 billion gallon increase in biofuels over this time period should offset about five billion gallons of gasoline per year by 2015, taking into account ethanol's considerably lower energy density compared to gasoline (USDOE undated).

The impacts on land use and food prices from such a large increase in corn production for ethanol may be significant. These will be considered below, when we evaluate the longer-term potential for oil and gas substitutes in the transportation sector.

Public Transportation. For people living in urban areas, public transportation can provide a substitute for automobiles, especially for purposes of commuting to work or school.

While many people live in areas that are not well served by public transportation, or do not have public transportation options that meet their particular needs, for others it is a viable option even within the existing transportation infrastructure. Upwards of 65 million people live in the 10 urban areas with the highest transit usage and many more live in other transit-serviced areas. As of December 31, 2009, 7,200 separate public transportation service systems were operating in the United States. Of this total, approximately 5,200 were classified as paratransit, or transportation for elderly and disabled persons that does not follow fixed routes or schedules (APTA 2011).

Due in part to high oil prices, transit usage reached an all-time high in 2008, with ridership declining slightly in 2009 (APTA 2011). Seventy percent of trips taken on public transportation were for travel to work or school. A similar proportion of riders used public transportation five or more days per week. However, only about five percent of workers nationwide used public transportation to commute to work on a regular basis (APTA 2011). We can conclude, then, that the greatest potential for increased use of public transportation exists among commuters who currently drive to work.

The extent of oil and gas savings from using public transportation instead of automobiles is dependent on a number of factors, including but not limited to the mode of public transportation used and its fuel source, the distances involved, and the fuel use characteristics of users' automobiles. In general, it is safe to conclude that due to the inherent efficiencies in transporting large numbers of people at once, public transportation usage reduces oil and gas consumption, even for those modes of travel such as most buses that rely on fossil fuels. The American Public Transportation Association (APTA) cites data from two major reports on the topic, showing that for a typical year, using public transportation produced direct energy savings equivalent to 420 million gallons of gasoline, plus an additional 340 million gallons from avoided congestion. An even larger amount, 3.4 billion gallons, was saved due to reduced travel distances caused by public transportation-related location decisions.[22]

It is difficult to estimate the extent to which increased reliance on public transportation in place of automobiles could reduce consumption of oil and gas in the near term. Aggregated data on the utilization rate of the Nation's public transportation infrastructure (that is, the proportion of the capacity in place that is already being used, the complement to which is the proportion that could be used to accommodate increased ridership without requiring additional investment) are not readily available. Nor is it clear how many Americans who do not currently use public transportation on a regular basis could choose to do so without moving or changing their place of work.

One method to estimate the benefits of increased public transportation on energy use is to assume a continuation of the growth trend in transit use from 2004-2008. In 2009 growth did not

[22] Note that this is energy savings, not oil savings. Public transportation vehicles powered by electricity would be using some electricity generated from oil and gas, but would also presumably be relying on large amounts of coal, hydropower, and nuclear power as their underlying primary energy sources. Thus, the oil and gas savings of public transportation are likely to be even larger than these numbers would suggest.

continue, but it is not clear if this is a change in trend or a short term dip (APTA 2011). The APTA cites the U.S. Census Bureau's American Community Survey, which reports that 4.57% of workers used public transportation as their primary means of travel to work in 2004, rising to 5.01% by 2008 (APTA 2011). This translates into an increase of about 0.11% of the overall working population per year. Data from the intervening years show that the increase was essentially linear. If this trend were to continue, 5.78% of all workers would be relying primarily on public transportation by 2015. Accounting for population growth of about one percent per year, this rate of increase would imply an additional 1.7 million regular public transportation users by 2015 over 2008 levels, an increase equivalent to 23.5 percent of 2008 transit-using commuters. If we assume that non-school and work trips remain constant, that would translate into a 16.5% increase in total transit trips. Based on the nationwide totals highlighted above, such an increase would produce an incremental energy savings of 125 million gallons of gasoline equivalent (assuming there are no new indirect savings from location decisions in this timeframe).

Long-Term Market Analysis of Substitutes. This section analyzes the long-term potential for substitution away from fossil fuels. The focus is primarily on ground transportation, which could demonstrate lower fuel consumption through efficiency improvements, a shift toward greater use of public transportation, or use of alternative fuels. This section also includes a discussion on the potential for oil substitution in air travel through both efficiency improvements and fuel switching.

More Efficient Vehicles. As noted above, automobiles in the United States currently have a lifespan of about 14 years. While some individual vehicles will remain in use for a longer period of time, we assume that the Nation's fleet will have turned over nearly in its entirety within 20 years. As of 2009, more than 254 million highway vehicles were registered in the United States, of which 194 million were light duty vehicles and 7.9 million were motorcycles. The remainder comprise other vehicle types, primarily trucks, vans, and larger SUVs). Population growth may add more vehicles, outpacing any decrease in vehicles per capita (USDOT 2012a). As recognized in the new fuel efficiency and greenhouse gas pollution standards, there is huge potential for oil reductions through efficiency improvements in the Nation's automobiles. As mentioned previously, the fuel efficiency and greenhouse gas pollution standards may create incentives for the deployment of the following technologies. Since natural gas currently accounts for such a small proportion of fuel used for transportation, we do not consider it further.

Hybrid Vehicles. Hybrid vehicles are already fairly well-established, with all of the major automakers now mass-producing hybrid models. While hybrids will remain somewhat more expensive than conventional cars in terms of the upfront cost, the premium will likely fall as technology improves and manufacturers continue to scale up production. With sufficiently strong tax incentives or other forms of policy support, hybrids could theoretically replace conventional automobiles entirely.

The calculations performed earlier can be repeated to illustrate the potential scale of the impacts such a shift would entail. If population growth continues at its current pace, there will be about 393 million people in the United States in 2035, likely translating into roughly

300 million vehicles. Projecting a 40 percent savings per vehicle, based on the hybrid and traditional Toyota Camry models, would imply a total savings of 65 billion gallons of gasoline, more than one-fourth of total current consumption for ground transportation. While this is a very rough, illustrative figure, it nonetheless shows that hybrid vehicles have the potential to offset a significant fraction of oil use. Other types of fuel efficiency improvements, such as switching from trucks to cars or using more lightweight materials, would offer additional gains.

Electric and Plug-in Hybrid Vehicles. The key to future rates of adoption of electric vehicles and plug-in hybrids are the batteries used to replace, in whole or in part, the gasoline-powered combustion engine. Both plug-in hybrids and electric vehicles currently use lithium-ion batteries. Most conventional hybrids use nickel-metal hydride technology, but are expected to switch over to lithium-ion batteries as well (Pike Research 2009). Within the broad characterization of lithium ion batteries are several different subtypes, each of which can be evaluated on six basic criteria: energy storage capacity, power, safety, performance, life span, and cost. Significantly, none of the battery types currently in use performs well across all six criteria. As a result, the Boston Consulting Group concluded that absent a major breakthrough, fully electric vehicles that are as convenient as conventional cars will likely not be available before 2020 (Boston Consulting Group 2010).

Similarly, a report from the National Research Council (NRC) explored the prospects for plug-in hybrid vehicles by 2030. The NRC estimates that under optimistic assumptions the maximum number of plug-in electric vehicles on the road at that time would be 40 million. Cost and convenience factors suggest that 13 million may be more likely. The NRC did not anticipate significant cost improvements in lithium-ion batteries in the foreseeable future (NRC 2010).

Given this outlook, the impact of plug-in hybrid and electric vehicles is likely to be comparatively modest, even over a fairly long 25-year horizon. Plug-in hybrids use 20 to 55 percent less gasoline than traditional hybrids, depending on the mix of electricity and gasoline used (NRC 2010). Electric vehicles, of course, use no oil at all. The existence of 40 million plug-in hybrids, matching the high estimate from the NRC, would imply a savings of about 12 billion gallons of gasoline per year. While the NRC report did not consider all-electric vehicles, a similar number of electric vehicles (a very aggressive assumption) would save about 22 billion gallons of gasoline per year. The more likely figure of 13 million vehicles would produce savings of four to seven billion gallons.

Ethanol Vehicles. Perhaps the single most important factor influencing the long-term adoption of ethanol is the cost of producing cellulosic ethanol. Unlike traditional corn- or sugar-based ethanol, which is derived from starch, cellulosic ethanol uses cellulose as its basis, a structural component of plant cell walls and the most common organic compound on earth. A cost-effective method to produce cellulosic ethanol would allow for the use of a wide variety of feedstocks, including inedible crop residues and plants that grow on marginal agricultural land with little or no active cultivation. This would in turn enable far greater use of ethanol as a substitute for petroleum-based fuel.

At this time, cellulosic ethanol production is too expensive to justify large-scale use, due largely to the cost of producing enzymes to convert cellulose into a useable form. However, many observers expect significant cost reductions in the coming years. An early bellwether may be Novozymes, the world's largest manufacturer of industrial enzymes, which announced in February 2010, that it was launching a line of enzymes that it expects will lower overall production costs to under $2 a gallon, a cost that is in line with those for corn-based ethanol and gasoline (Leber 2010; Motavalli 2010b). In April 2011, construction started on a plant expected to produce 13 million gallons of cellulosic ethanol annually (Novozymes Bioenergy 2012).

If ethanol production costs fall below those of petroleum, further policy support may be unnecessary, as ethanol may become the preferred transportation fuel. Failing this, however, energy policy could play a major role in determining future levels of ethanol use. As noted above, the Energy Independence and Security Act mandates the use of 36 billion gallons of ethanol in 2022, of which 16 billion is intended to be cellulosic ethanol (USEPA 2010a).

Another important consideration is the availability of sufficient agricultural capacity to support substantially greater reliance on biofuels without causing an unacceptable rise in the price of basic foods (due to upward pressure on demand for agricultural land). A 2005 joint report by the U.S. Departments of Energy and Agriculture examined the feasibility of displacing 30 percent of the country's petroleum consumption with biomass-based energy, which the authors estimated would require dry biomass potential of about one billion tons per year. That report identified the potential for 368 million dry tons biomass potential per year from forestlands and 998 million dry tons biomass potential from agricultural lands, with "relatively modest changes in land use and agricultural and forestry practices." Agricultural biomass would comprise a mix of crop residues, grains for biofuels, process residues, and dedicated perennial crops. Not all of this would be suitable for conversion to liquid fuels for transportation. Nonetheless, the report makes clear that the country has the productive capacity to meet a portion, but not all, of its transportation fuel demand from biofuels (USDOE and USDA 2005). In addition to estimating the potential capacity of biofuels, a follow up report has estimated capacity at different price ranges, which broadens the potential capacity range from well below to well above the 2005 estimate (USDOE and USDA 2011).

The USDOE/USDA 2005 study cited above noted several potential environmental impacts from increased use of forest and agricultural land for biofuel production.

- Increase logging could result in greater soil erosion and elevated levels of sediment in surface waters.

- Removing crop residues could reduce soil quality, increase erosion, and release carbon from the soil into the atmosphere.

- In addition, removing the nutrients embodied in crop residues could lead to increased fertilizer use, leading to increased nutrients in water runoff and greater use of fossil fuels for fertilizer manufacture (USDOE and USDA 2011).

Furthermore, agriculture is relatively fuel-intensive. Reliance on petroleum to power machinery and equipment and to manufacture fertilizers and other inputs could offset much of the potential for biofuels to reduce overall petroleum consumption. Cellulosic ethanol is expected to have a more favorable life-cycle profile than corn ethanol, but it will nonetheless be unable to reduce petroleum consumption on a one-to-one basis.

Overall, if cellulosic ethanol becomes cost-competitive with other liquid fuel sources and/or it is given sufficiently strong policy support, it may displace a significant amount of petroleum in the long term, possibly approaching 30 percent of total consumption.

Public Transportation. In the short term, cities that have established public transportation systems could see increased ridership on their existing routes. To expand the impact of public transportation over the longer term, cities could build new mass transit systems or expand existing systems, thereby allowing residents to reduce their use of gasoline-fueled automobiles. While no firm rules exist regarding the time needed to develop new systems, anecdotal information from cities that have recently created or expanded their transit networks is instructive.

- Houston voters approved a transit referendum involving light rail in 1988, but due to opposition by key lawmakers, it was not until March 2001 that construction started on the city’s METRORail system. It opened in January 2004.

- The Metro Light Rail system in Phoenix was created in the city’s 2000 Regional Transit Plan. Construction began in March 2005, and the system started operations in December 2008.

- Denver has had light rail since 1994, but recently completed a major expansion. A 1995 congestion study ultimately led to a major highway and light rail expansion project known as T-REX. Construction began in October 2001 and was completed in November 2006.

These experiences suggest that a 10- to 15-year time horizon should generally be sufficient for large cities to create or expand light rail systems. Bus-based systems could presumably be implemented in much shorter timeframes.

It is difficult to predict which cities that currently lack light rail or tram service would be most likely to add such systems, but the most populous metropolitan areas that do not currently have light rail or tram service would seem to be likely targets. These include:

- Austin, TX

- San Antonio, TX

- Cincinnati, OH

- Columbus, OH

- Kansas City, MO
- Las Vegas, NV
- Orlando, FL.

These metropolitan areas had an estimated combined population of 13.8 million as of July 2009, approximately 4.5 percent of the U.S. population (USCB 2010). The extent to which new public transit networks in these or other cities could reduce automobile use would depend on the extent of the systems, the frequency of service, and residents' driving habits. To illustrate the potential magnitude of the effect, however, if 10 percent of the residents of those cities switched from automobiles to public transit for commuting purposes, it would mean an 18.7 percent increase in total nationwide transit use. This would save the energy equivalent of approximately 142 million gallons of gasoline, about one percent of current consumption for ground-based travel.[23] It is important to note, however, that by influencing patterns of urban development, the development of light rail systems could have a substantially greater impact over the span of decades. The APTA study cited above estimates that the indirect oil savings from public transportation due to location effects were more than four times greater than the direct savings from substituting for individual automobile trips (APTA 2011).

Hydrogen and Fuel Cell Vehicles. The advantages of hydrogen gas as a transportation fuel include its abundance as an element, its density as an energy carrier, and its lack of harmful emissions. However, since its gas form is too rare to be collected, it must be created from water, making hydrogen more like a battery than a traditional fuel. In vehicles, hydrogen gas can be used in two different ways: for burning in an internal combustion engine or in a chemical reaction in a fuel cell. The focus of this section is on the latter, which has the potential for greater efficiency. Fuel cells work by separating a chemical fuel, such as hydrogen, into negatively charged electrons and positively charged ions. The electrons are forced through a wire to create an electrical current that powers the vehicle. The electrons are then reunited with the ions and oxygen to form pure water. Since there are no moving parts, fuel cells are reliable and can remain operational for a long time.

Although hydrogen is one of the most abundant elements on earth, it occurs only rarely in pure elemental form. Hydrogen for fuel must be gathered from another source. Currently, 95 percent of the hydrogen used in the United States is produced through steam reforming of natural gas, in which high-pressure steam reacts with methane to produce hydrogen, carbon monoxide, and a small amount of carbon dioxide (EERE 2008). A potentially more environmentally friendly, more expensive, alternative is to split water molecules into hydrogen and oxygen through the process of hydrolysis. Since hydrolysis is powered by electricity, renewable power sources, such as wind or solar, could theoretically be used to produce the hydrogen needed to fuel vehicles.

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[23] This estimate relies on the same assumptions used in section 3.2.3 to estimate the impact of a nationwide increase in public transit use from 2010 to 2015.

All of the technology needed for hydrogen-powered, fuel cell-operated cars is already in existence, but not at a stage that would permit cost-effective, widespread commercial deployment. Key areas of ongoing research include the materials and manufacturing process for fuel cells and, in particular, reducing the amount of platinum used. Sufficient progress appears to be occurring for Toyota to expect to market a mid-size hydrogen sedan in 2015 (Mukai and Hagiwara 2011). However, some analysts argue that automakers will need to realize further cost reductions to make hydrogen vehicles cost-competitive with current offerings (Ohnsman 2010). Another area of ongoing research concerns development of more efficient means of producing hydrogen through hydrolysis or from other non-fossil fuel sources, which would ultimately be more environmentally beneficial than production from natural gas.

Another critical issue is the “chicken-and-egg” problem inherent in deploying hydrogen fuel on a wide scale. Widespread adoption of hydrogen vehicles will necessitate significant investments in infrastructure to make the fuel as widely available as gasoline is at present. However, it will be difficult to justify investment on the scale required until there are enough hydrogen-fueled cars on the road to create sufficient demand to support the industry. So long as there is a sufficient supply of petroleum or biofuels that can use existing infrastructure to meet the needs of the Nation’s vehicle fleet, this will likely be more cost effective than the full cost of the transition to a hydrogen system. Well-timed policy support would likely be necessary to establish an adequate hydrogen fueling infrastructure and a smooth transition.

The California Fuel Cell Partnership estimates that if fuel cell vehicles are introduced into the market on a limited scale over the next decade as expected, they could be widely available by 2030. Due to the significant lag in vehicle turnover, it would likely be another 10 to 20 years before hydrogen could replace oil as the dominant transportation fuel. Some analysts argue that hydrogen has the potential to replace almost all of the petroleum used by the transportation sector, but over a long time horizon (NREL 2007).

More Efficient Planes. As noted above, air travel has grown significantly more fuel-efficient over time. This trend is expected to continue into the future, due in part to engineering changes and in part to operational improvements. A recent NASA and Boeing report forecasts that efficiency gains of 15 to 20 percent are possible in the medium term (Daggett et al. 2006). Meanwhile, member airlines of the International Air Transport Association, including American, Continental, Delta, United, and US Airways, have set a voluntary goal of a 25 percent improvement in fuel consumption (per revenue-ton-mile) by 2020 compared to 2005 levels (IATA undated).

If successful, a 25 percent fuel savings would reduce 4.7 billion gallons of fuel annually by 2020, based on 2008 levels of consumption. However, if passenger-miles traveled continue to grow at the three percent annual rate seen over the last five years, and if revenues rise accordingly, the reduction would be 6.4 billion gallons, equivalent to about 2.5 percent of total U.S. transportation fuel use in 2010.

Alternative-Fuel Planes. In a 2006 NASA Technical Memorandum, Daggett et al. explore the potential for alternative fuels in the aviation sector. The authors found that biofuel could be blended into jet fuel in small quantities (5 to 20 percent) without requiring any engine modifications, although an additional fuel processing step may be required to make the fuel compatible with the sector's exacting specifications. They go on to note that "[f]or biofuels to be viable in the commercial aviation industry, significant technical and logistical hurdles need to be overcome. However, the task is not insurmountable and no single issue makes biofuel unfit for aviation use." In fact, on November 7, 2011, in an effort to demonstrate technical viability, United became the first U.S. airline to fly commercial passengers on a plane fueled with a blend of biofuel and traditional jet fuel (United Airlines 2011). Other potential fuel sources, such as hydrogen or ethanol, are less suited to aviation, because the added weight of storage tanks (for hydrogen) or the weight and volume of fuel (ethanol) create significant energy efficiency penalties (Daggett et al. 2006).

As with biofuel use for ground vehicles, supply is likely to pose a bigger constraint than demand in the aviation sector. At 20 percent of current levels of fuel use, the upper limit suggested for blending with jet fuel as currently formulated, jet travel could consume as much as 2.2 billion gallons of biofuel. Soybeans, the major domestic biofuel crop, yields about 60 gallons of fuel per acre, meaning about 37 million acres would be required, an area the size of Illinois.

In light of the limits on available supply for biofuels, Daggett et al. conclude that it may be more efficient to concentrate use of this fuel source in the much larger ground transportation sector. They suggest that in the long term, the most attractive option for alternative jet fuel may be synthetic fuel produced from coal or natural gas (Daggett et al. 2006). However, to make this path environmentally preferable, at least with regard to greenhouse gas emissions, the processing plants involved would need to utilize carbon sequestration, a technology that has not yet been widely adopted.

In summary, our review of potential sources of oil and gas savings from the transportation sector highlights the following.

- The ground transportation sector accounted for about 168 billion gallons of gasoline and diesel fuel use in 2009. Air travel consumed roughly 13 billion gallons of fuel, while marine travel used approximately seven billion gallons. Natural gas did not play a significant role as a transportation fuel.

- In the near term, major sources of potential fuel savings include more efficient gasoline-powered automobiles and substitution of biofuels for gasoline in automobiles. Depending on assumptions, these two sources could save approximately 17 billion gallons of gasoline per year by 2015, or about 10 percent of the total for ground transportation.

- The potential for oil savings is greater in the long term. Most notably, cellulosic ethanol could displace as much as 30 percent of total oil consumption. Hybrid and electric vehicles, increased use of public transportation, and more efficient planes could generate oil savings as well, albeit in more modest amounts (likely on the order of nine to 14 billion gallons of gasoline equivalent). Finally, if adopted on a wide scale, hydrogen fuel could replace substantially all of the petroleum used by the transportation sector, but only over a very long time horizon.

4.5.7.1.2 Electricity Generation Sector. Petroleum plays a very modest role in electricity generation and the proportion of U.S. electricity generation from oil-fired power plants has been on a steep decline since the late 1970s. For natural gas, the converse is true. Gas-fueled electricity generation has increased steadily from 1996 to 2010, nearly doubling from 1996 to 2010 (EIA 2011f). The electricity generation sector is second only to industrial use in terms of overall consumption of natural gas. This section analyzes the use of oil and gas for electricity generation, beginning with an examination of recent trends and current use of oil and gas in the sector, and continuing with a discussion of the near- and long-term potential for substitutes. A particular focus is on the circumstances under which these fuels are used for electricity generation and how this affects the ability of renewable energy sources to serve as substitutes.

Current Use of Oil and Gas. Electricity generation consumed 65 million barrels of petroleum in 2010, or about 2.7 billion gallons. This translates into total primary energy use of about 376 trillion Btu (EIA 2011g). This represents a steep decline from 2005, when electricity production consumed more than three times as much. Prior to that, oil consumption had remained at approximately the same level since the mid-1980s. Oil consumption in the electricity generation sector peaked in 1977 at 3,900 trillion Btu, more than ten times the current level (EIA 2009c).

Within the electricity generation sector, petroleum is used primarily to fuel “peaker” plants — facilities that stand idle most of the time and are used only at times of very high demand. Generally, such plants are relatively cheap to build but expensive to operate, as the per-unit fuel costs are more expensive than other plants; thus, they are only used when all other options have been exhausted. As a result, oil provides the fuel for only a small fraction of electricity generated in the United States (Table 4.5.7-3). Petroleum was used to produce 37 million megawatt (MW) hours of electricity in 2010, less than one percent of the 4,127 million megawatt-hour (MWh) total. This was far less than the generation provided by coal, natural gas, nuclear, hydroelectric, or even biomass and wind resources (EIA 2011g).

Since most petroleum-fired plants are used relatively infrequently, these plants contribute a larger proportion of generating *capacity* to the total than they do actual generation. In 2010, oil-fired plants accounted for 57,647 MW of net summer generating capacity, or 5.3 percent of total U.S. capacity. This figure has remained fairly steady since 2002, despite the significant drop in petroleum-fueled electricity generation over that time period (during which overall peak electricity demand increased) (EIA 2010c, 2008b). For peaker plants in particular, this indicates that there may not be a strong correlation over the short run between available capacity and actual use. Thus, oil price changes may be reflected to some degree in electricity generation, but it will take a longer time (and a more sustained price change) before total capacity of oil-fired plants is similarly affected.

TABLE 4.5.7-3 Electric Utilities Generating Capacity and Net Generation

Energy Source	Generators	Generating Capacity (megawatts)	Net Generation (thousand megawatt-hours)	Percent of Net Generation
Coal	1,396	342,296	1,847,290	45
Gas	5,529	467,214	987,697	24
Nuclear	104	106,731	806,968	20
Hydroelectric	4,020	78,204	260,203	6
Other renewable	3,015	56,993	169,761	4
Petroleum	3,779	62,504	37,061	1
Total	17,843	1,113,942	4,127,648[a]	100

[a] Total includes sources not represented in table.

Source: EIA 2011h.

The use of oil predominantly as a peak fuel means that most oil-fired plants are relatively small and that there are a relatively high number of them in use. In 2010, 3,779 petroleum-fired generating stations were available, with an average capacity of 16.5 MW. By comparison, 1,396 coal-fired plants were in operation, with an average generating capacity of almost 250 MW.

Compared to petroleum, much larger quantities of natural gas are used for electricity generation. In 2010, 7,680 billion cubic feet of natural gas or 7,893 trillion Btu, were consumed in electricity generation (an energy content more than 20 times greater than that supplied by petroleum). Natural gas use rose sharply during the economic expansion years, growing by an average of 6.3 percent annually from 2003 to 2008. While that rate may seem modest, it was five times greater than the overall increase in electricity generation. More interestingly, after dipping in 2008, it grew substantially through 2010. Only coal supplied a larger share of the Nation’s electricity in 2010 (EIA 2011g).

In terms of nameplate generating capacity, natural gas ranks as the largest component of the electricity generation sector, with 467,214 MW in 2010, or about 40 percent of the total. Growth in gas-fired capacity has outpaced overall capacity expansion in recent years (2.2 percent vs. 1.3 percent per year). Notably, gas generation expanded much more rapidly in the early years of the last decade than in later years, growing more than 16 percent per year from 1999 to 2003. This was largely in response to the relative flexibility of natural gas power plants, which can be used for baseload, intermediate, or peak generation and the comparatively favorable environmental profile of such plants compared to coal or nuclear power. As of 2010, 5,529 gas-fired generators were in operation in the U.S., with an average capacity of approximately 85 MW (EIA 2011g).

Electricity generation is somewhat more efficient using gas than oil. This is partially due to the nature of the combustion engines used for each fuel. Since natural gas engines are more expensive and run more frequently, there is a greater incentive for efficient combustion. However, efficiency has also been rising in recent years as the result of greater use of natural gas combined-cycle plants. In a combined-cycle plant, the exhaust gases from the gas turbine are used to heat steam which is used to turn a second turbine, thereby capturing the waste heat from the first cycle. As these secondary steam turbines are installed in new gas power plants or placed into existing ones, the efficiency of gas-fired electricity generation should continue to improve.

Near-Term Market Analysis of Substitutes. A significant proportion of oil- and gas-fired generation does have the capability to switch between the two fossil fuels. As of 2010, 26 percent (124,412 MW) of capacity with natural gas listed as the primary fuel was capable of switching to petroleum liquids and 41 percent (22,296 MW) of capacity with oil listed as the primary fuel was capable of switching to natural gas (EIA 2011i). However, this report is not concerned with substitutions between oil and gas but rather switches from oil and gas to other energy sources. Although no comprehensive data exist, it seems logical to assume that a similar proportion of oil and gas plants would be capable of using biofuels, which can be refined to meet specifications similar to those of many petroleum products. In the near term, however, the increasing demand for biofuels in the transportation sector put in place by the Renewable Fuels Standard suggests that there will be relatively little additional biofuel supply available for use by power plants. It seems likely then that there is little if any near-term potential for cost-effective substitution away from oil and gas among existing power plants.

With existing generating plants excluded, we must then consider how the composition of the electricity generation sector as a whole could change in the near term. Power plants are long-lived assets, meaning that reactions to market or policy signals will necessarily be somewhat delayed. Using data from 2004 to 2008, approximately four to six percent of all petroleum-fired generators were retired each year, implying an expected lifespan of about 20 years; for natural gas-fired generators, the retirement rate was somewhat lower, implying an expected lifespan of 23 years (EIA 2010h). (This is consistent with a general rule of thumb that fossil fuel plants can run for about 25 years before needing to replace generators and other key equipment.) Therefore, we can assume that only those gas plants that were built in the late 1980s to early 1990s will likely be retired over the next few years. If recent trends continue, approximately 500 MW of oil-fired capacity and 2,100 MW of gas-fired capacity will be retired every year, or 2,500 MW and 10,500 MW respectively over a five-year period (EIA 2010h). These retirements will most likely be balanced at least in part by new capacity additions of the same type, but these figures nonetheless give an idea of the scope of potential near-term substitution away from oil and gas. If market conditions changed such that oil or gas became more expensive, this is the maximum amount of generation we could expect to be displaced by alternatives.[24]

[24] This considers only replacement of retiring units, and not additions of new capacity. Based on trends from 2004 to 2008, retirements of petroleum generation are likely to outpace new additions in the near future, while new natural gas generation will outpace retirements by more than 10,000 MW per year, U.S. Department of Energy, Energy Information Administration, *Electric Power Annual with Data for 2008*, January 21, 2010, "Table 1.5: Capacity Additions, Retirements and Changes by Energy Source, 2008." See http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html. It is highly doubtful that new renewables could displace this generation on top of the replacement of retiring units discussed here.

However, as noted above, different fuel sources are useful for electricity generation in varying contexts. This means that certain renewable electricity sources may not be direct substitutes for oil- and/or gas-fired generation. Biomass, geothermal and nuclear power are generally used as baseload power, making them poor substitutes for oil and of limited usefulness in replacing natural gas (which, while sometimes employed for baseload generation, is more commonly used as intermediate or peak power). Hydroelectric power is mostly used for baseload generation as well, although it is more flexible and can be ramped up and down more easily; however, with most potential large hydroelectric sites already developed, there is relatively limited potential for additional domestic capacity. A Navigant Consulting study, based on an earlier USDOE report, estimated a maximum technical capacity of about 84,000 MW of additional hydroelectric power, of which 22,000 MW could realistically be developed by 2025. This would constitute an increase of approximately 30 percent over 2010 levels, but would still leave hydropower at less than 10 percent of total electricity generation (Frantzis 2010).

Wind and solar power are more likely alternatives for both of these fossil fuels.[25] Due to their intermittent nature, however, there are limits to the maximum amount of near-term penetration that these energy sources will likely achieve in a cost-effective manner. Nonetheless, a report from National Renewable Energy Laboratory (NREL) projected that wind power could achieve a 20 to 30 percent penetration in the eastern United States by 2024, given sufficient investment in transmission upgrades. In the absence of such investment, this level of wind penetration would require significant curtailment or shutting down of wind plants, with a high associated cost (EnerNex Corp. 2010). Sufficiently robust infrastructure is important in that it can more effectively use widely-dispersed wind plants to ‘cancel out’ each other’s variability. While wind generation in particular has been growing at an impressive rate with nearly 10,000 MW installed in 2009 (AWEA 2010), on par with capacity additions of oil and gas in recent years (EIA 2011j),[26] it is not likely to approach this 20 percent constraint in the next five years. Indeed, uncertainty regarding Federal support for wind energy resulted in a decrease in new installed capacity in 2010 (a total of just over 5,100 MW); through the third quarter of 2011, new installed capacity for the year stood at 3,360 MW (AWEA 2011a, b). Solar power currently makes up a much smaller proportion of electricity generation and is not likely to displace a significant amount of fossil fuel generation over that time frame.

Finally, note that the electricity generation industry is shifting from simple-cycle steam turbines to combined-cycle generators for natural gas. Combined-cycle generators are about 25 to 30 percent more efficient than simple-cycle generators in terms of electricity produced per unit fuel (EIA 2011k). We can expect a trend towards greater efficiency to continue as newer

[25] This is true in terms of electricity produced and thus fuel used on an ongoing basis; with regard to *capacity*, it is a more dubious proposition. Since wind and solar are not firm resources, a certain level of natural gas or oil capacity will generally be required as a ‘backstop’ resources to protect against grid problems in times when the supply of these renewables cannot meet the instantaneous demand for electricity.

[26] Again, it is important to distinguish between capacity and electricity generation. Due to its intermittency, wind has a much lower capacity factor than oil or gas generation; thus, a megawatt of wind capacity will produce far less electricity over time than a megawatt of natural gas capacity (or petroleum, if it is being used for non-peak power). Capacity additions of wind and solar cannot be considered one-for-one substitutes for fossil fuels.

natural gas generators and power plants come online, meaning that less gas will be needed to meet the same level of electricity demand.

Overall, in the near term, the maximum potential for a shift away from oil and gas in the electricity generation sector is limited by the level of oil and gas generator retirements (expected to be about 2,500 MW and 10,500 MW over five years, respectively) and the extent to which these generators can be replaced by renewables (predominantly wind power) and more efficient natural gas combined cycle plants. Based on 2008 capacity factors and fuel efficiency, we estimate that this maximum replacement potential translates into about 182 billion cubic feet of gas and 3.5 million gallons of oil avoided each year. While wind power may place some strains on the grid at high levels of penetration, this is not a near-term concern. Biofuels and other renewables are not likely to play a significant role in replacing fossil fuels over this time period.

Long-Term Market Analysis of Substitutes. As noted above, fossil fuel generators, both oil and gas, have an expected lifespan of about 20 to 25 years. In this timeframe, there will be a more or less complete turnover of the Nation's oil and gas generators, as well as the new additions necessitated by growth in demand. There is significant potential for substitution away from these fuels over that period, dependent on the availability and suitability of other power sources.

Biofuels represent the most obvious potential substitute for petroleum and gas in terms of fuel characteristics, although, as noted above, they are more likely to be used in the transportation sector, which represents a much larger source of demand. Even assuming significant scale-up of new biofuel production capabilities, the maximum amount available from domestic sources would not likely be enough to meet current levels of both transportation and electricity fossil fuel demand. Therefore, biofuels are excluded from further consideration here.

As of 2010, natural gas accounted for 24 percent of electricity generation and petroleum provided an additional one percent. As noted above, NREL has concluded that wind power alone could achieve 20 to 30 percent penetration in the eastern U.S. by 2024, with adequate investments in transmission infrastructure (EnerNex Corp. 2010). Furthermore, a similar study found that 30 percent wind penetration is technically feasible in the western States as well, with some modifications to current practice by grid managers (GE Energy 2010). In simple terms of magnitude, wind could theoretically displace oil and gas for electricity generation entirely. Wind is already reasonably cost-competitive with oil and gas and will become more so if fuel prices rise and/or if climate policy results in a carbon tax or cap-and-trade mechanism. The manufacturing process and technology for wind turbines is fairly mature and well-established. For wind, therefore, the most important constraint will be the ability of the electric grid to accommodate significant amounts of an intermittent resource. Much of the wind potential evaluated by NREL would come from the Great Plains. While the report emphasizes the benefits of regional integration and coordination, this geographic dynamic suggests that a portion of the wind power is likely to be replacing coal, rather than oil or gas.[27] In addition, some amount of oil or gas will be needed to balance the intermittency of wind resources. Nonetheless, wind power could potentially replace a major portion of oil- and gas-fired electricity generation.

A substantial portion of the long-term wind potential identified by NREL, 54 gigawatts, is to come from offshore wind. The United States has areas appropriate for offshore wind power development near large coastal urban areas. With growing electricity demand and space constraints on land-based electricity generation and transmission, offshore wind is favorably positioned to play a role in meeting future energy demand (NREL 2010). Constructing sufficient transmission infrastructure is a significant barrier, but with Google and the renewable energy investment firm Good Energies committing to significant investments in an undersea transmission ‘backbone’ that would serve projects along the Atlantic coast, there could be sufficient infrastructure to spur additional offshore development (Wald 2010). Since coastal U.S. areas rely more heavily on natural gas (and small amounts of oil) for electricity generation than the Midwest, any offshore wind development that does result would help further reduce dependence on these fossil fuels.

Solar power, although not expected to play a significant role in centralized electricity generation over the next few years, could become more important given the right mix of technological improvements and market or policy influences. A study by the research firm Clean Edge, Inc. and the non-profit Co-op America found that photovoltaic and concentrated solar power could reach 10 percent of electricity generation by 2025, although this would require a capital investment of hundreds of billions of dollars. As a resource that is generally available during times of peak demand (i.e., warm-weather periods), widespread use of solar power would imply significant displacement of both oil and gas. Such a scenario is dependent on significant cost decreases in the manufacturing process, to be driven both by the realization of economies of scale and by other technological improvements (Clean Edge, Inc. and Co-op America 2008).

Overall, given favorable conditions, solar and wind power could be used to replace a significant portion of oil and gas used for electricity generation. The technical constraints posed by their status as intermittent resources mean that these energy sources cannot be used to completely replace fossil fuels, even with investments in the transmission grid and/or in battery storage. While it is not the aim of this report to develop a detailed forecast, some simple math can illustrate the potential scope of substitution. The EIA’s 2010 Annual Energy Outlook forecasts electricity generation to grow at one percent annually over the next 25 years (EIA 2011b). At that rate, total electricity generation would be approximately 5,389 billion MW-hours in 2035, up from 4,119 billion MW-hours in 2008. If wind is in fact able to reach 20 percent and solar to reach 10 percent penetration, this would imply a total of about 1,078 and 539 billion MW-hours respectively produced from these sources. By way of comparison, wind

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27 Although coal is a baseload power source, and thus not directly replaceable by a given wind plant, a widely dispersed network of wind plants could provide sufficiently firm power in the aggregate to eliminate the need for a portion of the region’s coal-fired capacity. The NREL report frames its results in terms of smaller increases in capacity of fossil plants, rather than absolute reductions, but it appears that they forecast wind to displace a mix of coal and gas plants.

accounted for 1.34 percent of all generation in 2008, while solar was virtually zero. If the assumption is made that half of the growth in these renewables replaces oil and gas, and half coal, then this suggests that they could displace 772 billion MW-hours of oil- and gas-fired electricity annually, more than 80 percent of the current total produced from these sources, or roughly two-thirds of what would come from these fossil fuels in 2035 if they were to continue to hold their current proportions of total generation. If expanded renewables displaced a higher proportion of oil and gas relative to coal, then even more electricity from these sources could be avoided.

Note that nuclear power represents another potential substitute for natural gas. The Nuclear Regulatory Commission is actively reviewing applications for operating licenses for 22 new nuclear power plants and power companies are considering additional plants as well (Nuclear Energy Institute 2011). However, since natural gas is used primarily as an intermediate or peak power source, whereas nuclear power is a baseload resource, the potential for substitution is limited. Furthermore, the extent to which nuclear power will be able to successfully compete with other baseload resources such as coal or biomass will depend on climate policy, the relative ease or difficulty of gaining regulatory approval, and fuel cost and availability. Nonetheless, expanded use of nuclear power could result in avoided natural gas use to a greater degree than outlined above.

Finally, we note that climate change and energy policy could have a significant effect on shaping the electricity sector. It is not the intention of this paper to discuss potential policy initiatives and their potential impacts in detail. It is difficult to predict the political appetite for climate and energy policy or the specific tools potentially employed. However, concepts discussed in the last five years include the following:

- *USEPA regulation of greenhouse gases as criteria pollutants under the Clean Air Act.* In April 2009, USEPA declared carbon dioxide and five other greenhouse gases to be endangering public health and welfare, a precursor for the agency to regulate them under the Clean Air Act. If regulations were promulgated, they would likely reduce coal use and increase oil and gas use.

- *A nationwide renewable energy standard or clean energy standard.* A renewable energy standard would require electric utilities to meet a minimum amount of electricity demand (e.g., 20 percent) through renewable sources. A clean energy standard, as proposed by the Administration, would credit a broader range of clean electricity sources – including nuclear power, with partial credit for generation from efficient combined-cycle natural gas plants and fossil fuel plants that capture and store carbon dioxide.

- *Subsidies for renewable energy production.* Policymakers could extend existing incentives for generation from renewable sources, such as the production tax credit of 2.1 cents per kilowatt-hour for wind or the investment tax credit of 30 percent of the cost of solar installations, or create new incentives, such as feed-in tariffs similar to those that enabled significant renewable energy capacity expansion in Europe in recent years.

These or other policy measures will influence the mix of renewables, oil, gas, and other resources in the electricity sector, but they will be unlikely to change the maximum potential levels of substitution described above. Even over a 25-year time horizon, natural gas is likely to contribute a significant portion of electricity generation in the United States.

4.5.7.1.3 Industrial Sector.

Current Use of Oil and Gas. The industrial sector used 1.57 billion barrels of petroleum in 2010, with primary energy use of 8,029 trillion Btu. It consumed a similar 7,930 trillion Btu in natural gas, slightly more than was used for electricity generation (7,380 trillion Btu). The industrial sector was therefore the second-largest petroleum-consuming sector of the economy after transportation and the highest gas-consuming sector (EIA 2011l, m).

Industrial oil use peaked domestically in 1979 at just less than two billion barrels. More recently, levels of consumption have remained relatively steady from year to year. From 1998 to 2007, annual industrial petroleum use held between 1.77 and 1.91 billion barrels, a difference of less than 10 percent. Oil use has remained lower since 2008, due to the economic recession. What has changed over the past decades is the composition of the sector's petroleum inputs. Liquid petroleum gases (LPG) have steadily increased as a proportion of total petroleum, from five percent in 1950 to 24.2 percent in 1980 to 33.3 percent in 2008. As LPG use has grown, residual fuel oil has virtually disappeared, dropping from 33.4 percent of industrial oil in 1950 to just 1.4 percent in 2010 (EIA 2011n). Since LPGs are comparatively cleaner than residual fuel oil, this indicates that the net environmental impact of industrial oil use has moderated over time.

Natural gas has a similar story. After peaking in 1973 at 10,388 trillion Btu, industrial natural gas consumption fell sharply in the late 1970s and early 1980s, before climbing back during the 1990s. Natural gas use has been falling again in recent years, from 9,933 trillion Btu in 1997 to 7.380 trillion Btu in 2010 (EIA 2011m). This could reflect a response to a long-term trend of rising natural gas prices over that time period.

Oil and gas are used for three broad purposes within the industrial sector: to generate heat and steam for industrial processes, either in boilers or in direct process heating; for heating and air conditioning of ambient air; and as nonfuel feedstocks for a variety of products, including solvents, lubricants, plastics, asphalt, and various chemicals. Oil and natural gas are also used by many industrial facilities for cogeneration, which produces electricity, as well as usable heat and steam to be consumed either on-site or by neighboring facilities.

The EIA's Annual Energy Review (AER), the source for the summary figures listed above, does not provide more fine-grained information on particular end uses of petroleum and natural gas. For that, we rely on EIA's quadrennial Manufacturing Energy Consumption Survey (MECS), which last reported data for 2006. There are discrepancies between the industrial sector as defined in the AER and manufacturing facilities as defined in the MECS, with the MECS appearing to cover a smaller amount of total industrial activity. Nonetheless, the two are sufficiently similar for our purposes to use manufacturing facilities as a proxy for the entire industrial sector. Doing so allows us to examine the particular end uses of oil and gas within the industrial sector in greater detail.

Table 4.5.7-4 shows total energy use in manufacturing facilities for both fuel and non-fuel applications. Specific end uses are discussed in greater detail below.

Process Heating. Process heating is the practice of heating particular materials used in manufacturing, such as metals, plastics, and ceramics. Process heating softens, melts, or evaporates materials, and may be used to catalyze chemical reactions. This can be accomplished through a variety of equipment types, including furnaces, ovens, dryers, and specially designed heaters for the process in question. Process heating systems may use fuel directly or may be electricity- or steam-based. Only direct fuel-burning equipment is considered here.

Process heating is the largest industrial fuel use of natural gas. Excluding onsite transportation within industrial facilities, electricity generation, and unspecified uses, process heating accounted for 47 percent of industrial natural gas use in 2006. In 2002, the date of EIA's previous MECS survey, this number stood at 49 percent. Total gas use for process heating dropped by nine percent over that time period.

Process heating is also a major industrial use of petroleum, if nonfuel applications are excluded. Process heating represented 32 percent of industrial petroleum fuel use in 2006, once again excluding transportation, electricity generation, and unspecified uses. Petroleum use for process heating dropped 23 percent from 2002, at which point it had accounted for 42 percent of industrial petroleum fuel use. If nonfuel applications are included, process heating accounted for less than five percent of total petroleum use in both 2002 and 2006 (EIA 2009i, h).

Boilers and Cogeneration. Boilers use a fuel source such as oil or gas to produce steam, which is in turn used to heat other materials and/or the ambient environment, or to drive turbines. The EIA's MECS distinguishes boilers from direct process heating, which does not use steam as an intermediary. The equipment used is different between these two processes, although the end application may often be the same (i.e., heating a manufacturing input).

Conventional boilers accounted for 28 percent of industrial petroleum use for fuel in 2006, with cogeneration responsible for another 20 percent, for a total of 48 percent. The numbers were somewhat lower for natural gas, at 24 percent and 16 percent respectively. Again, these figures exclude onsite transportation, non-cogeneration electricity production, nonfuel applications, and unspecified uses. There was relatively little change in these proportions from 2002. Including nonfuel use has only a modest impact on natural gas, but drops the proportion of petroleum use for boilers and cogeneration dramatically, to four percent for boilers and three percent for cogeneration. Both natural gas and petroleum use for boilers and cogeneration were virtually unchanged in absolute terms from 2002 to 2006 (EIA 2009i, h).

TABLE 4.5.7-4 Manufacturing Facilities Energy Use (trillion Btu)

	Net Electricity		Natural Gas		Petroleum		Coal		Other		Total	
End Use	2002	2006	2002	2006	2002	2006	2002	2006	2002	2006	2002	2006
Boiler Fuel												
Conventional boiler use	9	41	1,306	1,281	99	96	255	129	–[a]	–	1,679	1,547
CHP and/or cogeneration process	4	–	857	838	61	69	521	417	–	–	1,443	1,324
Direct uses – process												
Process heating	343	346	2,742	2,487	142	110	368	345	–	–	3,595	3,288
Process cooling and refrigeration	194	206	45	32	2	1	[b]	[b]	–	–	241	239
Other process use	1,681	1,692	169	269	23	41	12	66	–	–	1,885	2,068
Direct Uses – non-process												
Facility HVAC	262	265	417	378	13	13	5	2	–	–	699	658
Facility lighting	196	198	–	–	0	0	–	–	–	–	196	198
Other facility support	48	60	30	30	1	1	[b]	[b]	–	–	79	91
Other non-process use	3	8	10	8	1	7	0	[b]	–	–	14	23
Boiler fuel and direct uses subtotal	**2,740**	**2,817**	**5,576**	**5,322**	**342**	**342**	**1,162**	**961**	–	–	**9,831**	**9,442**
Nonfuel uses (Btu equivalent)	**0**	**0**	**674**	**398**	**3,022**	**2,380**	**799**	**473**	**3,693**	**3,711**	**8,189**	**6,962**
Boiler fuel, direct uses and nonfuel uses total	**2,740**	**2,817**	**6,251**	**5,719**	**3,364**	**2,722**	**1,961**	**1,434**	**3,693**	**3,711**	**18,020**	**16,404**
Other uses												
Onsite transportation	4	7	2	3	53	55	–	–	–	–	59	65
Conventional electricity generation	–	–	55	19	1	4	14	3	–	–	70	26
End use not reported	96	26	162	168	56	58	6	52	6,006	5,820	6,306	6,125
Total[c]	**2,840**	**2,850**	**6,470**	**5,909**	**3,474**	**2,839**	**1,981**	**1,489**	**9,699**	**9,531**	**24,455**	**22,620**

[a] – = Not applicable.

[b] Estimate less than 0.5.

[c] Numbers do not add due to rounding.

Sources: EIA 2006, 2009i.

Heating, Ventilation, and Air Conditioning (HVAC). After process heating and boilers and cogeneration, HVAC is the only significant industrial end use of petroleum and natural gas except use as chemical feedstocks. The HVAC sector accounted for four percent of petroleum and seven percent of natural gas fuel use in both 2002 and 2006. The proportion of petroleum use drops to less than one percent when nonfuel applications are factored in. Natural gas use for HVAC saw a modest decline in absolute terms from 2002, matching the overall pattern in industrial gas use, while petroleum remained constant (EIA 2009i, h).

Non-energy Uses. While nonfuel applications make up a relatively small proportion of industrial gas use, just seven percent in 2006, down from 11 percent in 2002, they account for nearly 90 percent of petroleum consumption (see Table 4.5.7-5). Thus, the use of petroleum products as chemical feedstocks deserves particular attention.

Over half of the nonfuel consumption of petroleum takes place at petroleum refineries. In addition to various forms of petroleum fuels, refineries also produce a range of petrochemicals, including lubricating oils, paraffin wax, and asphalt and tar. However, the information available is not sufficiently detailed to indicate petroleum use for each of these products (EIA 2009i).[28]

The next most significant source of demand is plastics materials and resins, which accounts for nearly 20 percent of nonfuel petroleum consumption (EIA 2009i). Plastics come in a wide variety of forms and are used for an equally wide variety of applications, but almost all plastics are composed of chains of carbon and hydrogen (sometimes with other elements included). This structure makes petroleum an ideal feedstock for plastics. Most plastic manufacturing processes have very little material waste and incorporate virtually all of the petroleum input into the final product (Graedel and Howard-Grenville 2005).

The other major consuming sectors of nonfuel petroleum are classified as "petrochemicals" and "other basic organic chemicals." Again, the information available does not provide any further detail. "Other basic organic chemicals" is also a major nonfuel user of natural gas. However, the most significant nonfuel consumer of natural gas is nitrogenous fertilizers, which are widely used throughout the agricultural sector (EIA 2009i).

Notably, nonfuel use of both petroleum and natural gas was significantly lower in 2006 than in 2002. The most significant decline for each came in chemicals. Detailed information was not available for petroleum. For natural gas, the decline was especially significant in nitrogenous fertilizers (which fell by 40 percent), basic organic chemicals (which dropped by 54 percent), and plastics (which fell by 83 percent). Although there is less detail, data from earlier years suggests this may be a sustained decrease rather than an isolated phenomenon.

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28 The input source for this sector is classified as 'other' in the MECS table regardless of the actual material type (petroleum, natural gas, coal). However, given the function of oil refineries, this energy is almost certainly taken from petroleum products. This discrepancy accounts for much of the 'other' nonfuel consumption in the table above.

TABLE 4.5.7-5 Manufacturing Facilities Select Nonfuel Uses of Natural Gas and Petroleum for Nonfuel (trillion Btu equivalent)

	Natural Gas		Petroleum	
End Use	2002	2006	2002	2006
Petroleum refineries	0	0	3,307[a]	3,399[a]
Chemicals				
Petrochemicals	37	0	899	[b]
Other basic organic chemicals	162	74	717	[b]
Plastic materials and resins	66	11	1,283	1,180
Nitrogenous fertilizers	295	176	0	0
All other chemicals	69	91	108	[b]
Total chemicals	629	352	3,007	2,297
All other applications	45	46	15	83
Total (all nonfuel)	674	398	6,329[a]	5,779[a]

[a] Numbers shown here include 3,307 trillion Btu in 2002 and 3,399 trillion Btu in 2006 in “other” fuel used at petroleum refineries, which we assume comes from petroleum.

[b] Data withheld in source material to prevent disclosing data on individual establishments.

Source: EIA 2009i.

There was relatively little change in nonfuel consumption of petroleum at petroleum refineries or for plastics, the only major categories for which data are available for both years (EIA 2009i).

Near-Term Analysis of Substitutes. Industrial equipment is typically long-lived. The Chartered Institute of Building Services Engineers (CIBSE) lists the “indicative life expectancy” for boilers at 15 to 25 years, and gas or oil fired furnaces at 15 years (CIBSE undated). In addition, such equipment often represents a significant expenditure. As a result, turnover rates are relatively low. Only in extreme circumstances would a change in fuel prices prompt a facility manager to replace petroleum- or gas-fired equipment significantly in advance of its planned retirement date. For that reason, any form of fuel switching that would require replacing major equipment as a long-term but not a near-term possibility is included.

Near-term substitution will require alternative fuel sources that are compatible with existing equipment. For petroleum, this implies liquid biofuels such as ethanol or biodiesel. As discussed in the transportation chapter, near-term biofuel use will most likely be driven largely by policy requirements. The Renewable Fuel Standard currently in place sets a target of 20.5 billion gallons of renewable fuel use *for transportation* by 2015. This is more than the total domestic production forecast for that year by EIA’s Annual Energy Outlook (USEPA 2010a; EIA 2011b). Even if this dynamic of demand outstripping supply corrects itself somewhat, there is unlikely to be any significant quantity of liquid biofuels left over for use in industrial, fuel-based applications.

For non-fuel uses such as plastics, there may be greater potential for substitution away from petroleum. The manufacture of biobased plastics, mostly produced from starch, sugar, and cellulose, increased by 600 percent between 2000 and 2008, although they still represent a small proportion of total plastics (Ceresana Research 2009). Globally, demand for bioplastics is forecast to grow at approximately 25 percent annually from 2010 to 2015 (Pira International 2010). This suggests potential for biobased plastics to replace a portion of conventional plastics.

Plastics manufacturing accounted for the equivalent of 1,198 trillion Btu of petroleum consumption in 2006. While it is not clear what proportion of total plastic produced domestically currently derives from non-petroleum sources, five to 10 percent appears to be reasonable based on global estimates (U.K. National Nonfood Crop Centre 2010; Nova Institute 2009). From this base, the projected growth rates in bioplastic manufacture just reported would suggest that an additional 130 to 260 trillion Btu of petroleum for plastics manufacturing could be replaced by biological feedstocks over the next five years. This amounts to approximately 1.5 to three percent of total industrial petroleum use (EIA 2011n).

The other readily available petroleum substitute for plastics manufacturing is recycled plastic, which can replace virgin materials. A large amount of potentially recoverable plastic is discarded in the United States each year. For example, only 7.1 percent of all plastic discarded in municipal solid waste in 2009 was recovered. However, even this represents a modest improvement from earlier years when the recovery rate was approximately six percent from 1990 through 2005 (USEPA 2010b). In the near-term, dramatically increased recovery of plastic seems unlikely. However, if the trend of modest increases from 2005 to 2009 continues, recycling rates could reach 8.75 percent by 2015, amounting to about 2.6 million tons of plastic. The incremental increase of 0.5 million tons recycled would save about 11 trillion Btu of oil.

Long-Term Analysis of Substitutes. There is greater potential for substitution in the longer term as industrial facilities replace their existing oil- and gas-fired equipment, affording them the opportunity to switch to systems using alternate fuel sources. Many facilities may switch from oil to gas, but we do not evaluate this possibility here, focusing instead on moves away from oil and gas to other fuel sources. Other substitutes include biofuels, electricity, and expanded use of the substitutes noted above for plastics manufacturing (i.e., recycled plastic or biobased chemicals). While there is significant variation between different types of equipment, an appropriate rule of thumb is that industrial equipment is replaced every 25 years. This represents the appropriate timeframe for our long-term analysis.

The potential for biofuel production has already been discussed in the transportation chapter and is not repeated in detail here. As described there, biofuels could displace a significant portion of petroleum use over the next 25 years, perhaps up to 30 percent of total nationwide consumption. Biofuels are unlikely to have much impact on natural gas. However, with three-fourths of U.S. petroleum use taking place in the transportation sector, most of the substitution is likely to take place there. Thus, there is likely comparatively little room for expanded biofuel use in the industrial realm. Furthermore, due to the limits on potential biofuel supply (based on available land to dedicate to growing fuel crops), if overall biofuel use does approach the upper boundary of 30 percent, any substitution of biofuels for petroleum that did happen in the industrial sector would come at the expense of similar substitution elsewhere. This would be true for biobased inputs for plastics manufacturing, as well as for fuel use.

Industrial facilities could also use equipment powered by electricity instead of oil- and gas-fired equipment. Given that most industrial oil- and gas-using equipment is used simply to provide heat (e.g., for process heating or in boilers), such a move would generally be thermodynamically inefficient. While electricity generation and consumption produces considerable energy losses, combustion for heat is far more efficient at utilizing embodied energy from a fuel source. Even so, electricity is a viable option, and if generated from renewable sources, it may result in lower environmental impacts.

As with biofuels, the potential for expanded use of renewable energy has been discussed previously in this report and is not repeated again here. We do note, however, that substitution of electrical equipment for oil- and gas-fired combustion equipment would result in an increase in overall electricity demand. As with biofuels, if renewable power generation approaches the upper boundaries outlined previously, any renewable electricity use by industrial sources would simply displace renewable energy use that would have occurred elsewhere.

Significantly increased plastic recycling represents the final mode of substitution away from industrial petroleum use. A recent report on the European plastics industry notes that Germany recycled the highest proportion of its post-consumer plastic waste of any European country, at 33.9 percent. An additional 60 percent of Germany's plastic waste was sent to waste-to-energy plants (PlasticsEurope, EuPC, EuPR, and EPRO 2010). Compared to the contemporaneous 7.1 percent U.S. recycling rate, this would constitute an ambitious goal. We therefore use it as an upper boundary on the potential for long-term recycling in the United States.

Thirty million tons of plastic waste was generated in this country in 2009 and this figure has held relatively constant in recent years (USEPA 2010b). If this level of waste production continues into the future, 33.9 percent recycling would represent an increase of 26.8 percent above recent levels, or an additional eight million tons of plastic. This level of recycling would save 192 trillion Btu of petroleum, or about 2.4 percent of 2010 total industrial petroleum use (EIA 2011l).

4.5.7.1.4 Residential and Commercial Sector. This chapter discusses oil and gas consumption in the commercial and residential sectors. Similar to the industrial sector, oil and gas use in residences and commercial establishments is dominated by a small number of specific end uses. There has been a long-term shift away from oil use toward electricity in these applications, while natural gas use has not changed as dramatically. The potential substitutes for commercial and residential use of oil and gas are similar to those for the commercial sector, consisting mainly of electricity and biogas, although efficiency could also be considered a feasible substitute in certain applications. The current trend of increased building efficiency and weatherization, supported in part by investments through the American Recovery and Reinvestment Act, favors decreasing use of oil and gas in the residential and commercial sector.

Current Use of Oil and Gas. The commercial and residential sectors consume negligible amounts of petroleum compared to the transportation and industrial sectors, but contribute more substantially to natural gas consumption. Residences used 1,220 trillion Btu of petroleum in 2010; commercial buildings used 717 trillion Btu, for a total of 1,937 trillion Btu (395 million barrels) (EIA 2011o). This amounts to 5.2 percent of nationwide petroleum consumption. For natural gas, the residential sector consumed 5,061 trillion Btu in 2010 and the commercial sector consumed 3,276 trillion Btu, for a total of 8,337 trillion Btu (EIA 2011p). Combined, these sectors accounted for 34 percent of gas consumption, greater than industrial levels and electricity generation (EIA 2011p).

Petroleum consumption has been falling steadily in both the residential and commercial sectors since the early 1970s. Residential petroleum consumption reached its highest point in 1972, at 2,856 trillion Btu, while commercial use peaked one year later at 1,604 trillion Btu. Overall oil use has fallen by nearly 60 percent for both sectors since that time (EIA 2011p).

As with the industrial sector, the composition of the residential and commercial sectors' petroleum inputs has evolved over time. In the residential sector, kerosene use has dropped precipitously, from 25.8 percent of the total in 1949 to 2.5 percent in 2010, while LPGs have more than made up the difference. Even more dramatically, in the commercial sector, residual fuel oil, which accounted for nearly half of all petroleum consumed in 1949, was down to just 11.7 percent of consumption in 2010. It was replaced mainly by distillate fuel oil, which almost doubled from 30.4 percent to 56.1 percent over the same time period (EIA 2011o). The replacement of residual fuel oil with distillate fuel oil, in particular, points to lower overall emissions from oil combustion over time.

After growing steadily from approximately 1,000 trillion Btu in 1950 to nearly 5,000 trillion Btu in 1970, annual residential natural gas consumption has remained between 4,000 and 5,250 trillion Btu over the past 40 years. Commercial gas use, meanwhile, remained largely steady throughout the 1970s and 1980s, increased by about 20 percent during the early 1990s, and has leveled off since. Growth in commercial gas use has been essentially flat since 1996 (EIA 2009j).

Most residential petroleum and natural gas use is for space heating and water heating. To a lesser extent, these fuels are also used for appliances such as ranges, ovens and refrigerators. Similarly, commercial gas and oil use is dominated by space heating and water heating, with additional small amounts for cooking and miscellaneous other applications. Electricity was another major energy source for these applications. The split between these fuel sources by end use is shown in the table below. Due to discrepancies between different data sources, the totals in the table do not match those reported above. Note that for residential buildings, the most recent year for which end-use data were available was 2005 and to balance comparability with currency throughout this section we use 2008 data for commercial buildings (EIA 2009l; EERE 2011c). Table 4.5.7-6 also shows electricity consumption by these sectors, which was discussed in the electricity generation chapter.

TABLE 4.5.7-6 Residential and Commercial Sector Energy Use (trillion Btu)

	Residential Sector, 2005				Commercial Sector, 2008			
End Use	Oil	Natural Gas	Electricity	Total	Oil	Natural Gas	Electricity and Other	Total
Space heating	1,070	2,950	280	4,300	240	1,560	1,000	2,800
Water heating	290	1,410	420	2,120	20	440	320	780
Cooking and appliances	50	430	2,770	3,250	–[a]	170	2,800	2,970
Air conditioning	–	–	880	880	–	30	4,110	4,140
Other	–	–	–	–	210	290	5,870	6,370
Total[b]	**1,410**	**4,790**	**4,350**	**10,550**	**470**	**2,490**	**14,100**	**17,060**

[a] – = Not applicable.

[b] Totals do not match those reported in text due to discrepancies between data sources.

Source: EIA 2011q; EERE 2011c.

Space Heating. Space heating is the most significant use of petroleum and natural gas in both the residential and commercial sectors, accounting for three-fourths of residential oil use and 62 percent of residential gas use in 2005. Electricity use for space heating was comparatively small. A similar proportion of natural gas use in the commercial sector was for space heating in the recent and comparable year of 2008 (63 percent), but oil use was minimal and electricity more substantial (EIA 2011r; EERE 2011c).

Perhaps surprisingly, given the low total amount of electricity used for residential space heating, 35 percent of homes used electricity as their primary heating type in 2009, a figure that has climbed steadily since 1980. The apparent mismatch between total consumption and proportional use suggests that electricity is used for heating primarily in areas with mild winters and low heating demand. The increasing percentage use of electricity has come mostly at the expense of heating oil, whose use dropped from 17 percent of homes in 1980 to six percent in 2009. The proportion of homes with natural gas as their primary heating fuel has declined only slightly over that same period, from 55 percent of homes to 50 percent. Other factors favoring electricity may include steady improvements in electric heat pump efficiency and the development of hybrid-heating systems that combine electric heating with gas heating, with each source used within its most efficient temperature band. However, historically low prices for natural gas since the most recent EIA data in 2009 could result in increasing market share for gas heating.

Water Heating. After space heating, water heating is the other most significant end use of oil and gas in the residential and commercial sectors, comprising 21 percent of residential oil use and 29 percent of residential gas use in 2005. In the commercial sector, water heating used negligible amounts of oil, but accounted for 18 percent of natural gas use in 2008 (EIA 2011r; EERE 2011c).

As might be expected, a similar proportion of homes use natural gas for water heating, as for space heating, or 51 percent in 2009. This has remained essentially unchanged since 1980. Just seven percent of homes used petroleum (fuel oil or liquefied petroleum gas) for water heating in 2005, down from 13 percent in 1980. The remaining 39 percent of homes relied on electricity for water heating in 2005, a modest increase from 33 percent in 1980. Only one percent of homes used other energy sources, such as solar water heating (EIA 2011r).

Cooking and Appliances. Cooking and appliances represent the final major end uses of residential and commercial gas. About nine percent of residential and seven percent of commercial gas use went toward cooking and appliances with residences also using a small amount of petroleum for these purposes. There is no information readily available on the proportion of homes using oil, gas, and other fuels for these end uses. In absolute terms, however, natural gas use for appliance applications grew by about 20 percent from 1980 to 2005, less than the rate of population growth. Meanwhile, oil use remained essentially unchanged and electricity use increased by 80 percent (EIA 2011r; EERE 2011c). The rise in total electricity use could be due in part to increased per-capita consumption, but it seems more likely that, matching the trend with space heating and water heating, an increasing proportion of homes are using electricity rather than oil or gas as their primary fuel. It would stand to reason that a home that used gas (or oil) for one major end use would be more likely to use it for others as well.

Near-Term Analysis of Substitutes. Furnaces and boilers, water heaters, and cooking appliances – the equipment directly responsible for oil and gas consumption in the commercial and residential sectors – are durable, long-lived goods. Water heaters have an average life span of 13 years, while furnaces, boilers and range/ovens typically last for 20 years or more (California Energy Commission, undated a). Such items also represent significant investments for most buyers. Thus, similar to industrial consumers, residential and commercial consumers would be unlikely to replace their oil- or gas-fired equipment any earlier than necessary except under extreme conditions. For that reason, any fuel-saving strategy that would require major new equipment to be a long-term but not a near-term possibility is considered.

Given that dynamic, we identify two broad strategies for near-term reductions in oil and gas use in these sectors. The first strategy considered is fuel switching or, more likely, fuel blending by oil and gas distribution utilities. Heating oil, which is often distributed by trucks, could be replaced or supplemented by ethanol or biodiesel, both of which are discussed earlier in this report. Although with greater transition costs, wood pellets are another substitute fuel for homes with heating oil. Fossil fuel natural gas can be supplemented with equivalent gas produced from renewable sources.

Biogas, which is created through the anaerobic breakdown of organic material, is produced mainly from manure, sewage, or agricultural wastes (in digesters), or in landfills, where such anaerobic digestion occurs naturally. While such gas is used primarily in industrial facilities for heating applications or by utilities for electricity generation, with some processing to remove moisture and impurities (similar to the process for fossil fuel natural gas), biogas can be refined to nearly pure methane and injected into distribution pipelines for use in the commercial and residential sectors. The potential for increased used of biogas was discussed in the industrial sector chapter of this report; if the United States reaches the levels of biogas production discussed, any biogas used to offset fossil fuel consumption in the commercial and residential sectors would simply replace substitution at industrial facilities or in the electricity generation sector.

The second strategy considered for reducing oil and gas use in commercial and residential sectors is efficiency upgrades to decrease space heating demand. This refers to efficiency improvements for buildings in retaining heat, rather than the efficiency of the heating equipment itself. Adding insulation, sealing leaks, and installing more efficient windows reduces the thermal transmissivity of a building envelope, thereby reducing the oil or gas needed to maintain a comfortable temperature in the winter. These actions can also save electricity from lower demand for space cooling in the summer or space heating where electricity rather than oil or gas is the primary energy source.

In recent years, this approach has emerged as a major energy-saving strategy, largely because it can often deliver substantial energy use reductions at a fairly modest cost. In addition to ARRA-based investments, another prominent example is the Recovery Through Retrofits initiative, overseen by the Council on Environmental Quality’s Middle Class Task Force. This initiative focused on overcoming market barriers to residential efficiency improvements, access to information, financing, and workforce training (White House Council on Environmental Quality undated). This follows on the efforts of numerous public utilities commissions and similar organizations as well as 26 States that have enacted energy savings targets, which often establish specific obligations or financial incentives for utilities to reduce energy consumption. Utilities in many jurisdictions are required to collect a separate monthly charge from customers that can only be used to fund efficiency programs. Others operate under a decoupling regulatory framework in which profits are determined not by direct revenues from energy sales, but rather from performance against a number of targets, including efficiency measures implemented. While such regulatory efforts initially focused on electric utilities, an increasing number apply to gas utilities as well (American Council for an Energy-Efficient Economy 2011).

On the household scale, the USDOE estimated that participants in its low-income weatherization program reduced their annual gas heating consumption by 32 percent (EERE 2009). Because the low-income households participating in this program have somewhat less efficient housing stock than the general population, this may overstate the potential gains somewhat, but it nonetheless indicates that there is room for substantial improvement among the entire universe of residential consumers. Forty million households are eligible for USDOE’s weatherization program (Eisenberg 2010).

On a larger level, States with gas reduction goals have generally set more modest statewide targets. For example, Massachusetts has a goal of 1.15 percent gas savings by 2012 and Minnesota’s goal is 1.5 percent savings in 2013. New York has the most aggressive and long-term goal, calling for a 14.7 percent reduction in gas demand by 2020 (Nowak et al. 2011).

In the near term, it is highly unlikely that all homes eligible for weatherization assistance, whether from USDOE or from State- or utility-level programs, will take advantage of them. Nonetheless, if all State-level programs weatherized as many homes as USDOE’s nationwide program, this would translate into a total of 200,000 homes per year, or one million over a five-year period (EERE 2009). Based on the average efficiency improvements noted above, this level of participation could result in 8.5 trillion Btu in natural gas savings, or an equivalent amount in oil or electricity.[29]

Long-Term Analysis of Substitutes. Over a longer timeframe, commercial and residential consumers will need to their replace space and water heating equipment and appliances as these objects reach the end of their useful lifespan. This will provide consumers with an opportunity to shift away from oil- and gas-fired equipment. Construction of new building stock and renovations of existing buildings allow further prospects for substitution.

The lowest capital cost substitution would typically be to replace oil- or gas-fired space and water heating equipment and appliances with electric-powered units, which are readily available and widely used. As noted above, in 2005, 30 percent of households used electricity as the primary energy source for space heating and 39 percent used it for water heating. Both of these proportions have been growing over the past several years (EIA 2009m).

Despite the lower up-front costs of electric space and water heating equipment, the fuel costs may be much higher compared to oil and gas. The Federal Energy Management Program estimates the annual energy cost of a typical gas water heater as approximately half the cost of an electric unit (EERE 2010), while the California Energy Commission reports that electricity usually costs three times as much as gas (California Energy Commission undated b). While gas water heaters are generally more expensive up front, the difference in fuel costs outweighs this initial price premium. A cost comparison for space heating is more complicated, and depends on the type of electric heating technology chosen. Appliances that use resistance heating (such as electric furnaces, baseboard heaters and electric oven/ranges) are generally uneconomical compared to gas or oil units (EERE 2011d; California Energy Commission undated c). On the other hand, air source heat pumps (which operate on the same principle as central air conditioners) are very efficient at moderate temperatures and may be cost competitive with oil or even natural gas, depending on local fuel prices and climate.[30] Some manufacturers also offer systems that heat pumps with natural gas backup heat (instead of traditional resistance heating), allowing consumers to take advantage of the most efficient heat source for a given ambient temperature.[31] Therefore, electricity remains a viable substitute for some end uses. The associated environmental impacts would depend on the fuel mix used to produce the electricity. These issues have been discussed previously, and we do not repeat them here.

A second substitute comes in the form of renewable energy, specifically solar water heaters. Solar water heaters use collectors to gather solar energy, which is then used to heat

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[29] 32 percent reduction in space heating gas demand per participating household × 1 million participating households / 111 million total households × 2,950 trillion Btu total household space heating gas demand = 8.5 trillion Btu savings.

[30] The Energy Information Administration maintains a detailed heating cost calculator at http://tonto.eia.doe.gov/ask/generalenergy_faqs.asp#compare_heating_fuels.

[31] Heat output of an air source heat pump declines with ambient temperature. Below a certain point (generally around 30–35°F), a backup heat source is required to maintain home temperature.

water in a storage tank. Active solar water heaters contain a circulating pump, while passive systems do not. Although solar water heaters are most effective in warm, sunny areas such as Florida or California, they can be used in colder locations as well. Germany, for example, has more than 9,800 MW_{th} of solar thermal capacity installed, while Austria has more than 3,200 MW_{th}. Most, but not all, of this is for water heating (EurObserv'ER 2011). In the United States, all 50 States have some form of incentive for solar water heating systems, while the Federal Government provides a tax credit covering 30 percent of the installed cost of such systems (N.C. Solar Center and Interstate Renewable Energy Council undated).

Solar water heaters usually have a gas or electric backup, to provide supplemental heating on cloudy days, in cold seasons, or in high-demand hours. As a result, they do not eliminate gas use entirely. The Solar Rating & Certification Corporation and the Energy Star program both estimate that typical solar water heaters cut gas consumption in half (Solar Rating and Certification Corporation undated; USDOE and USEPA undated a). If applied nationwide, this would imply residential gas savings of 700 trillion Btu and an additional oil savings of 150 trillion Btu. Solar water heating in the commercial sector could contribute modest further savings. Adoption on this scale is extremely unlikely; even 10 percent adoption, with savings of 70 trillion and 15 trillion Btu, would represent a substantial increase over current levels (less than one percent of U.S. homes used solar water heaters in 2005) (EIA 2009m). This would require significant policy support, as without generous tax credits or other incentives the higher upfront cost of a solar water heating system would make it uneconomical for most consumers to purchase, especially in less favorable climates.

Another alternative heating option is the geothermal (also known as the ground source) heat pump. Geothermal heat pumps take advantage of stable year-round temperatures below ground or in groundwater to provide a heat source in the winter or heat-sink in the summer. Geothermal heat pumps use 25–50% less energy than conventional heating and cooling systems, and provide excellent humidity control (USDOE 2011b). High installation costs (for underground or waterborne heat exchanger piping) have limited the use of geothermal heat pumps. They are generally installed only in new construction homes.

The other options for long-term substitution involve improvements to the building stock itself. Improved building-envelope efficiency has already been discussed as a short-term option. As stated earlier, if 200,000 homes per year are renovated, the resulting savings could reach 8.5 trillion Btu annually after five years. Simply extending this trend to a 25-year period would indicate that renovations to five million homes could save 42.5 trillion Btu in oil, gas, or electricity used for space heating. Of course, a more aggressive approach covering more homes would see proportionally greater impacts.

Over the long run, the building stock will also go through a more fundamental transformation, as new buildings are built to replace aging ones and to accommodate population growth. One well-regarded analysis estimates that 89 million new or replaced homes and 190 billion square feet of nonresidential building will be constructed by 2050, and that two-thirds of buildings that will exist at that time did not exist in 2007 (Ewing et al. 2008). For context, in 2009, there were an estimated 114 million households nationwide (EIA 2011r).

Given the massive scale of building expected, more efficient construction could produce substantial savings in oil and gas use for space heating (as well as electricity, for both heating and cooling). This could take the form of a greater number of high-efficiency buildings, such as those constructed to standards such as Energy Star or LEED, or improvements to building codes that raise minimum performance requirements for all buildings.

Minimum building energy efficiency standards have been tightening in recent years. The International Energy Conservation Code (IECC), a model code, is expected to require 30 percent energy savings in its 2012 form as compared to the 2006 code, which itself represented a significant improvement over prior years. Such a move would have far-reaching impacts. Thirty nine States have adopted residential codes based on some version of the IECC and most of these have adopted either the 2006 or 2009 versions. A similar number of States have adopted commercial energy codes based on ASHRAE 90.1, another model code (Online Code Environment & Advocacy Network undated). Presumably, these States will continue to adopt more recent versions of these codes as they are released.

On the upper end of the spectrum, voluntary standards have pushed 'green' buildings to outperform industry averages. The two most important such standards are Energy Star, managed by USEPA and USDOE, and the U.S. Green Building Council's LEED family of standards. The Energy Star program reports that 16,084 buildings and plants are currently Energy Star-certified (USDOE and USEPA undated b). To earn this designation, buildings must be more efficient than 75 percent of comparable buildings nationwide, which is roughly equivalent to 25 percent less energy use. LEED has been more widely adopted. As of March 2011, there were just over 30,000 registered commercial LEED building projects (U.S. Green Building Council 2011a). A 2008 study found that, while there was considerable variation between projects, the average LEED-certified commercial building had energy use 25 percent below that of conventional buildings (Turner and Frankel 2008). While this is similar to the results of the Energy Star program, LEED measures against presumed results from conventional new buildings, whereas Energy Star compares its buildings to existing buildings. This discrepancy notwithstanding, for our purposes we can assume that new commercial buildings meeting either the LEED or the Energy Star standard will result in at least a 25 percent reduction in energy use below current levels.

Both Energy Star and LEED also have programs addressing homes. Energy Star homes must be at least 15 percent more efficient than the 2004 International Residential Code, but with the additional energy-saving features included, they are typically 25 to 30 percent more efficient than standard homes. More than one million U.S. homes currently meet the Energy Star standard (USDOE and USEPA undated c). The LEED for Homes program has not achieved similar penetration, with just under 50,000 registered homes as of March 2011. As with commercial buildings, LEED measures energy gains versus standard new buildings. They estimate an average of 30 percent energy savings for LEED-certified homes (U.S. Green Building Council 2011b).

It can safely be assumed that most if not all new residential and commercial buildings will meet the stricter minimum standards envisioned by the latest IECC and ASHRAE energy codes. Meanwhile, the overall impact of LEED, Energy Star and other voluntary green building standards will depend on market penetration. While not attempting a definitive analysis, we can make some rough, order-of magnitude approximations to demonstrate the scale of potential savings. Replacing half of all currently existing residences and commercial buildings over the next 25 years, through new construction or retrofits, with buildings that are 25 percent more efficient in space heating (a conservative estimate, since space heating will likely account for a disproportionate level of total energy savings), would translate into an aggregate 12.5 percent reduction in space heating energy demand, or about 564 trillion Btu of natural gas and 164 trillion Btu of oil. If 10 percent of these buildings met Energy Star and/or LEED standards and realized a further 25 percent improvement from the new baseline, they would save an additional 42 trillion Btu of natural gas and 12 trillion Btu of oil from space heating. In total, under these assumptions more efficient new buildings could save approximately 782 trillion Btu of oil and natural gas per year within 25 years.

4.5.7.2 Analysis of the Environmental Effects of the No Action Alternative

The selection of the No Action Alternative would eliminate all oil and gas activities that were projected to occur under the Program. OCS-related activities could still occur, however, in these areas as a result of leasing activity during previous and future programs. At the same time, the No Action Alternative would require energy substitutes to replace the oil and gas production that would not occur as a result of the Program. The energy substitutions would be associated with their own potential environmental impacts that could occur within or outside program areas that were considered in the proposed action.

4.5.7.2.1 Energy Substitutions for OCS Oil and Gas. With less oil and gas available from the OCS under the No Action Alternative, consumers could obtain oil and gas from other sources, substitute to other types of energy, or consume less energy overall. Similarly, energy production may shift from OCS oil and gas to onshore oil and gas, overseas oil and gas production, or domestic production of oil and gas alternatives (e.g., coal). Each of these shifts in consumption and production relative to the proposed action yield environmental impacts that this section evaluates.

The process for calculating these impacts begins with the application of MarketSim, a multi-market equilibrium model that simulates the energy supply, demand, and price effects of OCS oil and gas production compared with baseline projections from the EIA's Annual Energy Outlook. In addition to simulating oil and natural gas markets, MarketSim includes separate modules for coal and electricity, enabling the model to capture the broad effects of the No Action Alternative across individual segments of the energy market. Modeling each of these sectors, MarketSim produces an estimate of the energy market's response to the absence of production that would occur as a result of the No Action Alternative.

Table 4.5.7-7 presents the changes in energy markets projected by MarketSim for the No Action Alternative. The table presents the quantities of the energy sources that would be used to replace the lost production of OCS hydrocarbons under the No Action Alternative. The quantities of domestic onshore production of both oil and natural gas is projected to increase but

TABLE 4.5.7-7 Cumulative Energy Substitutions for Oil and Gas Under the No Action Alternative

Energy Sector	Quantity[a]	Replacement Percent (%)
Domestic onshore oil	53–402	1–3
Domestic onshore gas	759–2,326	13–17
Oil imports	3,540–7,870	56–62
Gas imports	458–1,224	8–9
Other	108–274	2
Coal	335–925	5–6
Electricity[b]	146–388	3
Reduced demand[c]	330–814	6

[a] Quantities expressed as energy equivalents of a million bbl (Mbbl) of oil. Values derived from MarketSim output rounded to the nearest Mbbl. Range of values based on price assumptions of $60 and $160/bbl for oil and $4.27 and $11.39 per million cubic feet of gas. Quantities were calculated for a 40 year time period, which is slightly different than the 40-50 year assumed life of the program.

[b] Electricity generated from sources other than oil, gas or coal such as nuclear, hydro, solar and wind.

[c] Demand reductions resulting from energy conservation.

will make up for only a fraction of foregone OCS production. To ensure that demands for oil and gas are met, MarketSim projects a sharp increase in oil and gas imports under the No Action Alternative, via both tanker and pipeline. The model also projects that the reduction in OCS oil and gas production under the No Action Alternative will be replaced by an increase in domestic coal and electricity production and by energy conservation.

MarketSim projects that natural gas consumption will decline, while domestic consumption of oil, coal, and electricity will increase. Given that domestic oil production declines under the No Action Alternative, the increase in oil consumption may be somewhat unexpected. This increase in consumption reflects the fact that oil and gas are substitutes within the industrial sector and, to a lesser extent, the residential and commercial sectors. Therefore, as natural gas prices increase under the No Action Alternative, consumption of substitutes, including oil, increases. The increase in oil prices under the No Action Alternative may cause substitution in the opposite direction (i.e., from gas to oil), but the impact of increased gas prices is the more dominant of the two effects.

4.5.7.2.2 Impact Analysis.

Oil Spills. Table 4.5.7-8 shows the amount of oil projected to be developed in the planning areas considered in the Program and the amount of additional oil imported into planning areas that would be at risk from tanker spills because of their location relative to ports and terminals that would receive oil imports under the No Action Alternative. The table presents volumes of oil as a single quantity, rather than as a range of values, to simplify the comparison of quantities. The number of oil spills greater than 1,000 bbl that could result from import tanker accidents under the No Action Alternative and from accidents at OCS facilities and pipelines under the Proposed Action are presented. The number of spills was calculated by applying oil spill rates to the volume of OCS production and to the volume of import tankering projected under the two alternatives. Notably, the GOM is projected to experience four fewer large spills under the No Action Alternative. Part of this reduction is explained by the fact that the volume of oil imports under the No Action Alternative is smaller than the precluded volume of OCS oil that would have been produced under the No Action Alternative. Another factor is that tankering has a lower spill risk than OCS production in part because OCS production includes the risk of spills during both the production and the transportation phases, while tankering involves only risk during transportation. The production risk associated with oil import substitutes would occur in oil-exporting nations. It is interesting to note that while the Central GOM Planning Area accounts for most of the OCS oil production, and therefore would experience the greatest amount of reduction in oil spill risk under the No Action Alternative, the Western GOM Planning Area would experience the greatest amount of risk from the increased import tankering that is projected to occur.

Cook Inlet is projected to produce a small amount of oil under the proposed action and to import a small amount of oil as an energy substitute under the No Action Alternative. As a result, there would be no appreciable difference in oil spill risk between the two alternatives. Since there are no oil import ports or terminals in the Alaskan Arctic program area, the No Action Alternative would eliminate the risk from OCS sources without introducing any risk from oil tankers. It is important to keep in mind, however, that a reduction in the risk of oil spills from OCS production redistributes, rather than totally eliminates, the spill risk. As Table 4.5.7-8 shows, the Atlantic and Pacific coasts could each be exposed to an additional import tanker spill occurrence along these coasts under the No Action Alternative, whereas these areas would have no exposure to oil spill risk from OCS activities under the proposed action.

Routine Operations. Routine OCS operations, such as installing offshore facilities and pipelines, transporting materials and personnel from the coast to offshore, and conducting seismic surveys, are associated with impact factors that could have potential environmental effects. The effects of noise, collisions with service vessels, air emissions, drilling and production discharges, and other impact factors associated with OCS activities were analyzed in Section 4.4 of this draft PEIS. With no new OCS activity occurring under the No Action Alternative, the potential for impacts from these factors would be eliminated within the program areas considered in the proposed action. The elimination of potential impacts in these program areas could redistribute a range of other environmental impacts that would result from the development and transportation of energy substitutions. These impacts could occur on or near the OCS, or elsewhere. While insufficient data are available for quantification of these

TABLE 4.5.7-8 Projected Large Spill Occurrences under the No Action Alternative

Planning Area	Volume of Oil at Risk for Spill[a] (Bbbl)		Change in Spill Occurrence under the No Action Alternative[a]
	Proposed Action	Oil Imports	
Atlantic Coast	0	1.3	
North Atlantic	0	0.6	+1
Mid-Atlantic	0	0.5	
South Atlantic	0	0.1	
Straits of Florida	0	0.1	
Total Atlantic Coast	0	1.3	+1
Gulf of Mexico	4.1	2.7	
Central GOM	3.2	0.7	–2
Western GOM	0.8	1.9	1
Eastern GOM	<0.1	<0.1	0
Total GOM	4.1	2.7	–1
Pacific/South Alaska Coasts	0	1.6	
Southern California	0	0.4	+1
Central California	0	0.5	
Washington/Oregon	0	0.4	
Gulf of Alaska	0	0.2	
Shumagin	0	0.1	
Total Pacific/South Alaska Coasts	0	1.6	+1
Alaska Program Areas			
Cook Inlet	0.2	0.1	0
Arctic	1.6	0	–2
Alaska Program Area	1.8	0,01	–2

[a] OCS spill rate calculated as platform spill rate (0.25 spills/Bbbl) plus the pipeline spill rate (0.88 spills/Bbbl) since spills could occur at the platform or during transport. The tanker spill rate was calculated as 0.34 spills/Bbbl in lower 48 and 0.46 spills/Bbbl in Alaska.

substituted impacts, some issues of particular environmental concern from energy substitutions are listed below.

Acid Mine Drainage from Coal Mining. Runoff from coal mining sites may increase the acidity of surface waters near and downstream from coal mining sites, adversely affecting habitat for aquatic organisms and limiting human recreational uses.

Contamination of Groundwater from Oil and Gas Extraction. The extraction of oil and gas from onshore sources can, in some cases, lead to the contamination of local groundwater supplies. For example, focusing on shale gas extracted from wells in Pennsylvania and New York, Osborn et al. (2011) found that average methane concentrations in drinking water wells increased with proximity to the nearest gas well and were 17 times greater than wells not located near extraction sites (Osborn et al. 2011). In addition, oil and gas wells may lead to groundwater contamination from accidental spills, losses of well control, and/or pipeline leaks.

Water Discharges from Oil and Gas Operations.[32] To facilitate resource extraction from subsurface formations, oil and gas producers use water to develop pressure, causing oil and gas to rise to the surface (e.g., enhanced oil recovery and hydraulic fracturing). Producers must manage these waters as well as waters extracted from geologic formations during oil/gas extraction. The environmental impacts associated with this "produced water" vary based on the geologic characteristics of the reservoir that produced the water and the separation and treatment technologies employed by producers.

Coal Combustion Impacts. Coal consumed in place of gas under the No Action Alternative will result in environmental costs associated with diminished air quality and the disposal of coal combustion residuals. The combustion of coal in power plants or industrial boilers produces higher emissions of NO_X, SO_X, and PM than the combustion of natural gas and results in greater CO_2 emissions.[33] In addition, coal combustion residuals generated by power plants or coal-fired industrial boilers may pose a risk to local groundwater supplies when disposed in surface impoundments or landfills when such units are not properly maintained.

Socioeconomic and Sociocultural Effects. Sections 4.4.9.1 and 4.4.13.1 describe the effects of the proposed action on socioeconomic and sociocultural conditions, respectively, in the GOM. OCS oil- and gas-related activities have been an important source of employment and income in GOM coastal areas. According to Henry et al. (2002), the nature of blue-collar jobs in the oil and gas industry has been instrumental in the formation and persistence of Cajun culture in South Louisiana. The No Action Alternative would result in reduced employment and income opportunities and potentially could affect the stability and cohesion of communities and cultures. The No Action Alternative could also be interpreted as a boom-bust event. The infrastructure and population of affected areas in the GOM have developed over decades in association with a regular occurrence of lease sales and resulting OCS activities. The No Action Alternative could result in situations in which local infrastructure and populations could not be maintained,

32 This discussion is based on USEPA (2008a).

33 For detailed emissions data for power plants, see USEPA (2010d).

resulting in out-migration and a reduction in public services. Furthermore, the No Action Alternative's disruption of a continuous process of activity in the GOM could affect future investments which would compound the social, economic, and cultural effects associated with the No Action Alternative.

Conclusion. No potential impacts from routine operations or from accidental discharges described in Section 4.4 would occur under the No Action Alternative. Most of the oil that was projected to be developed in the Arctic under the Proposed Action would be replaced by tanker imports that would offload at U.S. ports, none of which are located within the Arctic area. Under the No Action Alternative, Arctic program areas would therefore not receive any impacts from the Program or from energy substitutions such as tankering. The spill risk associated with replacing the lost OCS Arctic oil production would be transferred to other Planning Areas along the Atlantic, GOM, and Pacific coasts where increases in oil imports and associated risks of tanker spills would occur. The Pacific and Atlantic coasts would each be exposed to the risk of one additional tanker spill under the No Action Alternative. About two-thirds of the lost OCS production in the GOM would be replaced by tanker imports into GOM terminals. The spill risk from tankering would be greater in the Western GOM Planning Area than in the Central GOM based on the location of terminals. There would be effects of the No Action Alternative on socioeconomic conditions in the GOM and potential effects on community cohesion and levels of public services available there. The potential exists for low-probability catastrophic consequences from the development of energy substitutes to OCS oil and gas. For example, a nuclear accident could occur as a result of nuclear power production or a catastrophic discharge event could occur in offshore waters of other nations during oil and gas exploration and production activities. The potential risk from impacts associated with routine OCS operations and activities removed under the No Action Alternative would be transferred to other areas within and beyond the OCS where energy substitutes such as imported and onshore oil and gas, and coal would be developed and transported.

4.6 CUMULATIVE IMPACTS

A cumulative impact, as defined by the CEQ, "results from the incremental impact of [an] action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or nonfederal) or person undertakes such other actions" (40 CFR 1508.7). The analyses presented in this section place the direct and indirect impacts of the 2012-2017 Program alternatives, presented in the preceding sections of Chapter 4, into a broader context that takes into account the full range of impacts of actions taking place within the Eastern, Western, and Central GOM and the Cook Inlet, Chukchi Sea, and Beaufort Sea Planning Areas currently and into the foreseeable future. Repeated actions, even minor ones, may produce significant impacts over time through additive or interactive (synergistic) processes. The goal of the cumulative impacts assessment, therefore, is to identify such impacts early in the planning process to improve decisions and move toward more sustainable development (CEQ 1997).

A separate analysis accounting for the full range of possible actions under the No Action Alternative (NAA) has not been included in the cumulative impacts assessment. However, the types of activities and most significant effects resulting from a no action scenario are addressed in Section 4.5.7. Moreover, many of the past, present, and reasonably foreseeable future actions and trends that would contribute to cumulative impacts under the Program "action" alternatives also contribute to cumulative impacts under the NAA. Under the NAA, there would be no OCS oil and gas lease sales conducted during the 2012-2017 Program, and as a result, energy would be obtained from other sources to replace the lost oil and gas production. Most of the lost OCS production would be replaced by tanker imports into GOM terminals, but some would also be made up by onshore production (transported via pipelines) and domestic production of oil and gas alternatives such as coal. Because the mix of non-OCS sources of energy and the locations of resource or energy development are unknown (but could occur throughout the United States or the world, on land or at sea), setting the spatial boundaries for the NAA over the 40- to 50-year time frame of the cumulative impacts analysis is tantamount to speculation. For this reason, a separate treatment of the cumulative effects under NAA is not considered herein.

4.6.1 Methodology for Assessing Cumulative Impacts

The general approach for the cumulative impacts assessment follows the principles outlined by the CEQ (1997) and the guidance developed by the EPA (1999) for independent reviewers of environmental impact statements. It also considers the findings and recommendations of the NEPA task force as they pertain to programmatic assessments and environmental management systems (NEPA Task Force 2003). The cumulative impacts analyses presented in Sections 4.6.2 (Marine and Coastal Physical Resources), 4.6.3 (Marine and Coastal Habitats), 4.6.4 (Marine and Coastal Fauna), and 4.6.5 (Social, Cultural, and Economic Resources) incorporate the following basic guidelines:

- The individual receptors and receptor groups (i.e., resources, ecosystems, and human communities) identified in the affected environment sections of Chapter 3 become the endpoints or units of analysis;
- Direct and indirect impacts of the proposed action (Alternative 1) and other action alternatives (Alternatives 2 through 7) described in the environmental consequences sections of Chapter 4 form the basis for the impact-producing factors considered;
- Impact-producing factors are derived from a set of past, present, and reasonably foreseeable future actions (including the Program) and trends; and
- The spatial and temporal boundaries are defined around the individual receptors and receptor groups and the set of past, present, and reasonably foreseeable future actions and trends that could impact them.

The cumulative impacts assessment focuses on the resources, ecosystems, and human communities that may be affected by the incremental impacts associated with the Program (under any of the seven action alternatives) in combination with other past, present, and reasonably foreseeable future actions. The CEQ discusses the assessment of cumulative impacts in detail in its report, *Considering Cumulative Effects under the National Environmental Policy Act* (CEQ 1997). On the basis of the guidance provided in this report, the following methodology was developed for assessing cumulative impacts:

1. Potential cumulative impacts issues associated with the Program (under any of the seven action alternatives) were identified during the scoping and consultation phases of the assessment. Other actions and issues were added later as they were identified.

2. The spatial boundaries of cumulative impacts (i.e., regions of interest) were defined. The regions of interest encompass the geographic areas of affected resources, ecosystems, and human communities, and the distances at which impacts associated with the Program and other past, present, and reasonably foreseeable future actions may occur. The spatial boundaries for the cumulative impacts assessment are discussed in Section 4.6.1.1.1.

3. The temporal boundaries (i.e., the time frame) of cumulative impacts were defined. The time frame of the cumulative impacts analysis extends from the past history of impacts on each receptor or receptor group through the anticipated life of the Program and beyond. The temporal boundaries for the cumulative impacts assessment are discussed in Section 4.6.1.1.2.

4. Past, present, and reasonably foreseeable future actions were identified. These include projects and activities that could impact resources, ecosystems, or human communities within the defined regions of interest and within the defined time frame. Other processes and general trends (e.g., those associated with climate change) were also identified. Past and present actions are generally accounted for in the analysis of direct and indirect impacts under each resource area as part of the current baseline (described in Chapter 3) and are carried forward to the cumulative impacts analysis. The exploration and development scenarios for the Program cumulative cases in the GOM, Cook Inlet, and Arctic regions are presented in Section 4.6.1.2.1. The types of other past, present, and reasonably foreseeable future actions and general trends in the GOM, Cook Inlet, and Arctic OCS regions are identified and described in Sections 4.6.1.2.2, 4.6.1.2.3, and 4.6.1.2.4.

5. The potential impact-producing factors of past, present, and reasonably foreseeable future actions and general trends were determined. Impact-producing factors are the mechanisms by which an action or trend affects a given resource, ecosystem, or human community. The contributions of impact-producing factors from various actions and general trends were aggregated to form the contextual framework of the cumulative impact assessment to follow.

6. Cumulative impacts were evaluated by considering the incremental impacts of the Program (under any of the seven action alternatives) in combination with

> other past, present, and reasonably foreseeable future actions and general trends. The cumulative impacts analyses for resources, ecosystems, and human communities are presented in Sections 4.6.2, 4.6.3, 4.6.4, and 4.6.5, and are summarized at the end of each section. Conclusions for resource and systems analyses in these sections use the same four-level classification scheme that was used for the direct/indirect impacts analyses, as defined in Section 4.1.4. A comprehensive summary of cumulative impacts for each of the OCS regions is provided in Section 4.6.6.

Cumulative impacts on a given resource, ecosystem, or human community may result from single actions or a combination of multiple actions over time. They may be additive, less than additive (countervailing), or more than additive (synergistic). The analyses presented in the following sections identify these effects and their importance where they are thought to occur.

Because this is a programmatic-level assessment, lease sale-specific issues, such as the determination of appropriate mitigation measures and environmental monitoring, are not addressed here. However, BOEM imposes environmental controls on operators through rules and regulations included in its lease sale proposals (see Appendix B). These rules and regulations include lease stipulations, OCS regulations, notice to lessees (NTLs), and other measures to protect the environment from the effects of lease-related activities. Environmental protection on the OCS is an ongoing priority. The BSEE has broad permitting and monitoring authority to ensure safe operations and environmental protection as OCS projects within a lease block are implemented.

The cumulative impacts assessment presented in this PEIS is the first of many such analyses that will be conducted for activities under the Program. NEPA reviews are required for various phases of projects taking place within a lease block or portion of a lease block; these reviews will focus on the application and enforcement of mitigation measures, as well as environmental monitoring to demonstrate the effectiveness of such measures (see Table 1-1).

Appendix C provides a listing of Federal laws and Executive Orders that would apply to leasing under the Program.

4.6.1.1 Spatial and Temporal Boundaries for the Cumulative Impacts Assessment

4.6.1.1.1 Spatial Boundaries. The spatial boundaries, i.e., regions of interest, for the cumulative impacts assessment encompass the geographic areas of affected resources and the distances at which impacts associated with past, present, and reasonably foreseeable future actions may occur. For the cumulative impacts analysis, marine and coastal ecoregions are used as the spatial framework for most resources because they encompass the areas potentially affected by the Program and other (non-Program) actions, both within and beyond the administrative (planning area) boundaries in which such activities are taking place. Marine ecoregions are ecosystem-based regions defined according to the boundaries of LMEs developed by NOAA (see Section 3.2). The analysis also uses the marine and coastal ecoregions developed by the CEC for North America to subdivide the LMEs into more localized regions, as appropriate. Coastal and nearshore areas are delineated by coastal ecoregions. The geographic scope of the cumulative analysis varies depending on the resources being evaluated. Table 4.6.1-1 provides a summary of the regions of interest for the cumulative assessment by resource for the GOM, Cook Inlet, and Arctic OCS regions.

The regions of interest presented in Table 4.6.1-1 are relevant for the proposed action (Alternative 1) and other action alternatives (Alternatives 2 through 7) because they span the broadest possible geographic areas of affected resources and the extent of their potential impacts. It is acknowledged, however, that the spatial boundaries of each of the action alternatives are different in that each alternative omits one of the planning areas included in the proposed action for the duration of the Program (see Chapter 2).

4.6.1.1.2 Temporal Boundaries. The cumulative impacts analysis incorporates the sum of the effects of the Program in combination with other past, present, and future actions, since impacts may accumulate or develop over time. The future actions described in this analysis are those that are "reasonably foreseeable"; that is, they are ongoing (and will continue into the future), are funded for future implementation, or are included in firm near-term plans. The reasonably foreseeable time frame for future actions evaluated in this analysis is 40 to 50 years from the time the Program takes effect (in 2012). This time frame represents the temporal boundaries for all the alternatives.

4.6.1.2 Past, Present, and Reasonably Foreseeable Future Actions

The cumulative impact analyses that follow evaluate OCS oil and gas related activities associated with the Program, as well as activities associated with past and future 5-year programs that could occur over the next 40 to 50 years. These are presented in Section 4.6.1.2.1 under the cumulative case for the GOM, Cook Inlet, and Arctic OCS regions. The analyses also take into consideration impacts from other types of actions and general trends not related to the Program. These actions and trends and their impact-producing factors are described in Sections 4.6.1.2.2 (GOM), 4.6.1.2.3 (Cook Inlet), and 4.6.1.2.4 (Arctic Region).

4.6.1.2.1 Cumulative Case Scenario for the OCS Program. Tables 4.6.1-2 and 4.6.1-3 present the exploration and development scenarios for the cumulative case for the GOM and Alaska (Cook Inlet and Arctic) regions, respectively, over the next 40 to 50 years. The cumulative case scenarios take into account activities that will be part of the Program, as well as those from past and future 5-year OCS programs. The estimates for each case represent the broadest possible analysis of potential elements affecting the OCS over the next 40 to 50 years, consistent with the proposed action (Alternative 1), and are, therefore, also applicable to the other action alternatives (Alternatives 2 through 7) considered in this PEIS since each alternative is the same as the proposed action (less one planning area) for the duration of the Program (see Chapter 2). Certain effects, however, were not considered under the cumulative cases presented here. For example, Alternative 4 includes all but one of the six planning areas

TABLE 4.6.1-1 Regions of Interest for the Cumulative Impacts Analysis by Resource

	Regions of Interest		
Resource	Gulf of Mexico	Cook Inlet	Arctic Region
Water Quality	Coastal waters (bays and estuaries), marine waters (State offshore and Federal OCS), and deep water (depths greater than 305 m [1,001 ft])	All waters of Cook Inlet	Coastal waters (bays); and marine (State offshore and Federal OCS) and deep waters in the Chukchi and Beaufort Seas
Air Quality	Coastal counties in Texas, Louisiana, Mississippi, Alabama, and Florida	Kenai Peninsula, Alaska Peninsula, and Kodiak Island Boroughs	North Slope Borough
Acoustic Environment (Noise)	GOM LME	Gulf of Alaska LME	Chukchi Sea and Beaufort Sea LMEs
Coastal and Estuarine Habitats	Estuarine drainage areas (NOAA); coastal and nearshore habitats, including barrier islands, beaches, wetlands, and seagrasses	Coastal and nearshore habitats within estuarine watersheds of the coastline and around bays, lagoons, and river mouths; includes beaches, marshes, tidal flats, scarps, riverine mouths/deltas, and marine algae	Coastal and nearshore habitats within estuarine watersheds along the coastline and around bays, lagoons, and river mouths; includes barrier islands, beaches, low tundra, marshes, tidal flats, scarps, peat shorelines, and marine algae
Marine Benthic Habitats	Seafloor of the OCS and slope/deep sea; includes soft sediments, hard bottom areas, chemosynthetic communities, warm water coral reefs, and deepwater coral reefs	Seafloor of the Alaska Fjordland Shelf Ecoregion; includes Kachemak Bay, Shelikof Strait, and lower Cook Inlet; and Gulf of Alaska (oil spills)	Seafloor of the Beaufort/ Chukchi Shelf Marine Ecoregion and the Arctic Slope and Arctic Plains Marine Ecoregions
Marine Pelagic Habitats	Water column and water surface of the Mississippi and Texas Estuarine Areas	Water column and water surface of the Cook Inlet and Shelikof Strait	Water column and water surface of the Beaufort/ Chukchi Shelf Marine Ecoregion

TABLE 4.6.1-1 (Cont.)

	Regions of Interest		
Resource	Gulf of Mexico	Cook Inlet	Arctic Region
Essential Fish Habitat	Water and substrate of coastal, estuarine, and marine environments; includes submerged aquatic vegetation, emergent intertidal wetlands (marshes and mangroves), soft-bottom (mud, sand, or clay), live/hard-bottom, oyster reefs, coral reefs, marine sediment, continental slope, chemosynthetic cold seeps, *Sargassum*, and manmade structures identified by the GOM Fishery Management Council	Water and substrate from the lower Cook Inlet to the Gulf of Alaska shelf; includes estuaries, bays, kelp forests, and reefs identified by the Gulf of Alaska Fisheries Management Area of the North Pacific Fisheries Management Council	Water and substrate of the Arctic Management Area
Marine Mammals (ESA- and non-ESA species)	Northern GOM waters	Cook Inlet Level III Coastal Region; Gulf of Alaska Level III Coastal Region	Beaufort/Chukchian Self Level II Ecoregion, including the Chukchian Neritic and Beaufortian Neritic Level III Ecoregions
Terrestrial Mammals (ESA- and non-ESA species)	Coastal habitats of northern GOM waters	Coastal habitats in the Cook Inlet Planning Area and nearby coastal habitats in the Gulf of Alaska	Coastal habitats of the Arctic region
Marine and Coastal Birds (ESA- and non-ESA species)	Northern GOM coastline, including coastal habitats used by migratory species from northern latitudes; includes coastal wetlands and marshes, mud flats, and beaches	Cook Inlet Planning Area, including coastal habitats (wetlands and bays) used by migratory species; includes mudflats, beaches, lagoons, and islands	Beaufort and Chukchi Seas, including coastal habitats
Reptiles (ESA- and non-ESA species)	Coastal habitats of the Eastern, Western, and Central GOM Planning Areas	NA[a]	NA

TABLE 4.6.1-1 (Cont.)

Resource	Regions of Interest		
	Gulf of Mexico	Cook Inlet	Arctic Region
Fish	Northern GOM waters and seafloor (continental shelf to abyssal plain) and associated rivers, bays, lakes, and estuaries	Cook Inlet waters and seafloor and associated rivers and bays	Waters and seafloor of the Beaufort and Chukchi Seas and associated bays, ice, and reefs
Invertebrates	Northern GOM Shelf and Slope Marine Ecoregions	Cook Inlet and Gulf of Alaska	Beaufort and Chukchi Seas
Special Areas of Concern	Eastern, Western, and Central GOM Planning Areas, including adjacent onshore areas	Cook Inlet and Gulf of Alaska Planning Areas, including adjacent onshore areas	Beaufort and Chukchi Seas Planning Areas, including adjacent onshore areas
Population, Employment and Income	129 counties in the 23 Labor Market Areas (LMAs) in Texas, Louisiana, Mississippi, Alabama, and Florida along the GOM coast	Anchorage municipality, Kenai Peninsula, Kodiak Island, and Matanuska-Susitna Boroughs	North Slope and Northwest Arctic Boroughs
Land Use and Infrastructure	Coastal counties along the northern GOM	Lands in the vicinity of the Cook Inlet Planning Area	Land in the vicinity of the Beaufort and Chukchi Seas Planning Areas
Commercial and Recreational Fisheries	GOM coastal States	Upper and Lower Cook Inlet Management Areas; Gulf of Alaska	Arctic Management Area
Tourism and Recreation	Coasts of Florida, Alabama, Mississippi, Louisiana, and Texas	Cook Inlet area (including Anchorage), Kenai Peninsula, and Prince William Sound	North Slope Borough (mainly Barrow or Deadhorse)
Sociocultural Systems and Subsistence	Coastal counties along the northern GOM	South central Alaska (including Anchorage, Kenai, Soldotna, Nikiski, Port Lions, and Alaska Native communities)	Adjacent Native communities

TABLE 4.6.1-1 (Cont.)

	Regions of Interest		
Resource	Gulf of Mexico	Cook Inlet	Arctic Region
Environmental Justice	129 counties in the 23 LMAs in Texas, Louisiana, Mississippi, Alabama, and Florida along the GOM coast	Anchorage municipality, Kenai Peninsula, Kodiak Island, and Matanuska-Susitna Boroughs	North Slope and Northwest Arctic Boroughs
Archaeological and Historic Resources	Eastern, Western, and Central GOM Planning Areas, including adjacent onshore areas (e.g., river channels, floodplains, terraces, levees)	Cook Inlet Planning Area, including adjacent onshore areas	Beaufort and Chukchi Seas Planning Areas, including adjacent onshore areas

[a] NA=not applicable.

TABLE 4.6.1-2 Estimated Offshore Exploration and Development Activity for All of GOM OCS Cumulative Case Compared to the 2012-2017 Program

Activity Elements[a]	Estimated Activity for all GOM OCS Cumulative Case[b]	GOM OCS 2012-2017 Program Activity
Years of activity	40–50	40–50
Oil (Bbbl)[c]	18–26	2.7–5.4
Gas (Tcf)[d]	76–112	12–24
New Platforms[e]	1,400–2,000	200–450
FPSOs[f]	1–6	0–2
No. of exploration and delineation wells	6,900–9,800	1,000–2,100
No. of development and production wells	8,500–12,000	1,300–2,600
Miles of pipeline	19,000–43,000	2,400–7,500
Service vessel trips/week to new facilities	1,400–1,900	300–600
Helicopter trips/week to new facilities	12,000–24,000	2,000–5,500
New pipeline landfalls	0–40	0–12
New natural gas processing facilities	0–14	0–12
Platforms removed with explosives	870–1,200	150–275
Drill Muds/Well (tons)		
New exploration and delineation wells	1,000	1,000
New development and production wells	1,000	1,000
Drill Cuttings/Well (tons)		
New exploration and delineation wells	1,200	1,200
New development and production wells	1,200	1,200
Produced Water/yr (Mbbl) [g]		
Oil well	19,000–27,000	73–140
Natural gas well	161–247	26–52
Bottom Area Disturbed (ha)[h] *for new activity*		
Platforms	960–12,000	150–2,500
Pipeline	9,500–69,000	2,000–11,500

[a] See Figure 4.6.1-1 and Section 3.11 Land Use and Infrastructure figures depicting current levels of OCS GOM activity elements.

[b] Except where noted.

[c] Bbbl = billion barrels.

[d] Tcf = trillion cubic feet.

[e] Note that these platform numbers are only for new activity associated with past, present, or reasonably foreseeable future programs. The number of platforms currently active on the GOM OCS is approximately 3,000.

[f] FPSOs = floating, production, storage, and offloading systems.

[g] Based on 1.04 bbl produced water/bbl of oil, and 86 bbl produced water/1 Mcf gas (Clark and Veil 2009); Mbbl = million barrels. Calculations based on the total volume of oil or gas produced; actual discharges at a well are highly variable depending on geologic formation and age of well.

[h] Assumes 0.7–6 ha (1 ac) per platform and 0.5–1.6 ha (1.2–2.5 ac) per mile of pipeline.

TABLE 4.6.1-3 Offshore Exploration and Development Scenario for the OCS Program Alaska Cumulative Case and the OCS 5-Year Program under the Proposed Action[a]

	Arctic Region				South Central Alaska Region	
	Beaufort Sea		Chukchi Sea		Cook Inlet	
Scenario Elements	Cumulative Case	OCS 5-Year Program	Cumulative Case	OCS 5-Year Program	Cumulative Case	OCS 5-Year Program
Years of activity	40–0	40–50	40–50	40–50	40–50	40–50
Oil (Mbbl)[b]	500–1,100	200–400	1,500–6,225	500–2,200	100–200	100–200
Gas (Tcf)[c]	0–5.75	0–2.2	0–24.75	0–8.0	0–0.68	0–0.68
Platforms	2–10	1–4	3–16	1–5	1–3	1–3
No. of exploration and delineation wells	12–40	6–16	12–54	6–20	6–12	6–12
No. of platform production wells	90–310	40–120	180–880	60–280	42–110	42–110
No. of subsea production wells	20–25	10	54–235	18–82	0	0
Miles of new offshore pipelines	50–423	30–155	150–1,000	25–250	25–150	25–150
Miles of new onshore pipelines	40–290	10–80	250–500	0	50–105	50–105
Service vessel trips/week[d]	2–30	1–12	3–48	1–15	1–3	1–3
Helicopter trips/week	2–30	1–12	3–48	1–15	1–3	1–3
New pipeline landfalls	0	0	0	0	0–1	0–1
New shore bases	0	0	0	0	0	0
New waste facilities	2–4	0	2–4	0	0	0
New natural gas processing facilities	2–4	0	2–4	0	0	0
Docks/causeways	2–4	0	2–4	0	0	0
Exploration well muds, cuttings, produced water	425 tons dry mud with 80% recycled; 525 tons dry rock cuttings, totaling 610 tons discharged at each well site.		425 tons dry mud with 80% recycled; 525 tons dry rock cuttings, totaling 610 tons discharged at each well site.		360 tons dry mud, with 80% recycled; 450 tons dry rock cuttings; totaling 522 tons per site.	

TABLE 4.6.1-3 (Cont.)

	Arctic Region				South Central Alaska Region	
	Beaufort Sea		Chukchi Sea[a]		Cook Inlet	
Scenario Elements	Cumulative Case	Proposed Action	Cumulative Case	Proposed Action	Cumulative Case	Proposed Action
Development wells muds, cuttings, produced water	All muds, cuttings, and produced water treated and disposed of in wells.		All muds, cuttings, and produced water treated and disposed of in wells.		All muds, cuttings, and produced water discharged down hole.	
Bottom Area Disturbed (ha)[e]						
Platforms	3–15	1.5–6	4–24	1.5–7.5	1.5–4.5	1.5–4.5
Pipelines[f]	70–595	42–217	210–1,400	35–350	35–210	35–210
Surface Soil Disturbed (ha)[g]						
Pipeline	290–1,825	70–584	1,825–3,650	0	365–770	365–770

[a] Values for the cumulative case represent the proposed action (under the 2012 to 2017 OCS program) and actions associated with ongoing and future OCS program oil and gas activities. Because no OCS program oil and gas activities other than those associated with the 5-yr 2012–2017 OCS program are anticipated in the Cook Inlet Planning Area, the cumulative case scenario for the Cook Inlet Planning Area is the same as for the proposed action.

[b] Mbbl = million barrels.

[c] Tcf = trillion cubic feet.

[d] In the Arctic region, service vessel trips will only occur during open-water and broken-ice conditions (typically during August and September).

[e] Assumes 0.7–6 ha (1.7–15 ac) per platform and 0.5–1.6 ha (1.2–4.0 ac) per mile of pipeline.

[f] Value represents bottom area disturbance from offshore pipeline construction only.

[g] Onshore pipeline construction only. Assumes 7.3 ha (18 ac) per pipeline mile.

included in the proposed action (Alternative 1): the Central GOM Planning Area. The Program under Alternative 4 could have the effect of diverting oil and gas exploration and development activity to the Western GOM Planning Area (or elsewhere) or accelerating activity already planned there to compensate for lost production in the Central GOM Planning Area.

It should be noted that the cumulative case scenario for the Arctic planning areas reflects inherent uncertainty about the future of OCS oil and gas activities. To date, there have been no development and production activities on the Arctic OCS, partly because of operational issues related to the extreme environmental conditions and legal issues associated with approving activities in the region. The values presented in Table 4.6.1-3 for the cumulative case reflect a small increase in activity in the Arctic as a result of future leasing beyond the 2012-2017 Program. These values are for analytical purposes only and are not intended as forecasts of future activity. At this time, future activity is unpredictable and could span a considerable range. Transportation and other scenario assumptions that were used in the proposed action exploration and development scenario and impact analyses (Section 4.4.1) also apply to the cumulative analyses.

Estimates of the assumed numbers of large and small oil spills that could result from all Program activities over the 40- to 50-year time frame are presented in Table 4.6.1-4. The source and number of assumed spills were based on the volume of anticipated oil production in each region, the assumed mode of transportation (pipeline and/or tanker), and the spill rates for large spills. Assumptions regarding the number of large oil spills from import tankers were based on the estimated level of crude oil imports and worldwide tanker spill rates. We assume that these spills would occur with uniform frequency over the life of the Program.

There is currently a total of 29,097 lease blocks in the GOM planning areas; of these, 7,800 are active (Section 4.4.1.1). Shallow-water oil production in the GOM OCS has been in decline since 1997, and is expected to be offset by deepwater production over the life of the Program. Over the next 5 years, BOEM projects that GOM OCS oil production will exceed 1.7 Mbbl/day (620 Mbbl annually). Gas production is expected to increase, then level off to about 8 Bcf/day (2,920 Bcf annually) (Karl et al. 2007).

The Cook Inlet Planning Area has had oil and gas operations in State waters since the late 1950s and currently has a well-established oil and gas infrastructure. The most recent sale in which leases were purchased occurred in 1997 (when two leases were purchased). A lease sale was held in 2004, but no leases were purchased (Section 4.4.1.2). There are currently no existing OCS-related oil and gas activities in Cook Inlet.

There has been no oil and gas development activity in the Arctic planning areas. Since 1979, 10 lease sales have been held in the Beaufort Sea Planning Area and three in the Chukchi Sea Planning Area, but no activity has resulted to date (Section 4.4.1.3).

The impact-producing factors for the Program (under any of the action alternatives) are listed in Table 2.10-1. A summary of related impacts is provided in Table 2.10-2.

TABLE 4.6.1-4 Large and Small Oil Spill Assumptions for the Cumulative Case

		Number of Spill Events[a]		
			Arctic Region	South Alaska Region
Scenario Elements	Assumed Spill Volume	Gulf of Mexico Region	Beaufort and Chukchi Seas	Cook Inlet
Oil Production (Bbbl)[b]		18–26	2–7.3	0.1–0.2
Large (bbl)	≥1,000			
Pipeline	1,700[c]	16–23	1–6	1 spill from either
Platform	5,000[d]	4–7	1–2	
Tanker	3,100–5,800[e]	5–10		
Small (bbl)[f]	≥50 to <1,000	230–330	25–95	1–3
	≥1 bbl to <50	1,350–1,950	150–550	7–15

[a] The assumed number of spills are estimated using the 1996–2010 spill rates in Anderson et al. (2012). The assumed spill rate for pipeline is 0.88 spills/Bbbl produced. The assumed spill rate for platforms is 0.25 spills/Bbbl produced. For the Alaska OCS region, the 1996–2010 spill rates were compared to fault-tree rates in Bercha Group, Inc. (2011, 2008a, b, 2006). The greater number of spills from Anderson et al. (2012) is represented in Table 4.6.1-4. The values provided for the Arctic region are the combined totals for the Beaufort and Chukchi Seas.

[b] Bbbl = billion barrels.

[c] During the last 15 years (1996–2010), 7 oil spills ≥1,000 bbl occurred from U.S. OCS pipelines. The median spill size was 1,720 bbl. The maximum spill size between 1996 and 2010 from U.S. OCS pipelines was 8,212 bbl.

[d] During the last 15 years (1996–2010), 2 oil spills ≥1,000 bbl occurred from U.S. OCS platforms. During Hurricane Rita, one platform and two jack-up rigs were destroyed, and a combined total of 5,066 bbl were spilled. The median spill size, when not accounting for a decreasing trend in the rate of platform spills over 1964–2010, is 7,000 bbl. The low-probability very large spill occurrence, such as the DWH event, is represented as a catastrophic spill event.

[e] 3,100 bbl for tankers in the GOM; 5,800 bbl for TAPS tankers transporting Alaska OCS oil.

[f] The number of spills <1,000 bbl is estimated using a spill rate for both pipeline and platform spills.

4.6.1.2.2 Non-OCS Program Actions and Trends – Gulf of Mexico Region. Table 4.6.1-5 summarizes ongoing and reasonably foreseeable future actions and trends affecting resources and systems in the GOM. Past and present actions are generally accounted for in the baseline environment (described in Chapter 3) and the analysis of direct and indirect impacts under each resource area (Section 4.4). These impacts are carried forward to the cumulative analysis, which also takes into account the effects of ongoing and reasonably foreseeable future actions and trends. Cumulative scenarios (based on types of actions) and impact-producing factors are described for each action or trend on the basis of recent environmental reports or NEPA reviews.[34] General locations of ongoing and reasonably foreseeable future actions in the GOM relative to the OCS planning areas and LMEs are shown on maps provided throughout this section.

Ongoing Oil and Gas Exploration, Development, and Production. Oil and gas development is the main industrial activity occurring in the GOM region. In addition to activity related to past OCS programs, oil and gas development has taken place in the coastal waters of the GOM States and in Mexico's waters. These activities contribute to cumulative effects on air and water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine and terrestrial mammals, and birds), commercial and recreational fisheries, sociocultural systems (local economies and subsistence), and cultural resources (if present). Important impact-producing factors associated with oil and gas development in the GOM include subaerial noise and subsea noise and vibrations, platform lighting, engine emissions and fuel spills (marine vessels), oil spills (storage tanks and vessel casualty), hazardous spills and releases, oil and chemical releases (from wells and produced water), disturbance or injury of fish and wildlife, habitat displacement or degradation, chronic seafloor disturbance (by anchors and mooring lines), bottom sediment disturbance (turbidity and contaminant resuspension), resource consumption, wildlife collisions with infrastructure and marine vessels, and collisions among marine vessels (e.g., 1979 collision of the Burmah Agate tanker with the freighter Mimosa about 8 km (5 mi) off Galveston, Texas, as documented by ERCO [1982]).

State Waters. All the GOM States except Florida[35] have active oil and natural gas programs in both offshore State waters and on coastal lands. In 2009, oil and natural gas produced in GOM State waters totaled 503 million barrels (Mbbl) and 114 Bcf, respectively (EIA 2010a, b). Offshore State oil and gas activity levels are highest in Texas and Louisiana, a long-established trend that will likely continue over the next 40 to 50 years. Figure 4.6.1-1 shows active producing wells and oil/gas pipelines in State waters of the GOM (Louisiana only; producing wells and oil/gas pipeline data for Texas were not publicly available).

Crude oil production in Texas has a long history, but has declined over the past decade (from approximately 449 Mbbl in 1999 to 404 Mbbl in 2009). During the same period, its

[34] It should be noted that the DWH event is not included in Table 4.6.1-5 since it is not an on-going or reasonably foreseeable future event. However, the effects of the DWH event are incorporated into the cumulative impacts sections for those resources it has affected.

[35] A drilling moratorium in Florida State waters has been in effect since July 1990 and there has been no leasing of tracts since the early 1980s (Lloyd 1991).

TABLE 4.6.1-5 Ongoing and Reasonably Foreseeable Future Actions and Trends – Gulf of Mexico

Type of Action or Trend	Associated Activities, Facilities, or Processes	Impact-Producing Factors	Affected Resources and Systems
Ongoing oil and gas exploration, development, and production (onshore, in State and Federal OCS waters and Mexico's waters)	Construction of infrastructure (ports, platforms, and pipelines) Onshore fuel storage tanks, refineries, and transfer stations Pipeline landfalls Onshore support facilities (e.g., pipe yards) Operations and maintenance Seismic surveys Exploratory drilling Waste generation (produced water, drilling fluids, and muds/cuttings) Oil and gas production Decommissioning (plugging production wells and removing infrastructure) Marine vessel traffic Aircraft traffic	Subaerial noise and subsea noise and vibration Platform lighting (offshore) Engine emissions (marine vessels) Fuel spills (marine vessels) Oil spills (storage tanks and vessel casualty) Hazardous spills/releases Oil and chemical releases (wells and produced water) Disturbance or injury of fish and wildlife Habitat displacement and degradation Chronic seafloor disturbance (by anchors and mooring lines) Bottom sediment disturbance (turbidity and contaminant resuspension) Resource consumption Collisions (wildlife with infrastructure and marine vessels) Collisions (among marine vessels)	Air quality, water quality, acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, sociocultural systems (local jobs and revenue, and subsistence harvesting), and cultural resources (if present)
Existing oil and gas infrastructure (onshore, and in State and Federal waters)	Ports Exploration wells Oil and gas pipelines Pipeline landfalls Platforms Tanker vessels Louisiana Offshore Oil Port Onshore fuel storage tanks and transfer stations	Noise Engine emissions (marine vessels) Fuel spills (marine vessels) Oil spills/releases (tanker accidents, transfers, and pipeline or well releases) Hazardous spills/releases Collisions (wildlife with infrastructure and marine vessels) Collisions (among marine vessels)	Air quality, water quality, acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, sociocultural systems (local jobs and revenue, and subsistence harvesting), and cultural resources (if present)

TABLE 4.6.1-5 (Cont.)

Type of Action or Trend	Associated Activities, Facilities, or Processes	Impact-Producing Factors	Affected Resources and Systems
Oil imports	Tanker traffic Lightering (transfer) operations	Noise Oil spills Engine emissions (tankers) Collisions (wildlife with tankers) Collisions (among marine vessels)	Air quality, water quality, acoustic environment, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds)
Onshore industry and agriculture	Port facilities Erosion control structures (e.g., jetties and groins) Platform fabrication yards Shipyards Support and transport facilities Pipelines Pipecoating plants and yards Natural gas processing plants and storage facilities Refineries Petrochemical plants Waste management facilities Land-based vehicle traffic and equipment Agricultural crops and livestock	Noise Erosion of downdrift areas Engine emissions (marine vessels and land-based vehicles and equipment) Fuel spills (marine vessels and land-based vehicles and equipment) Permitted discharges to air and water Pollutant releases via surface runoff (non-point sources) Hazardous spills/releases Collisions (wildlife with vessels and infrastructure)	Air quality, water quality, acoustic environment, coastal habitats, benthic and marine habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, sociocultural systems (local jobs, subsistence harvesting), and cultural resources (if present)
Commercial fishing	Fishing vessel traffic Use of drifting gear (purse nets and bottom longlines) Use of pots and traps Use of hook and line Bottom trawling Surface longlining	Noise Fuel spills (fishing vessels) Disturbance or injury of marine wildlife (e.g., ingestion and/or entanglement) Bottom sediment disturbance (turbidity and contaminant resuspension) Damage to hard bottoms (e.g., reefs) Resource consumption	Water quality, acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (local jobs and revenue)

TABLE 4.6.1-5 (Cont.)

Type of Action or Trend	Associated Activities, Facilities, or Processes	Impact-Producing Factors	Affected Resources and Systems
Alternate energy development	Wind, wave, and ocean current technologies and infrastructure (including subsea cables) Technology testing (bottom sampling, deep-tow sonar surveys, borings) Facility construction and operation Periodic maintenance (by marine vessel) Facility decommissioning (facility removal)	Subaerial noise and subsea noise and vibration Bottom sediment disturbance (turbidity and contaminant resuspension) Collisions (wildlife with infrastructure)	Acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and cultural resources (if present)
Military operations	Surface marine vessel traffic Aircraft traffic Aerial operations (e.g., flight training) Submarine operations Offshore dumping areas (ordnance, chemical waste, vessel waste)	Subaerial noise and subsea noise and vibration Engine emissions (marine vessels) Fuel spills (marine vessels) Disturbance or injury of fish and wildlife Bottom sediment disturbance (turbidity and contaminant resuspension) Contaminant releases Collisions (wildlife with marine vessels)	Water quality, acoustic environment, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds)
Marine vessel traffic	Crude oil tankers LNG tankers Commercial container vessels Tugs and barges Military vessels U.S. Coast Guard vessels (search, rescue, and homeland security) Cruise ships Commercial fishing vessels Small watercraft	Noise Engine emissions (marine vessels) Fuel spills (marine vessels) Discharges of bilge water and waste Oil spills (vessel casualty) Increased wave action (nearshore and along navigation channels) Collisions (wildlife with marine vessels) Collisions (among marine vessels)	Air quality, water quality, acoustic environment, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds)

TABLE 4.6.1-5 (Cont.)

Type of Action or Trend	Associated Activities, Facilities, or Processes	Impact-Producing Factors	Affected Resources and Systems
Scientific research	Oceanographic and biological surveys Marine vessel traffic (including submersibles) Sampling, tagging, and tracking species of interest Seismic surveys Drilling Sediment and subsurface sampling Well installation and geophysical logging	Subsea noise and vibration Disturbance or injury of wildlife Bottom sediment disturbance (turbidity and contaminant resuspension)	Water quality, acoustic environment, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds)
Liquefied natural gas (LNG) import terminals (offshore)	Operation of existing LNL terminal Construction and operation of new onshore and offshore LNG import terminals Tanker traffic	Accidental explosions or fires Cooled water releases Fuel spills (tankers) Collisions (wildlife with tankers)	Water quality, marine and coastal habitats, marine and coastal fauna (fish and marine mammals)
Marine mineral mining	Marine vessel traffic Bottom sampling and shallow coring Mining (coastal waters) Coastal and barrier island restoration Beach nourishment Public works projects	Noise Bottom sediment disturbance (turbidity and contaminant resuspension) Resource consumption	Water quality, acoustic environment, and marine and coastal habitats
Wastewater discharge to MARB watershed and GOM waters	Discrete conveyances such as pipes or man-made ditches from sewage treatment plants, industrial facilities, and power generating plants Drilling wastes (offshore) Marine vessel and platform discharges	Permitted releases to water Pollutant releases via surface runoff (non-point sources)	Water quality, marine and coastal habitats, marine and coastal fauna (fish, mammals, and birds), commercial and recreational fisheries, and sociocultural systems (local communities and subsistence harvesting)

TABLE 4.6.1-5 (Cont.)

Type of Action or Trend	Associated Activities, Facilities, or Processes	Impact-Producing Factors	Affected Resources and Systems
Persistent contaminants and marine debris	Accumulation of contaminants from multiple sources (discharges, spills, and releases; and atmospheric deposition) Accumulation of floating, submerged, and beached debris	Exposure to contaminants in marine waters and sediments, and in the food web via toxicity or bioaccumulation Collisions (marine vessels with debris) Entanglement in or ingestion of debris by marine wildlife Habitat displacement and/or degradation	Water (and sediment) quality, marine and coastal habitats, marine and coastal fauna (fish, mammals, and birds), commercial and recreational fisheries, and sociocultural systems (subsistence harvesting)
Hypoxic zone in northern GOM	Accumulation of nutrients mainly from MARB watershed Seasonal zone of depleted dissolved oxygen (increasing in size and during over the past 50 years)	Exposure to low dissolved oxygen levels in marine waters (with mortality and reproduction impacts also affecting food web) Habitat displacement and/or degradation	Water quality, marine and coastal habitats, marine and coastal fauna (benthic organisms and fish), commercial and recreational fisheries, and sociocultural systems (subsistence harvesting)
Dredging and marine disposal	Excavation of subaqueous sediments Transport of sediments (by dredger or pipeline) Relocation and disposal of sediments	Noise Reduction of sediment deposition on downdrift landforms Bottom sediment disturbance (turbidity and contaminant resuspension)	Water quality, acoustic environment, marine and coastal habitats, marine and coastal fauna (fish and marine mammals), and cultural resources (if present)
Recreation and tourism	Shores and beaches Resorts, marinas, parks, and gardens Recreational and sport fishing Water sports Cruise ships	Noise Disturbance or injury of fish and wildlife Habitat displacement and/or degradation Economic activity	Air quality, water quality, acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (jobs and revenues, and subsistence harvesting)
Climate change	Increase in atmospheric and ocean temperatures Increase in precipitation rate Increase in storm frequency and intensity Sea level rise and coastal erosion Ocean acidification	Changes in water quality (temperature, salinity, and pH) Changes in water circulation Changes in storm frequency and intensity Saltwater intrusion (coastal aquifers)	Air quality, water quality, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds)

TABLE 4.6.1-5 (Cont.)

Type of Action or Trend	Associated Activities, Facilities, or Processes	Impact-Producing Factors	Affected Resources and Systems
Legislative actions (existing and forthcoming)	Federal statutes and regulations Executive Orders State statutes and regulations International agreements	Management and protection of various resources throughout the marine and coastal regions of the GOM	All resources

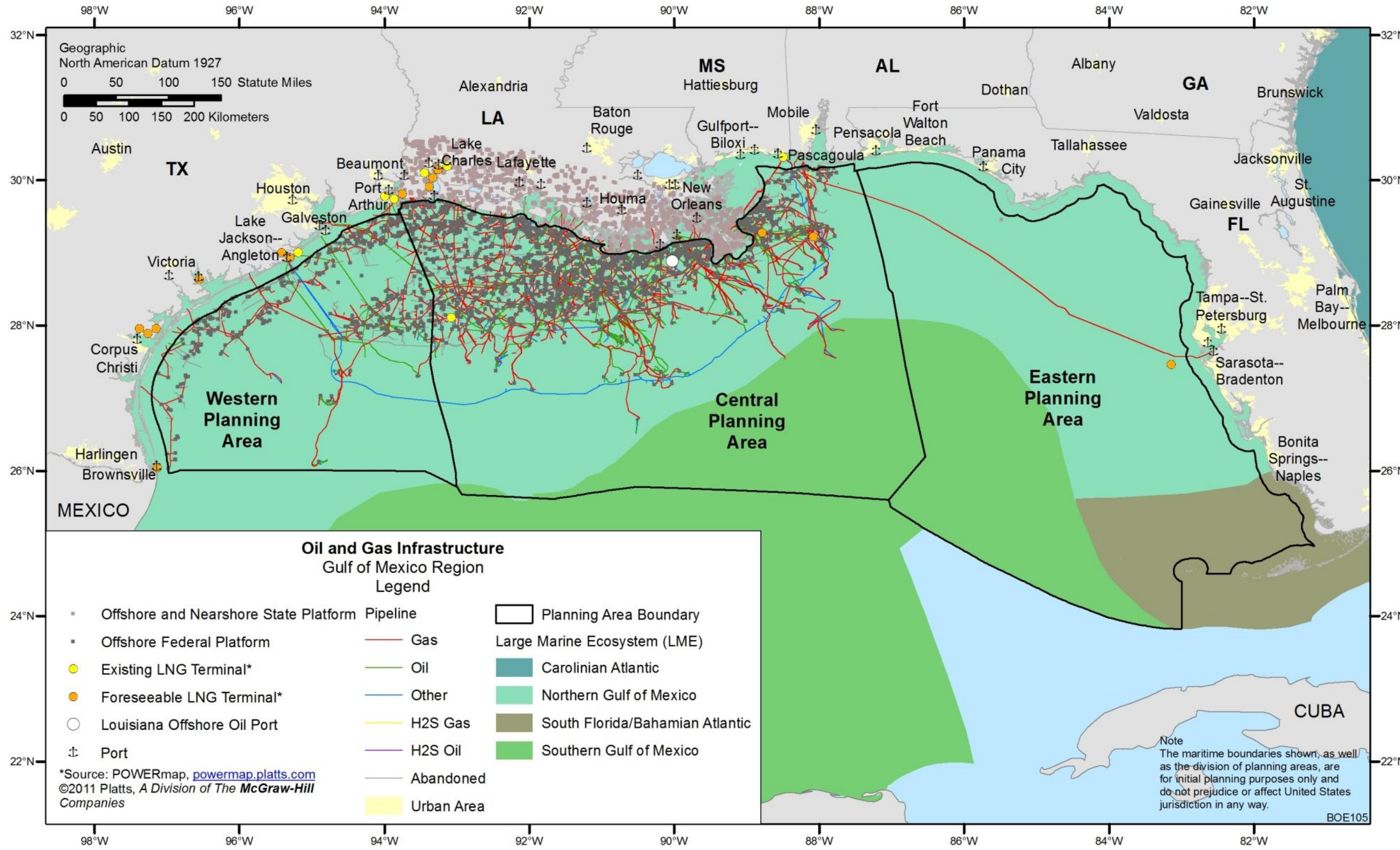

FIGURE 4.6.1-1 Oil and Natural Gas-Related Infrastructure in State Waters and GOM OCS Planning Areas

offshore production increased from 475,000 to 897,000 bbl (EIA 2000, 2010a). From 2005 to 2009, the State's offshore gas withdrawals (from gas and oil wells) totaled 38 Bcf (EIA 2010b). Louisiana's offshore program produced 5.5 Mbbl of crude oil in 2009; from 2005 to 2009, its offshore gas withdrawals totaled 76 Bcf (EIA 2010a, b).

Although Mississippi ranked eleventh in the nation in both crude oil and natural gas production in 2009 (EIA 2010a, b), the State does not currently have an offshore program. Alabama did not produce crude oil from offshore waters in 2009; however, from 2005 to 2009 its offshore gas withdrawals totaled 109 Bcf (EIA 2010b).

Mexico's Waters. Mexico is the world's seventh largest crude oil producer (producing about 2.6 Mbbl/day in 2010) and the second largest source of oil imports to the United States. Most of its current production comes from the two oil fields, Cantarell and Ku-Maloob-Zaap (KMZ), located about 80 km (50 mi) offshore in the Bay of Campeche, in the southern GOM. In 2010, oil production from the Cantarell field was 558,000 bbl/day, down 74% from its peak production level of 2.14 Mbbl/day in 2004. Production from the KMZ field has offset some of these losses, producing 839,200 bbl/day in 2010. (Natural gas production from the Cantarell field has increased since 2005, totaling 457 Bcf in 2010.) As of January 1, 2011, Mexico had 10.4 Bbbl of proven oil reserves, most of which are concentrated offshore in the Campeche Basin, more than 1,000 km (620 mi) to the south of the Louisiana coast (EIA 2011s).

Various types of oil and gas related infrastructure exist within Mexico's offshore region. These include platforms and pipelines, natural gas flares, natural gas processing and pipeline distribution networks (including a pipeline network with 10 active connections with the United States), and two LNG terminals (with another currently under construction) (EIA 2011s). A major oil spill resulting from a blowout at the Ixtoc I platform in the Cantarell oil field in 1979 resulted in a release of about 3.3 Mbbl of oil, some of which travelled as far as the Texas shoreline (ERCO 1982; Miglierini 2010).

In February 2012, the United States and Mexico signed the *Transboundary Hydrocarbons Agreement* in relation to the development of oil and gas reservoirs that cross the international maritime boundary between the two countries in the GOM. The agreement provides a legal framework and establishes guidelines for transboundary commercial developments between U.S. companies and Petroleos Mexicanos (Pemex), Mexico's State-owned oil and gas company. It provides for joint inspections teams to ensure compliance with applicable laws and regulations (U.S. Department of State 2012).

Existing Oil and Gas Infrastructure. The oil and gas industry in the GOM is one of the most developed in the world. There are currently more than 3,200 active platforms in operation at water depths less than 61 m (200 ft) and 63 active platforms at water depths greater than 61 m (200 ft) (26 of which are in waters greater than 300 m [1,000 ft] deep) (Figure 4.6.1-1). An estimated 41,843 km (26,000 mi) of oil and gas pipeline stretches across the seafloor. As of October 2011, there were more than 38,000 approved applications to drill in the GOM (BOEM 2012c; NOAA 2011c). Oil and gas infrastructure contributes to cumulative effects on air and water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, sociocultural systems (local economies and subsistence), and cultural resources (if present). Important impact-producing factors associated with infrastructure include noise, engine emissions (marine vessels), fuel spills (marine vessels), oil spills or releases (tanker accidents, transfers, and pipeline or well releases), hazardous spills or releases, wildlife collisions with infrastructure and marine vessels, and collisions among marine vessels.

The Louisiana Offshore Oil Port (LOOP), operated by Marathon Domestic LLC, is a deepwater port petroleum terminal located in the GOM, about 26 km (16 mi) southeast of Port Fourchon (Figure 4.6.1-1). The terminal has been operational since 1981 and serves as an unloading and distribution port for supertankers entering the GOM. Petroleum is transported via pipeline from the LOOP to Lafourche Parish where it is stored and distributed to U.S. markets. Marathon Domestic LLC has announced its intention to expand the port’s storage capacity and construct a new pipeline; but no near term plans have been submitted to Maritime Administration (MARAD) or the USCG (MARAD 2012). Operations at the LOOP may contribute to cumulative effects on water quality, marine and coastal habitats, and marine and coastal fauna (fish, mammals, and birds). An important impact-producing factor associated with the LOOP is oil spills (from tanker accidents, transfers, and pipeline releases).

Oil Imports. U.S. imports of crude oil and petroleum products grew steadily every year from 1981, when the annual total was 2.2 Bbbl, to a peak in 2005, when the annual total was 5.0 Bbbl. Since 2005, imports have been in decline, dropping to an annual total of 4.3 Bbbl in 2009 (its lowest point since 2000). The Gulf Coast district was the largest importer of crude oil, with a total of 1.9 Bbbl in 2009 (EIA 2010b, 2011a). The USDOE estimates that crude oil imports will continue to decline from 2009 to 2035 as the growth in demand is met by domestic production (EIA 2011b). Canadian oil imports, representing about 21% of the total in 2009, are delivered by pipeline (EIA 2010a). The remaining oil arrives in the United States on tankers. In 2009, an estimated 3,800 tankers were received in GOM ports, about 10 tankers daily (assuming an average tanker capacity of 500,000 bbl).

Tanker traffic in the GOM contributes to cumulative effects on air and water quality, the acoustic environment, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds). Important impact-producing factors associated with tanker traffic include noise, oil spills (from accidents and lightering operations), wildlife collisions with tankers, and collisions among marine vessels.

Onshore Industry and Agriculture. Oil and gas development and production play an important role in onshore industrial development in the GOM region. Onshore industry provides locations from which offshore operations are staged and where the exploration and production equipment, personnel, and supplies used for oil and gas operations on the GOM OCS originate (see Section 3.11.1). The level of use of onshore facilities and new facility development closely follow the level of activity in offshore drilling. The types of onshore facilities that support the offshore oil and gas industry include port facilities (12 of the nation’s 20 largest ports are located in the GOM), platform fabrication facilities, shipyards, shipbuilding and repair facilities, support and transport facilities, pipelines, pipe coating yards, natural gas processing and storage facilities, refineries, petrochemical plants, and waste management facilities. Figures 3.11.1-4 and 3.11.1-5 (Section 3.11) show the locations of these facilities. Onshore industry contributes to cumulative effects on air and water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, sociocultural systems (local economies and subsistence), and cultural resources (if present). Important impact-producing factors include noise, engine emissions and fuel spills (marine vessels and land-based vehicles and equipment), permitted discharges to air and water, pollutant releases via surface water runoff, hazardous spills or releases, and wildlife collisions with marine vessels and infrastructure.

Agriculture in the Mississippi and Atchafalaya River Basins (MARB) contributes 70% of the nitrogen and phosphorus discharged to the northern GOM each year. These nutrients originate mainly from cultivated crops (predominantly corn and soybean), but also from animal grazing and manure on pasture and rangelands. Urban sources contribute another 9 to 12% (Alexander et al. 2008). Nutrient loadings in the MARB contribute to cumulative effects on water quality (hypoxia), marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, and sociocultural systems (local economies and subsistence). Important impact-producing factors include permitted discharges to water and nutrient releases via surface water runoff.

Several Federal and State initiatives are in progress to control nutrient loads in the MARB (GOM Task Force 2012). These include the following:

- *Clean Water Act (CWA) Impaired Waters (USEPA).* Under Section 303(d) of the CWA, States have identified more than 15,000 nutrient-related impairments, the majority of which are in MARB States. Over the past 20 years, Total Maximum Daily Loads (TMDLs) have been developed to address nutrient loads in impaired waters.

- *Numeric Nutrient Criteria (USEPA).* The USEPA is working with States to develop water quality criteria for nutrients (phosphorus and nitrogen) in States within the Mississippi River Basin.

- *Nutrient Application Management System (USDA).* Under the nutrient application management system, land is managed to control the amount, source, placement, form, and timing of the application of plant nutrients and soil amendments; since 2000, 113,312 km^2 (28 million acres) of land within the MARB have been managed under this system.

- *Erosion Control Practices (USDA).* Since 2005, erosion control practices associated with crop production on 137, 593 km^2 (34 million acres) of land within the MARB have helped to reduce sheet and rill erosion, thus improving soil fertility, soil health, and sustainable crop production, and reducing offsite impacts such as phosphorus loads in surface runoff.

The ultimate goal of these initiatives is to reduce or make progress toward reducing the areal extent of the hypoxic zone in the GOM to a 5-year running average of less than 5,000 km^2

(1,930 mi^2) by the year 2015, as stated in the *Gulf Hypoxia Action Plan* developed by the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (GOM Task Force 2008).

Commercial Fishing. Commercial fishery landings in the GOM, including western Florida, Alabama, Mississippi, Louisiana, and Texas, amounted to an estimated 649,000 metric tons in 2009, worth more than $629 million (see Section 3.12.1.1). Commercially important species groups in the GOM include oceanic pelagic (epipelagic) fishes, reef (hard bottom) fishes, coastal pelagic species, and estuarine-dependent species. White and brown shrimp accounted for 25% and 23%, respectively, of the entire GOM commercial fishery in 2009. In terms of total landing weight reported in 2009, the top U.S. ports in the GOM region were Empire-Venice, Louisiana; Intracoastal City, Louisiana; and Pascogoula-Moss Point, Mississippi. The highest reported total catch values were for two ports in Louisiana: Empire-Venice ($67.2 million) and Dulac-Chauvin ($50.9 million).

In 2010, the DWH event, located about 80 km (50 mi) southeast of the Mississippi River, caused the temporary closure of both offshore and nearshore/inshore commercial fishing grounds, stressing an industry already severely damaged by Hurricanes Katrina and Rita in 2005. The effects of the DWH event are still being assessed and recovery efforts (e.g., habitat restoration and stock assessments) are regularly monitored to assess their effectiveness (GSMFC 2011). By November 15, 2010, the NOAA Fisheries Service reported that there were about 2,697 km^2 (1,041 mi^2) or 0.4% of fishing areas in the GOM still closed because of the DWH event (down from a high of about 229,270 km^2 [88,522 mi^2] or 36.6% on June 2, 2010). All fishery areas were reopened as of April 19, 2011 (NOAA 2012c).

While fishery-related activities have beneficial effects to local economies, they may also contribute to adverse cumulative effects on water quality, the acoustic environment, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds). Important impact-producing factors include noise, fuel spills, disturbance or injury of marine wildlife (ingestion and/or entanglement), bottom sediment disturbance (turbidity and contaminant resuspension), damage to hard bottoms (e.g., reefs), and resource consumption.

Alternate Energy Development. The Energy Policy Act of 2005 amended Section 8 of the Outer Continental Shelf Lands Act (OCSLA) (43 USC 1337) to give the Secretary of the Interior authority to issue a lease, easement, or ROW on the OCS[36] for activities that are not otherwise authorized by the OCSLA or other applicable law, if those activities:

- Produce or support production, transportation, or transmission of energy from sources other than oil and gas; or

- Use, for energy-related purposes or other authorized marine-related purposes, facilities currently or previously used for activities authorized under the OCSLA, except that any oil and gas energy-related uses shall not be

[36] This excludes areas on the OCS within the exterior boundaries of any unit of the National Park System, National Wildlife Refuge System, National Marine Sanctuary System, or any National Monument.

> authorized in areas in which oil and gas preleasing, leasing, and related activities are prohibited by a moratorium.

In response to this new authority, BOEM of the USDOI, formerly the Minerals Management Service (MMS), established an Alternative Energy and Alternate Use Program on the OCS (now referred to as its Renewable Energy Program) to approve and manage these potential activities. BOEM completed its PEIS to evaluate the potential environmental impacts of implementing the program and established initial policies and best management practices to mitigate these impacts in October 2007 (MMS 2007e). Each project developed under this new program will be subject to environmental reviews under NEPA, and each project may have additional project-specific mitigation measures. On April 22, 2009, BOEM published its final regulations to establish an environmentally responsible Renewable Energy Program on the OCS. Documents and information related to the program can be found at http://www.boem.gov/Renewable-Energy-Program/index.aspx.

While it is too early to predict the number and types of alternate uses and renewable energy projects that could be developed over the next 40 to 50 years, several OCS renewable energy projects have been proposed. Most of these are wind energy projects. The first commercial wind lease (Cape Wind off the coast of Massachusetts) was signed by the Secretary of the Interior in 2010 and its construction is expected to begin by the end of 2011 (BOEMRE 2011g). Noncompetitive leases for 14 lease areas off the coasts of New Jersey (6), Delaware (1), Georgia (3), and southeast Florida (4) have also been approved. These leases are for data collection and technology testing activities related to the development of wind and ocean current resources (BOEMRE 2011h). None of these leases are within the subject regions for this PEIS.

Alternate energy projects provide beneficial effects in terms of providing cleaner sources of energy and adding jobs to local communities. They may also contribute to adverse cumulative effects (mainly during their construction) on the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and cultural resources (if present). Important impact-producing factors associated with alternate energy development in the GOM include subaerial noise and subsea noise and vibration, bottom sediment disturbance (turbidity and contaminant resuspension), and wildlife collisions with infrastructure.

Military Operations. Numerous U.S. military bases are located along the GOM coast (Figure 4.6.1-2; see also Section 3.9.1.2.3). U.S. Navy air stations serve as training bases in jet aviation, sea and air rescue, and coastal mine countermeasures, as well as home ports for various ships and operations. Some support U.S. Army and USCG activities. The U.S. Air Force conducts training activities over the deepwater region of the GOM. There are more than 40 military warning areas in the northern GOM region; most of these areas are designated for testing and training operations and overlie waters that are less than 800 m (2,600 ft) deep. Several military dumping areas have also been designated within the GOM planning areas (Figure 4.6.1-2). These areas are used for the disposal of spoil, ordnance, chemical waste, and vessel waste. To avoid multiple-use conflicts in GOM OCS areas used by both the military and oil and gas lessees and operators, BOEM applies a standard military areas stipulation to all leases in the Western and Central GOM Planning Areas.

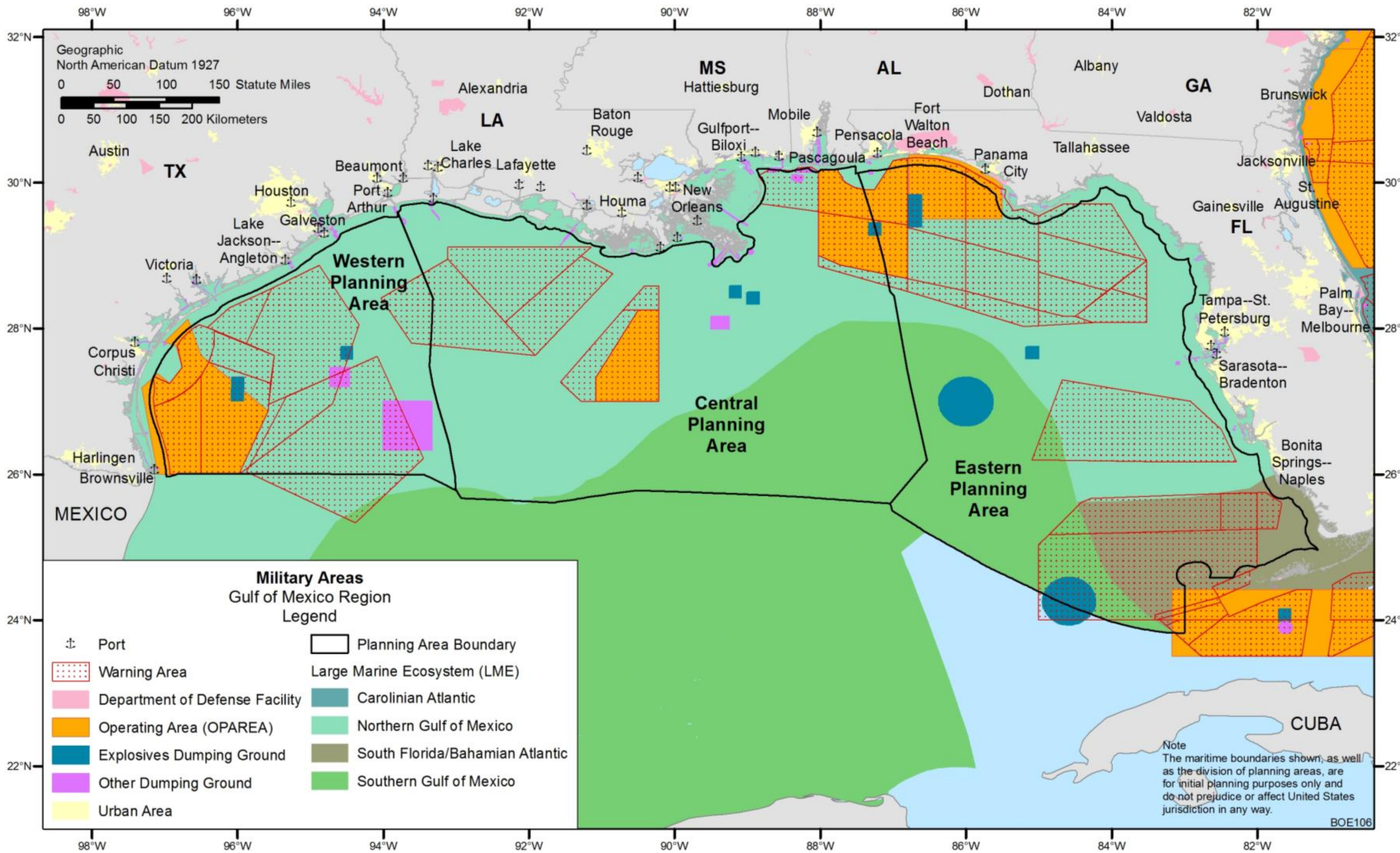

FIGURE 4.6.1-2 Military Operations and Dumping Grounds in the GOM OCS Planning Areas

Military operations in the GOM are expected to continue and military use areas are expected to remain the same (and not be released for nonmilitary use) over the next 40 to 50 years. These operations contribute to cumulative effects on water quality, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds). Important impact-producing factors associated with military operations include subaerial noise and subsea noise and vibrations, engine emissions (marine vessels), fuel spills (marine vessels), disturbance or injury of fish and wildlife, bottom sediment disturbance (turbidity and contaminant resuspension), contaminant releases, and wildlife collisions with marine vessels.

Marine Vessel Traffic. Marine vessel traffic includes crude oil and LNG tankers, commercial container vessels, military, USCG vessels, cruise ships, commercial fishery vessels, and small watercraft. In 2009, a total 18,956 vessel calls were made in GOM ports, comprising about 34% of all U.S. vessel calls. U.S. vessel calls overall have been in decline in recent years (down 7% in 2009 from 2004) (USDOT 2011b). It is estimated that about 60% of all crude oil imports into the United States are delivered by tanker ships entering through the GOM (VesselTrax 2007). BOEM expects that over the next 40 to 50 years, total vessel calls in GOM ports will rise about 3% per decade beyond current rates.

Marine vessels in the GOM contribute to cumulative effects on air and water quality, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds). Important impact-producing factors associated with tanker traffic include noise, engine emissions, discharges of bilge water and waste, fuel spills, oil spills (vessel casualty), wildlife collisions with marine vessels, increased wave action (nearshore and along navigation channels), and collisions among marine vessels. Figure 4.6.1-3 shows shipping channels (also known as shipping safety fairways) in the GOM.

Scientific Research. Various ongoing scientific studies are conducted by Federal and State agencies, universities, and organizations to study water quality and biological resources (and systems) in coastal and marine waters of the GOM. Research operations typically involve research cruises or the use of robotic or human-operated submersible vessels. Such research provides important information on the stock, safety, and value of GOM fisheries; the effects of various actions taking place in the region (e.g., oil spills); the status of the seasonal hypoxic zone; and the effects of global climate change. Activities related to scientific research of biological systems requires some human presence and interaction with wildlife, such as sampling, tagging, or tracking species of interest.

Other types of research relate more to the physical processes and systems within the GOM: depositional and erosional processes (along the coast and on the OCS), seafloor geology and geologic hazards (e.g., mass wasting and subsidence), and non-oil and gas energy resources (e.g., gas hydrates). Activities related to scientific research of physical systems involve the use of marine vessels, and include seismic surveys, ocean floor drilling/sampling, well installation, and geophysical logging.

Research-related activities in the GOM are likely to increase over the next 40 to 50 years (in response to concerns over the environmental effects of the DWH event and climate change). While such activities are necessary and beneficial, they may also contribute to adverse

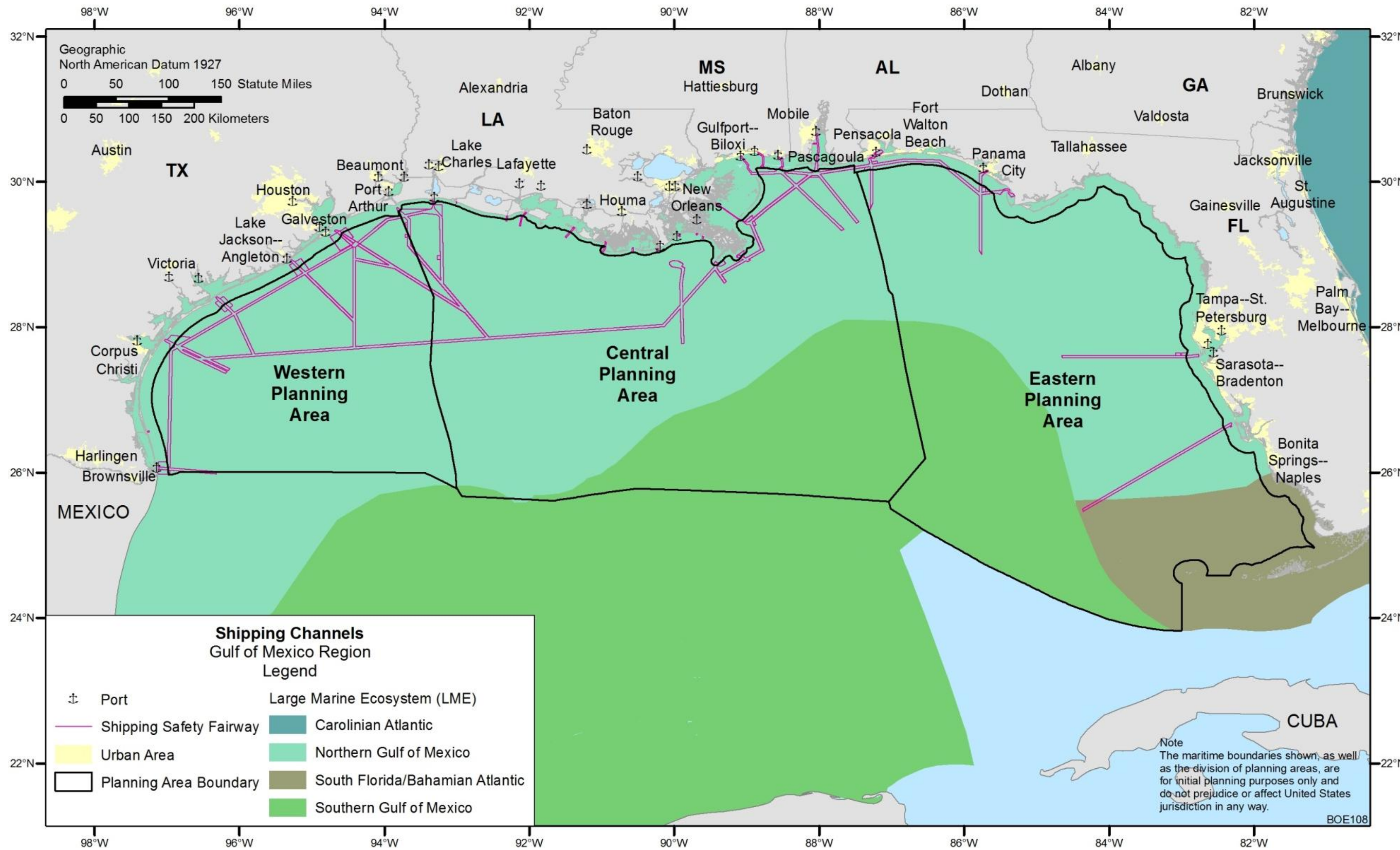

FIGURE 4.6.1-3 Shipping Channels in the GOM

cumulative effects on water quality, the acoustic environment, coastal and marine habitats, and coastal and marine fauna (fish, marine mammals, and birds). Important impact-producing factors include subsea noise and vibration, disturbance or injury of fish and wildlife, and bottom sediment disturbance (turbidity and contaminant resuspension).

Liquefied Natural Gas Terminals. The United States is an importer and exporter of natural gas (EIA 2010b). The USDOE projects a significant increase in overall natural gas consumption between 2009 and 2035; estimates of LNG imports over this period are variable, ranging from 140 to 2,140 Bcf by 2035 (EIA 2011b). The United States currently operates 12 LNG import terminals, only one of which is located offshore in the GOM — the Gulf Gateway Energy Bridge, a 0.5 Bcf/day facility operated by Excelerate Energy, located off the coast of Louisiana (Figure 4.6.1-1; FERC 2012a). It is reasonably foreseeable that additional LNG terminals will be constructed in the GOM over the next 40 to 50 years to offload LNG from tankers into the existing offshore natural gas pipeline system. As of February 2012, an additional seven applications for licenses to import LNG (or expand current LNG facilities) have been approved by FERC (Figure 4.6.1-1). These include three along the coast of Texas (Cheniere, Corpus Christi; Cheniere/Freeport LNG Expansion, Freeport; and Gulf Coast LNG Partners, Port Lavaca) and one along the Louisiana coast (Sempra-Cameron LNG Expansion, Hackberry). The U.S. Department of Transportation (MARAD) has also approved three offshore LNG import terminals: Main Pass — McMoRan Exploration Company and TORP Technology-Bienville LNG (in the GOM) and the Hoegh LNG-Port Dolphin Energy facility (offshore Florida) (FERC 2012b). An additional seven LNG import terminals have been proposed off the coast of Texas and Louisiana (FERC 2012c).

LNG import terminals in the GOM contribute to cumulative effects on water quality, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds). Important impact-producing factors include accidental explosions or fires, cooled water releases, fuel spills (LNG tankers), and wildlife collisions with LNG tankers.

Marine Mineral Mining. Marine minerals, such as sulfur, sand, gravel, and shell, have been extracted in the northern part of the GOM. OCS sand and gravel resources are currently used for coastal restoration, beach nourishment, barrier island restoration, and other purposes such as public works projects (Figure 4.6.1-4). BOEM has conveyed rights to about 44 million m^3 (58 million yd^3) of OCS sand for 31 coastal restoration projects in five States, under the authority of the *Outer Continental Shelf Lands Act*. A summary of completed and ongoing noncompetitive lease agreements for OCS sand and gravel resources issued under the BOEM Marine Minerals Program can be found on BOEM's Marine Mineral Projects Web page at http://www.boem.gov/Non-Energy-Minerals/Marine-Mineral-Projects.aspx. It is expected that funding for State-led restoration projects will increase over the next 40 to 50 years and such projects will request offshore sand resources from both State and Federal jurisdictions; however, most of these resources will come from the OCS.

While mining in GOM coastal waters has beneficial effects when materials are used for restoration projects, it may also contribute to adverse to cumulative effects on water quality, the acoustic environment, and marine and coastal habitats. Important impact-producing factors associated with mining are turbidity/contaminant resuspension caused by bottom sediment

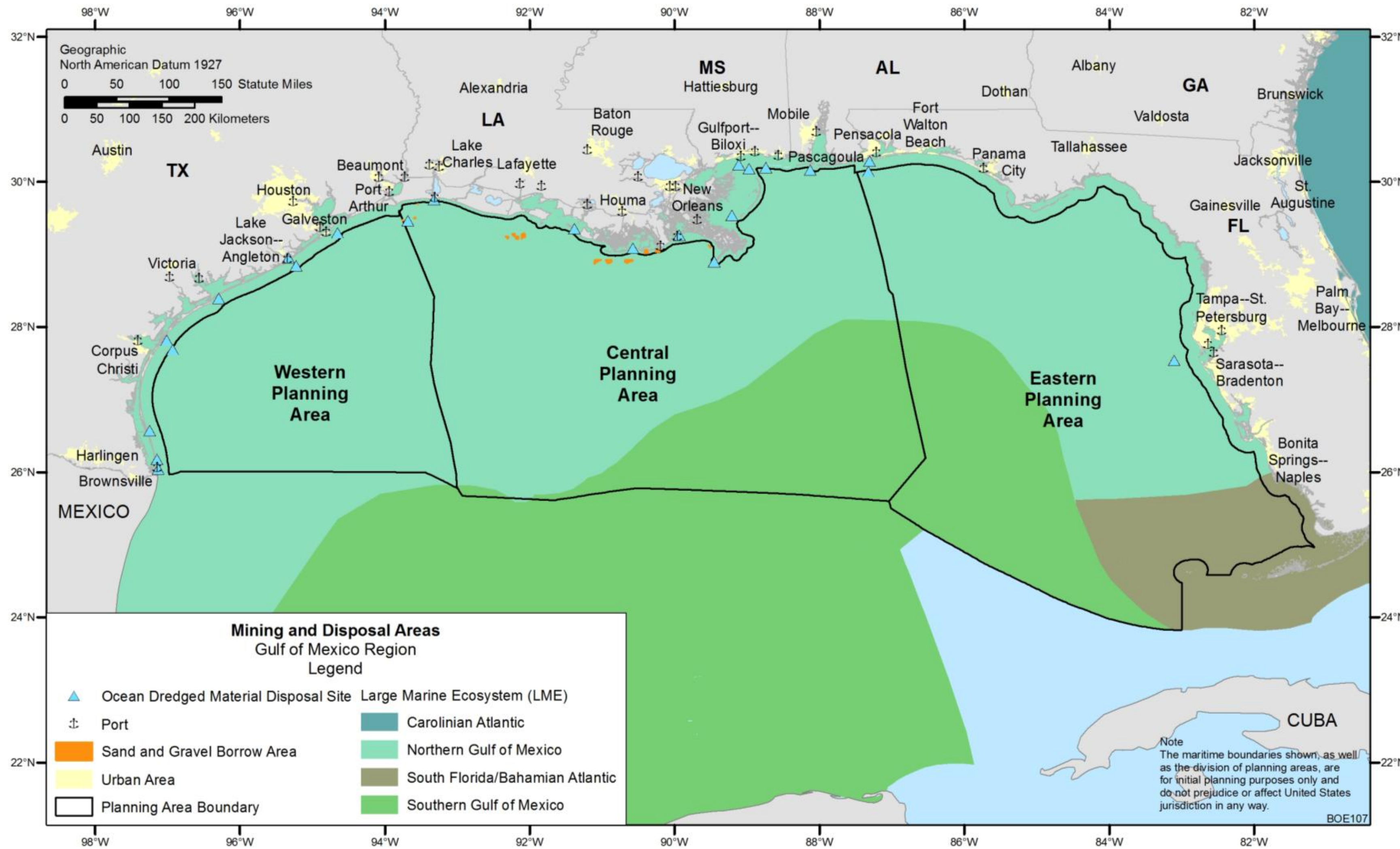

FIGURE 4.6.1-4 Marine Mining (Sand and Gravel) and Ocean Dredged Material Disposal Sites in the GOM

disturbance and resource consumption. It should be noted here that BOEM provides guidance to lessees and operators for the avoidance and protection of significant OCS sand and gravel resources in the GOM region through NTL 2009 G04, so they may be preserved for coastal restoration activities.

Mining from the cap rock of coastal and offshore salt domes has been active along the Texas-Louisiana coast since the 1890s (Kyle 2002). The Main Pass Block 299 mine, operated by McMoran Exploration Company, was leased to mine sulfur and salt in Federal waters of the GOM (lease OCS-G9372). The mine is located about 26 km (16 mi) offshore, east of Plaquemines Parish, Louisiana. It was closed in 2002 and is currently the location of what McMoRan refers to as Main Pass Energy Hub. The ROD for a closed-loop regasification (LNG) system at the Hub was issued by MARAD in 2007; the license for the project is pending (MARAD 2012). The hub would make use of the closed mine for natural gas storage (McMoran 2007).

Wastewater Discharge to MARB Watershed and GOM Waters. The major point sources of pollution to the MARB watershed, and GOM coastal and marine waters include discharges (by discrete conveyances such as pipes or man-made ditches) from sewage treatment plants, industrial facilities, and power generating plants. Also included are offshore discharges from drilling activities and marine vessels. Discharges are regulated through the NPDES permit program. Section 403 of the *Clean Water Act* (CWA) established the Ocean Discharge Criteria, which provide additional requirements for these types of discharges (USEPA 2003, 2012d, e).

Non-point sources of pollution in the GOM include rainfall, snowmelt, or irrigation water that runs over land or through the ground, entraining pollutants and depositing them into rivers, lakes, and coastal waters (including wetlands and estuaries). Pollutants such as fertilizers, herbicides, and insecticides; oil, grease, and toxic chemicals; sediment; and bacteria and nutrients can make their way to coastal waters and have harmful effects on drinking water supplies, recreation, fisheries, and wildlife. Non-point source management programs under Section 319 of the CWA regulate these pollutant sources. The USEPA and NOAA also co-administer State Coastal Non-Point Pollution Control Programs under Section 6217 of the *Coastal Zone Act Reauthorization Amendments of 1990* (USEPA 2011g).

Both point and non-point source discharges to waters of the GOM are expected to continue and will likely increase over the next 40 to 50 years (based on projected increases in population and development in the GOM region States). Pollutant discharges contribute to cumulative effects on water quality, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, and sociocultural systems (local communities and subsistence). Important impact-producing factors associated with discharges include contaminant releases via permitted conveyances and surface runoff.

Persistent Contaminants and Marine Debris. Persistent contaminants are natural and man-made substances introduced to the environment that are resistant to degradation naturally; these include various heavy metals (e.g., mercury, cadmium, lead, and chromium), as well as herbicides, pesticides, PCBs, and dioxin.

Because they do not degrade naturally, these substances are capable of long-range transport and may bioaccumulate in the tissues of ecological and human receptors. Sources of persistent contaminants include permitted discharges and surface runoff (with suspended sediments) from agricultural, industrial or urban areas; and atmospheric deposition. The presence of persistent contaminants in the waters and sediments of the GOM contributes to cumulative effects on water and sediment quality, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, and sociocultural systems (subsistence). Important impact-producing factors include exposure of marine fauna to toxic pollutants (resulting in mortality or reproduction problems) and habitat displacement and/or degradation. Such factors lead to unstable or contaminated fish stocks (or other species) that in turn affect species higher in the food web (via toxicity or bioaccumulation).

NOAA defines marine debris as “any persistent, manufactured, or processed solid material that is directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment” (NOAA 2009). Marine debris in the GOM includes a range of objects such as fishing gear, lost vessel cargo, or plastics, as well as natural objects (such as logs) that find their way into GOM waters after major storms and hurricane. All of these objects pose environmental and collision hazards to navigation and other ocean-related activities such as fishing and recreational boating; some also present hazards to birds and marine wildlife that may become entangled in or ingest them (Ryan 1990). Surveys have discovered as many as 5,000 items generated by Hurricane Katrina within an area of 3.4 km^2 (744 nautical mi^2) mainly in State waters of the north-central GOM region, about 40% of which were submerged in water depths less than 1.5 m (5 ft). The presence of marine debris in the waters and sediments of the GOM contributes to cumulative effects on the same resources as described for persistent contaminants. Important impact-producing factors include collisions of marine vessels with debris and entanglement in or ingestion of debris by marine wildlife.

Hypoxic Zone in Northern GOM. Excess nutrients released to the northern GOM have created a seasonally observed zone of oxygen depletion (hypoxic zone) at the bottom of the continental shelf off Louisiana and Texas that is harmful to aerobic organisms (see Section 3.4.1.2). The hypoxic zone generally stretches from the mouth of the Mississippi River westward to the coastal waters of Texas and extends up to 130 km (80 mi) offshore (Figure 4.6.1-5). The zone is attributed to the discharge of high nutrient loads, particularly nitrogen and phosphorus, from agricultural runoff and other human activities (such as industrial and sewage treatment plant discharges) within the MARB, and stratification due to salinity and temperature differences across the water column that prevents mixing of water (USEPA 2011f). In July 2011, scientists from NOAA measured the size of the hypoxic zone at 17,520 km^2 (6,765 mi^2), smaller than originally predicted based on recent trends (due to weather patterns not accounted for in forecast models). While its size varies from year to year, the hypoxic zone has increased in size and duration over the past 50 years. Its future trends are uncertain; however, the USEPA is currently using models to estimate several nutrient reduction scenarios to better understand what the allowable nutrient loads should be to limit the hypoxic zone to a 5-year running average of 5,000 km^2 (1,930 mi^2), the goal specified by the *Gulf Hypoxia Action Plan* (GOM Task Force 2008).

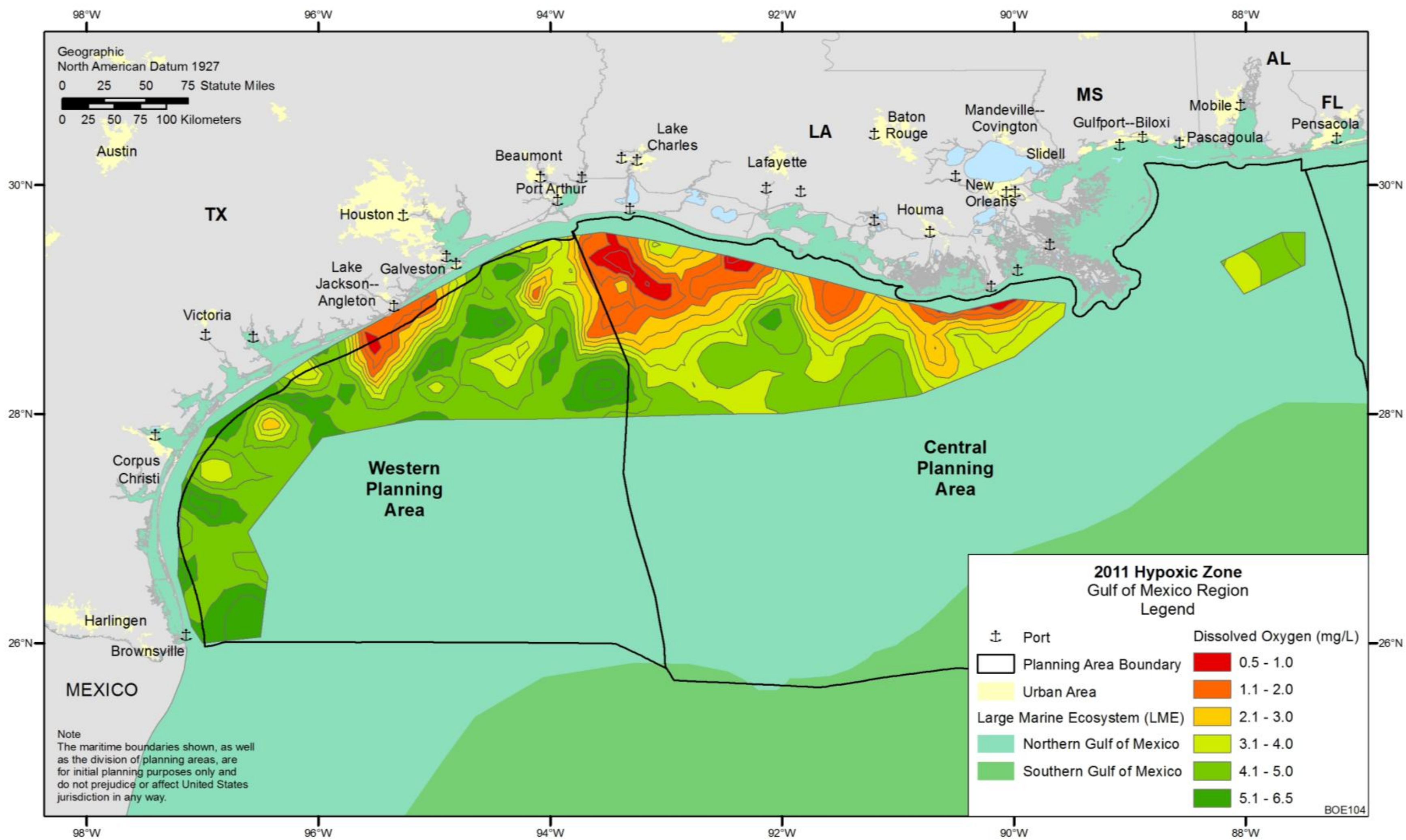

FIGURE 4.6.1-5 Hypoxic Zone in the Northern GOM, July 2011

The hypoxic zone contributes to cumulative effects on water quality, marine and coastal habitats, marine and coastal fauna (especially benthic organisms and fish), commercial and recreational fisheries, and sociocultural systems (subsistence). Important impact-producing factors include exposure of marine fauna to low dissolved oxygen (resulting in mortality or reproduction problems) and habitat displacement and/or degradation. Such factors cause unstable and reduced fish stocks that in turn affect other species relying on fish for food. Studies conducted by NOAA have found that some fish (i.e., the Atlantic croaker) exposed to low dissolved oxygen levels (mainly along the edge of the hypoxic zone where they congregate) suffer reproductive problems because low dissolved oxygen levels disrupt the female endocrine system (leading to masculinization and decreased reproduction) (GOM Task Force 2012).

Dredging and Marine Disposal. There are currently 23 designated ocean dredged material disposal sites (ODMDS) in the GOM, including 16 off the coast of Texas and Louisiana and in the Mississippi River GOM outlet (USEPA Region 6) and six off the coasts of Mississippi, Alabama, and Florida (USEPA Region 4), as shown in Figure 4.6.1-4 (USACE 2011a). Most disposal is of sediments dredged from the bottom of channels and water bodies to maintain adequate channel depth for navigation and berthing. The largest quantities of disposed materials come from dredging of the Mississippi River bar channel (USACE 2011a). The USEPA is responsible for designating and managing ODMDS, as authorized by the *Marine Protection*, *Research and Sanctuaries Act*. Permits for ocean dumping of dredged materials are granted by the USACE, subject to USEPA review and concurrence, as authorized by Section 404 of the CWA (USEPA 2011c). Dredged materials are also available for potential beneficial uses to restore and create habitat, beach nourishment projects, and industrial and commercial development. The amount of dredged material disposed of at ODMDS will likely vary over the next 40 to 50 years, depending on the needs of districts in Louisiana (New Orleans) and Texas (Galveston) where most dredging occurs. However, as more beneficial uses for dredged materials are identified, the disposal at ODMDS could decrease.

While dredging has beneficial effects on marine vessel navigation in the GOM and coastal restoration projects, dredging and disposal at ODMDS may contribute to adverse cumulative effects on water quality, the acoustic environment, coastal and marine habitats, coastal and marine fauna (fish and marine mammals), and cultural resources (if present). Important impact-producing factors for dredging and disposal are noise and turbidity/contaminant resuspension caused by bottom sediment disturbance.

Recreation and Tourism. The GOM coastal zone is one of the major recreational regions of the United States; marine fishing and beach-related activities are of particularly importance (see Section 3.13.1.1). Publicly owned and administered areas (such as national seashores, parks, beaches, and wildlife lands), as well as specially designated preservation areas (such as historic and natural sites and landmarks, wilderness areas, wildlife sanctuaries, and scenic rivers), attract residents and visitors throughout the year. Commercial and private recreational facilities and establishments, such as resorts, marinas, amusement parks, and ornamental gardens, are also popular with tourists and in-State visitors. In 2000, Florida was the most important destination for marine recreation, with more than 22 million people participating in the State (NOAA 2005). Reef fisheries established on oil and gas structures in the northern GOM provide significant benefits to recreational fishing (see Section 3.13.4.1).

Recreation and tourism are major sources of employment in the GOM States, with total employment exceeding one million in these sectors in 2008 (see Section 3.13.5.1). Most tourism-related employment is concentrated in the Miami and Tampa-St. Petersburg areas of Florida. These trends are likely to increase over the next 40 to 50 years (based on past trends).

While recreation and tourism have beneficial effects on local economies, they may also contribute to adverse cumulative effects on air and water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (subsistence). Important impact-producing factors include noise, disturbance or injury of fish and wildlife, habitat displacement and/or degradation, and economic activity.

Climate Change. Because a growing body of evidence shows that climate change is occurring (Section 3.3), we have included it as a current and foreseeable natural trend in the cumulative impacts analysis for some resources in the GOM. Analyses that take into account impact-producing factors related to climate change meet one or both of the following two criteria:

- The resource is already experiencing impacts from climate change, so the effects are observable and not speculative.

- The resource will be directly affected by warming temperatures.

In the GOM, climate change is expected to affect coastal ecosystems, forests, air and water quality, fisheries, and business sectors such as industry and energy (see Section 3.3.1). The GOM region has already experienced increasing atmospheric temperatures since the 1960s, and from 1900 to 1991, sea surface temperatures have increased in coastal areas and decreased in offshore regions. Impacts associated with sea level rise, including the loss of coastal wetland and mangrove habitats, saltwater intrusion into coastal aquifers and forests, and increases in shoreline erosion also have been observed along the GOM’s northern coast.

Not all impacts from climatic and hydrologic changes that are the indirect result of temperature changes have been analyzed because they may be too uncertain to predict. For example, it is reasonable to expect changes in precipitation regimes as a result of climate change. Furthermore, it is also likely that precipitation changes would, in turn, affect the coastal salinity balance between freshwater flow and tidal influence in some areas, and that these changes would affect fisheries and fish populations in some way. Both the magnitude and direction of each factor in this sequence of occurrences, however, are uncertain. While we acknowledge that continuing climate change could result in changing regional ecological and socioeconomic patterns and distributions, at this stage of our understanding of underlying processes, the rates and directions of many of these changes are too speculative to include in the cumulative analyses that follow.

Legislative Actions. Major statutes governing the management and protection of resources within the GOM OCS planning areas are listed in Appendix C. Regulations and permitting programs based on these statutes, for example, the NPDES permitting program based on Section 402 of the *Clean Water Act*, are overseen by the USEPA and other regulating authorities. The statutes and regulations (including international agreements between the United States and Mexico) are discussed in the previous sections and in the resource impacts sections, as they apply.

In addition to legislative actions, there are several voluntary initiatives under way, such as those with the goal of reducing nutrient loads in the MARB, which aim to preserve and protect resources in the GOM by changing agricultural practices in watershed States.

4.6.1.2.3 Non-OCS Program Actions and Trends – Cook Inlet. Table 4.6.1-6 summarizes ongoing and reasonably foreseeable future actions and trends affecting resources and systems in Cook Inlet. Past and present actions are generally accounted for in the baseline environment (described in Chapter 3) and the analysis of direct and indirect impacts under each resource area (Section 4.4). These impacts are carried forward to the cumulative analysis, which also takes into account the effects of ongoing and reasonably foreseeable future actions and trends. Cumulative scenarios (based on types of actions) and impact-producing factors are described for each action or trend on the basis of recent environmental reports or NEPA reviews. Figure 4.6.1-6 shows general locations of ongoing and reasonably foreseeable future actions in the Cook Inlet Planning Area, which lies entirely within the Gulf of Alaska LME.

Ongoing Oil and Gas Exploration, Development, and Production Activities and Existing Infrastructure. The area of oil and gas discoveries in the upper Cook Inlet basin covers an estimated 11,400 km^2 (4,400 mi^2), extending from the Kachemak Bay area north to the Susitna River. This area includes fields in offshore Cook Inlet, the west shore of Cook Inlet, and the western half of the Kenai Peninsula. As of 2009, about 1,300 Mbbl of oil and 7,800 Bcf of natural gas (net) have been produced from reserves in Cook Inlet. Remaining reserves (including oil and natural gas liquids) through 2034 are estimated to be about 34 Mbbl, with annual production projected to decline from 3.4 Mbbl in 2010 to about 0.52 Mbbl in 2034 (ADNR 2009c).

The ADNR estimates that there are 393 active oil and gas leases in the Cook Inlet region, covering a total of 214,172 ha (529,230 acres) onshore and 182,321 ha (450,526 acres) offshore (ADNR 2012b). Currently, there are 16 offshore production platforms in Cook Inlet, all of which are in State waters (Figure 4.6.1-6; ADNR 2012b). Twelve of these platforms are currently active (World Oil Online 2012). Crude oil production is handled through the Trading Bay production facility, located on the west side of Cook Inlet, which pipelines crude oil it receives to the Drift River oil terminal. Almost all of the Drift River crude oil (most of which is consumed within Alaska) is transported to the Tesoro refinery in Nikiski; natural gas is also processed through several plants in Nikiski and consumed locally.

Existing infrastructure in the Cook Inlet region includes five onshore and 14 offshore pipeline systems, totaling about 251 km (156 mi) of pipeline. About 135 km (84 mi) of pipeline transport crude oil from offshore platforms to shore; onshore pipelines transport processed oil to either the Drift River oil terminal (west side) or Nikiski (east side). Offshore gas pipelines in the Trading Bay area are about 200 km (124 mi) in length; onshore pipelines on the Kenai Peninsula

TABLE 4.6.1-6 Ongoing and Reasonably Foreseeable Future Actions and Trends – Cook Inlet

Type of Action or Trend	Associated Activities, Facilities, or Trends	Impact-Producing Factors	Affected Resources and Systems
Ongoing oil and gas exploration, development, and production activities and existing infrastructure (onshore and in State waters)	Construction of infrastructure (ports, platforms, and pipelines) Onshore fuel storage tanks, refineries, pipelines, and transfer stations Pipeline landfalls Seismic surveys Exploratory drilling Waste generation (produced water, drilling fluids, and muds/cuttings) Oil and gas production Decommissioning (plugging production wells and removing infrastructure) Vessel traffic Air traffic	Subaerial noise and subsea noise and vibration Platform lighting (offshore) Engine emissions (marine vessels) Fuel spills (marine vessels) Oil spills (storage tanks and vessel casualty) Hazardous spills/releases Oil and chemical releases (wells and produced water) Disturbance or injury of fish and wildlife Habitat displacement or degradation Chronic seafloor disturbance (by anchors and mooring lines) Bottom sediment disturbance (turbidity and contaminant resuspension) Resource consumption Collisions (wildlife with infrastructure and marine vessels) Collisions (among vessels)	Air quality, water quality, acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, mammals, and birds), sociocultural systems (local jobs and revenue, and subsistence harvesting), and cultural resources (if present)
Commercial fishing	Fishing vessel traffic Use of gill nets, seines, purse seines, trawls, dredges, pots, jigs Use of diving equipment	Noise Fuel spills (fishing vessels) Disturbance of marine wildlife (e.g., ingestion and/or entanglement) Bottom sediment disturbance (turbidity and contaminant resuspension) Damage to hard bottoms Resource consumption	Water quality, acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (local jobs and revenue)

TABLE 4.6.1-6 (Cont.)

Type of Action or Trend	Associated Activities, Facilities, or Trends	Impact-Producing Factors	Affected Resources and Systems
Harbors, ports, and terminals	Port of Anchorage Port McKenzie Tyonek/North Forelands Drift River Oil Terminal Nikiski Industrial Terminals Port of Homer Seldovia Harbor Port Graham Williamsport	Noise Engine emissions (marine vessels) Fuel spills (marine vessels) Permitted discharges to air and water Pollutant releases via surface runoff (non-point sources) Oil spills (vessel casualty, pipeline or storage tank release) Hazardous spills/releases Accidental explosions or fires Cooled water releases (LNG plant) Collisions (wildlife with infrastructure and marine vessels) Collisions (among marine vessels)	Air quality, water quality, acoustic environment, coastal habitats, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, sociocultural systems (local jobs, subsistence harvesting), and cultural resources (if present)
Port of Anchorage Intermodal Expansion Project	Dredging Placement of fill material Installation of sheet pile Additional road, rail, and utility extensions Installation of final docks Installation of fendering systems Demolition of existing docks Marine vessel traffic Land-based vehicle traffic and equipment	Noise and vibration Engine emissions (marine vessels and land-based vehicles and equipment) Fuel spills (marine vessels and land-based vehicles and equipment) Disturbance or injury of fish and wildlife Habitat displacement or degradation Bottom sediment disturbance (turbidity and contaminant resuspension) Permitted discharges to air and water Pollutant releases via surface runoff (non-point sources) Oil spills (marine vessel casualty) Collisions (wildlife with infrastructure and marine vessels) Collisions (among marine vessels)	Air quality, water quality, acoustic environment, coastal habitats, benthic and marine habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, sociocultural systems (local jobs, subsistence harvesting), and cultural resources (if present)

TABLE 4.6.1-6 (Cont.)

Type of Action or Trend	Associated Activities, Facilities, or Trends	Impact-Producing Factors	Affected Resources and Systems
Knik Arm Crossing Project	Construction of bridge and roads Pile driving Artificial lighting Vessel traffic Vehicle traffic across bridge (once operational)	Noise Engine emissions (marine vessels and land-based vehicles and equipment) Fuel spills (marine vessels and land-based vehicles and equipment) Disturbance or injury of fish and wildlife Habitat displacement and/or degradation Collisions (wildlife with marine vessels)	Air quality, water quality, acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, mammals, and birds), sociocultural systems (local jobs and recreational facilities), and cultural resources (historic buildings or properties)
Marine vessel traffic	Crude oil tankers LNG tankers Tugs and barges Ferries Commercial vessels Commercial fishing vessels Military vessels Coal carrier Government vessels Dredge vessels USCG vessels Cruise ships Small watercraft	Noise Engine emissions (marine vessels) Fuel spills (marine vessels) Discharges of bilge water and waste Oil spills (vessel casualty) Increased wave action (nearshore) Collisions (wildlife with marine vessels) Collisions (among marine vessels)	Air quality, water quality, acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (subsistence harvesting)
Wastewater discharge to Cook Inlet	Discrete conveyances such as pipes or Man-made ditches from sewage treatment plants, industrial facilities, and power generating plants Drilling wastes (offshore) Marine vessel and platform discharges	Permitted releases to water Pollutant releases via surface runoff (non-point sources)	Water quality, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, and sociocultural systems (local communities and subsistence harvesting)

TABLE 4.6.1-6 (Cont.)

Type of Action or Trend	Associated Activities, Facilities, or Trends	Impact-Producing Factors	Affected Resources and Systems
Persistent contaminants and marine debris	Accumulation of contaminants from multiple sources (discharges, spills, and releases; and atmospheric deposition) Accumulation of floating, submerged, and beached debris	Exposure to contaminants in marine waters and sediments, and in the food web via toxicity or bioaccumulation Collisions (marine vessels with debris) Entanglement in or ingestion of debris by marine wildlife Habitat displacement and/or degradation	Water (and sediment) quality, marine and coastal habitats, marine and coastal fauna (fish, mammals, and birds), commercial and recreational fisheries, and sociocultural systems (subsistence harvesting)
Alternate energy development	<u>Cook Inlet Tidal Energy Project (ORPC)</u> Tidal energy (East Foreland) Wind energy project (Fire Island) Underwater transmission line <u>Turnagain Arm Tidal Energy Corporation (TATEC)</u> Tidal energy project (Turnagain Arm) Underwater transmission line	Subsea noise and vibration Bottom sediment disturbance (turbidity and contaminant resuspension) Collisions (wildlife with infrastructure)	Acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and cultural resources (if present)
Military operations	<u>Joint Base Elmendorf-Richardson</u> Airfield and aircraft traffic Combat training center Munitions storage Community facilities and residences Communication centers Impact areas and firing ranges (onshore) Maneuver areas (onshore) Major ranges (onshore) Contaminated sites (currently undergoing remediation)	Noise and vibration Disturbance or injury of fish and wildlife Disturbance of nearby residents Contaminant releases	Air quality, water quality, acoustic environment, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (local communities and subsistence harvesting)

TABLE 4.6.1-6 (Cont.)

Type of Action or Trend	Associated Activities, Facilities, or Trends	Impact-Producing Factors	Affected Resources and Systems
Mining (coal and minerals)	<u>Chuitna Coal Project</u> Surface coal mine Support facilities Mine access road Coal transport conveyor Personnel housing Air strip facility Logistic center Coal export terminal Marine vessel traffic Aircraft traffic Land-based vehicle traffic and equipment	Noise and vibration Coal particulate and dust releases to air Soil erosion (from land disturbance) Deposition of fugitive dust Permitted releases to water Pollutant releases via surface runoff (non-point sources) Engine emissions (marine vessels and land-based vehicles and equipment) Fuel spills (marine vessels and land-based vehicles and equipment) Disturbance or injury of fish and wildlife Collisions (wildlife with marine vessels) Collisions (among marine vessels)	Air quality, water use (and patterns of recharge/discharge), water quality, acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (local jobs and revenue, and subsistence harvesting)
	<u>Pebble Mining Project</u> Mine pit or workings Access infrastructure Power facilities Mill Tailings storage Low-grade ore stockpiles Warehouses Administrative facilities Worker housing Land-based vehicle traffic and equipment	Particulate releases to air Engine emissions (land-based vehicles and equipment) Permitted releases to water Soil erosion (from land disturbance) Pollutant releases via surface runoff (non-point sources) Disturbance or injury of wildlife	Air quality, groundwater quality, surface water quality and stream flow, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (local jobs and revenue, and subsistence harvesting)
	<u>Abandoned Mine Lands</u>		Air quality, groundwater quality, surface water quality and stream flow, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (local jobs and revenue, and subsistence harvesting)

TABLE 4.6.1-6 (Cont.)

Type of Action or Trend	Associated Activities, Facilities, or Trends	Impact-Producing Factors	Affected Resources and Systems
Dredging and marine disposal	Excavation of subaqueous sediments by clamshell, hydraulic cutterhead, pipeline suction, or bulldozer Transport or conveyance of dredged materials (by barge or suction pipeline)	Bottom sediment disturbance (turbidity and contaminant resuspension)	Water quality, marine and coastal habitats, marine and coastal fauna (fish and marine mammals), and cultural resources (if present)
Recreation and tourism	Shores and beaches Recreational fishing Water sports Cruise ships	Noise Disturbance or injury of fish and wildlife Habitat displacement and/or degradation Economic activity	Water quality, marine and coastal habitats, marine and coastal fauna (fish, mammals, and birds), and sociocultural systems (jobs and revenues, and subsistence harvesting)
Climate change	Increase in atmospheric and ocean temperatures Increase in precipitation rate Sea level rise and coastal erosion Ocean acidification	Changes in water quality (temperature, salinity, and pH) Changes in water circulation	Air quality, water quality, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds)
Legislative actions (existing and forthcoming)	Federal statutes and regulations Executive orders State statutes and regulations	Management and protection of various resources throughout the marine and coastal regions of Cook Inlet	All resources

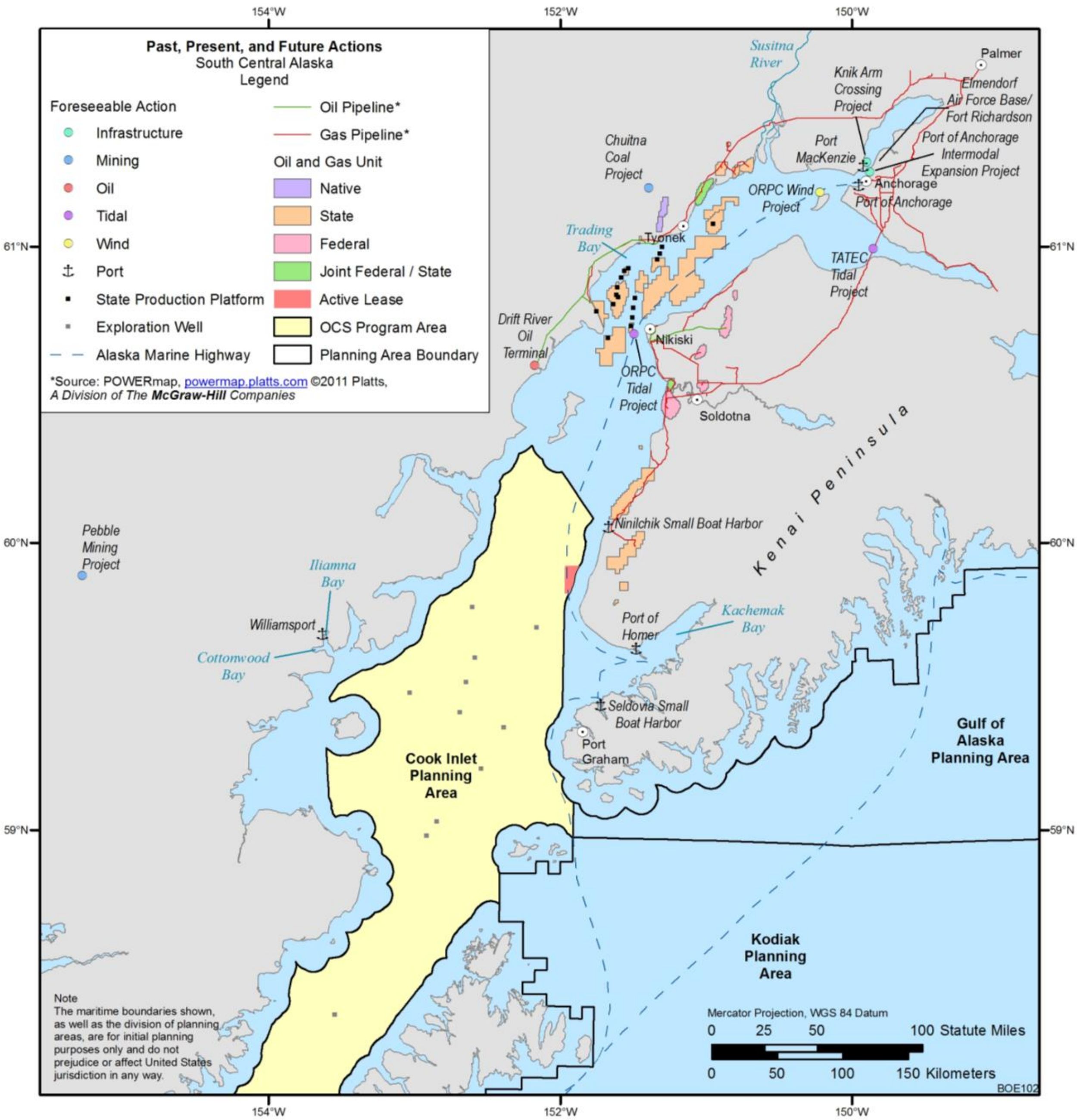

FIGURE 4.6.1-6 Ongoing and Reasonably Foreseeable Future Actions in Cook Inlet (within the Gulf of Alaska LME)

and on the west bank total about 322 km (200 mi) and 257 km (160 mi), respectively, in length (some of which are double lines) (MMS 2003a). Figure 4.6.1-6 shows the offshore production platforms and onshore producing wells; key processing, storage, and refining facilities; and oil and natural gas pipelines in and around Cook Inlet.

Ongoing oil and gas activities and existing infrastructure (both onshore and offshore) in the Cook Inlet region contribute to cumulative effects on air and water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine and terrestrial mammals, and birds), sociocultural systems (local economies and subsistence), and cultural resources (if present). Important impact-producing factors include subaerial noise and subsea noise and vibration, platform lighting, engine emissions and fuel spills (marine vessels), oil spills (storage tanks and vessel casualty), hazardous spills and releases, oil and chemical releases (from wells and produced water), disturbance or injury of fish and wildlife, habitat displacement or degradation, chronic seafloor disturbance (by anchors and mooring lines), bottom sediment disturbance (turbidity and contaminant resuspension), resource consumption, wildlife collisions with marine vessels and infrastructure, and collisions among vessels.

Commercial Fishing. Commercial fisheries in Cook Inlet and the Gulf of Alaska are diverse and chiefly target groundfish, Pacific halibut, Pacific salmon, herring, crab, shrimp, clams, scallops, sea urchins, and sea cucumbers (see Section 3.12.1.2). In 2009, groundfish fisheries accounted for the largest share ($640 million or about 48%) of the ex-vessel value of all commercial fisheries in Alaska, followed by the Pacific salmon and shellfish fisheries, at $345 million (26%) and $195 million (15%).

All five species of Pacific salmon, razor clams, Pacific herring, and smelt are commercially harvested in the UCI Management Area.[37] The LCI Management Area supports commercial fisheries for salmon, groundfish, and scallops, but herring, king crab, Dungeness crab, and shrimp fisheries are currently restricted or closed while stocks rebuild. There are also gear restrictions in Cook Inlet, where the use of non-pelagic trawl gear is prohibited north of a line extending between Cape Douglas (58°51.10' N latitude) and Point Adam (59°15.27' N latitude).

The Pacific salmon commercial fisheries in State waters of the Gulf of Alaska are important to the economy of the region and are the second most valuable fisheries in Alaska ($345 million in 2009). The UCI Management Area supports gill net fisheries targeting Chinook, coho, pink, chum, and sockeye salmon. The LCI Management Area fisheries use gill net or seine gear and target pink, chum, and sockeye salmon. Total salmon harvest in LCI and UCI was approximately 3.85 million fish ($17.9 million ex-vessel value) in 2009. Pink salmon and sockeye salmon dominate the Cook Inlet salmon fishery by weight and monetary value.

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[37] The State of Alaska divides Cook Inlet into the Lower Cook Inlet (LCI) Management Area comprised of all waters west of the longitude of Cape Fairfield, north of the latitude of Cape Douglas, and south of the latitude of Anchor Point; and the Upper Cook Inlet (UCI) Management Area, which consists of Cook Inlet north of the latitude of the Anchor Point Light (see Section 3.12.1.2).

Pacific herring are targeted for food, bait, or herring roe. Depending on the area, herring harvested as food or bait may be commercially fished using trawl, seine, or gill net gear. Sac roe may be harvested using seine, purse seine, or gill net gear. In Cook Inlet, herring harvests are greatest in Kamishak Bay. Over the last decade, the abundance of Pacific herring has been stable, but historically very low, and the commercial Pacific herring fishery in LCI Management Area was closed during 2010 for the 12th successive season. The decline in herring may be attributable to the protozoan pathogen *Ichthyophonus*. In the UCI Management Area, eulachon and smelt are commercially harvested. The smelt harvest in the UCI Management Area has generally increased from 1978 (0.2 tons) to 2010 (63 tons [Shields 2010b]). Smelt are primarily sold as bait and have low commercial value.

While fishery-related activities have beneficial effects to local economies, they may also contribute to adverse cumulative effects on water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (local economies). Important impact-producing factors include noise, fuel spills (fishing vessels), disturbance of marine wildlife (ingestion and/or entanglement), bottom sediment disturbance (turbidity and contaminant resuspension), damage to hard bottoms, and resource consumption.

Harbors, Ports, and Terminals. The largest port facilities in Cook Inlet are Anchorage, MacKenzie, Tyonek, Nikiski, Drift River, Kenai, Anchor Point, and Homer (Figure 4.6.1-6). Alaska's largest seaport is the Port of Anchorage, located along the lower Knik Arm. The port is a deep draft facility that accommodates barges and ships of all types (although cruise ships are infrequent). It is the main port of entry for the south-central and interior regions of Alaska. Port MacKenzie is a barge port located at the head of Cook Inlet along the Knik Arm across from the Municipality of Alaska. It recently completed the second phase of its development, which includes a deep-draft marine port. The Tyonek/North Foreland's Dock is a light-draft port located on the west side of Cook Inlet; it did not have vessel calls in 2010 (NMFS 2010; Matanuska-Susitna Borough 2012; Eley 2006, 2012).

The Nikiski industrial terminals are located on the east side of Cook Inlet, between Homer and Anchorage. Three side-by-side deep-draft moorages extend about 1.6 km (1 mi) from Tesoro's Kenai pipeline pier at the north end of the complex to the Agrium wharf at the south end; the ConocoPhillips pier lies between them. At one time, activity here included the shipping and receiving of anhydrous ammonia (Agrium), dry bulk urea, LNG (ConocoPhillips), petroleum products, sulfuric acid, caustic soda, and crude oil. In 2010, however, only the Kenai pipeline dock was active. The Agrium dock and ConocoPhillips LNG facility were dormant in 2010 and 2011. The LNG facility is currently the only LNG export operation in the United States and at its peak exported about 64 Bcf of LNG per year. It has opened temporarily in 2012 and will lease a tanker to make four exports to Asia later in the year before shutting down its operations (Mazurek 2011; Eley 2012).

The Drift River oil terminal is located about 37 km (23 mi) west-southwest of Nikiski on the west shore of Cook Inlet. It is mainly used as a loading platform for shipping crude oil collected via pipeline from various production platforms in the inlet. The docking facility is connected to a shore-side tank farm (with a storage capacity greater than 1 Mbbl) and is designed to accommodate tankers in the 150,000 ton class. Tank ships moor at the terminal while loading crude oil, then transport it to Tesoro's Kenai pipeline at Nikiski, where the oil is offloaded and refined (NMFS 2010; Eley 2006, 2012).

The Port of Homer is located within Kachemak Bay. It consists of a boat harbor, two deep draft docks, two deep draft moorages, and one deep draft anchorage. It also has three shallow draft docks. Alaska Marine Highway ferries and USGC cutters are moored at the port year round; cruise ships call from May through September. There is a pilot "embarkation station" west of the Homer spit in Kachemak Bay; it is used by ships and tugs as they wait for favorable weather conditions in the inlet or the Gulf of Alaska (Eley 2012).

There is a 6-m (20-ft) draft dock at the City of Seldovia. Moorages there accommodate the Alaska Marine Highway System ferries and are available for fuel barges and small passenger vessels. There are shallow draft facilities at Port Graham (receiving fuel oil barges and fishing vessels) and Williamsport (in Iliamna Bay) (Eley 2012).

The Alaska Marine Highway System, part of the National Highway System, runs along the south-central coast of Alaska, the eastern Aleutian Islands, southeast Alaska, and British Columbia (Canada) to Bellingham, Washington. Portions of the highway operate in Cook Inlet, from Anchorage, Homer, and Seldovia, and various other ports in the Gulf of Alaska (Figure 4.6.1-6).

Activities and vessel calls at ports, harbors, and terminals in Cook Inlet are likely to increase over the next 40 to 50 years as several port expansion projects are completed and economic activity increases. Activities associated with port facilities contribute to cumulative effects on air and water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, sociocultural systems (local economies and subsistence), and cultural resources (if present). Important impact-producing factors include noise, engine emissions, fuel spills (marine vessels), permitted discharges to air and water, pollutant releases via surface water runoff, oil spills, hazardous spills and releases, accidental explosions or fires, cooled water releases (LNG plant), wildlife collisions with infrastructure and marine vessels, and collisions among marine vessels.

Port of Anchorage Intermodal Expansion Project. The Port of Anchorage Intermodal Expansion Project, shown in Figure 4.6.1-6, is currently under way to create two new barge berths, two new large cargo vessel ship berths, deep draft for modern vessels (with greater spacing between berths), improved seismic capacity, 26 ha (65 ac) of new land designated for commercial and industrial use at the Port, and an 8-km (5-mi) haul road to provide secure access to Joint Base Elmendorf-Richardson (JBER). The project permit was obtained in 2007 and sheet pile installation began in 2008. The expansion project is scheduled to be completed by 2019 (Port of Anchorage 2012).

Marine vessel traffic at the Port of Anchorage will likely increase over the next 40 to 50 years as the expansion project is completed and marine vessel traffic increases. Activities associated the expansion project (both construction and operational phases) would contribute to cumulative effects on air and water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, sociocultural systems (local economies and subsistence), and cultural resources (if present). Important impact-producing factors include noise, engine emissions and fuel spills (marine vessels and land-based vehicles and equipment), disturbance or injury of fish and wildlife, habitat displacement or degradation, bottom sediment disturbance (turbidity and contaminant resuspension), permitted discharges to air and water, pollutant releases via surface water runoff, oil spills (marine vessel casualty), wildlife collisions with infrastructure and marine vessels, and collisions among marine vessels.

Knik Arm Crossing Project. The Knik Arm Crossing Project, shown in Figure 4.6.1-6, would construct a 2,500-m (8,200-ft) bridge crossing of Knik Arm and 29 km (18 mi) of connector roads (on both sides) to connect the Municipality of Anchorage and the Matanuska-Susitna (Mat-Su) Borough. The project's objective is to improve regional connectivity and capacity needed to accommodate existing and projected growth in population, economic development, and transportation in the upper Cook Inlet region in the coming decades. A ROD for the project was issued by the Federal Highway Administration on December 15, 2010 (Miller 2010). Preconstruction for the bridge began in 2009; construction is expected to run through 2015 (KABATA 2012).

The benefits of the Knik Arm Crossing are numerous, including economic stimulus, lowered costs for Alaskan drivers, and reductions in carbon emissions (Miller 2010). Construction (and some operational) activities may also contribute to adverse cumulative effects on air and water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), sociocultural systems (local economies and recreational facilities), and cultural resources (historic buildings or properties). Important impact-producing factors associated with bridge and road construction include noise, engine emissions and fuel spills (marine vessels and land-based vehicles and equipment), disturbance of wildlife, habitat displacement and/or degradation, fuel spills, and wildlife collisions with marine vessels.

Marine Vessel Traffic. Marine vessel traffic in Cook Inlet is moderate to low when compared to other west coast ports and water ways, with an average of 486 ships of 300 gross tons or more each year, about 8 to 10 ships per week (Eley 2006). Vessels range in size from the smallest fishing vessels to gas tankers weighing over 65,000 gross tons. In 2010, large vessel calls at marine facilities and terminals in Cook Inlet totaled 480 (similar to 2005 and 2006); of these, 218 were to the Port of Anchorage; 86 were to the Nikiski oil or gas terminals; and 123 were through Kachemak Bay. Most of these calls (67%) were container vessels, roll-on/roll-off cargo ships, or ferries; 20% were gas or liquid petroleum tankships; and 4% were bulk carriers and general cargo. Another 4% were fishing vessels and cruise ships (Eley 2012).

In 2010, crude oil and persistent product tank ships called at the Nikiski Tesoro facility and the Drift River oil terminal (no chemical tanker transits or port calls occurred in 2010). There were 12 gas tank ship calls to the ConocoPhillips LNG plant in Nikiski (all by the same tanker). Only refined product (jet fuel) tank ships called at the Port of Anchorage, including one military vessel (a product tank ship). One coal vessel docked at Port MacKenzie to obtain coal trucked from Healy, Alaska. Most deep draft vessel traffic occurs along the east side of the inlet, while tank ships travel between Nikiski and the Drift River terminal on the west side (Eley 2012).

Vessel traffic in the coming decade is expected to remain relatively flat or show only moderate increases (about 1.5 to 2.5% annually), although larger increases could be seen if the global demand for Alaska resources (oil, gas, coal) increases and the construction of the Alaska gas pipeline attracts cargo ship calls to the Port of Anchorage or Port McKenzie. Most of the vessel traffic is expected to be from U.S. tank ships (double-hulled) calling at Nikiski and other scheduled port calls (Eley 2012).

Oil spills from vessels in Cook Inlet are relatively rare. Between 1992 and 2006, there were 295 oil spills reported from vessels operating in Cook Inlet, all of which were classified by the USCG as “minor” (i.e., not connected to a vessel casualty). About 43% of these spills were small diesel or gasoline spills from fishing vessels and pleasure craft. A significant vessel spill occurred in 1987 when a tank ship (Glacier Bay) ran aground south of the mouth of the Kenai River en route to Nikiski. Hull damage caused the release of 492,000 L (130,000 gal) of oil[38] (Eley 2006).

Marine vessel traffic contributes to cumulative effects on air and water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (subsistence). Important impact-producing factors associated with tanker traffic in Cook Inlet include noise, engine emissions, fuel spills, discharges of bilge water and waste, oil spills (vessel casualty), wildlife collisions with marine vessels, increased wave action (nearshore), and collisions among marine vessels.

Wastewater Discharge to Cook Inlet. The major point sources of pollution in Cook Inlet include discharges (by discrete conveyances such as pipes and man-made ditches) from municipal wastewater treatment plants (e.g., Anchorage), seafood processors, and the petroleum industry (MMS 1995b). Also included are offshore discharges from drilling activities and marine vessels. Most of these activities would remain at present levels for the foreseeable future and are not expected to affect the overall water quality in Cook Inlet. Discharges are regulated through the USEPA NPDES permit program. Section 403 of the CWA established the Ocean Discharge Criteria, which provide additional requirements for these types of discharges. The Alaska Department of Environmental Quality issues all NPDES permits in Alaska except for those related to oil and gas, munitions, cooling water, pesticides, and offshore seafood processors, and those on tribal lands. Current NPDES permits in Alaska are available on the USEPA Region 10 Web site (see http://yosemite.epa.gov/r10/water.nsf/NPDES+Permits/CurrentAK822).

Non-point sources of pollution include stormwater and snowmelt that runs over land or through the ground, entraining pollutants and depositing them into the inlet. (The Cook Inlet watershed is home to two-thirds of Alaska’s population; therefore, the quality of runoff in the

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38 The State of Alaska Department of Environmental Conservation (Division of Spill Prevention and Response) reports that the tanker spill was as high as 784,000 L (207,000 gal) (ADEC 2012a).

watershed is heavily influenced by human activity). The most common forms of pollution in Alaska's urban runoff include fecal coliform, sedimentation, and petroleum. Snow disposal into the marine environmental also introduces oil, grease, antifreeze, chemicals, trash, animal wastes, salt, and sediments (sand, gravel, suspended and dissolved solids) (ADEC 2007b). Non-point source management programs under Section 319 of the CWA regulate these pollutant sources. The USEPA and NOAA also co-administer State Coastal Non-Point Pollution Control Programs under Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (USEPA 2011g).

Both point and non-point source discharges to Cook Inlet are expected to continue and could increase over the next 40 to 50 years (based on projected increases in population and development along the inlet). Pollutant discharges contribute to cumulative effects on water quality, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, and sociocultural systems (local communities and subsistence). Important impact-producing factors associated with discharges include contaminant releases via permitted conveyances and surface runoff.

Persistent Contaminants and Marine Debris. Persistent contaminants are natural and man-made substances introduced to the environment that are resistant to natural degradation; these include various heavy metals (e.g., mercury, cadmium, lead, and chromium), as well as herbicides, pesticides, PCBs, and dioxin. Because they do not degrade naturally, these substances are capable of long-range transport and may bioaccumulate in the tissues of ecological and human receptors. Sources of persistent contaminants include permitted discharges and surface runoff (with suspended sediments) from agricultural, industrial, or urban areas; and atmospheric deposition. The presence of persistent contaminants in the waters and sediments of Cook Inlet contributes to cumulative effects on water and sediment quality, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, and sociocultural systems (subsistence). Important impact-producing factors include exposure of marine fauna to toxic pollutants (resulting in mortality or reproductive problems) and habitat displacement and/or degradation. Such factors lead to unstable or contaminated fish stocks (or other species) that in turn affect species higher in the food web (via toxicity or bioaccumulation).

NOAA defines marine debris as "any persistent, manufactured, or processed solid material that is directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment" (NOAA 2009). Marine debris in Cook Inlet could include ocean-based materials such as fishing gear, oil and gas items (plastic drill pipe thread protectors, hard hats, gloves, and 55-gal storage drums), and lost vessel cargo. Materials from land-based sources can also find their way into Cook Inlet waters via blowing winds, waves washing ashore, littering, dumping in rivers and streams, and industrial losses. Weather also plays a role as storm water flows along streets and the ground carrying litter into storm drains; high winds, heavy rains, tsunamis, and tidal surges are also capable of dispersing solid objects into marine waters (NOAA 2012d). The presence of marine debris in the waters and sediments of Cook Inlet contributes to cumulative effects on the same resources as described for persistent contaminants. Important impact-producing factors include collisions of marine vessels with debris and entanglement in or ingestion of debris by marine wildlife.

Floating debris from the 2011 Japan tsunami (a soccer ball and a volleyball) was discovered in April 2012 in Middleton Island, Gulf of Alaska, about 80 km (50 mi) south of Prince William Sound. There is no longer a floating debris field as most of the tsunami-related objects have dispersed across a large area of the North Pacific, and there are no estimates of how much debris is still floating or whether this debris will reach the U.S. coast (AOOS 2012; NOAA 2012d).

Alternate Energy Development. Upper Cook Inlet has a large tidal range (9 m [30 ft]) that produces rapid currents throughout the inlet, especially through the constricted Forelands area. Two projects have been proposed to develop tidal energy in Cook Inlet (Figure 4.6.1-6). The Ocean Renewable Power Company (ORPC) proposes to build a project offshore of the East Foreland near Nikiski that would convert tidal currents into electricity and transmit it to the Alaskan Railbelt grid using an underwater transmission line. The pilot project would produce up to 5 MW of electricity; ORPC anticipates that each 1 MW of nameplate capacity would produce up to 3,450 MW-hours per year. A preliminary permit to produce 1,000 MW of electricity was issued by FERC in 2010 for this project; construction is scheduled to begin in 2012. The ORPC has also been awarded a preliminary permit to build a wind turbine on the west side of Fire Island, near Anchorage (Figure 4.6.1-6). The wind turbine would provide energy to the City of Anchorage and the Alaskan Railbelt grid (ORPC 2010; FERC 2012d).

The Turnagain Arm Tidal Energy Corporation (TATEC) proposes to build the Turnagain Arm Tidal Energy Project to develop tidal energy on 26 ha (65 acres) within Cook Inlet near Anchorage. The project would transmit tidal power to the Alaskan Railbelt grid. A preliminary permit to produce 240 MW of electricity (expandable to 1,200 MW) was issued by FERC in 2010 for this project. Construction is expected to occur between 2014 and 2018 (TATEC 2011; FERC 2012d).

Alternate energy projects provide beneficial effects in terms of providing cleaner sources of energy and adding jobs to local communities. They may also contribute to adverse cumulative effects (mainly during their construction) on the acoustic environment, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds). Important impact-producing factors associated with alternate energy development in Cook Inlet include subsea noise and vibration, bottom sediment disturbance (turbidity and contaminant resuspension), and wildlife collisions with infrastructure).

Military Operations. JBER consists of the combined bases of Elmendorf Air Force Base and Fort Richardson (U.S. Army). JBER-Elmendorf sits on 5,445 ha (13,455 ac) within the Municipality of Anchorage, about 11 km (7 mi) northeast of downtown Anchorage (Figure 4.6.1-6). The base has an active duty Air Force, tenant units (U.S. Navy, U.S. Marine Corps, and U.S. Army and their dependents), a civilian and contractor workforce, and retired military in south-central Alaska. Its main facility is the airfield located in the southern part of the base. The northern part of the base includes a munitions storage area, an Explosive Ordnance Disposal range, a small arms range, a combat training center, and various communication centers. Its mission support activities include airfield flight line functions, munitions storage, base security, and readiness training for remote airbase development (JBER 2011).

JBER-Richardson is located about 11 km (7 mi) northeast of Anchorage (Figure 4.6.1-6). It encompasses 2,330 ha (5,760 ac) of developed land along the Glenn Highway and provides housing, community facilities (e.g., schools, libraries, medical and dental, and physical fitness, among others), and various activities for military residents. It has another 22,260 ha (55,000 ac) of maneuver areas, 31 training areas, numerous impact areas (artillery and mortar firing points), and major ranges (including small arms ranges, two demolition ranges, landing zones, and drop zones). The 4/25th Infantry Brigade Combat Team (Airborne) is located at Fort Richardson (JBER 2011).

Although the various activities at JBER are land- or air-based, they have the potential to impact resources in Cook Inlet. These include the types of activities mentioned above, as well as historical disposal practices (e.g., sites such as Eagle River Flats contaminated by white phosphorus, currently undergoing remediation; ADEC 2012a). JBER has detailed its current resource management practices and compliance with environmental requirements (e.g., pertaining to monitoring and protection of threatened or endangered species) in its *Integrated Natural Resource Management Plan* (JBER 2011).

Military operations at JBER are expected to continue and military use areas are expected to remain the same over the next 40 to 50 years. Such operations contribute to cumulative effects on air and water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (local communities and subsistence). Important impact-producing factors associated with military operations in Cook Inlet include noise and vibrations, disturbance or injury of fish and wildlife, disturbance of nearby residents, and contaminant releases.

Mining (Coal and Minerals).

Chuitna Coal Project. The proposed Chuitna Coal Project is a surface coal mining and export development located on public and private lands in the Beluga Coal Field of south-central Alaska, about 72 km (45 mi) west of Anchorage and 19 km (12 mi) northwest of the Native Village of Tyonek (Figure 4.6.1-4). The center of the proposed project is about 19 km (12 mi) from the Cook Inlet coast. As currently proposed, the project would consist of a surface mine, support facilities, a mine access road, a coal transport conveyor, personnel housing, an air strip facility, a logistics center, and a coal export terminal. The project would have a life of about 25 years, with a production rate of up to 12 million tons of ultra-low, sub-bituminous coal per year (an estimated lifetime production of 300 million tons). Project applications to the ADNR (the lead State permitting agency) by PacRim Coal LLC are currently undergoing revisions. The Draft EIS for the project is scheduled to be completed in late 2012 (ADNR 2012a; USACE 2012).

The Chuitna Coal Project would likely contribute to cumulative effects on air and water quality, water use (and patterns of recharge and discharge), the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine and terrestrial mammals, and birds), and sociocultural systems (local economies and subsistence). Important impact-producing factors associated with surface mining include noise and vibration, coal particulate and dust releases to air, soil erosion (from land disturbance), deposition of fugitive dust, permitted releases to water, pollutant releases via surface runoff (non-point sources), engine emissions and fuel spills (marine vessels and land-based vehicles and equipment), disturbance or injury of fish and wildlife, wildlife collisions with marine vessels, and collisions among marine vessels.

Pebble Mining Project. The Pebble deposit is located north of Iliamna Lake, about 27 km (17 mi) northwest of Iliamna and Newhalen (Figure 4.6.1-6). The deposit is one of the world's largest copper-gold porphyry systems. It is estimated to contain 48 billion pounds of copper, 57 million ounces of gold, and 2.9 billion pounds of molybdenum and may also contain economically significant quantities of silver, palladium, and rhenium. The Pebble mining project would include mine pits (or workings), access infrastructure, power facilities, a mill, tailings storage, low-grade ore stockpiles, warehousing, administrative facilities, and worker housing (Pebble Limited Partnership 2011). Although the site is located at some distance from Cook Inlet, resources in the inlet could be affected by potential releases of contaminants via drainages discharging to the inlet and atmospheric deposition from the project area. To date, only an environmental baseline study has been completed (conducted between 2004 and 2008); there are no set plans for construction of the project.

The Pebble Mining Project would likely contribute to cumulative effects on air quality, groundwater (quality), surface water (quality and stream flow), marine and coastal habitats, marine and coastal fauna (fish, marine and terrestrial mammals, and birds), and sociocultural systems (local economies and subsistence). Important impact-producing factors associated with mining include particulate releases to air, engine emissions (land-based vehicles and equipment), permitted releases to water, soil erosion (from land disturbance), deposition of fugitive dust, pollutant releases (via surface runoff), and disturbance or injury of wildlife.

Abandoned Mine Lands. There are seven abandoned mine lands (coal projects) in south-central Alaska. The specific locations of these lands have not been reported by the ADNR. The types of risks associated with these lands include surface impoundments, gob piles, slurry deposits, and surface burning; and physical hazards such as portals, vertical openings, high walls, rock piles and embankments, spoil areas, hazardous equipment and facilities, and subsidence or slumping (ADNR 2011a).

Abandoned mine lands are currently undergoing restoration under the ADNR's Abandoned Mine Lands Program to reduce their environmental impact and the risk they pose to the public. Until they are restored, these lands could contribute to cumulative effects on air quality, groundwater (quality), surface water (quality and stream flow), marine and coastal habitats, marine and coastal fauna (fish, marine and terrestrial mammals, and birds), and sociocultural systems (local economies and subsistence). Important impact-producing factors associated with abandoned mines include particulate releases to air, pollutant releases (via surface runoff), releases to groundwater (via infiltration and leaching), soil erosion (from land disturbance), deposition of fugitive dust, and potential injury or mortality of humans and wildlife.

Dredging and Marine Disposal. As authorized by the *Rivers and Harbors Appropriation Act*, the USACE conducts annual maintenance dredging projects to prevent shoaling at several locations within Cook Inlet: in Anchorage Harbor (in Knik Arm), Homer

Small Boat Harbor, and Ninilchick Harbor (Anderson 2010). Dredging in Anchorage Harbor occurs during the ice-free season, beginning in the spring, and continuing into the summer when shoaling is greatest, and into the fall. Operations typically use a clamshell (with or without a small hopper dredge) and barge. Dredged material from the harbor is tested for various contaminants (pesticides, PCBs, petroleum hydrocarbons, volatile and semi-volatile organics, and heavy metals) and, if clean, moved by barge and tug to a deepwater site south of the project, where it is dispersed by tidal activity (USACE 2011b).

At Homer Small Boat Harbor, dredging typically occurs in September. Dredging is conducted with a hydraulic cutterhead and pipeline suction dredge. Dredged materials are tested for various contaminants, then conveyed via portable pipeline (from the floating dredge plant) to a bermed site on the pit where they are used to maintain its integrity. Because the harbor is located within the Kachemak Bay Critical Habitat Area, a CWA Section 404 permit is required for dredging (USACE 2011b).

Dredging at Ninilchik Harbor (in lower Cook Inlet) usually runs from December through mid-May (or as soon as possible to avoid conflicts with the in-coming salmon run). Material is either hydraulically dredged (from a floating plant with a hydraulic cutterhead) or removed with a bulldozer. Dredged material from the basin is tested for various contaminants and, if clean, conveyed by pipeline to a beach north of the project; material bulldozed from the entrance is used as a containment dike for dredge spoils from the basin (USACE 2011b).

In addition to annual maintenance dredging activities, several other dredging actions associated with ongoing and planned construction projects throughout Cook Inlet will continue and likely increase over the coming decades. These include dredging actions related to various USACE civil works projects, as well as those associated with the expansion of the Port of Anchorage, the Knik Crossing Bridge (new bridge piers), the Chuitna Coal Project (new terminal near Tyonek), the Diamond Point Granite Rock Quarry (vessel dock in Cottonwood Bay), and the Pebble Mine Project (new terminal in Iniskin Bay).

The beneficial effects of dredging include improving navigational depths for marine vessels and providing materials for restoration projects. Dredging and disposal may also contribute to adverse cumulative effects on water quality, the acoustic environment, coastal and marine habitats, coastal and marine fauna (fish and marine mammals), and cultural resources (if present). Important impact-producing factors of dredging and disposal are noise and turbidity/contaminant resuspension caused by bottom sediment disturbance.

Recreation and Tourism. The Cook Inlet offers many opportunities for recreational activities such as hunting, hiking, boating, wildlife viewing, and sightseeing, and tourism in the region is robust (see Section 3.13.1.2). Tour ships from the lower 48 States regularly travel to southeast Alaska, and independent travelers use the Alaska Maritime Highway (ferry) system to access the region. Sightseeing tours via small aircraft and helicopters have developed locally. Other tours involve small regional tour ships, river jet-boat tours, fishing charters, and bed-and-breakfast operations.

While recreation and tourism have beneficial effects on local economies, they may also contribute to adverse cumulative effects on water quality, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (subsistence). Important impact-producing factors include noise, wildlife disturbance or injury, and habitat displacement and/or degradation.

Climate Change. Because a growing body of evidence shows that climate change is occurring (Section 3.3), we have included it as a current and foreseeable natural trend in the cumulative impacts analysis for some resources in Cook Inlet. Analyses that take into account impact-producing factors related to climate change meet one or both of the following two criteria:

- The resource is already experiencing impacts from climate change, so the effects are observable and not speculative, or

- The resource will be directly affected by warming temperatures.

Not all impacts from climatic and hydrologic changes that are the indirect result of temperature changes have been analyzed because they may be too uncertain to predict. For example, it is reasonable to expect changes in precipitation regimes as a result of climate change. Furthermore, it is also likely that precipitation changes would, in turn, affect the coastal salinity balance between freshwater flow and tidal influence in some areas, and that these changes would affect fisheries and fish populations in some way. However, both the magnitude and direction of each factor in this sequence of occurrences are uncertain. While we acknowledge that continuing climate change could result in changing regional ecological and socioeconomic patterns and distributions, at this stage of our understanding of underlying processes, the rates and directions of many of these changes are too speculative to include in the cumulative analyses that follow.

Legislative Actions. Major statutes governing the management and protection of resources within the Cook Inlet Planning Area are listed in Appendix C. Regulations and permitting programs based on these statutes, for example, the dredge permitting program based on Section 404 of the *Clean Water Act*, are overseen by the USACE and other regulating authorities. The statutes and regulations are discussed in the previous sections and in the resource impacts sections, as they apply.

4.6.1.2.4 Non-OCS Program Actions and Trends – Arctic Region. Table 4.6.1-7 summarizes ongoing and reasonably foreseeable future actions and trends affecting resources and systems in the Arctic region. Past and present actions are generally accounted for in the baseline environment (described in Chapter 3) and the analysis of direct and indirect impacts under each resource area (Section 4.4). These impacts are carried forward to the cumulative analysis, which also takes into account the effects of ongoing and reasonably foreseeable future actions and trends. Cumulative scenarios (based on types of actions) and impact-producing factors are described for each action or trend on the basis of recent environmental reports or NEPA reviews. Figures 4.6.1-7 and 4.6.1-8 show general locations of ongoing and reasonably

TABLE 4.6.1-7 Ongoing and Reasonably Foreseeable Future Actions and Trends – Arctic Region

Type of Action or Trend	Associated Activities, Facilities, or Trends	Impact-Producing Factors	Affected Resources and Systems
Ongoing oil and gas exploration, development, and production activities and existing infrastructure (onshore, in State waters, and Canadian and Russian waters)	*Ongoing activities onshore and in State waters:*		
	<u>35 producing oil fields</u> Seismic surveys Exploratory drilling Offshore drilling vessels Bridges, roadways, and docks Processing facilities Waste disposal facilities Gravel and ice pads Artificial gravel islands Production wells Pipelines (gathering and carrier) TAPS (Pump Station 1) Dredging Gravel mining Marine vessel traffic Land-based vehicles and equipment traffic Aircraft traffic	Subaerial noise and subsea noise and vibration Facility lighting Engine emissions (marine vessels and land-based vehicles and equipment) Fuel spills (marine vessels and land-based vehicles and equipment) Oil spills (storage tanks and vessel casualty) Hazardous spills/releases Oil and chemical releases (wells and produced water) Chronic seafloor disturbance (anchors) Bottom sediment disturbance (turbidity and contaminant resuspension) Disturbance or injury of fish and wildlife Habitat displacement or degradation Deposition of fugitive dust Altered wildlife migration patterns (e.g., caribou) Collisions (wildlife with marine vessels and infrastructure) Resource consumption	Air quality, water quality, acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, mammals, and birds), terrestrial habitat and fauna, sociocultural systems (local jobs and revenue, and subsistence harvesting), and cultural resources (if present)
	Ongoing activities in Canadian waters:		
	MacKenzie Valley and onshore Yukon Arctic Islands MacKenzie Delta/Beaufort Sea	Same as for ongoing activities onshore and in State waters	Same as for ongoing activities onshore and in State waters
	Ongoing activities in Russian waters (unknown)	Same as for ongoing activities onshore and in State waters	Same as for ongoing activities onshore and in State waters

TABLE 4.6.1-7 (Cont.)

Type of Action or Trend	Associated Activities, Facilities, or Trends	Impact-Producing Factors	Affected Resources and Systems
Foreseeable future oil and gas exploration, development, and production activities and infrastructure (onshore, and in State and Federal OCS waters)	*Foreseeable future activities onshore and in State waters:*		
	Alaska (Gas) Pipeline Project New gas treatment plant (Prudhoe Bay) 32- in. pipeline (Point Thomson to Prudhoe Bay) 48-in. (main) pipeline system Compressor stations Marine vessel traffic (sealifts) Land-based vehicles and equipment traffic LNG shippers (Valdez option)	Same as for ongoing activities onshore and in State waters	Same as for ongoing activities onshore and in State waters
	Point Thomson Project (Beaufort) Central and satellite pads Production and injection wells Processing facility (including flare stacks) Pipelines Support facilities (offices, warehouses, maintenance buildings, camps, waste management facilities, and boat ramp) Water and electricity distribution systems Ice and gravel roads Airstrip Service pier Sealift facility and barge mooring dolphins Dredging Gravel mining	Same as for ongoing activities onshore and in State waters	Same as for ongoing activities onshore and in State waters

TABLE 4.6.1-7 (Cont.)

Type of Action or Trend	Associated Activities, Facilities, or Trends	Impact-Producing Factors	Affected Resources and Systems
	Liberty Project (Beaufort) Expansion of existing infrastructure (Endicott Satellite Drilling Island) New bridge and ice road/ice pad Seismic surveys Marine vessel and land-based vehicle traffic Production wells Water and gas injection wells Pipeline transport (TAPS) Gravel mining	Same as for ongoing activities onshore and in State waters	Same as for ongoing activities onshore and in State waters
	Foreseeable future activities in Federal lands and OCS waters:		
	National Petroleum Reserve (BLM land) Exploratory drilling (past and future)	Same as for ongoing activities onshore and in State waters (if developed)	Same as for ongoing activities onshore and in State waters (if developed)
	ANWR - 1002 Area (FWS-managed) Research and monitoring (past)	Same as for ongoing activities onshore and in State waters (if developed)	Same as for ongoing activities onshore and in State waters (if developed)
	Beaufort and Chukchi Seas OCS Seismic surveys Exploratory drilling Marine vessel traffic Offshore drilling vessels Production wells	Same as for ongoing activities onshore and in State waters	Air quality, water quality, acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, mammals, and birds), and sociocultural systems (subsistence harvesting)
Subsistence activities	Hunting and trapping Fishing Whaling and sealing Onshore camping (crews) Small marine vessel traffic (*umiat* and aluminum skiffs)	Resource consumption	Marine, coastal, and terrestrial fauna

TABLE 4.6.1-7 (Cont.)

Type of Action or Trend	Associated Activities, Facilities, or Trends	Impact-Producing Factors	Affected Resources and Systems
Marine vessel traffic	Cargo vessels Tugs and barges Service vessels Cruise ships (limited) Spill-response vessels Hovercraft Military vessels Research vessels (icebreakers) Small watercraft (hunting and intra-village transportation)	Noise Fuel spills Engine emissions Discharges of bilge water and waste Oil spills (vessel casualty) Increased wave action (nearshore) Collisions (wildlife with marine vessels) Collisions (among vessels)	Air quality, water quality, acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (subsistence harvesting)
Scientific research	Marine vessel traffic (including submersibles) Sampling, tagging, and tracking species of interest Seismic surveys Drilling Sediment and subsurface sampling Well installation and geophysical logging	Subsea noise and vibration Disturbance of wildlife Bottom sediment disturbance (turbidity and contaminant resuspension)	Water quality, acoustic environment, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds)
Wastewater discharge to Arctic waters	Discrete conveyances such as pipes or man-made ditches from sewage treatment plants, industrial facilities, and power generating plants Drilling wastes (offshore) Marine vessel discharge	Permitted releases to water Pollutant releases via surface runoff (non-point sources)	Water quality, marine and coastal habitats, marine and coastal fauna (fish, mammals, and birds), commercial and recreational fisheries, and sociocultural systems (local communities and subsistence harvesting)
Persistent contaminants and marine debris	Accumulation of contaminants from multiple sources (discharges, spills, and releases; and atmospheric deposition) Accumulation of floating, submerged, and beached debris	Exposure to contaminants in marine waters and sediments, and in the food web via toxicity or bioaccumulation Collisions (marine vessels with debris) Entanglement in or ingestion of debris by marine wildlife Habitat displacement and/or degradation	Water (and sediment) quality, marine and coastal habitats, marine and coastal fauna (fish, mammals, and birds), commercial and recreational fisheries, and sociocultural systems (subsistence harvesting)

TABLE 4.6.1-7 (Cont.)

Type of Action or Trend	Associated Activities, Facilities, or Trends	Impact-Producing Factors	Affected Resources and Systems
Military operations	Aircraft traffic Marine vessel traffic (submarines and icebreakers)	Subaerial and subsea noise Engine emissions (marine vessels) Fuel spills (marine vessels) Discharges of bilge water and waste Oil spills (vessel casualty) Collisions (wildlife with marine vessels)	Air quality, water quality, acoustic environment, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (subsistence harvesting)
Mining (coal and minerals)	<u>Red Dog Mine (Chukchi)</u> Open pit lode mine (lead and zinc) Mineral extraction (drilling, blasting, loading, and hauling of ore) Waste rock and ore stockpiles Tailings impoundments Incinerator Solid waste disposal areas Land-based vehicle traffic (transport of ore by to port facility) Marine vessel traffic (transport of ore by barge from port facility) Mine expansion (to include Aqqaluk deposit) Reclamation activities (e.g., grading) <u>Coal Development in Northern Alaska</u> Nanushak project (proposed) <u>Other (placer) mining (Chukchi)</u> Possible use of mercury amalgamation (of gold placers)	Noise Permitted releases to air and water Particulate and dust releases to air Pollutant releases via surface runoff (non-point sources) Engine emissions (marine vessels and land-based vehicles and equipment) Fuel spills (marine vessels and land-based vehicles and equipment) Deposition of fugitive dust Collisions (wildlife with marine vessels)	Air quality, water quality, marine and coastal habitats, marine and coastal fauna (fish, mammals, and birds), and sociocultural systems (local jobs and revenue, and subsistence harvesting).
Dredging and marine disposal	Excavation for artificial islands and shipping corridors (oil and gas industry) Excavation for harbors, and nearshore channels and mooring basins Transport or conveyance of dredged materials (by barge or pipeline)	Noise Bottom sediment disturbance (turbidity and contaminant resuspension)	Water quality, acoustic environment, marine and coastal habitats, marine and coastal fauna (fish and marine mammals), and cultural resources (if present)

TABLE 4.6.1-7 (Cont.)

Type of Action or Trend	Associated Activities, Facilities, or Trends	Impact-Producing Factors	Affected Resources and Systems
Recreation and tourism	Wildlife viewing Aircraft traffic Marine vessel traffic (cruise ships and commercial vessels) Recreational/sport fishing and hunting Recreational activities (e.g., rafting) Cruise ships and commercial vessels	Noise Disturbance or injury of fish and wildlife Habitat displacement and/or degradation	Water quality, marine and coastal habitats, marine and coastal fauna (fish, mammals, and birds), and sociocultural systems (jobs and revenues; subsistence harvesting)
Climate change	Increase in atmospheric temperatures Increase in precipitation rates Sea level rise and coastal erosion Reduction in extent of September sea ice Reduction in multi-year sea ice Thawing of permafrost	Changes in water quality (temperature, salinity, and pH) Changes in water circulation Increased navigability	Air quality, water quality, marine and coastal habitats, and marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, and sociocultural systems (community structures infrastructure, and subsistence harvesting)
Legislative actions (existing and forthcoming)	Federal statutes and regulations Executive orders State statutes and regulations International agreements	Management and protection of various resources throughout the marine and coastal regions of the Beaufort and Chukchi Seas	All resources

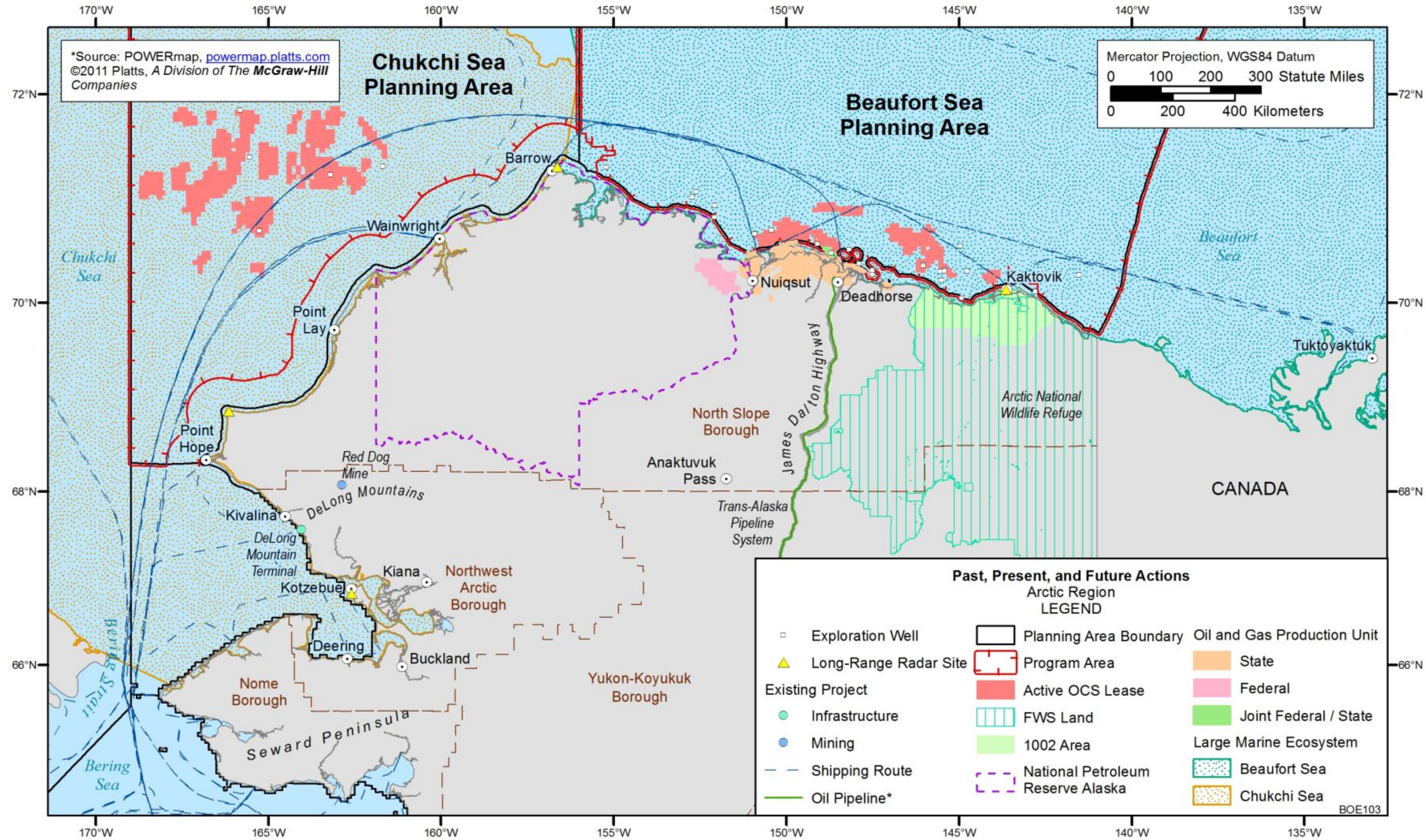

FIGURE 4.6.1-7 Ongoing and Reasonably Foreseeable Future Actions in the Arctic Region

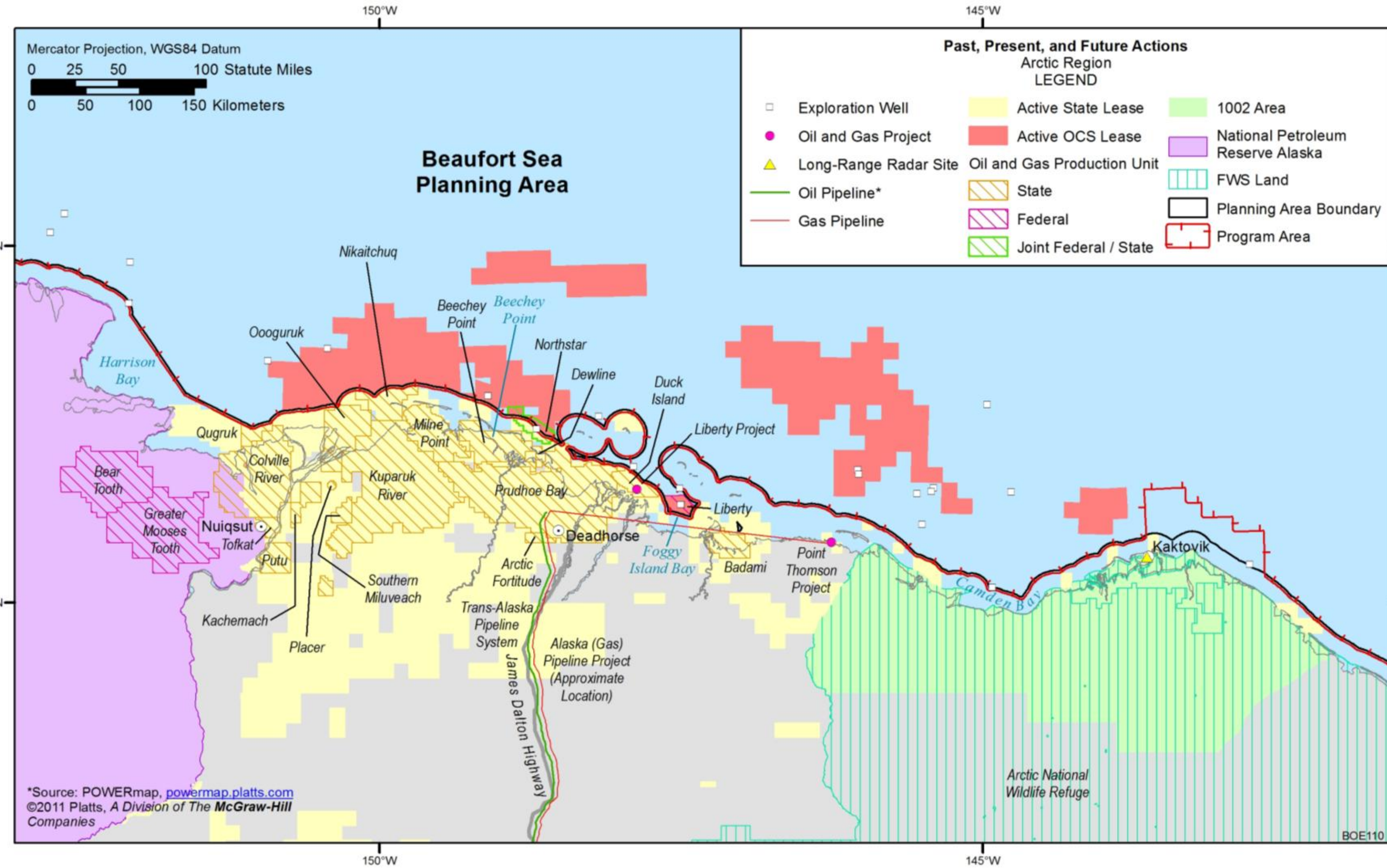

FIGURE 4.6.1-8 Ongoing and Reasonably Foreseeable Future Actions along the Beaufort Sea Coastline

foreseeable future actions in the Beaufort Sea and Chukchi Sea Planning Areas relative to the LMEs.

Ongoing Oil and Gas Exploration, Development, and Production Activities and Existing Infrastructure.

Onshore and in State Waters. Oil and gas exploration in the Arctic region of Alaska began in the late 1950s when federally-sponsored geological studies found that the region had significant oil reserve potential. The first State of Alaska lease sale on the North Slope took place in 1964, and by 1968, the Prudhoe Bay oil field (the largest oil field in North America) was in production. By 2001, oil development on the North Slope consisted of 19 producing fields and related infrastructure (roads, pipelines, power lines, production facilities, and transportation hubs). Because of the high cost of building infrastructure (due to the remoteness and harsh weather of the region), many Arctic fields remain undeveloped; for example, the EIA estimates that 35.4 Tcf of the discovered natural gas resources in the Arctic, two-thirds of which is in the Prudhoe Bay field, remain undeveloped due to lack of transportation infrastructure (NRC 2003; Budzik 2009).

Currently, there are 35 producing oil fields and satellites on the North Slope and nearshore areas of the Beaufort Sea. The oil fields are distributed among the various unit pools shown in Figure 4.6.1-8: Prudhoe Bay (12), Duck Island (3), Northstar (1), Badami (1), Kuparak (5), Milne Point (3), Colville River (8), Ooogaruk (1), and Nakiatchuq (1) (NTEL 2009). Industrial development centers on Prudhoe Bay; infrastructure includes artificial gravel islands, roadways, pipelines, production and processing facilities, gravel mines, and docks. Most oil and gas projects are onshore or are located offshore in State waters of the Beaufort Sea. Currently, there are no leases in the State waters of the Chukchi Sea, and no oil and gas production along its coast (MMS 2008b).

Two large diesel fuel spills occurred in the Beaufort Sea — one with a volume of 2,440 bbl, from a diesel tank on an eroded gravel island in the Canadian Beaufort Sea (September 1985); and another with a volume of 1,600 bbl, from a punctured barge delivering fuel to Kaktovik (August 1988) (MMS 2008b). Between 1995 and 2005, there were 4,481 spills of seawater, produced water, crude oil, diesel, and drilling muds on the Alaska North Slope subarea, with an estimated volume of 45,000 bbl (98% of which resulted from spills greater than 99 gal). Oil exploration and production facilities were responsible for more than 90% of the spills and about 90% of the volume. Over the past 20 years, however, most large spills were of diesel fuel and occurred in local villages (ADEC 2007a; MMS 2008b).

Ongoing oil and gas activities and existing infrastructure (both onshore and offshore) in the Arctic region contribute to cumulative effects on air and water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine and terrestrial mammals, and birds), sociocultural systems (local economies and subsistence), and cultural resources (if present). Important impact producing factors include subaerial noise and subsea noise and vibration, facility lighting, engine emissions and fuel spills (marine vessels and land-based vehicles and equipment), oil spills, hazardous spills and releases, oil and chemical releases (from wells and produced water), chronic seafloor disturbance (by anchors), bottom sediment disturbance (turbidity and contaminant resuspension), disturbance or injury of fish and wildlife, habitat displacement or degradation, deposition of fugitive dust, altered wildlife migration patterns, wildlife collisions with marine vessels and infrastructure, and resource consumption.

Canadian Arctic Activities. Northern Canada contains about a quarter of Canada's remaining discovered resources of conventional petroleum and a third to a half of the country's estimated potential (Northern Oil and Gas Directorate 2007). This resource is distributed throughout northern Canada as follows:

- Mackenzie Valley and onshore Yukon – Twenty-six significant discoveries and three producing fields: the Norman Wells oil field produces oil at rates of 30,000 bbl per day (6.294 bbl = 1 m^3) with initial recoverable reserves of 235 Mbbl; the Kotaneelee and Pointed Mountain fields close to the British Columbia-Alberta border had produced 417 billion ft^3 (35.3 ft^3 = 1 m^3) of gas by the end of 1997.

- Arctic Islands – Nineteen significant discoveries after fewer than 200 exploration wells; the Bent Horn field in the Arctic Islands, which produced high-quality light oil for many years on a seasonal basis, has only recently been abandoned.

- Mackenzie Delta/Beaufort Sea – Discovered resources of in excess of 1 Bbbl of oil and 9 Tcf of gas in 53 significant discoveries. Four Tcf of marketable gas have been discovered in three onshore discoveries, and offshore discoveries include over 200 Mbbl in the Amauligak field. On the Mackenzie Delta, the Ikhil gas discovery is being developed to supply natural gas to the town of Inuvik, where it will replace imported diesel oil for power generation and domestic use.

There is little information on oil and gas exploration and development activities currently being conducted by Canada in the Arctic. If such activities are in progress, it is assumed that the effects would be similar to those resulting from oil and gas exploration and development in the Alaska Arctic region.

Russian Arctic Activities. There is little information on oil and gas exploration and development activities currently being conducted by Russia adjacent to the U.S. Arctic. If such activities are in progress, it is assumed that the effects would be similar to those resulting from oil and gas exploration and development in the Alaska Arctic region.

Foreseeable Future Oil and Gas Exploration, Development and Production Activities and Infrastructure.

Onshore and in State Waters. Several exploration wells on State oil and gas leases in the Beaufort Sea have either been drilled recently or are reasonably foreseeable in 2012 (Petroleum News 2012a). These include:

- Repsol – One exploratory well (Kachemak-1) was drilled and experienced a loss of well control releasing about 42,000 gallons of drilling mud; no oil was spilled (ADEC 2012d). A permit for a second well, Q-4, was approved on March 29. The North Slope Borough and Nuiqsut has set a limit of no more than three drilling rigs operating at any given time;

- Brooks Range Petroleum Corp. – One well completed;

- Savant – Permit approved for one well, drilling would begin sometime in April;

- ConocoPhillips – One well completed;

- Pioneer – One well completed, another being drilled; and

- Great Bear – Seismic surveys underway (as of April 2), six to eight wells to be drilled beginning in mid-May.

In addition to these wells, Brooks Range Petroleum Corporation plans to drill seven horizontal production wells in the Mustang prospect by 2014. The prospect is located in the new Southern Miluveach Unit, on the southwestern boundary of the Kuparuk River Unit (Figure 4.6.1-8). Several other prospects held by Brooks Range Petroleum Corporation (near the Prudhoe Bay and Badami Units and Beechey Point) are considered economically feasible and will likely be developed in the near future (Petroleum News 2012b).

There are three other oil and gas developments in the Beaufort Sea coastal region that are reasonably foreseeable in the next 5 to 10 years, including the Alaska (Gas) Pipeline Project, the Point Thomson Project, and the Liberty Project (Figure 4.6.1-8). These projects would take place onshore or nearshore, in areas where industry infrastructure is already well established, but would also involve activities that could contribute to cumulative impacts in the marine environment, especially air and water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), sociocultural systems (local economies and subsistence), and cultural resources (if present).

Important impact-producing factors associated with new oil and gas projects in the Beaufort Sea coastal region include subaerial noise and subsea noise and vibration, engine emissions and fuel spills (marine vessels and land-based vehicles and equipment), oil spills, hazardous spills and releases, oil and chemical releases (in produced water), bottom sediment disturbance (turbidity and contaminant resuspension), disturbance or injury of fish and wildlife, habitat displacement or degradation, altered wildlife migration patterns, wildlife collisions with marine vessels and infrastructure, and resource consumption.

Alaska (Gas) Pipeline Project. The Alaska Pipeline Project (TransCanada) would connect the natural gas resources developed on the North Slope to markets both within and outside of Alaska. The project consists of a new gas treatment plant (GTP) near Prudhoe Bay; 93 km (58 mi) of 32-in.-diameter pipeline connecting the processing plant at the Point Thomson field to the GTP; and about 1,200 km (745 mi) of 48-in.-diameter mainline pipeline from the GTP to the Alaska-Yukon (Canada) border. TransCanada is currently in the process of conducting baseline studies and preparing reports in support of its Federal permit. The NOI to prepare an EIS for the pipeline project was issued by FERC on August 1, 2011, and public scoping took place in February 2012 (FERC 2012e). According to Office of the Federal Coordinator (Alaska Natural Gas Transportation Projects), further action on the pipeline to Alberta may be delayed while a second option, involving a pipeline to Valdez to facilitate large-scale LNG exports to Asia, is considered (OFC 2012). The pipeline project is estimated to take 10 years to permit and construct once its application is filed with FERC.

Point Thomson Project. The proposed Point Thomson Project (ExxonMobil) would delineate and evaluate hydrocarbon resources in the Point Thomson Unit (Figure 4.6.1-8), with the objective of initiating production of commercial hydrocarbon liquids by the winter season of 2015–2016. Hydrocarbon liquids would be delivered to the TAPS for shipment to market. Project activities include the construction of a central gravel pad for production and injection wells; support facilities, including offices, warehouses, maintenance buildings, temporary camps, drinking water and sanitary wastewater treatment systems, waste management facility, communication facilities, electric power generation and distribution facilities, and an emergency response boat ramp; two satellite gravel pads for production wells; ice roads; a gravel airstrip for year-round access to Point Thomson; a service pier; a sealift facility and barge mooring dolphins; a new gravel mine site; infield gravel roads; and infield gathering pipelines, one for each production well. Offshore portions of the reservoir would be reached using directional drilling. An export pipeline would also be constructed from the central pad to the existing Endicott common carrier pipeline connecting to TAPS Pump Station No. 1. Other infrastructure to be built includes water and power distribution systems, communications towers, and staging facilities (USACE 2011a).

Liberty Project. The proposed Liberty Project (British Petroleum) is an oil and gas development located about 8.9 km (5.5 mi) offshore on an expanded area of the Endicott Satellite Drilling Island (SDI) into the Beaufort Sea (Figure 4.6.1-8). The project involves expanding the Endicott SDI by about 8 ha (20 ac) to support drilling into the Liberty reservoir located on Federal offshore leases managed by BOEM and upgrading the Sagavanirktok River road bridge to accommodate the transportation of Liberty's drilling rig (both completed in 2009; Petroleum News 2009). The drilling program will include one to four production wells, and one or two water and gas injection wells. Oil produced from the project will be sent by existing pipeline infrastructure (Endicott production flowline system) from the Endicott SDI to the Endicott Main Production Island (MPI) for processing, then to the TAPS through the existing Endicott sales-oil pipeline. Produced gas will be used for fuel or re-injected into the reservoir for enhanced oil recovery. Equipment, supplies, and personnel will access the project site via the existing Endicott road system, which connects with roads at Prudhoe Bay and with the Dalton Highway. Onshore and offshore ice roads will be built to support project construction (and possibly drilling operations). No regularly scheduled helicopter access to the project site is expected (although there is sufficient area on the Endicott SDI for landing, if needed). A sealift by barge would necessitate travel through the Chukchi and Beaufort Seas; the barge would offload at an existing MPI dock. Extensive dredging is not anticipated (BP 2007).

Another onshore support activity associated with the Liberty project is the development of a new permitted gravel mine site. Water for the project is provided by the existing produced-water injection system and augmented with treated seawater (from the existing Endicott Seawater Treatment Plant), as needed (BP 2007).

The land use permit and easements for wellbores and injection wells into State subsurface were issued by the ADNR in January 2010 (ADNR 2010). The project was originally expected to start production in 2010, but has been delayed until 2013 or later (Petroleum News 2011a, b).

Federal Land and OCS Waters. There are three major areas of Federal land for which oil and gas activities are reasonably foreseeable in the next 5 to 15 years. These include the National Petroleum Preserve-Alaska (NPR-A), the Arctic National Wildlife Refuge (ANWR) Area 1002, and the Beaufort and Chukchi Seas OCS (discussed below).

<u>National Petroleum Reserve-Alaska.</u> The NPR-A is a 9.3-million-ha [23-million-ac] area of public land on the North Slope of Alaska managed by the BLM (Figures 4.6.1-7 and 4.6.1-8). The USGS estimates mean volumes of recoverable oil and natural gas in the NPR-A of 896 Mbbl and 53 Tcf, respectively. This estimate was lowered from the previous estimates on the basis of recent exploration drilling that showed an abrupt transition from oil to gas just 16 to 32 km (10 to 20 mi) west of the Alpine oil field and poor reservoir quality in key formations (Houseknect et al. 2010).

Integrated activity plans have been developed by BLM (2004, 2006a, and 2012a) that identify the lands within the NPR-A available for leasing, as well as those restricted from leasing, and specify stipulations and restrictions on surface activities in the lease areas of the NPR-A. There have been seven lease sales in the NPR-A (in 1999, 2002, 2004, 2006, 2008, 2010, and 2011) and as a result of these sales, the BLM currently administers 186 Federal oil and gas leases on the NPR-A (BLM 2012b). However, no production wells have been established in the NPR-A to date. A total of 29 exploration wells have been drilled within the reserve since 2000 (most focused to the west and southwest of Alpine), and additional exploratory drilling is likely in the coming decades (BLM 2012b). It is less certain at this time whether production facilities would be established within the NPR-A during the life of the Program.

<u>Arctic National Wildlife Refuge (1002 Area).</u> The ANWR is located on the northern coast of Alaska to the east of Prudhoe Bay (Figures 4.6.1-7 and 4.6.1-8). The area was designated by the Alaska National Interest Lands Conservation Act (ANILCA) in 1980. The USGS estimates that recoverable oil in the coastal plain area of ANWR (referred to as the 1002 Area) is between 5.7 and 16.0 Bbbl. Section 1002 of ANILCA deferred any decisions on oil and gas development until studies could be performed to better assess the extent and amount of petroleum resources, as well as potential impacts to the fish and wildlife resources in the region. These studies were completed and submitted to Congress in 1987. Currently, the 1002 Area is managed by the USFWS as a “minimal management” area and it will continue to be managed by the USFWS until Congress decides how petroleum resources in the 1002 Area will be developed. For this reason, it is uncertain whether leasing in ANWR will occur during the life of the Program (Budzik 2009; USFWS 2008).

The USFWS Comprehensive Conservation Plan (CCP) is a document that outlines and guides long-term management for a National Wildlife Refuge. The original CCP for Arctic Refuge was signed into effect in 1988. The USFWS is now midway through a 2-year process to revise the 1988 CCP and the accompanying EIS. The draft CCP contains six management alternatives but no preferred alternative. The USFWS will consider public comments before selecting a preferred alternative. The final CCP and EIS are anticipated in the summer of 2012 (see http://arctic.fws.gov/ccp.htm).

Beaufort and Chukchi Seas OCS. Exploratory drilling in Federal OCS lands began in 1981, a few years after construction of the TAPS was completed. After 33 years of leasing, however, there are no commercial oil or gas facilities on the OCS (see Figure 4.6.1-7 for active leases on the Federal OCS; Northstar accesses Federal reserves from a facility within State waters). Although exploratory drilling in the Beaufort Sea OCS has declined since 1990, there were several seismic programs in the region during the 1990s and early 2000s. Acquisitions of leases by Shell during OCS Lease Sale No. 195 (2005) and recent approval of its oil spill response plan by the BSEE indicate that drilling activity on the Beaufort Sea OCS is likely in the near term. Shell submitted its exploration plan to drill on three OCS lease blocks in the Camden Bay area of the Beaufort Sea in 2011. ConocoPhillips has also proposed drilling in the Chukchi Sea; however, at this date there in no approved plan (NRC 2003; NTEL 2009; BOEM 2012c).

Exploratory drilling in the Chukchi Sea OCS began in the late 1980s and continued into the 1990s; most of the seismic data acquisition was completed by the end of 1991 (although 2D and 3D surveys were conducted in 2006 and 2007). A second phase of activity began in early 2008 prior to OCS Lease Sale No. 193, where industry spent over 2.6 billion dollars acquiring leases. This sale is expected to initiate an exploration effort in the near term (NTEL 2009).

Exploration activities on the Beaufort and Chukchi Seas OCS could contribute to cumulative impacts in the marine environment, especially air and water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (subsistence). Important impact-producing factors associated with these activities include subaerial noise and subsea noise and vibration, engine emissions and fuel spills (marine vessels), hazardous spills and releases, oil and chemical releases (from wells and produced water), disturbance or injury of fish and wildlife, and wildlife collisions with marine vessels.

Subsistence Activities. The majority of permanent residents of the Arctic and Bering Sea coasts are Alaska natives for whom subsistence activities are group activities that further core values of community, kinship, cooperation, and reciprocity (see Section 3.14.3.2). In general, subsistence foods consist of a wide range of fish and game products; these include fish, such as Broad white fish, Arctic cisco, and Arctic char/Dolly Varden; marine mammals, such as bowhead whale, bearded seal, ringed seal, and walrus; terrestrial mammals, such as caribou, wolves, and wolverines; and waterfowl, such as geese and eider. Table 3.14.3-14 provides a more comprehensive list of subsistence resources used by Alaska Native villages.

Each community has its own unique harvest pattern and preferences. Subsistence harvesting follows a seasonal pattern and is constrained by changes in climate and by the migration patterns of whales, fishes, and birds. Bowhead whales are harvested during both their spring and fall migrations. Subsistence activities generally occur along the coast, concentrated in areas directly offshore from villages. The village of Nuiqsut stages its fall bowhead whale hunt on Cross Island. Seaward harvesting occurs within 40 km (25 mi) of shore, but may extend as far as three times that distance, depending on the conditions of sea and ice. Marine vessels used in subsistence marine harvesting include light seal-skin *umiat* and aluminum skiffs (in open water for the fall harvest).

Subsistence resources on Federal lands and the navigable waters along the Arctic coast are managed by the Federal Subsistence Management Program under the FSB. The program is a multi-agency effort to support a subsistence way of life by rural Alaskans on Federal public land and waters while maintaining healthy populations of fish and wildlife (through research and monitoring). Priority for subsistence harvesting of Federal public lands and water are expressed in ANILCA. The MMPA encourages cooperative agreements between Alaska Native organizations and Federal agencies to conserve marine mammals and provide management of subsistence use.

Marine Vessel Traffic. The current level of vessel traffic is low, consisting mainly of vessels supporting the oil and gas industry (e.g., cargo vessels, tugs/barges, service vessels, spill response vessels, and hovercraft). Other vessels include those used by the military, by Arctic researchers (icebreakers), and by local communities for hunting and between-village transportation during the open water period. As open water season begins earlier and ends later, vessel traffic is likely to increase for shipping, research, and cruise-ship tourism in the coming decades (MMS 2008b).

There is substantial international vessel traffic in the Bering Strait (the narrow international strait that connects the northern Pacific Ocean to the Arctic Ocean) and Chukchi Sea (Figure 4.6.1-7); activity in this region increased from 245 marine vessel transits in 2008 (in the Bering Strait) to 325 transits in 2010. This trend is expected to continue with ongoing exploration and drilling activities on the U.S. OCS and the Northern Sea Route along the Russian portion of the Chukchi shelf (USCG 2011a).

Scientific Research. Scientific research programs are ongoing in the offshore areas of the Beaufort and Chukchi Seas. These include studies of marine mammals, fish, birds, habitats, ecosystems, and physical oceanography conducted by Federal agencies such as BOEM, NOAA (NMFS), and the NSF. Activities related to scientific research of physical systems involve the use of marine vessels, and include seismic surveys, ocean floor drilling/sampling, well installation, and geophysical logging. Activities related to scientific research of biological systems requires some human presence and interaction with wildlife, such as sampling, tagging, or tracking species of interest.

Research-related activities in the Beaufort and Chukchi Seas are likely to increase over the next 40 to 50 years (in response to concerns over the environmental effects of oil and gas development and climate change in the Arctic region). While such activities are necessary and beneficial, they may also contribute to adverse cumulative effects on water quality, the acoustic environment, coastal and marine habitats, and coastal and marine fauna (fish, marine mammals, and birds). Important impact-producing factors include subsea noise and vibration, disturbance or injury of fish and wildlife, and bottom sediment disturbance (turbidity and contaminant resuspension).

Wastewater Discharge to Arctic Waters. Point-source discharges to the Beaufort and Chukchi Seas include those from facilities related to the oil and gas industry, hard-rock and placer mining, military operations, and seawater treatment (ADEC 2010; USEPA 2010c). Most of these activities would remain at present levels for the foreseeable future and are not expected to affect the overall water quality in these regions. Discharges are regulated through the USEPA NPDES permit program. Section 403 of the CWA established the Ocean Discharge Criteria, which provide additional requirements for these types of discharges. The Alaska Department of Environmental Conservation issues all NPDES permits in Alaska except for those related to oil and gas, munitions, cooling water, pesticides, and offshore seafood processors, and those on tribal lands. Current NPDES permits in Alaska are available on the USEPA Region 10 Web site (see http://yosemite.epa.gov/r10/water.nsf/NPDES+Permits/CurrentAK822).

Non-point sources of pollution include stormwater and snowmelt that run over land or through the ground, entraining pollutants and depositing them into Arctic waters. The most common forms of pollution in Alaska's urban runoff include fecal coliform, sedimentation, and petroleum. Snow disposal into the marine environment also introduces oil, grease, antifreeze, chemicals, trash, animal wastes, salt, and sediments (sand, gravel, suspended and dissolved solids) (ADEC 2007b). Non-point source management programs under Section 319 of the CWA regulate these pollutant sources. The USEPA and NOAA also co-administer State Coastal Non-Point Pollution Control Programs under Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990.

Both point and non-point source discharges to Arctic waters are expected to continue and could increase over the next 40 to 50 years (based on projected increases in economic development in the Beaufort and Chukchi Seas coastal regions). Pollutant discharges contribute to cumulative effects on water quality, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, and sociocultural systems (local communities and subsistence). Important impact-producing factors associated with discharges include contaminant releases via permitted conveyances and surface runoff.

Persistent Contaminants and Marine Debris. Persistent contaminants are natural and manmade substances introduced to the environment that are resistant to degradation naturally; these include various heavy metals (e.g., mercury, cadmium, lead, and chromium), as well as herbicides, pesticides, PCBs, and dioxin. Because they do not degrade naturally, these substances are capable of long-range transport and may bioaccumulate in the tissues of ecological and human receptors. Sources of persistent contaminants include permitted discharges and surface runoff (with suspended sediments) from agricultural, industrial, or urban areas; and atmospheric deposition. The presence of persistent contaminants in the waters and sediments in the Arctic region contributes to cumulative effects on water and sediment quality, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), commercial and recreational fisheries, and sociocultural systems (subsistence). Important impact-producing factors include exposure of marine fauna to toxic pollutants (resulting in mortality or reproduction problems) and habitat displacement and/or degradation. Such factors lead to unstable or contaminated fish stocks (or other species) that in turn affect species higher in the food web (via toxicity or bioaccumulation).

NOAA defines marine debris as "any persistent, manufactured, or processed solid material that is directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment" (NOAA 2009). Marine debris in Arctic waters could include ocean-based materials such as fishing gear, oil and gas items (plastic drill pipe thread protectors, hard hats, gloves, and 55-gal storage drums), and lost vessel cargo. Materials from land-based sources can also find their way into Arctic waters via blowing winds, waves washing ashore, littering, dumping in rivers and streams, and industrial losses. Weather also plays a role as storm water flows along streets and the ground carrying litter into storm drains; high winds and heavy rains are also capable of dispersing solid objects into marine waters (NOAA 2012d). The presence of marine debris in the waters and sediments of the Beaufort and Chukchi Seas contributes to cumulative effects on the same resources as described for persistent contaminants. Important impact-producing factors include collisions of marine vessels with debris and entanglement in or ingestion of debris by marine wildlife.

Military Operations. As an effect of changing climate in the Arctic (the opening of Arctic waters in the coming decades) and in response to security concerns (boundary disputes and competition for resources), the military plans to increase its presence in the Arctic region to monitor the air, land, maritime, space, and cyber domains for potential threats to the United States. This effort would include coordination with various domestic (e.g., USCG) and international partners (e.g., Russia and Canada). Military activities in the region would mainly involve the use of aircraft, submarines, icebreakers, or ice-strengthened surface vessels. The military does not anticipate a need for a deep-draft port between now and 2020. It is uncertain whether (or when) basing infrastructure would be needed; the military plans to reassess these needs periodically. Its strategy is finding balance between investing in Arctic capabilities in a timely fashion without making premature investments that draw resources away from more pressing needs (O'Rourke 2012).

Currently, the U.S. Air Force maintains four long range radar sites along the coasts of the Beaufort and Chukchi Seas: Kotzebue, Cape Lisburne, Point Barrow, and Barter Island (Figures 4.6.1-7 and 4.6.1-8). Four others have been deactivated: Point Lay (in 1994), and Wainwright, Bullen Point, and Flaxman Island (in 2007) (National Air Defense Radar Museum 2012).

In the coming decades, the military will likely increase its presence in the Arctic region via aircraft and marine vessels, including submarines and icebreakers. Increased air and marine vessel traffic contributes to cumulative effects on air and water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (subsistence). Important impact-producing factors associated with increased traffic in the Beaufort and Chukchi Seas include subaerial and subsea noise, engine emissions and fuel spills (marine vessels), discharges of bilge water and waste, oil spills (vessel casualty), and wildlife collisions with marine vessels.

Mining (Coal and Minerals).

***Red Dog Mine**.* The Red Dog Mine, operated by Teck Cominco Alaska, (Teck Cominco is now known as Teck Alaska, a subsidiary of Teck Resources) is one of the largest lead and zinc mines in the world and the only base-metal lode mine currently in production in northwest Alaska (Figure 4.6.1-7). The open-pit mine (with processing mill, tailings impoundment, and support facilities) is located in the DeLong Mountains about 130 km (82 mi) north of Kotzebue and 74 km (46 mi) inland from the Chukchi seacoast; it produced more than a million tons of zinc and lead concentrates annually, but is estimated to be mined out by 2012. Teck Cominco Alaska is proposing to mine an adjacent deposit (Aqqaluk Deposit) and continue its operations until 2031 (USEPA 2010e; TCAK 2009 2012).

Processed ore (concentrate) is transported from the Red Dog Mine by an 84-km (52-mi) road to the DeLong Mountain Terminal, a port facility located on the Chukchi Sea (Figure 4.6.1-7). The terminal consists of a housing unit, six diesel storage tanks, two concentrate storage buildings, a laydown area, and a concentrate conveyor/ship loading system. Although concentrate is shipped from the mine to the terminal year-round, shipping of concentrate by barge (to deep sea cargo ships) occurs only during months when the waters are ice free (generally from July through October). The port site also includes a small domestic wastewater treatment system that discharges to the Chukchi Sea under a NPDES permit (USEPA 2006).

The Red Dog Mine would likely contribute to cumulative effects on air and water quality, marine and coastal habitats, marine and coastal fauna (fish, marine and terrestrial mammals, and birds), and sociocultural systems (local economies and subsistence). Important impact-producing factors associated with mining include noise, permitted releases to air and water, particulate and dust releases to air, engine emissions and fuel spills (marine vessels, and land-based vehicles and equipment), pollutant releases (via surface runoff), deposition of fugitive dust, and wildlife collisions with marine vessels.

Coal Development in Northern Alaska. Most of the coal resources in Alaska occur north of the Brooks Range, in the Northern Alaska-Slope coal province. The USGS estimates coal reserves in this region to be 3,870 billion short tons (1,910 billion short tons of bituminous and 1,960 billion short tons of sub-bituminous); however, the remoteness of the region and high cost of logistics and transport currently make large-scale coal development in northern Alaska uneconomical. Depending on infrastructure availability (e.g., if a gas pipeline were to be built), however, coalbed methane could be a target of future development (Flores et al. 2004).

The ADNR's Division of Mining, Land, and Water is currently considering a coal prospecting permit for the proposed Nanushak coal project, a small project located along the northern foothills of the Brooks Range near Anaktuvuk Pass. Currently, there are no large-scale coal mining proposals in the region (ADNR 2012c).

Other Mining Activities. Mining of placer gold in beach deposits and bench gravels along the Seward Peninsula (Chukchi Sea) continued through the 1950s (Koschmann and Bergendahl 1968). Past mining of this nature could have contaminated nearby water and sediments with metals such as mercury (if used in collecting gold). Most of the current placer operations are taking place near Nome, in the South Seward Peninsula, and would not affect the waters of the Beaufort or Chukchi Seas (BLM 2005).

There are no abandoned mine lands in the Arctic region (ADNR 2011a).

Dredging and Marine Disposal. Mechanical and hydraulic dredges have been used to excavate materials to construct artificial islands (drilling platforms), helipads, and coastal harbors/shipping corridors in the Beaufort Sea. All past dredging activities have been conducted to support the oil and gas industry — in the 1950s and 1960s, it was for shipping and transportation; in the 1970s and 1980s, it was mainly for the construction of islands (30 islands were built during this time). Most dredging occurred during the open water season in water depths less than 50 m (150 ft). Harbors, channels, and mooring basins were dredged in MacKinley Bay, Tuft Point, and Tuktoyaktuk (IMG Golder Corp. 2004). Several State and Federal regulations and permitting processes govern dredging operations in Arctic waters. The likelihood of future dredging projects is not certain, but is considered to be low.

The main benefit of dredging in Arctic waters is the improvement of navigational depths for marine vessels. Dredging and disposal may also contribute to adverse cumulative effects on water quality, the acoustic environment, coastal and marine habitats, coastal and marine fauna (fish and marine mammals), and cultural resources (if present). Important impact-producing factors of dredging and disposal are noise and turbidity/contaminant resuspension caused by bottom sediment disturbance.

Recreation and Tourism. Most nonresident recreational activity in the North Slope Borough consists of tour groups visiting Barrow or Deadhorse (see Section 3.13.1.3). Travel to these areas is primarily by air, although bus tours occasionally arrive via the Dalton Highway between Deadhorse and Fairbanks. Hikers and river rafters also visit the Arctic National Wildlife Refuge and other areas, using scheduled (to Kaktovik) or chartered (for remote locations) airplanes for access. An increasing number of cruise ships enter the Chukchi and Beaufort Seas, and a growing number of hikers and rafters visit coastal areas of the Chukchi Sea; lodging is currently available in Kaktovik. Gates of the Arctic National Park receives limited visitation, accessed through Anuktuvuk Pass or by chartered airplane. Hunters also visit the area using aircraft for access, and some hunters may enter the area using the Dalton Highway. Tourism and recreation in the Arctic region will likely increase in the coming decades as more enterprises take advantage of the longer summer (ice-free) seasons.

While recreation and tourism may have beneficial effects on local economies, they also contribute to adverse cumulative effects on water quality, marine and coastal habitats, marine and coastal fauna (fish, marine mammals, and birds), and sociocultural systems (subsistence). Important impact-producing factors include noise, disturbance or injury of fish and wildlife, and habitat displacement and/or degradation.

Climate Change. Because a growing body of evidence shows that climate change is occurring (Section 3.3), it is included as a current and foreseeable natural trend in the cumulative impacts analysis for some resources in the Arctic region. Analyses that take into account impact-producing factors related to climate change meet one or both of the following criteria:

- The resource is already experiencing impacts from climate change, so the effects are observable and not speculative.

- The resource will be directly affected by warming temperatures.

In the Arctic region, impacts of climate change include warming ocean temperatures, reductions in sea ice, permafrost thawing, and coastal erosion, which all affect terrestrial, coastal, and marine ecosystems (see Section 3.3.2). In addition to ecosystem effects, the loss of sea ice contributes to an ice-albedo feedback process that affects regional atmospheric circulation patterns and global heat budgets. Changes to the Arctic climate have been documented in several studies; these include an increase in atmospheric temperature (by 2 to 4°F since 1960), an increase in precipitation (by a rate of about 1% per decade), a decrease in the extent of sea ice (by a rate of about 3% per decade for March and 12% per decade for September since the 1970s); and a decrease in multi-year sea ice (by a rate of about 9 to 12% per decade since the 1980s).

Not all impacts from climatic and hydrologic changes that are the indirect result of temperature changes have been analyzed because they may be too uncertain to predict. For example, it is reasonable to expect changes in precipitation regimes as a result of climate change. Furthermore, it is also likely that precipitation changes would, in turn, affect the coastal salinity balance between freshwater flow and tidal influence in some areas, and that these changes would affect fisheries and fish populations in some way. Both the magnitude and direction of each factor in this sequence of occurrences, however, are uncertain. While we acknowledge that continuing climate change could result in changing regional ecological and socioeconomic patterns and distributions, at this stage of our understanding of underlying processes, the rates and directions of many of these changes are too speculative to include in the cumulative analyses that follow.

Legislative Actions. Major statutes governing the management and protection of resources within the Beaufort Sea and Chukchi Sea Planning Areas are listed in Appendix C. Regulations and permitting programs based on these statutes (e.g., the NPDES permitting program based on Section 402 of the Clean Water Act) are overseen by the USEPA and other regulating authorities. The statutes and regulations (including international agreements between the United States, Canada, and Russia) are discussed in the previous sections and in the resource impacts sections, as they apply.

4.6.2 Marine and Coastal Physical Resources

4.6.2.1 Gulf of Mexico Region

4.6.2.1.1 Water Quality. Section 4.4.3.1 discusses potential water quality impacts in coastal (bays and estuaries), marine (State offshore and Federal OCS), and deepwater environments in the GOM resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on water quality result from the incremental impacts of the Program (described in Section 4.4.3.1) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS program activities. Table 4.6.1-2 presents the exploration and development scenario for the GOM cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the GOM are summarized in Table 4.6.1-5 and discussed below, as applicable.

Ongoing and future routine OCS program activities, including those of the Program, involve vessel traffic, well drilling, pipelines (trenching, landfalls, and construction), chemical releases (drilling, operation discharges, and sanitary wastes), platforms (anchoring, mooring, and removal, except in deep waters), and onshore construction (coastal waters only). All of these activities have the potential to adversely affect water quality in the GOM over the next 40 to 50 years. Accidental oil spills are also counted among OCS program-related activities; assumptions for oil spills under the cumulative case scenario are provided in Table 4.6.1-4.

OCS program-related service vessel traffic in the GOM (to new facilities) could be as high as 1,900 trips per week over the next 40 to 50 years; service vessel traffic associated with the Program (a maximum of 600 trips per week) represents about 32% of this traffic.

Other types of marine vessel traffic occur in the GOM, one of the world's most concentrated shipping areas (USACE 2010). Non-OCS program traffic includes that related to crude oil and natural gas imports, commercial container shipments, tugs and barges, military and USCG operations, cruise ships, commercial fishing, and small watercraft. In 2010, the Port of New Orleans alone handled about 7,500 vessel calls (mainly tanker and dry bulk carrier), about 140 vessel calls per week (USDOT 2011b). Impacts on water quality from marine traffic arise from regular discharges of bilge water and waste, leaching of antifouling paints, and incidental spills (MMS 2001d), although operational discharges and spillage from marine vessels have declined substantially in the past few decades (NRC 2003b). Oil releases associated with vessel casualty are rare, but have been documented in the GOM.

The number of development and production wells and platforms constructed over the duration of the Program (at most 2,600 and 450, respectively) would be proportional to the amount of oil produced; these numbers represent about 22% of the total number of production wells and platforms (respectively) anticipated to be built in the GOM over the next 40 to 50 years as part of ongoing and future OCS programs. The length of new pipeline (at most

12,070 km [7,500 mi]) added as part of the Program represents about 17% of that anticipated as part of ongoing and future OCS programs.

The area of disturbed sea bottom from construction of platforms and pipelines over the duration of the Program (as much as 14,000 ha [34,600 ac] total) represents about 17% of that associated with ongoing and future OCS programs over the next 40 to 50 years. Bottom disturbance degrades water quality by increasing water turbidity in the vicinity of the operations and adding contaminants to the water column. It also changes sediment composition as suspended sediments (and contaminants, if present) are entrained in currents and deposited in new locations.

An inventory conducted by NOAA found that there were about 766 major and 8,147 minor land-based point sources of pollution releasing to watersheds and coastal drainage areas of the GOM; these included discharges from industrial facilities (6,909), wastewater treatment plants (1,925), and power plants (79) — most of which were located in the watersheds of the Atchafalaya/Vermilion Bays and Galveston Bays at the time of the inventory (NOAA 1995). The kinds of contaminants released include nitrogen (from organic chemicals, petroleum refining, industrial plants, and pesticide sources), phosphorus, metals (zinc, arsenic, cadmium, lead, and mercury), oil and grease, suspended solids (turbidity), biocides, and heat (from power plant cooling water discharges). Non-point sources release pollutants to the GOM via rivers and on-land drainages and are primarily from urban and agricultural runoff (containing animal waste and residual fertilizer, in particular nitrogen and phosphorous compounds), but also originate from seepage from landfills and industrial facilities and various kinds of on-land spills. These sources (together with similar sources from Mexico) combine to degrade water quality in the GOM, especially in coastal waters. Coastal water quality is also adversely affected by the loss of wetlands (Section 3.7.1).

Other types of actions taking place within GOM waters also contribute to the degradation of water quality in the GOM. These include marine mining operations, sediment dredging and disposal operations (suspended sediments and contaminants), LNG terminal operations (biocide-laden, cooled water), and activities related to the oil and gas industry, which operates hundreds of platforms in State and Federal waters and discharges large volumes of drilling wastes, produced water, and other industrial waste streams into GOM waters. Hydrocarbon releases through natural oil seeps along the continental slope and accidental oil spills are additional sources of water and sediment contamination.

There are 23 designated ocean dredged material disposal sites in the GOM, including 16 off the coast of Texas and Louisiana and in the Mississippi River GOM outlet and six off the coasts of Mississippi, Alabama, and Florida. Dredging operations are routinely conducted for channel construction and maintenance, pipeline emplacement, access to support facilities, creation of harbor and docking areas, and siting for onshore facilities. Offshore disposal, authorized under Title I of the *Marine Protection, Research and Sanctuaries Act of 1972*, as amended (33 USC 1401), and the *Federal Water Pollution Control Act*, as amended (33 USC 1251), consists primarily of dredged sediments but may also include fish wastes and decommissioned vessels. The site management and monitoring plans for many of these sites are available on the USEPA’s website (http://www.epa.gov). The USACE maintains an online database that tracks the projects (including quantities of materials, dredging and transport methods, and dumping frequency, size, and location) that dispose of materials at designated offshore disposal sites (http://el.erdc.usace.army.mil/odd). The direct impacts of dredging on water quality (increased turbidity and decreased dissolved oxygen at the dredge site) are fairly short lived; however, long-term landscape-scale changes can have significant adverse impacts on aquatic organisms and their habitats (Nightingale and Simenstad 2001) (Sections 4.6.3 and 4.6.4).

Currently, there is only one offshore LNG terminal in the GOM (Gulf Gateway Deepwater Port off the coast of Louisiana). However, natural gas demand growth in the United States has accelerated since the 1980s, and LNG imports are expected to increase significantly to meet this demand. As a result, 25 LNG terminal proposals have been approved to serve the U.S. market (Parfomak and Vann 2009). At least seven new licenses have been issued for additional facilities in the GOM, and it is anticipated that more LNG facilities will be built over the coming decades (USDOT 2012b) (Section 4.6.1.5). The impacts of LNG transport and LNG receiving terminals are associated with explosions and fires and with the cryogenic and cooling effects of either an accidental release of LNG or the release of cooled water during the vaporization process.

The majority of oil released to the GOM comes from chronic releases, mainly from naturally occurring seeps and runoff from land-based sources (NRC 2003b). Oil seeps are estimated to contribute up to 62% of the oil input in U.S. marine waters overall; runoff from land-based sources, about 21% (NRC 2003b). As many as 350 crude oil and tar seeps have been identified in the GOM. Seepage rates for the northern part of the GOM (along the continental slope) have been estimated at about 73,000 tons (526,000 bbl) per year,[39] comparable to that estimated for spills from OCS programs over the next 40 to 50 years (based on a worst-case scenario of about 559,600 bbl per year, excluding catastrophic events; Table 4.6.1-4). Spills associated with the Program (based on a worst-case scenario of about 114,500 bbl per year, excluding catastrophic events (Table 4.4.2-1), represent a small fraction, about 11%, of the combined annual oil inputs from oil seeps and oil spills (from pipelines, platforms, and tankers/barges and incidental spills) from OCS programs over the next 40 to 50 years. Natural gas seeps are also common, but little is known about their seepage rates (Kvenvolden and Cooper 2003).

The second largest contribution to oil releases in U.S. marine waters overall is related to oil consumption (about 32%): land-based runoff and river discharge (21%), recreational marine and non-tank vessels (2.6%), tank vessel operational discharges (<1%), atmospheric deposition (8.1%), and jettisoned aircraft fuel (<1%). Other important sources of oil releases include those associated with non-OCS program oil extraction/transportation activities (about 4.7% in total): platforms, produced water, atmospheric deposition, pipeline and tank vessel spills, operational discharges (cargo washings), and coastal facility spills (NRC 2003b).

[39] Total estimates for the GOM, taking into account oil seeping from the Campeche Basin offshore of Mexico in the southern part of the Gulf, run as high as 140,000 tons (1 Mbbl) per year (Kvenvolden and Cooper 2003).

Another issue of importance to the water quality in the GOM concerns the hypoxic zone in the GOM coast shelf waters (offshore of Louisiana and Texas to the west of the Mississippi Delta) (see Figure 4.6.1-5). The hypoxic zone is an area near the sea bottom that contains less than 2 ppm of dissolved oxygen, causing a condition of hypoxia that is inhospitable to fish and causes stress or death to benthic organisms (USGS 2011c). The hypoxic zone is attributed to water column stratification (driven by weather and river flow) and the decomposition of organic matter in bottom waters, as well as organic matter and nutrients (that fuel phytoplankton growth) carried by waters of the MARB. In July 2011, the hypoxic zone measured 17,520 km^2 (6,765 mi^2), which is smaller than originally predicted by the USEPA based on recent trends (USEPA 2011f). River discharge from the MARB watershed is projected to increase by as much as 20% in the coming decades. This phenomenon, in addition to natural upwelling of nutrient-rich deep ocean water into shallow areas (which may be an effect of climate change), could increase the extent of the hypoxic zone in the northern GOM over the next 40 to 50 years (USGCRP 2009). Activities associated with the Program are not expected to have a large effect on the hypoxic zone, because inflows of contaminants causing hypoxia are mainly from MARB waters discharging to the GOM.

Catastrophic oil spills are rare events, but their releases have a high potential to degrade water quality in both coastal and deep waters. Since the 1970s, there have been two CDEs in the GOM: the Ixtoc I event in the Cantarell oil field (Mexico), in 1979; and the DWH event, in 2010. The DWH event released an estimated 4.9 Mbbl between April 22 and July 15, 2010 (see Section 3.4.1.4.1 for a more detailed discussion on the effects of the DWH event). In response to the spill, 7,000 m^3 (1.84 million gal) of chemical dispersants were also released (Section 3.4.1.3). The short- and long-term impacts of the spill on water quality in the GOM are still being assessed, but as of January 2011, 134 km (83 mi) of shoreline were classified as heavily or moderately oiled (NOAA 2012b). SCAT observations in March 2012 indicated that oiling was still present in some areas along barrier islands and coastal areas in Louisiana, Mississippi, Alabama, and Florida (ERMA 2012a, b).

Studies conducted two months after the start of the DWH event (at depths of 1,500 m [4,921 ft]) found a continuous plume of dispersed oil at a depth of approximately 1,100 m (3,609 ft) that extended for 35 km (22 mi) from the DWH event site (Camilli et al. 2010). The plume consisted of droplets between 10 and 60 μm in size and contained monoaromatic hydrocarbons (benzene, toluene, ethyl benzene, and xylene) at concentrations greater than 50 μg per liter and persisted for months at this depth with no substantial biodegradation. High concentrations of aromatic hydrocarbons were detected in the upper 100 m (328 ft). PAHs were found at concentrations as high as 189 μg per liter extending as far as 13 km (8 mi) from the subsurface DWH event site, at depths between 1,000 and 1,400 m (3,281 and 4,593 ft) and extending as far as 13 km (8 mi) from the subsurface DWH site (Diercks et al. 2010).

Joye et al. (2011) estimated that the DWH event released 450 million kg (500,000 tons) of hydrocarbon gases at depth. In May through June 2010, high concentrations of dissolved hydrocarbon gases (methane, ethane, propane, butane, and pentane) were detected in a water layer between 1,000 and 1,300 m (3,281 and 4,265 ft) (Joye et al. 2011).

The fate of the estimated 771,000 gal of chemical dispersants injected at the DWH wellhead near the seafloor (at depths of about 1,500 m [4,921 ft]) was studied by Kujawinski et al. (2011). The study concluded that chemical dispersants at this depth underwent slow rates of biodegradation and recommended further studies to assess the impact of dispersant-oil mixtures on pelagic biota.

Global climate change will also affect water quality in the GOM in the coming decades, especially in terms of surface temperature, salinity, vertical stratification, and pH (USGCRP 2009). Increases in sea surface temperature in the GOM are thought to be correlated to increased hurricane intensity, similar to the way the “Loop Current” played a part in intensifying Hurricanes Ivan, Katrina, and Rita. Increased surface temperatures also increase thermal expansion of marine waters, thus adding to sea level rise. Changes in temperature and salinity affect density parameters, which in turn affect vertical mixing and stratification of the water column, processes that are especially important in estuaries (in terms of oxygen concentrations and nutrient availability). Estuaries with low-amplitude tides, such as those in the northeastern GOM, are highly susceptible to stratification and hypoxia. As sea surface temperatures increase, the ocean’s ability to absorb CO_2 is also decreased (because CO_2 is less soluble in warmer waters). Currently, healthy coastal wetlands (e.g., seagrasses, salt marsh, and mangroves) are important natural CO_2 “sinks.” As coastal wetlands are lost through coastal development and sea level rise, their function as CO_2 sinks is diminished.

The GOM region has already experienced increasing atmospheric temperatures since the 1960s. From 1900 to 1991, sea surface temperatures increased in coastal areas and decreased in offshore areas. Sea level rise along the northern coast is as high as 0.01 m/yr (0.03 ft/yr) and has contributed to the loss of coastal wetland and mangroves and increased the rates of shoreline erosion. Future sea level rise is expected to cause saltwater intrusion into coastal aquifers, potentially making some unsuitable as potable water supplies (Section 3.3.1).

Significant changes (increases or decreases) in precipitation and river discharges to the GOM would affect salinity and water circulation — which in turn affects water quality. Water quality impacts associated with increased river discharges result from increases in nutrients (nitrogen and phosphorous) and contaminants to estuaries, increases in harmful algal blooms, and an increase in stratification. Such changes could also affect dissolved oxygen content and the extent of the GOM hypoxic zone. Decreased discharge would diminish the flushing of estuaries and increase concentrations of pathogens.

Conclusion. Water quality in GOM coastal and marine waters would be affected by various activities associated with OCS programs over the next 40 to 50 years. These include service vessel traffic, well drilling, pipelines (trenching, landfalls, and construction), chemical releases (drilling, operation discharges, and sanitary wastes), platforms (anchoring, mooring, and removal, except in deep waters), construction of shore-based infrastructure (coastal waters only), and accidental oil spills. Coastal waters in the GOM are also affected by numerous other factors, including river inflows, urbanization, agricultural practices, municipal waste discharges, and coastal industry. Non-OCS activities likely to contribute to cumulative impacts include marine vessel traffic, wastewater discharge to coastal and marine waters, dredging and marine disposal, oil and gas production in State waters, oil and gas infrastructure, marine mineral mining, existing oil and gas-related infrastructure in State waters, military operations, and renewable energy development. Natural seepage of oil along the continental slope is also significant.

The cumulative impacts of ongoing and reasonably foreseeable future activities on water quality in the GOM are unavoidable and may, in cases like salinity and pH, be irreversible, since such trends are natural and are occurring on a global scale. However, because many other impacts could be mitigated (i.e., minimized) by the various regulatory controls already in place to protect the marine waters of the GOM, the overall cumulative impacts are considered to be moderate. The incremental contribution of the Program to cumulative impacts on water quality in the GOM would be small to medium relative to the cumulative case and relative to other ongoing and reasonably foreseeable future actions in the GOM (see Section 4.4.3.1).

The USEPA, in collaboration with other Federal and coastal State agencies, has assessed the coastal conditions of each region of the United States, including the GOM coast, by evaluating five indicators of condition, one of which was water quality, based on such parameters as dissolved oxygen, chlorophyll *a*, nitrogen, phosphorus, and water clarity.[40] The most recent assessment found the overall condition of the coastal waters of the GOM coast region to be fair to poor, with an overall condition rating score of 2.2 (on a 5.0-point scale) and an individual indicator score of 3.0 for water quality. Parameters such as dissolved oxygen and water clarity vary in relation to climatic factors (e.g., annual rainfall) (USEPA 2008a).[41] In addition, the hypoxic zone has been a perennial feature in the northern GOM since the 1950s.

The number of expected accidental oil spills in GOM waters associated with the Program would represent only a small increase over the number of expected spills from ongoing and future OCS programs and non-OCS program activities, comparable in volume to releases from naturally occurring oil seeps (discounting catastrophic spills). The incremental increase in adverse water quality impacts from these spills would depend on the weather and sea conditions at the spill location, the type of waves and tidal energy at the spill locations, the type of oil spilled (very light to very heavy), the depth of the spill event (deep water, shallow water, or surface water), and the volume and rate of spillage; therefore, the incremental contribution of expected oil spills to cumulative water quality impacts could range from small to large. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from moderate to major if it were to occur. Spill response and cleanup activities (e.g., *in situ* burning and use of chemical dispersants) could contribute to water quality impacts regardless of the size of spill. A more detailed discussion of the effects of oil spills on water quality in the GOM is presented in Section 4.4.3.1.2.

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[40] Other indicators used to assess coast conditions include sediment quality (toxicity, contaminants, and total organic carbon), benthic community condition, coastal habitat loss, and fish tissue contaminants. The assessment found sediment quality in the Gulf coast region also to be poor (with sediments containing pesticides, metals, PCBs, and PAHs) (USEPA 2008b).

[41] The water quality score does not include the impact of the hypoxic zone in offshore GOM coast waters or the recent DWH event (USEPA 2008a).

4.6.2.1.2 Air Quality. Section 4.4.4.1 discusses potential air quality impacts in onshore and offshore areas of the GOM resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on air quality result from the incremental impacts of the Program (described in Section 4.4.4.1) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS program activities. Table 4.6.1-2 presents the exploration and development scenario for the GOM cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the GOM are summarized in Table 4.6.1-5 and discussed below, as applicable.

Ongoing and future routine OCS program activities, including those of the Program, involve production platforms, exploration wells, platform construction and removal, service vessels (pipelaying, support, and survey), helicopters, and tanker and barge transport. All these activities have the potential to adversely affect air quality in the GOM over the next 40 to 50 years. Accidental oil spills are also counted among OCS program-related activities; assumptions for expected oil spills under the cumulative case scenario are provided in Table 4.6.1-4. Other emission sources on the OCS that are not associated with oil and gas development activities include commercial marine vessels, commercial and recreational fishing, tanker lightering, military vessels, and natural sources such as oil or gas seeps. Onshore emission sources include power generation, industrial processing, manufacturing, refineries, commercial and home heating, on-road vehicles, and non-road engines (e.g., aircraft, locomotives, and construction equipment).

Criteria Pollutants. Over the past 20 years, the USEPA has promulgated a series of measures to reduce regional and nationwide emissions from fuel combustion sources (e.g., diesel marine engines), and the beneficial effects of these measures are evident in the data collected in 2006 (the most recent year for which data are reported).[42] NO_x emissions, mainly from transportation and fuel combustion sources, decreased nationwide by about 29% between 1990 and 2006. Most of the reductions in NO_x emissions occurred between 1998 and 2006 and are attributed to implementation of the Acid Rain Program and the NO_x State Implementation Plan (SIP) Call. SO_2 emissions, mainly from fuel combustion, industrial processes, and transportation sources, also decreased nationwide by about 38% between 1990 and 2006. During this same period, emissions from $PM_{2.5}$, PM_{10}, and CO decreased by 14, 30, and 38%, respectively (USEPA 2008b). At the State level, data collected between 1990 and 2002 indicate overall emissions have also declined in the five GOM coast States (Alabama, Florida, Louisiana, Mississippi, and Texas) in total: NO_x, down by 31%; SO_2, down by 15%; PM_{10}, down by 34%;

[42] This does not include new USEPA regulations that will apply international emission standards for ships operating off North American coasts, beginning in August 2012. The U.S. and Canada have designated waters off North American coasts collectively as an area in which stringent emission standards are needed (USEPA 2010f). In August 2012, the USEPA will require that ships operating within 200 nautical miles of the majority of U.S. and Canadian coastline, including the GOM (an area designated as the North American Emission Control Area), use lower sulfur fuels. The fuel standards are expected to reduce emissions of SO_x and fine particulate matter ($PM_{2.5}$) by as much as 85% from current levels. Engine-based controls (such as the use of high efficiency engines) would also reduce NO_x emissions.

and VOCs, down by 8%. Increases were observed only in Florida (NO_x up by 15% and VOCs up by 20%) and Alabama (VOCs up by 2%) during this period (USEPA 2011h).

Table 4.6.2-1 lists the estimated total emissions associated with ongoing and future OCS oil and gas activities in the GOM, including the 2012-2017 Program, over the next 40 years. These emissions were estimated by BOEM using emission factors from the *2008 Gulfwide Emission Inventory Study* (Wilson et al. 2010). In terms of absolute amounts, the largest emissions would be NO_x, followed by CO, with lesser amounts of VOC, SO_x, PM_{10}, and $PM_{2.5}$, in order of decreasing emissions. Under both the high and low scenarios, well drilling would be the largest source of NO_x; support vessels would be the largest source of SO_x. Well drilling and support vessels would be the largest sources of PM (equally); new production platforms would be the largest source of VOCs and CO. Emissions from Program activities in the GOM generally represent about 17 to 22% of the cumulative case emissions.

The USEPA's Acid Rain Program (established under Title IV of the 1990 CAA amendments) sets a permanent cap on the total amount of SO_2 that can be released from the electric power sector, with the final 2010 cap set at 8.95 million tons (about half of the emissions from the electric power industry in 1980). NO_x emissions from coal-fired boilers were also limited under the program (to about 8.1 million tons). Between 1980 and 2008, SO_2 emissions were reduced by about 52% compared to 1990 levels. In 2008, SO_2 emissions had already fallen below the emissions cap set for 2010 and monitoring data indicated the national composite average of SO_2 mean ambient concentrations declined by 71% between 1980 and 2008. NO_x emissions from the electric power sector in 2008 were also greatly reduced (by as much as 63% relative to projected levels in 2000 without the program). The USEPA also reports significant improvements in acid deposition indicators (wet sulfate and nitrogen deposition) (USEPA 2011i).

The Cross-State Air Pollution Rule was finalized in 2011 (replacing the USEPA's 2005 Clean Air Interstate Rule) and will take effect in 2012. The rule requires 27 States in the eastern half of the United States (including all of the GOM coast States) to reduce power plant emissions contributing to ozone and/or fine particulate pollution in other States by mandating significant reductions in SO_2 and NO_x emissions from power plants. The USEPA estimates that these actions will reduce SO_2 and NO_x emissions by 73% and 54%, respectively, from 2005 levels (USEPA 2011j).

MMS (currently BOEM) performed a cumulative air quality modeling analysis of platform emissions in a portion of the GOM in 1992 (MMS 1997b). The modeling incorporated a 40% increase in emissions above the 1992 levels to account for growth in oil and gas development. Predicted concentrations were well within the NAAQS and the Prevention of Significant Deterioration (PSD) Class II maximum allowable increases. An inventory study in the Breton National Wilderness Area (BNWA), a Class I area under the USEPA's PSD regulations, was conducted by MMS to estimate the contribution of OCS and non-OCS program emissions to concentrations of NO_x and SO_2 in the BNWA[43] (Billings and Wilson 2004). A

[43] Under the CAA, water quality degradation is limited in Class I areas by establishing stringent "increment" limits for NO_x and SO_2. These increments are the maximum increases in ambient pollutant concentrations allowed over baseline concentrations (Billings and Wilson 2004).

TABLE 4.6.2-1 Estimated Total Air Emissions for the Offshore Exploration and Development Scenario for the OCS GOM Cumulative Case

	Pollutant (10^3 tons for 40 yr)[a]					
Activity	NO_x	SO_x	PM_{10}	$PM_{2.5}$	CO	VOC
Well Drilling (D&P)	2,341.95–3,177.43	1.97–2.2	36.3–49.34	35.87–48.75	429.58–592.49	46.15–63.11
Well Drilling (E&D)	1,807.5–2,560.34	1.55–2.2	28.03–39.78	27.69–39.29	336.14–477.62	35.83–50.87
Helicopters	9.79–14.02	2.42–3.46	1.91–2.73	1.91–2.73	119.85–171.65	23.67–33.9
Oil Tanker/Barge Idling	0–29.67	0–3.85	0–0.57	0–0.57	0–3.15	0–28.91
Pipe-laying Vessels	250.54–574.33	42.54–97.53	9.45–21.67	9.45–21.67	52.00–119.2	9.45–21.67
Platform Construction	43.7–65.34	6.24–9.34	1.03–1.54	1.03–1.54	5.67–8.49	1.03–1.54
Platform Production	660.22–945.58	9.04–12.94	6.06–8.67	5.94–8.51	726.44–1,040.42	591.00–846.44
Platform Removal	43.7–65.34	6.24–9.34	1.03–1.54	1.03–1.54	5.67–8.49	1.03–1.54
Support Vessels	1,188.5–1,702.19	160.15–229.37	20.58–29.48	20.58–29.48	113.21–162.14	20.58–29.48
Survey Vessels	22.09–31.49	2.67–3.8	0.34–0.48	0.34–0.48	1.84–2.63	0.34–0.48
Total (Cumulative OCS)	6,367.98–9,165.72	232.81–374.56	104.73–155.82	103.85–154.57	1,790.4–2,586.27	729.95–1,079.16
Total (Program)[b]	1,031.11–1,983.79	40.49–81.11	16.78–32.97	16.64–32.71	304.63–575.9	132.25–250.22

[a] The range of values reflects the low and high end of new exploration and development activity.

[b] Values from Table 4.4.4-1.

recent modeling-based cumulative increment analysis for SO_2 and NO_2, conducted by MMS, considered the cumulative effect of all onshore and offshore emission sources in the area with respect to the baseline year (Wheeler et al. 2008). The model results are summarized as follows:

- The increase in the 3-hr SO_2 concentration within the BNWA since 1977 (the baseline year) ranges from 0.42 to 1.70 µg/m^3; the maximum increment of 25.0 µg/m^3 has not been exceeded within the BNWA but a small portion of the increment may have been consumed. The largest change within a 50-km (31-mi) radius of the BNWA is 2.6 µg/m^3 and occurs to the south and east of Breton Island.

- The increase in the 24-hr SO_2 concentration within the BNWA since 1977 ranges from 0.11 to 1.18 µg/m^3; the maximum increment of 5.0 µg/m^3 has not been exceeded within the BNWA but a portion of the increment may have been consumed. The maximum 24-hr average SO_2 has increased over most of the GOM since 1977; it has increased or decreased over land, depending on location. For example, it has decreased as much as 7.7 µg/m^3 near Mobile, Alabama. In areas east of the Chandeleur Islands and southeast of the Breton Islands, it has increased between 1.0 and 1.64 µg/m^3.

- The annual SO_2 concentration within the BNWA has decreased by 1.07 to 1.89 µg/m^3 since 1977. The decrease in annual SO_2 is less than 0.5 µg/m^3 over much of the GOM and is greatest (more than 1.5 µg/m^3) near the GOM coast and inland over south Mississippi, Alabama, and eastern Louisiana. Isolated increases at grid points in Louisiana and the GOM are likely due to local additions of SO_2 point sources since 1977.

- The maximum increase in annual NO_2 concentration within the BNWA since 1988 (the baseline year) is 0.10 µg/m^3, well below the maximum allowable increment of 2.5 µg/m^3. Only a very small portion of the increment has been consumed. Since 1988, annual NO_2 concentrations have decreased over land where controls have been implemented, but have increased over the GOM due to the addition of offshore NO_x emission sources. The boundary between decreased onshore concentrations and increased offshore concentrations follows the southern Louisiana coastline then turns northeastward away from the Louisiana coast and over the GOM where it crosses the BNWA and runs through the northern part of the Chandeleur Island chain. Part of the BNWA has experienced an increase in NO_2 concentrations since 1988. Larger increases are observed in areas within 75 km (47 mi) of the BNWA boundaries.

BOEM continues to consult with the USFWS, which manages the BNWA, on any plans within 100 km (62 mi) of the BNWA.

Ozone Formation. In the Nation's ozone (O_3) nonattainment areas, emissions of NO_x and VOCs are being reduced through the SIP process in order for those areas to achieve compliance with the national O_3 standard. Prior to the revocation of the 1-hr O_3 standard in 2004, the Houston-Galveston-Brazoria (Texas) and Baton Rouge (Louisiana) areas were classified as severe nonattainment; the Beaumont-Port Arthur (Texas) nonattainment classification was serious. While the 1-hr O_3 standard no longer applies, the same emission controls will remain in effect while each State develops its plan to reach compliance with the new 8-hr standard. In October 2008, the USEPA reclassified the Houston-Galveston-Brazoria O_3 nonattainment area from a moderate 8-hr O_3 attainment area to a severe 8-hr O_3 nonattainment area and required the State to submit a revised SIP addressing the severe O_3 requirements of the CAA (73 FR 56983). In September 2010, the USEPA published a notice that the Baton Rouge moderate 8-hr O_3 attainment area had attained the 1997 8-hr O_3 NAAQS (75 FR 54778); the Beaumont-Port Arthur area was also designated an attainment area for the 1997 8-hr O_3 NAAQS in 2010 (75 FR 64675). There are no O_3 nonattainment areas in Alabama, Florida, or Mississippi.

Ozone levels in the southeast Texas have been in a steady downward trend since 1995. The maximum observed fourth highest 8-hr O_3 concentration in the Houston-Galveston area decreased from about 0.140 parts per million (ppm) in 1995 to around 0.100 ppm in 2005. Ozone levels in the Baton Rouge area remained steady over the same period, but the number of exceedances of the O_3 standard decreased. This data indicates that emission-reduction measures have been effective in reducing O_3 levels.

Modeling studies were performed using the preliminary emissions inventory prepared by Wilson et al. (2010) to examine the O_3 impacts with respect to the 8-hr O_3 standard of 80 parts per billion (ppb). One modeling study focused on the coastal areas of Louisiana extending eastward to Florida (Douglas et al. 2009). This study showed that the impacts of OCS emissions on onshore O_3 levels were very small, with the maximum contribution at locations where the standard of 1 ppb or less was exceeded. Another study, conducted by Yarwood et al. (2004), evaluated O_3 levels in southeast Texas. The results of this study indicated a maximum contribution to areas exceeding the standard of 0.2 ppb or less. The projected emissions for the cumulative case would be about the same as the emissions used in these modeling studies. The contributions to O_3 levels would therefore be similar. As emissions within the nonattainment areas are expected to decrease further in the future, the cumulative impacts from the OCS oil and gas program on O_3 levels would likely be reduced.

Visibility Impairment. Gaseous and fine particulate matter in the atmosphere can potentially degrade atmospheric visibility. Existing visibility in the eastern United States, including the GOM coast States, is impaired due to fine particulate matter containing primarily sulfates and carbonaceous material. High humidity is an important factor in visibility impairment in the GOM coastal areas. The absorption of water by the particulate matter makes them grow to a size that enhances their ability to scatter light and reduce visibility. The estimated natural mean visibility in the eastern United States is 97 to 129 km (60 to 80 mi) (Malm 1999).

Based on data presented by Malm (2000), the observed mean visual range in coastal Louisiana, Mississippi, and Alabama is about 38 to 48 km (24 to 30 mi). In the Texas coastal areas, the average visibility is about 48 to 64 km (30 to 40 mi). In the GOM coast States, about

60 to 70% of the human-induced visibility degradation (impairment) is attributed to sulfate particles, while about 20% is from organic or elemental carbon particles. About 8% of the visibility degradation is attributed to nitrate particles (Malm 2000; USEPA 2001).

Visibility degradation in large urban areas, such as Houston, can be especially pronounced during air pollution episodes. In some severe cases, it may hinder navigation by boats and aircraft. Degraded visibility also adds to the perception by the observer of bad air quality even when monitors do not record unhealthful pollutant levels.

A study of visibility from platforms off Louisiana revealed that significant reductions in Louisiana coastal and offshore visibility are almost entirely due to transient occurrences of fog (Hsu and Blanchard 2005). Episodes of haze are short-lived and affect visibility much less. Offshore haze often appears to result from plume drift generated from coastal sources. The application of visibility screening models to individual OCS facilities has shown that the emissions from a single facility are not large enough to significantly impair visibility. It is not known to what extent aggregate OCS sources contribute to visibility reductions; however, the effects from OCS sources are likely to be very minor because offshore emissions are substantially smaller than the onshore emissions.

In July 1999, the USEPA published its Regional Haze Regulations Final Rule to address visibility impairment in the Nation's National Parks and Wilderness Areas (64 FR 35714). These regulations established goals for improving visibility in Class I areas through long-term strategies for reducing emissions of air pollutants that cause visibility impairment. The rule requires States to establish goals for each affected Class I area to improve visibility on the haziest days and to ensure no degradation occurs on the clearest days. Since visibility impairment involves considerable cross-boundary transport of air pollutants, States are encouraged to coordinate their efforts through regional planning organizations. Texas and Louisiana are part of the Central States Regional Air Planning Association. Mississippi, Alabama, and Florida are members of the Visibility Improvement State and Tribal Association of the Southeast. The USEPA provides funding to the regional planning organizations to address regional haze by developing regional strategies to reduce emissions of particulate matter and other pollutants that lead to haze (USEPA 2011k).

The Regional Haze Regulations along with the rules on ozone and acid rain should result in a lowering of regional emissions and improvement in visibility. Projected emissions from all cumulative OCS program activities are not expected to be substantially different from year 2000 emissions. The contribution of OCS program-related emissions to visibility impairment is expected to be very minor.

Greenhouse Gases. Table 4.6.2-2 lists the total calculated emissions of CO_2, CH_4, and N_2O from OCS activities related to the GOM portion of the 2012-2017 Program and compares them to the 2012-2017 Program overall (accounting for OCS program activities in GOM, Cook Inlet, and the Arctic region); the total U.S. emissions from all sources in 2009 are also provided for reference. Activities in the GOM account for most of the GHG emissions associated with the 2012-2017 Program, comprising between 95% and 98% of all Program-related GHG emissions. For reference, the estimated annual emissions of CO_2 and CH_4 from OCS activities in the GOM

TABLE 4.6.2-2 Estimated Greenhouse Gas Emissions for the 2012-2017 Program in the GOM Relative to the OCS Program Overall over the Next 40 Years

Pollutant	2012-2017 OCS Program (all) (Tg CO_2e)[a, b]	2012-2017 GOM Program (Tg CO_2e)	Total U.S. Emissions from All Sources (2009) (Tg CO_2e)	Percent of Total U.S. Emissions (2009) from GOM Program[c]
CO_2	336.25–512.6	341.54–487.94	5,505.2	0.15–0.22
CH_4	3.98–120.22	3.17–115.88	686.3	0.01–0.42
N_2O	2.85–4.23	2.83–4.14	295.6	0.02–0.04
$CO_2 + CH_4 + N_2O$	348.37–637.05	342.25–607.97	6,487.1	0.13–0.23
All GHG	348.37–637.05	342.25–607.97	6,633.2	0.13–0.23
Total	348.37–637.05	342.25–607.97	38,726.0	

[a] One Tg is equal to 10^{12} g, or 10^6 metric tons. The CO_2e for a gas is derived by multiplying the mass of the gas by the associated GWP, which accounts for the relative effectiveness of a gas to contribute to global warming with respect to the same amount of CO_2. In these calculations, CH_4 is given a GWP of 21, while NO_2 is given a GWP of 310.

[b] Values represent the total emissions for the 2012-2017 Program in the GOM, Cook Inlet, and Arctic regions.

[c] Values are calculated by dividing the estimated annual emissions of the GOM program (equal to the value in the third column divided by 40) by the total U.S. emission from all sources in 2009 (fourth column).

Source: USEPA 2011l.

were less than 0.5% of CO_2 and CH_4 emissions in the United States from all sources in 2009; the estimated annual N_2O emissions from OCS activities in the GOM comprise less than 0.05% of N_2O emissions in the United States from all sources in 2009. Although these are small contributions, it should be noted that some GHGs (e.g., CO_2) can persist in the atmosphere for a century, well beyond the life of the Program.

GHG emissions are one of the causes of climate change; however, assessing their impact requires consideration on a global scale. For this reason, it is not possible to estimate the impact of GHG emission from particular sources, such as the OCS activities associated with the Program. On a global scale, the contribution from the Program to total GHG emissions is small. On a national scale, the contribution of the Program could be significant, although greater contributions of GHG to the U.S. total come from energy consumption (generated mainly by the combustion of coal and natural gas). Total U.S. GHG emissions increased by 11% between 1990 and 2010 (at an average annual rate of 0.5%); GHG emissions from the Program would contribute to this trend in future years.

Oil Spills. Accidental oil spills are sources of gaseous emissions. No more than 40 large spills (greater than 1,000 bbl) and 2,280 small spills (1,000 bbl or less) are expected for the GOM cumulative case as a result of the OCS program (Table 4.6.1-4). Oil spills cause localized increases in VOC concentrations (proportional to the size of the spill) due to evaporation. Most of these emissions would occur within a few hours of the spill and decrease (by dispersion) drastically after that period (MMS 2003a). A more detailed discussion of the effects of oil spills on air quality in the GOM is presented in Section 4.4.4.1.

Unexpected catastrophic discharge events at well locations may result in fires; *in situ* burning is also a preferred technique for cleanup and disposal of oil spills (documented in soil spill contingency plans). Smoke generated from such fires would be expected to reach shore quickly (within a day), but would be limited in geographic extent (MMS 2003a). A discussion of the effects of fires on air quality in the GOM is presented in Section 4.4.4.1.

Conclusion. The effects of various U.S. EPA regulations and standards are expected to result in a steady, downward trend in future air emissions. This trend should be realized in spite of continued industrial and population growth along the GOM coast. Previous O_3 nonattainment areas in the GOM coast region (Beaumont-Port Arthur, Texas, and Baton Rouge, Louisiana) were reclassified as attainment areas in 2010. States such as Texas are required to implement SIPs to reduce emissions in their O_3 nonattainment areas. The overall cumulative impacts on air quality in the GOM over the next 40 to 50 years are expected to be minor to moderate, and the incremental contribution of the routine Program activities to air quality impacts would be small (see Section 4.4.4.1).

The Program would contribute slightly to onshore levels of NO_2, SO_2, and PM_{10}, but concentrations are well within the national standards and PSD increments. The effects from future OCS program activities are expected to remain about the same as in previous years. Portions of the GOM coast region have O_3 levels that exceed the Federal standard, but the contribution from all OCS program activities to ozone levels is very small (about 1%; see Section 4.4.4.1.1). Ozone levels are on a declining trend due to air pollution control measures that have been implemented by the States. This trend is expected to continue as a result of local as well as nationwide control efforts. The contribution of the Program to onshore O_3 would therefore remain very small. The GOM coast region has significant visibility impairment from anthropogenic emission sources. However, visibility is expected to improve somewhat as a result of regional and national programs to reduce emissions. The contribution from OCS program activities to visibility impairment, therefore, is expected to remain small. The number of expected accidental oil spills in GOM waters associated with the Program would represent only a small increase over the number of expected spills from ongoing and future OCS programs and non-OCS program activities. The incremental increase in adverse air quality impacts from these spills (and *in situ* burning of spilled crude or diesel) would be localized and temporary (due to the spreading of oil and action by winds, waves, and currents that disperse volatile compounds to extremely low levels over a relatively large area); therefore, the incremental contribution of expected oil spills to cumulative air quality impacts could range from small to medium. Air quality impacts associated with an unexpected, low-probability CDE (and *in situ* burning) would also be reduced by these factors, and could be moderate if it were to occur. Spill response and cleanup activities (e.g., *in situ* burning and use of chemical dispersants) could contribute to air quality impacts regardless of the size of spill. A more detailed discussion of the effects of oil spills on air quality in the GOM is presented in Section 4.4.4.1.2.

4.6.2.1.3 Acoustic Environment. Section 4.4.5.1 discusses impacts on the acoustic environment in the GOM resulting from the Program. Section 4.4.7 evaluates the direct and indirect impacts of noise on marine fauna (fish, marine mammals, sea turtles, and birds), and Section 4.6.4 addresses the cumulative impacts of noise on marine fauna. Cumulative impacts on the acoustic environment result from the incremental impacts of the Program when added to impacts from existing and reasonably foreseeable future OCS program activities (that are not part of the Program) and other non-OCS program activities. Table 4.6.1-2 presents the exploration and development scenario for the GOM cumulative case (encompassing the Program and other OCS program activities). Ongoing and reasonably foreseeable non-OCS program activities contributing to adverse cumulative impacts on the acoustic environment in the GOM include marine subsurface and surface vessel traffic, aircraft traffic (helicopters and fixed-wing aircraft), dredging, construction of onshore and offshore facilities (e.g., production platforms and drilling rigs in State waters), LNG facility operations, renewable energy projects (foreseeable), marine geophysical (seismic) surveys, active sonars, underwater explosions, ocean science studies, and mining operations. This section addresses the quality of the acoustic environment only; the cumulative impacts of noise on GOM marine fauna are discussed in Section 4.6.4.1.

Ambient (background) noise has numerous natural and man-made sources that vary with respect to season, location, depth of occurrence, time of day, and noise characteristics (e.g., frequency and duration).[44] Natural sources of ambient noise include wind and waves, surfs (produced by waves breaking onshore), precipitation (rain and hail), lightning, volcanic and tectonic noise, and biological noise (from fishes, shrimp, and marine mammals). Vessels are the greatest man-made contributors to overall marine noise in the GOM. Underwater explosions in open water are the strongest point sources of man-made sound. Baseline acoustic conditions in the GOM are discussed in more detail in Section 3.6.1.

Ongoing and future routine OCS program activities, including those of the Program, that generate noise include operating airgun arrays (during marine seismic surveys), drilling, pipeline trenching, and onshore and offshore construction and decommissioning of platforms and drilling rigs. New marine vessel and aircraft traffic (including those associated with emergency-response and cleanup activities in the event of a spill), accidental releases (e.g., loss of well control events), and marine vessel collisions also contribute to noise. A preliminary study of the noise impacts of OCS-related geophysical surveys found that marine seismic surveys have the greatest impact on marine mammals, sea turtles, fish, and commercial and recreational fisheries (MMS 2004a). Noise generated from OCS and non-OCS program activities would be transmitted through both air and water, and may be transient or more extended (occurring over the long term). Table 3.6.1-1 provides a listing of the source levels and frequencies associated with various anthropogenic activities in the GOM.

Conclusion. The quality of the acoustic environment in the GOM would continue to be adversely affected by routine operations of ongoing and future OCS program and non-OCS program activities. The magnitude of cumulative impacts in the GOM is time- and

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[44] Higher frequencies are attenuated with distance from the source more rapidly than lower frequencies. Traffic noise generated in deep water contributes to background noise levels at greater distances than traffic noise generated in shallow water.

location-specific and could range from minor to major, depending on the ambient acoustic conditions and the nature and combination of all OCS and non-OCS program activities taking place in the GOM over the next 40 to 50 years. The incremental contributions due to noise generated by routine Program activities could range from small to medium, depending on the timing of the disturbance and the location and characteristics of noise sources present (e.g., their frequency and duration). The cumulative impacts of noise on marine fauna (fish, marine mammals, sea turtles, and birds) are discussed in Section 4.6.4.

The number of expected accidental oil spills in GOM waters associated with the Program would represent only a small increase over the number of expected spills from ongoing and future OCS programs and non-OCS program activities. The incremental increase in adverse acoustic environment impacts from these spills (mainly due to noise sources associated with response and cleanup activities) would be localized and temporary; therefore, the incremental contribution of expected oil spills due to noise would be small. Impacts associated with an unexpected, low-probability CDE could be minor to moderate if it were to occur. Most of the impacts to the acoustic environment are due to noise sources (e.g., mechanical equipment, skimmers, support vessel traffic, and aircraft traffic) associated with spill response and cleanup activities. A more detailed discussion of the effects of oil spills on the acoustic environment in the GOM is presented in Section 4.4.5.1.

4.6.2.2 Alaska Region – Cook Inlet

4.6.2.2.1 Water Quality. Section 4.4.3.2 discusses potential water quality impacts in coastal (bays and estuaries), marine (State offshore and Federal OCS), and deepwater environments in Cook Inlet resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on water quality result from the incremental impacts of the Program (described in Section 4.4.3.2) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS program activities. Table 4.6.1-3 presents the exploration and development scenario for the Cook Inlet cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in Cook Inlet are summarized in Table 4.6.1-6 and discussed below, as applicable.

OCS program activities (i.e., those of the Program; there are no existing OCS program activities) involve service vessel traffic, chemical releases (permitted discharges), and disturbance of bottom sediments. Accidental oil spills are also counted among OCS program-related activities; assumptions for oil spills under the cumulative case scenario are provided in Table 4.6.1-4. All these activities have the potential to adversely affect water quality in Cook Inlet.

OCS program-related service vessel traffic in Cook Inlet could be as high as one to three trips per week over the next 40 to 50 years, all of which are associated with the Program. Extensive non-OCS program marine traffic also occurs in Cook Inlet. Non-OCS program traffic includes that related to crude oil and finished product transport, LNG and ammonia carriers (at the Nikiski industrial complex), tugs and barges, ferries, commercial fishing vessels, military and USCG vessels, a coal carrier, dredge vessels, cruise ships, and small watercraft. Fuel barge traffic is minimal since much of the refined oil for regional consumption is transported to Anchorage by a pipeline from the Tesoro refinery in Nikiski. An estimated 480 large vessels (other than fuel barges on domestic trade) called at Cook Inlet ports in 2010. About 67% of these were made by container vessels, roll-on/roll-off cargo ships, or ferries; 20% were gas or liquid tank ships calling at Nikiski. The remaining traffic consisted of bulk carriers, general cargo ships, tugs, and fishing and passenger vessels. Impacts on water quality from vessel traffic in Cook Inlet result mainly from oil and gasoline spills when vessels run aground, collide, catch fire, or sink (Eley 2012).

The number of platform production wells constructed over the period of the Program (at most, 110) would be proportional to the amount of oil produced and reflects the total number of new platform production wells anticipated to be built in Cook Inlet over the next 40 to 50 years as part of the OCS program (no subsea production wells are planned). The length of new pipeline (at most 241 km [150 mi] offshore and 169 km [105 mi] onshore) added as part of the Program represents all of that anticipated over the next 40 to 50 years as part of the OCS program.

The area of sea bottom disturbed from construction of platforms and pipelines over the period of the Program (as much as 215 ha [530 ac] total) also represents that associated with the OCS program over the next 40 to 50 years. Bottom disturbance degrades water quality by increasing water turbidity (i.e., suspended sediment concentration) in the vicinity of the operations and adding contaminants to the water column. It also changes sediment composition as suspended sediments (and contaminants, if present) are entrained in currents and deposited in new locations.

As summarized in Section 3.4.2, the principal point sources of pollution in Cook Inlet include municipal discharges, as well as discharges from seafood processors and the petroleum industry. Point-source pollution is rapidly diluted by the energetic tidal currents in Cook Inlet, and the USEPA *National Coastal Condition Report III* has rated the coastal waters of south central Alaska, including Cook Inlet, as good (although water clarity in upper Cook Inlet was rated poor because of very high loadings of glacial river sediments) (USEPA 2008a). Non-point sources release a range of contaminants via rivers and on-land drainages and are primarily from urban runoff (related to land development); forest practices (e.g., timber harvest operations); harbors and marinas; roads, highways, and bridges; hydromodification (related to dams, channel modification, and stream bank erosion); mining; and agriculture (ADEC 2007). Point-source discharges are anticipated to remain at present levels for the foreseeable future; non-point-source discharges should improve as a result of Alaska's water pollution control strategy (as outlined in ADEC 2007). Low concentrations of hydrocarbons are found throughout the waters of Cook Inlet and are attributed to natural sources — natural oil seeps, river discharges carrying carbon compounds of biogenic origin, and the deposition of fuel and natural organic matter (e.g., from fires) (MMS 2003a).

Activities taking place within Cook Inlet waters also contribute to the degradation of water quality. These include oil spills associated with marine vessel traffic, sediment dredging and disposal in local harbors (suspended sediments and contaminants), and activities related to the oil and gas industry, which operates platforms in State waters and discharges drilling wastes, produced water, and other industrial waste streams into Cook Inlet waters (MMS 2003a).

Most of the oil released to Cook Inlet is from commercial and recreational vessels (MMS 2003a). Small spills (less than 1,000 bbl) from commercial and recreational vessels or from OCS program activities (e.g., accidental releases) are not expected to affect the overall quality of Cook Inlet water (because they would be localized and short in duration); however, large spills (greater than 1,000 bbl) could temporarily degrade the overall quality of its water (MMS 2003a). Oil spills in ice-covered waters during winter months are generally contained within a much smaller area (compared with spills in open waters) because oil weathering (i.e., spreading, evaporation, and migration) is much slower and some oil may solidify. While such factors have proven to be favorable for most response strategies, the presence of ice can also complicate response efforts. Spills on ice are fairly easy to detect and map, unless there is fresh snowfall at the time of the spill; however, oil spilled within and under the ice can be hidden from view. Broken ice also makes spilled oil difficult to detect and map, and it can reduce the effectiveness of conventional recovery systems (MMS 2009b; DF Dickens Associates, Ltd. 2004).

Climate change predictions are based on models that simulate all relevant physical processes under a variety of projected greenhouse gas emission scenarios (Section 3.3). Because the complexity of modeling global and region climate systems is so great, uncertainty in climate projections can never be eliminated. The IPCC projections relating generally to water and water quality over the next two decades include:

- Sea level will rise by 0.18 to 0.59 m (0.6 to 2 ft) by the end of the twenty-first century;
- Sea ice, glaciers, and ice sheets in polar regions will continue melting;
- Ocean pH will decrease by 0.14 to 0.35 over the twenty-first century;
- Precipitation will increase at high latitudes (>90% likely); and
- Annual river discharges (runoff) will increase by 10 to 40% at high latitudes and decrease by 10 to 30% in the dry regions at mid-latitudes.

Alaska has experienced extensive regional warming since the 1960s, with a rise in annual temperature of about 3°C (5°F) since the 1960s. The general effects of warming include the extensive melting of glaciers, thawing of permafrost, and increased precipitation (Section 3.3). Modeling studies of warming in Cook Inlet project very large warming trends, ranging from 4°C to 10°C (7°F to 18°F) by the year 2100; precipitation is projected to increase by 20 to 25% (Kyle and Brabets 2001).

Conclusion. Water quality in Cook Inlet would be affected by various activities associated with the Program over the next 40 to 50 years. These include marine vessel traffic, chemical releases (sanitary wastes), disturbance of bottom sediments, and accidental oil spills (from marine vessel casualty and the oil and gas industry). Water quality is also affected by many other factors, including river inflows, urbanization, forest practices, mining, municipal waste discharges, and agriculture. Non-OCS program activities likely to contribute to cumulative impacts include marine vessel traffic, wastewater discharge to the inlet, dredging and marine disposal, and oil and gas related activities, as well as infrastructure in State-owned marine waters. Natural seepage of oil along the west part of the inlet also may be significant. The cumulative impacts on Cook Inlet water quality from all OCS and non-OCS activities in Cook Inlet over the next 40 to 50 years are expected to be minor to moderate, and the incremental contribution of the routine Program activities to water quality impacts would be small to medium. These impacts may lessen with time since oil and gas production in the Cook Inlet is currently on the decline (see Section 4.4.3.2).

The USEPA, in collaboration with other Federal and coastal State agencies, has assessed the coastal conditions of each region of the United States, including Cook Inlet, by evaluating five indicators of condition, one of which was water quality, based on such parameters as dissolved oxygen, chlorophyll *a*, nitrogen, phosphorus, and water clarity. The most recent assessment found the overall condition of the coastal waters of south central Alaska, including Cook Inlet, good (although water clarity in upper Cook Inlet was rated poor). Point source discharges are anticipated to remain at present levels for the foreseeable future; non-point source discharges should improve as a result of Alaska's water pollution control strategy. Low concentrations of hydrocarbons are found throughout the waters of Cook Inlet and are attributed to natural sources.

The number of expected accidental oil spills in Cook Inlet waters associated with the Program would represent only a small increase over the number of expected spills from ongoing non-OCS program activities (mainly oil and gas production in State waters). The incremental increase in adverse water quality impacts from these spills would depend on the weather and sea conditions at the spill location (e.g., whether ice is present), the type of waves and tidal energy at the spill locations, the type of oil spilled (very light to very heavy), the depth of the spill event (deep water, shallow water, or surface water), and the volume and rate of spillage; therefore, the incremental contribution of expected oil spills to cumulative water quality impacts could range from small to large. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from moderate to major if it were to occur. Spill response and cleanup activities (e.g., *in situ* burning and use of chemical dispersants) could contribute to water quality impacts regardless of the size of spill. A more detailed discussion of the effects of oil spills on water quality in Cook Inlet is presented in Section 4.4.3.2.2.

4.6.2.2.2 Air Quality. Section 4.4.4.2 discusses potential air quality impacts in onshore and offshore areas of Cook Inlet resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on air quality result from the incremental impacts of the Program (described in Section 4.4.4.2) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS program activities. Table 4.6.1-3 presents the exploration and development scenario for Cook Inlet cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in Cook Inlet are summarized in Table 4.6.1-6 and discussed below, as applicable.

OCS program activities, i.e., those of the Program (there are no existing OCS program activities), involve production platforms, exploration wells, platform construction and removal, marine vessels (pipelaying, support, and survey), helicopters, and tanker and barge transport. All these activities have the potential to adversely affect air quality in the Cook Inlet region via direct emissions or other releases to air (e.g., volatile components of fuel). Accidental oil spills are also counted among OCS program-related activities; assumptions for oil spills under the cumulative case scenario are provided in Table 4.6.1-4. Existing emission sources in the Cook Inlet Planning Area include oil production activities in State waters, onshore petroleum processing and refining, onshore oil and gas production, marine terminals, and commercial shipping.

Criteria Pollutants. Except for a few population centers such as Anchorage, Fairbanks, and Juneau, the existing air quality in Alaska is relatively pristine, with pollutant concentrations well within ambient standards (Section 3.5.2.2). The primary industrial emissions in the Cook Inlet region are associated with oil and gas production, power generation, small refineries, paper mills, and mining. Other sources include vessel traffic in Cook Inlet and emissions from on-land motor vehicles and refuse burning (MMS 2003a). While some growth of these activities is likely to take place in the future, overall emissions are expected to remain low. More stringent emission standards on motor vehicles and new USEPA standards on non-road engines and marine vessels would result in a downward trend in emissions.

Modeling studies of proposed OCS production facilities in the Cook Inlet show that concentrations of NO_2, SO_2, and PM_{10} are within the PSD Class II and Class I maximum allowable increments and the NAAQS. Pollutant concentrations within the Tuxedni NWA, the only Class I area adjacent to the Cook Inlet Planning Area, exceed the Class I significance levels. As a consequence, any proposed facilities that would exceed the Class I significance levels, would need a comprehensive PSD increment consumption analysis done before permitting (MMS 2003a).

New USEPA regulations will apply international emission standards for ships off North American coasts. The U.S. and Canada have designated waters off North American coasts as an area in which stringent emission standards will become enforceable in August 2012 (USEPA 2010f). The area, called the North American Emission Control Area (NA ECA), will require the use of lower sulfur fuels in ships operating within 200 nautical miles of the majority of U.S. and Canadian coastline, including Cook Inlet. The fuel standards are expected to reduce emissions of SO_x and fine particulate matter ($PM_{2.5}$) by as much as 85% from current levels. Engine-based controls (such as high efficiency engines) would also reduce NO_x emissions.

Ozone Formation and Visibility Impairment. The baseline conditions and impacts from OCS activities on ozone and visibility are discussed in Sections 3.5.2.2 and 4.4.4.2, respectively. Because conditions in Alaska are seldom favorable for significant O_3 formation, the contribution of leasing activity associated with the Program to O_3 levels in the Cook Inlet region is expected to be small. OCS emission sources affecting visibility are also small; however, preliminary visibility screening for the Tuxedni NWA suggests sources within about 50 km (30 mi) may result in a plume visible from the site (MMS 2003a).

Greenhouse Gases. GHG emissions are one of the causes of climate change; however, assessing their impact requires consideration on a global scale. For this reason, it is not possible to estimate the impact of GHG emission from particular sources, such as the OCS activities associated with the Program. On a global scale, the contribution from the Program to total GHG emissions is small. On a national scale, the annual contribution of the Program is also small (generally less than 0.5%, much less significant than from activities in the GOM).

Oil Spills. Accidental oil spills are sources of gaseous emissions. No more than one large spill (1,000 bbl or greater) and 18 small spills (less than 1,000 bbl) are projected for the Cook Inlet Planning Area cumulative case as a result of the OCS program (Table 4.6.1-4). Most accidental spills in the Cook Inlet region are of non-crude products caused by onshore train derailments, pipeline failures, and leaks (crude oil comprises about 4% of all product spills) (ADEC 2007b). Since 1976, there have been nine major crude oil spills in the inlet, ranging in volume from 10,000 to 396,000 gal (with the largest of these coming from construction barges, offshore platforms, and jet fuel releases); the last oil spill (9,000 gallons; 214 barrels) occurred in 1997 as a result of a loss of well control incident at the Steelhead Platform (State of Alaska 2011). Oil spills cause localized increases in VOC concentrations (proportional to the size of the spill) due to evaporation. Most of these emissions would be expected to occur within a few hours of the spill and decrease (by dispersion) drastically after that period (MMS 2003a). However, oil spills in ice-covered waters during winter months would be contained within a much smaller area (compared with spills in open waters) because oil weathering (i.e., spreading, evaporation, and migration) is much slower and some oil may solidify (MMS 2009b). A more detailed discussion of the effects of oil spills on air quality in Cook Inlet is presented in Section 4.4.4.2.

Catastrophic events at well locations may result in fires; *in situ* burning is also a preferred technique for cleanup and disposal of oil spills (documented in soil spill contingency plans). Smoke generated from such fires would be expected to reach shore quickly (within a day), but would be limited in geographic extent (MMS 2003a). A discussion of the effects of fires on air quality in Cook Inlet is presented in Section 4.4.4.2.

Conclusion. OCS program activities in combination with other oil and gas exploration, development, and production activities in the Cook Inlet Planning Area could affect air quality in the region over the next 40 to 50 years. Air pollutant concentrations associated with offshore and onshore emission sources are expected to remain well within applicable State and Federal standards over the life of the Program. Therefore, the overall cumulative impacts on air quality in Cook Inlet from all OCS and non-OCS activities over the next 40 to 50 years are expected to be minor to moderate, and the incremental contribution of the routine Program activities to air quality impacts would be small (see Section 4.4.4.2).

The number of expected accidental oil spills in Cook Inlet associated with the Program would represent only a small increase over the number of expected spills from ongoing non-OCS program activities (mainly oil and gas production in State waters). The incremental increase in adverse air quality impacts from these spills (and *in situ* burning of spilled crude or diesel) would be localized and temporary (due to the spreading of oil and action by winds, waves, and currents that disperse volatile compounds to extremely low levels over a relatively large area); therefore, the incremental contribution of expected oil spills to cumulative air quality impacts could range from small to medium. Air quality impacts associated with an unexpected, low-probability CDE (and *in situ* burning) would also be reduced by these factors, and could be moderate if it were to occur. Spill response and cleanup activities (e.g., *in situ* burning and use of chemical dispersants) could contribute to air quality impacts regardless of the size of spill. A more detailed discussion of the effects of oil spills on air quality in Cook Inlet is presented in Section 4.4.4.2.2.

4.6.2.2.3 Acoustic Environment. Section 4.4.5.2 discusses impacts on the acoustic environment in Cook Inlet resulting from the Program (OCS program activities from 2012 to 2017). Section 4.4.7 evaluates the direct and indirect impacts of noise on marine fauna (mammals, birds, and fish), and Section 4.6.4 addresses the cumulative impacts of noise on marine fauna. Cumulative impacts on the acoustic environment result from the incremental impacts of the Program when added to impacts from reasonably foreseeable future OCS program activities (that are not part of the Program) and other non-OCS program activities.[45] Table 4.6.1-3 presents the exploration and development scenario for the Cook Inlet cumulative case (encompassing the Program and other OCS program activities). Ongoing and reasonably foreseeable non-OCS program activities contributing to adverse cumulative impacts on the acoustic environment in the Cook Inlet include aircraft overflights, vessel activities and traffic, construction and decommissioning of onshore and offshore facilities (e.g., related to ongoing oil and gas exploration and development in State waters), and other activities (e.g., seismic surveys) conducted as part of the existing oil and gas industry in the inlet. This section addresses the quality of the acoustic environment only; the cumulative impacts of noise on Cook Inlet marine fauna are discussed in Section 4.6.4.2.

Ambient (background) noise has numerous natural and man-made sources that vary with respect to season, location, depth of occurrence, time of day, and noise characteristics (e.g., frequency and duration).[46] Natural sources of ambient noise include wind and wave action, strong tidal fluctuations, currents, ice, precipitation (rain and hail), lightening, volcanic and tectonic noise, and biological noise (from marine mammals and coastal birds). Vessels (e.g., tankers, supply ships, tugboats, barges, and fishing boats) are the greatest man-made contributors to overall marine noise in Cook Inlet. Baseline acoustic conditions in Cook Inlet are discussed in more detail in Section 3.6.2.

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[45] Currently, there are no existing OCS program activities in Cook Inlet.

[46] Higher frequencies are attenuated with distance from the source more rapidly than lower frequencies. Traffic noise generated in deep water contributes to background noise levels at greater distances than traffic noise generated in shallow water.

Future routine OCS program activities, including those of the Program, that generate noise include operating airgun arrays (during marine seismic surveys), drilling, pipeline trenching, and onshore and offshore construction of platforms and drilling rigs. Vessel and aircraft traffic (including that associated with emergency response and cleanup activities in the event of a spill), accidental releases (e.g., loss of well control events), and vessel collisions also contribute to noise. A preliminary study of the noise impacts of OCS-related geophysical surveys found that marine seismic surveys have the greatest impact on marine mammals, sea turtles, fish, and commercial and recreational fisheries (MMS 2004a). Noise generated from OCS and non-OCS program activities would be transmitted through both air and water, and may be transient or more extended (occurring over the long term).

Conclusion. The quality of the acoustic environment in Cook Inlet would continue to be adversely affected by ongoing and future non-OCS program activities and by future OCS program activities (currently there are no existing OCS activities). The magnitude of cumulative impacts due to noise in Cook Inlet water from all OCS and non-OCS activities taking place in the inlet over the next 40 to 50 years is time- and location-specific and could range from minor to major, depending on the ambient acoustic conditions and the nature of activities taking place. The incremental contributions due to noise generated by routine Program activities could range from small to medium, depending on the timing of the disturbance and the location and characteristics of noise sources present (e.g., their frequency and duration). The cumulative impacts of noise on marine fauna (fish, marine mammals, sea turtles, and birds) are discussed in Section 4.6.4.

The number of expected accidental oil spills in Cook Inlet waters associated with the Program would represent only a small increase over the number of expected spills from ongoing non-OCS program activities. The incremental increase in adverse acoustic environment impacts from these spills (mainly due to noise sources associated with response and cleanup activities) would be localized and temporary; therefore, the incremental contribution of expected oil spills due to noise could range from small to medium. Impacts associated with an unexpected, low-probability CDE could be minor to moderate if it were to occur. Most of the impacts to the acoustic environment are due to noise sources (e.g., mechanical equipment, skimmers, support vessel traffic, and aircraft traffic) associated with spill response and cleanup activities. A more detailed discussion of the effects of oil spills on the acoustic environment in Cook Inlet is presented in Section 4.4.5.2.

4.6.2.3 Alaska Region – Arctic

4.6.2.3.1 Water Quality. Section 4.4.3.3 discusses potential water quality impacts in coastal (bays and estuaries), marine (State offshore and Federal OCS), and deepwater environments in the Arctic region resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on water quality result from the incremental impacts of the Program (described in Section 4.4.3.3) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS program activities.[47] Table 4.6.1-3 presents the exploration and development scenario for the Arctic region cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the Arctic are summarized in Table 4.6.1-7 and discussed below, as applicable.

Ongoing and future routine OCS program activities (i.e., those of the Program and existing OCS program activities) involve service vessel traffic, waste disposal, chemical releases (permitted discharges), and disturbance of bottom sediments. All these activities have the potential to adversely affect water quality in the Beaufort and Chukchi Seas. Accidental oil spills are also counted among OCS program-related activities; assumptions for oil spills under the cumulative case scenario are provided in Table 4.6.1-4.

OCS program-related service vessel traffic in the Beaufort and Chukchi Seas could be as high as 78 trips per week (up to 30 in the Beaufort Sea and 48 in the Chukchi Sea) over the next 40 to 50 years; vessel traffic associated with the Program represents about 35% of this traffic but would occur only during open-water and broken ice conditions (typically during August and September). Non-OCS program traffic in the Beaufort and Chukchi Seas is relatively low and includes that related to the oil and gas industry (e.g., cargo vessels, spill response vessels, and hovercraft), military operations, and Arctic research. Small marine vessels are used by local communities for hunting and between-village transportation during the open water period (MMS 2008b). Impacts on water quality from marine vessel traffic arise from regular discharges of bilge water and waste, leaching of anti-fouling paints, and incidental spills.

In the Beaufort Sea Planning Area, the number of platform and subsea production wells constructed over the period of the Program (at most 120 and 10, respectively) would be proportional to the amount of oil produced; these numbers represent about 39 and 40% (respectively) of the total number of platform and subsea production wells to be built in the planning area over the next 40 to 50 years as part of the Program. The lengths of new onshore and offshore pipeline (at most 129 km [80 mi] and 250 km [155 mi], respectively) added as part of the Program represent about 28 and 37%, respectively, of that anticipated as part of the OCS program over the next 40 to 50 years.

In the Chukchi Sea Planning Area, the number of platform and subsea production wells constructed over the period of the Program (at most 280 and 82, respectively) would be proportional to the amount of oil produced; these numbers represent about 32 and 35%%, respectively, of the total number of new platform and subsea production wells anticipated to be built in the planning area over the next 40 to 50 years as part of the OCS program. The lengths of new onshore and offshore pipeline (at most 0 km [0 mi] and 402 km [250 mi], respectively) added as part of the Program represent about 0 and 19%, respectively, of that anticipated as part of the OCS program.

[47] Currently, there are no existing OCS program activities in the Beaufort Sea and Chukchi Sea Planning Areas, but it is assumed that exploration and development activities as a result of Sale 193 (Chukchi Sea) will have occurred before commencement of the exploration and development activities associated with the Program (Section 4.4.1.3).

The area of sea bottom disturbed from construction of platforms and pipelines over the period of the Program (as much as 581 ha [1,440 ac] in the planning areas combined) represents about 29% of that associated with the OCS program over the next 40 to 50 years. Bottom disturbance degrades water quality by increasing water turbidity in the vicinity of the operations and adding contaminants to the water column. It also changes sediment composition as suspended sediments (and contaminants, if present) are entrained in currents and deposited in new locations.

As summarized in Section 3.4.3.3, the water quality in the Beaufort and Chukchi Seas is relatively uncontaminated by anthropogenic pollutants (compared to other regions that typically receive pollutants from industrial, agricultural, and municipal discharges and related runoff). The principal point sources of pollution are facilities related to the oil and gas industry, hard-rock mining, military operations, and seawater treatment. Non-point sources release a range of contaminants via rivers and on-land drainages that could include contaminated runoff related to mining operations (e.g., gold mining on the Seward Peninsula). Most of these activities would remain at present levels for the foreseeable future and are not expected to affect the overall water quality in these regions.

Activities taking place within Arctic waters also contribute to the degradation of water quality. These include oil spills associated with vessel traffic, sediment dredging and disposal in local harbors (suspended sediments and contaminants), and activities related to the oil and gas industry, which operates platforms in State waters and discharges drilling wastes, produced water, and other industrial waste streams into the Beaufort Sea (MMS 2008b; ADEC 2007a).

Most of the oil released to Arctic waters is from leaks related to the oil industry (ADEC 2007a). Small spills (less than 1,000 bbl) from commercial and recreational vessels or from OCS program activities (e.g., accidental releases) are not expected to affect the overall quality of the Beaufort or Chukchi Seas because they are localized and short in duration; however, large spills (1,000 bbl or greater) could temporarily degrade the overall quality of their water (MMS 2003a). Oil spills in ice-covered waters are generally contained within a much smaller area (compared with open-water spills) because in the cold Arctic environment, oil weathering (i.e., spreading, evaporation, and migration) is much slower and some oil may solidify or become contained within sea ice. While such factors have proven to be favorable for most response strategies, the presence of ice can also complicate the response strategy. Spills on ice are fairly easy to detect and map, unless there is fresh snowfall at the time of the spill; however, oil spilled within and under the ice can be hidden from view. Broken ice also makes spilled oil difficult to detect and map, and it can reduce the effectiveness of conventional recovery systems (MMS 2009b; DF Dickens Associates, Ltd. 2004).

Climate change predictions are based on models that simulate all relevant physical processes under a variety of projected greenhouse gas emission scenarios (Section 3.3). Because the complexity of modeling global and region climate systems is so great, uncertainty in climate projections can never be eliminated. Changes to the Arctic climate include:

- Atmospheric temperature increases of 1 to 2°C (2–4°F) since the 1960s and continuing increases at a rate 1°C (2°F) per decade in winter and spring;

- Precipitation increases at a rate of about 1% per decade;

- Decreases in March sea ice extent at a rate of about 3% per decade and September sea ice at a rate of about 12% per decade (since the 1970s);

- Multi-year ice decreases at a rate of about 9% per decade (since the 1980s);

- Temperatures increases at the top of the permafrost layer by up to 3°C (5°F) since the 1980s; and

- Thawing of the permafrost base at a rate of up to 0.04 m/yr (0.13 ft/yr).

The retreat of sea ice is increasing impacts on coastal areas from storms. In areas where permafrost has thawed, coastlines are more vulnerable to erosion from wave action.

Conclusion. Water quality in the Beaufort and Chukchi Seas would be affected by the following activities associated with the Program: marine vessel traffic, waste disposal, chemical releases (permitted discharges), disturbance of bottom sediments, and accidental oil spills (from vessels and the oil and gas industry). Non-OCS program activities likely to contribute to cumulative impacts include marine vessel traffic, wastewater discharge, dredging and marine disposal, oil-related, and gas-related activities and infrastructure in State-owned marine waters, and other industrial activities (e.g., Red Dog Mine). Impacts related to marine vessel traffic in the Beaufort and Chukchi Seas (especially shipping and research vessels, icebreakers, and cruise ships) would likely increase in the coming decades as the open-water season begins earlier and ends later.

The cumulative impacts of ongoing and reasonably foreseeable future activities on water quality in the Arctic are unavoidable and may, in cases of melting sea ice, be irreversible, since such trends are natural and are occurring on a global scale. However, because many other impacts could be mitigated (i.e., minimized) by the various regulatory controls already in place to protect the marine waters of the Beaufort and Chukchi Seas, the overall cumulative impacts are considered to be moderate. The incremental contribution of the Program to cumulative impacts on water quality would be small to medium relative to the cumulative case and relative to other ongoing and reasonably foreseeable future actions in the Arctic (see Section 4.4.3.3).

The number of expected accidental oil spills in Arctic waters associated with the Program would represent only a small increase over the number of expected spills from future OCS programs and ongoing and future non-OCS program activities (mainly oil and gas development in State waters). The incremental increase in adverse water quality impacts from these spills would depend on the weather and sea conditions at the spill location (e.g., whether ice is present), the type of waves and tidal energy at the spill locations, the type of oil spilled (very light to very heavy), the depth of the spill event (deep water, shallow water, or surface water), and the volume and rate of spillage; therefore, the incremental contribution of expected oil spills to cumulative water quality impacts could range from small to large. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from moderate to major if it were to occur. Spill response and cleanup activities could contribute to water quality impacts regardless of the size of spill. A more detailed discussion of the effects of oil spills on water quality in Arctic waters is presented in Section 4.4.3.3.2.

4.6.2.3.2 Air Quality. Section 4.4.4.3 discusses potential air quality impacts in onshore and offshore areas of the Beaufort and Chukchi Seas resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on air quality result from the incremental impacts of the Program (described in Section 4.4.4.3) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS program activities.[48] Table 4.6.1-3 presents the exploration and development scenario for the Arctic cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the Arctic are summarized in Table 4.6.1-7 and discussed below, as applicable.

Ongoing and future routine OCS program activities, including those of the Program, involve production platforms, exploration wells, platform construction and removal, marine vessels (pipelaying, support, and survey), helicopters, and tanker and barge transport. All these activities have the potential to adversely affect air quality in the Beaufort and Chukchi Seas. Accidental oil spills are also counted among OCS program-related activities; assumptions for oil spills under the cumulative case scenario are provided in Table 4.6.1-4. Existing emission sources in the Beaufort Sea and Chukchi Sea Planning Areas include oil and gas exploration, development, and production activities in State waters (Beaufort Sea only); onshore petroleum processing and refining; marine terminals (e.g., DeLong Mountain Terminal on the Chukchi Sea); aircraft traffic; and vessel traffic.

Except for a few population centers such as Anchorage, Fairbanks, and Juneau, the existing air quality in Alaska is relatively pristine with pollutant concentrations well within ambient standards (Section 3.5.2.3). This is also the case in the Chukchi and Beaufort Seas and the North Slope area, with the exception of "Arctic haze," which is attributed to combustion sources in Russia (MMS 2010). The primary industrial emissions in the Beaufort and Chukchi Sea Planning Areas are associated with onshore oil development and production, offshore oil development and production (in State waters), power generation, mining (Red Dog Mine), and marine transportation. While some growth of these activities is likely to take place in the future, overall emissions are expected to remain low. More stringent emission standards on motor vehicles and new USEPA standards on non-road engines and marine vessels would result in a downward trend in emissions.

Criteria Pollutants. On the Alaska North Slope, the main sources of air emissions are associated with onshore oil production from the Prudhoe Bay, Kuparuk River, Colville River, Oooguruk, Milne Point, and Badami fields and oil production in State waters (Northstar and

48 Currently, there are no existing OCS program activities in the Beaufort Sea and Chukchi Sea Planning Areas, but it is assumed that exploration and development activities as a result of Sale 193 (Chukchi Sea) will have occurred before commencement of the exploration and development activities associated with the Program (Section 4.4.1.3).

Duck Island fields). As of 2009, about 16.2 Bbbl[49] of oil have been produced from North Slope reservoirs, including the Beaufort Sea (ADNR 2009c). Production from the region peaked at about 730 Mbbl in 1988 and has been in decline since then (EIA 2011c). The USDOE projects that the annual production of oil will continue to decline, from about 234 Mbbl in 2010 to 37 Mbbl in 2050 (EIA 2009n). There are a number of planned and potential future oil development projects, both onshore and in State and Federal waters in the Beaufort Sea Planning Area. There are very few other emission sources in the Chukchi Sea Planning Area.

Air monitoring at a number of sites in the Kuparuk and Prudhoe Bay fields has shown that concentrations of NO_2, SO_2, and PM_{10} are well within the NAAQS. Modeling studies for the Liberty project indicate that emissions from these areas have little effect on ambient concentrations in other locations (with maximum concentrations occurring within 100 to 200 m [330 to 660 ft] from the facility boundary and considerably lower concentrations at a distance of 1 km [0.62 mi]) (MMS 2010). For this reason, it is anticipated that emissions from new facilities would be small and localized with little interaction between facilities.

Table 4.6.2-3 lists the estimated total emissions associated with all future OCS oil and gas activities in the Beaufort and Chukchi Seas, including the 2012-2017 Program, over the next 50 years. These emissions were estimated by BOEM using emission factors from the *2008 Gulfwide Emission Inventory Study* (Wilson et al. 2010).[50] In terms of absolute amounts (using the high scenario), the largest emissions would be NO_x, followed by VOCs, CO, and SO_x, with lesser amounts of PM_{10} and $PM_{2.5}$, in order of decreasing emissions. Under both the high and low scenarios, support vessels would be the largest source of NO_x; the drilling of exploration and development wells would be the largest source of SO_x and PM; and platform production would be the largest source of CO and VOCs. Emissions from Program activities in the Arctic region generally represent about 37 to 39% of the Arctic cumulative case emissions.

Ozone Formation and Visibility Impairment. The baseline conditions and impacts from OCS activities on ozone and visibility are discussed in Sections 3.5.2.3 and 4.4.4.3, respectively. Because conditions in Alaska are seldom favorable for significant O_3 formation, the contribution of leasing activity associated with the Program to O_3 levels in the Beaufort and Chukchi Sea Planning Areas is expected to be small. OCS emission sources affecting visibility are also small.

Greenhouse Gases. Table 4.6.2-4 lists the total calculated emissions of CO_2, CH_4, and N_2O from OCS activities related to the Beaufort and Chukchi Seas (Arctic region) portion of the 2012-2017 Program and compares them to the 2012-2017 Program overall (accounting for OCS program activities in GOM, Cook Inlet, and the Arctic region) and to the total U.S. emissions from all sources in 2009. Activities in the Arctic region account for a small portion of the GHG emissions associated with the 2012-2017 Program, comprising between 1.8 and 4.6% of all program-related GHG emissions. For reference, the estimated annual emissions of CO_2, CH_4,

49 Historic figures include both oil and natural gas liquids produced at Prudhoe Bay and surrounding fields.

50 In the absence of Arctic-specific data, the emission factors from the Wilson et al. (2010) study are considered the best approximation for estimating total emissions related to exploration and development in the Arctic region. Another source, Shell Offshore Inc. (2010), was used to estimate emissions related to icebreakers.

TABLE 4.6.2-3 Estimated Total Air Emissions for the Offshore Exploration and Development Scenario for the OCS Program Arctic Region Cumulative Case

	Pollutant (10^3 tons for 50 yr)[a]					
Activity	NO_x	SO_x	PM_{10}	$PM_{2.5}$	CO	VOC
Well drilling (D&P)	6.57–27.7	1.34–5.66	0.45–1.89	0.45–1.89	0.03–0.15	0.17–4.93
Well drilling (E&D)	11.86–46.46	3.07–12.03	0.54–2.10	0.49–1.92	0.01–0.04	0.51–2.01
Helicopters	0.1–0.53	0.02–0.13	0.02–0.1	0.02–0.1	1.21–6.43	0.24–1.27
Pipe-laying vessels	2.65–18.84	0.45–3.2	0.1–0.71	0.1–0.71	0.55–3.91	0.1–0.71
Platform construction	4.63–24.06	1.09–5.65	0.18–0.95	0.17–0.88	0.14–0.75	0.16–0.83
Platform production	6.64–35.41	0.09–0.47	0.06–0.33	0.06–0.33	7.31–39.01	5.95–31.74
Platform removal	4.63–24.06	1.09–5.65	0.18–0.95	0.17–0.88	0.14–0.75	0.16–0.83
Support vessels	11.95–63.77	1.61–8.59	0.21–1.10	0.21–1.10	1.14–6.07	0.21–1.10
Survey vessels	0.15–0.80	0.02–0.1	0–0.01	0–0.01	0.01–0.07	0–0.01
Total (Cumulative OCS)	49.18–241.63	9.78–41.47	1.74–8.14	1.66–7.82	10.55–57.18	8.5–43.45
Total (Program)[b]	19.59–89.16	3.65–15.04	0.71–2.92	0.68–2.8	3.77–22.2	3.15–16.79

[a] The range of values reflects the low and high end of new exploration and development activity.

[b] Values from Table 4.4.4-5.

TABLE 4.6.2-4 Estimated Greenhouse Gas Emissions for the 2012-2017 Program in the Arctic Region Relative to the 2012-2017 OCS Program Overall over the Next 40 Years

Pollutant	2012-2017 Program (all) (Tg CO_2e) [a, b]	2012-2017 Arctic Program (Tg CO_2e)	Total U.S. Emission from All Sources (2009)	Percent of Total U.S. Emissions from Arctic Program [c]
CO_2	341.54–512.6	5.29–24.66	5,505.2	0.003–0.010
CH_4	3.98–120.22	0.81–4.33	686.3	0.004–0.014
N_2O	2.85–4.23	0.02–0.09	295.6	0.00–0.001
$CO_2 + CH_4 + N_2O$	348.57–637.05	6.12–29.08	6,487.1	0.003–0.010
All GHG	348.57–637.05	6.12–29.08	6,633.2	0.003–0.010
Total	348.57–637.05	6.12–29.08	38,726.0	

[a] One Tg is equal to 10^{12} g, or 10^6 metric tons. The CO_2e for a gas is derived by multiplying the mass of the gas by the associated GWP, which accounts for the relative effectiveness of a gas to contribute to global warming with respect to the same amount of CO_2. In these calculations, CH_4 is given a GWP of 21, while NO_2 is given a GWP of 310.

[b] Values represent the total emissions for the 2012-2017 Program in the GOM, Cook Inlet, and Arctic regions.

[c] Values are calculated by dividing the estimated annual emissions of the Arctic Program (equal to the value in the third column divided by 40) by the total U.S. emission from all sources in 2009 (fourth column).

Source: USEPA 2011l.

and N_2O from OCS activities in the Arctic region were less than 0.05% of CO_2, CH_4, and N_2O emissions in the United States from all sources in 2009. Although these are small contributions, it should be noted that some GHGs (e.g., CO_2) can persist in the atmosphere for a century, well beyond the life of the Program.

GHG emissions are one of the causes of climate change; however, assessing their impact requires consideration on a global scale. For this reason, it is not possible to estimate the impact of GHG emissions from particular sources, such as the OCS activities associated with the Program. On a global scale, the contribution from the Program to total GHG emissions is small. On a national scale, the contribution of the Program is also small (much less significant than from activities in the GOM).

Oil Spills. Accidental oil spills are a source of gaseous emissions. No more than six large spills (1,000 bbl or greater) and 450 small spills (less than 50 bbl) are projected for the Beaufort and Chukchi Sea Planning Areas cumulative case as a result of the OCS program (Table 4.6.1-4). Most of the accidental spills in the North Slope region are of non-crude products during fuel transfer operations at remote villages (ADEC 2007a). While there is no discernible trend in the annual number of spills or total volume released, there is a seasonal pattern to spill events, with increases occurring during winter months (likely coinciding with increased exploration activities). Since 1976, there have been no major crude oil spills in Arctic waters (State of Alaska 2011). Oil spills cause localized increases in VOC concentrations (proportional to the size of the spill) due to evaporation. Most of these emissions would be expected to occur within a few hours of the spill and decrease (by dissipation) drastically after that period (MMS 2010). However, oil spills in ice-covered waters during winter months would be contained within a much smaller area (compared with spills in open waters) because oil weathering (i.e., spreading, evaporation, and migration) is much slower and some oil may solidify (MMS 2009b). A more detailed discussion of the effects of oil spills on air quality in the Arctic region is presented in Section 4.4.4.3.

Catastrophic events at well locations may result in fires; *in situ* burning is also a preferred technique for cleanup and disposal of oil spills (documented in oil spill contingency plans). Smoke generated from such fires would be expected to reach shore quickly (within a day), but would be limited in geographic extent (MMS 2003a). A discussion of the effects of fires on air quality in the Arctic region is presented in Section 4.4.4.3.

Conclusion. OCS program activities in combination with other oil and gas exploration, development, and production activities in the Beaufort and Chukchi Sea Planning Areas could affect air quality in the region. Air pollutant concentrations associated with offshore and onshore emission sources are expected to remain well within applicable State and Federal standards over the life of the Program. Therefore, the overall cumulative impacts on air quality in the Beaufort and Chukchi Sea Planning Areas are expected to be minor to moderate, and the incremental contribution of routine Program activities to air quality impacts would be small (see Section 4.4.4.3).

The number of expected accidental oil spills in Arctic waters associated with the Program would represent only a small increase over the number of expected spills from ongoing non-OCS program activities (mainly oil and gas production in State waters). The incremental increase in adverse air quality impacts from these spills (and *in situ* burning of spilled crude or diesel) would be localized and temporary (due to the spreading of oil and action by winds, waves, and currents that disperse volatile compounds to extremely low levels over a relatively large area); therefore, the incremental contribution of expected oil spills to cumulative air quality impacts could range from small to medium. Air quality impacts associated with an unexpected, low-probability CDE (and *in situ* burning) would also be reduced by these factors, and could be moderate if it were to occur. Spill response and cleanup activities (e.g., *in situ* burning and use of chemical dispersants) could contribute to air quality impacts regardless of the size of spill. A more detailed discussion of the effects of oil spills on air quality in the Arctic region is presented in Section 4.4.4.2.3.

4.6.2.3.3 Acoustic Environment. Section 4.4.5.3 discusses impacts on the acoustic environment in the Arctic region resulting from the Program. Section 4.4.7 evaluates the direct and indirect impacts of noise on marine fauna (fish, marine mammals, and birds), and Section 4.6.4 addresses the cumulative impacts of noise on marine fauna. Cumulative impacts on the acoustic environment result from the incremental impacts of the Program when added to impacts from reasonably foreseeable future OCS program activities (that are not part of the

Program) and other non-OCS program activities.[51] Table 4.6.1-3 presents the exploration and development scenario for the Beaufort Sea and Chukchi Sea Planning Areas cumulative case (encompassing the Program and other OCS program activities). Ongoing and reasonably foreseeable non-OCS program activities contributing to adverse cumulative impacts on the acoustic environment in the Arctic region include aircraft traffic, marine vessel traffic, construction of onshore and offshore facilities (e.g., related to ongoing oil and gas exploration and development in State waters), and other activities (e.g., seismic surveys) conducted as part of the existing oil and gas industry in the Beaufort and Chukchi Seas. This section addresses the quality of the acoustic environment only; the cumulative impacts of noise on marine fauna in the Beaufort and Chukchi Seas are discussed in Section 4.6.4.3.

Ambient (background) noise has numerous natural and man-made sources that vary with respect to season, location, depth of occurrence, time of day, and noise characteristics (e.g., frequency and duration).[52] Natural sources of ambient noise include wind and wave action, currents, ice, precipitation (rain and hail), lightening, and biological noise (from marine mammals and coastal birds). Marine vessels (e.g., tankers, supply ships, tugboats, barges, and fishing boats) are the greatest man-made contributors to overall marine noise in the Arctic region. Baseline acoustic conditions in the region are discussed in more detail in Section 3.6.3.

Future routine OCS program activities, including those of the Program, that generate noise include operating airgun arrays (during marine seismic surveys), drilling, pipeline trenching, and onshore and offshore construction and decommissioning of platforms (including artificial islands and causeways), and drilling rigs. Vessel and aircraft traffic (including that associated with emergency response and cleanup activities in the event of a spill), accidental releases (e.g., loss of well control events), and vessel collisions also contribute to noise. A preliminary study of the noise impacts of OCS related geophysical surveys found that marine seismic surveys have the greatest impact on marine mammals, sea turtles, fish, and commercial and recreational fisheries (MMS 2004a). Noise generated from OCS and non-OCS program activities would be transmitted through both air and water, and may be transient or more extended (occurring over the long term).

Conclusion. The quality of the acoustic environment in the Beaufort and Chukchi Seas would continue to be adversely affected by ongoing and future non-OCS program activities and by future OCS program activities (currently there are no existing OCS activities, although seismic studies and exploratory drilling have been conducted in the past). The magnitude of cumulative impacts due to noise in the Beaufort and Chukchi Seas from all OCS and non-OCS activities taking place in the Arctic region over the next 40 to 50 years is time- and location-specific and could range from minor to major, depending on the ambient acoustic conditions and the nature of activities taking place. The incremental contribution due to noise generated by

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51 Currently, there are no existing OCS program activities in the Beaufort Sea and Chukchi Sea Planning Areas, but it is assumed that exploration and development activities as a result of Sale 193 (Chukchi Sea) will have occurred before the Program (Section 4.4.1.3).

52 Higher frequencies are attenuated with distance from the source more rapidly than lower frequencies. Traffic noise generated in deep water contributes to background noise levels at greater distances than traffic noise generated in shallow water.

routine Program activities could range from small to medium, depending on the timing of the disturbance and the location and characteristics of noise sources present (e.g., their frequency and duration). The cumulative impacts of noise on marine fauna (fish, marine mammals, and birds) are discussed in Section 4.6.4.

The number of expected accidental oil spills in Arctic waters associated with the Program would represent only a small increase over the number of expected spills from ongoing non-OCS program activities. The incremental increase in adverse acoustic environment impacts from these spills (mainly due to noise sources associated with response and cleanup activities) would be localized and temporary; therefore, the incremental contribution of expected oil spills due to noise could range from small to medium. Impacts associated with an unexpected, low-probability CDE could be minor to moderate if it were to occur. Most of the impacts to the acoustic environment are due to noise sources (e.g., mechanical equipment, skimmers, support vessel traffic, and aircraft traffic) associated with spill response and cleanup activities. A more detailed discussion of the effects of oil spills on the acoustic environment in the Arctic region is presented in Section 4.4.5.3.

4.6.2.4 Summary for the Gulf of Mexico Region

4.6.2.4.1 Water Quality. There are many factors affecting the water quality in the GOM currently. In general, these include marine vessel traffic, wastewater discharge, dredging and marine disposal, oil and gas production (in State waters and on the OCS), military operations, LNG terminal operations, LOOP operations, and natural oil seepage along the continental slope. Coastal waters are also affected by numerous other factors, including river inflows, urbanization, agricultural practices, municipal waste discharges, and coastal industry. Climate change is also expected to affect water quality in the coming decades, especially in terms of surface temperature, salinity, vertical stratification, and pH. Another issue of importance to water quality in the GOM concerns an area known as the hypoxic zone, a zone of oxygen depletion (due to high nutrient loads) which is located at the bottom of the continental shelf of Louisiana and Texas. Cumulative impacts on water quality are attributed to a combination of all these factors and, overall, are considered to be moderate. The incremental contribution of the Program to cumulative impacts on water quality in the GOM would be small to medium.

Routine operations under the Program could result in localized and short-term minor to moderate impacts as a result of structure placement and construction (pipelines and platforms), operational discharges (produced water, bilge water, and drill cuttings), bottom disturbance, and waste discharges. Compliance with NPDES permits and USCG regulations would reduce the magnitude of most of these impacts. The effects of expected accidental oil spills (most of which are less than 1,000 bbl) would depend upon weather and sea conditions at the spill site, the type of oil spilled, the depth of the spill event, and the volume and rate of spillage; therefore, the incremental contribution of expected oil spills to cumulative water quality impacts could range from small to large. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from moderate to major if it were to occur. Spill response and cleanup activities could also contribute to water quality impacts. While small spills (less than 1,000 bbl) would result in short-term, localized impacts, the impacts associated with larger spills (1,000 bbl or greater) or a CDE could persist for an extended period (especially in wetlands and low-energy environments).

4.6.2.4.2 Air Quality. In general, the ambient air quality in coastal counties along the GOM is relatively good. Coastal counties are in attainment for all criteria pollutants except 8-hr ozone (in some areas of Texas and Louisiana). Visibility in the coastal region is about 48 to 64 km (30 to 40 mi). Most of the human-caused visibility degradation is attributed to sulfate particles, but also to organic or elemental carbon particles and nitrate particles. The effects of various USEPA regulations and standards are expected to result in a steady, downward trend in future air emissions in the coming decades. Cumulative impacts on air quality in the GOM region are attributed to both offshore and onshore activities. Offshore activities in the GOM are mainly associated with the oil and gas industry, but also include various marine vessel traffic (shipping, fishing, cruise ships), tanker lightering, and military operations. Onshore emission sources include power generation, industrial processing, manufacturing, refineries, commercial and home heating, on-road vehicles, and non-road engines (e.g., aircraft, locomotives, and construction equipment). Overall, cumulative impacts on air quality in the GOM over the next 40 to 50 years are expected to be minor to moderate.

The incremental contribution of routine operations under the Program would be small, because they would not cause exceedance of the NAAQS in public access areas or affect visibility. Small accidental oil spills (less than 1,000 bbl) would have localized and temporary effects and are considered minor from an air quality standpoint. The effects of expected accidental oil spills (most of which are less than 1,000 bbl) would be localized and temporary due to dispersion; therefore, the incremental contribution of expected oil spills to cumulative air impacts could range from small to medium. Air quality impacts associated with an unexpected, low-probability would also be reduced by these factors, and would be moderate if it were to occur. Spill response and cleanup activities could also contribute to air quality impacts.

4.6.2.4.3 Acoustic Environment. Sources of ambient noise in the GOM include wind and wave activity, precipitation (rain and hail), lightning, biological noise, and distant marine vessel traffic. The main sources of anthropogenic noise are numerous in the GOM and include marine vessel traffic, dredging, construction, oil and gas activities (such as seismic surveys), marine mineral mining, sonar, explosions, and ocean science studies. The quality of the acoustic environment in the GOM would continue to be adversely affected by ongoing and future OCS and non-OCS activities. The magnitude of cumulative impacts in the GOM is time- and location-specific and could range from minor to major, depending on the ambient acoustic conditions and the nature and combination of noise sources from all OCS and non-OCS activities.

Routine operations under the Program would result in minor impacts to ambient noise levels mainly associated with seismic surveys, drilling and production, infrastructure placement and removal, and marine vessel traffic. Depending on the source, changes in ambient noise levels could be short-term and localized (e.g., from vessel traffic), long-term and localized (e.g., from production), or short-term and less localized (e.g., seismic surveys), and some may extend well beyond the survey boundary. The contribution of the Program to cumulative impacts could be small to medium, depending on the timing of the disturbance and the location and characteristics of noise sources present (e.g., their frequency and duration). The incremental increase in adverse acoustic environmental impacts from expected accidental oil spills in GOM waters (most of which are less than 1,000 bbl) would be localized and temporary; therefore, the incremental contribution of expected oil spills to cumulative noise-related impacts would be small. Impacts associated with an unexpected, low-probability CDE could range from minor to moderate if it were to occur. Most of the impacts to the acoustic environment would be due to noise sources associated with response and cleanup activities.

4.6.2.5 Summary for Alaska – Cook Inlet

4.6.2.5.1 Water Quality. Factors affecting the water quality in Cook Inlet include marine vessel traffic, wastewater discharge, dredging and marine disposal, oil and gas production (currently only in State waters), and military operations. Water quality is also affected by numerous other factors, including river inflows, urbanization, forest practices, mining, municipal waste discharges, and agriculture. Natural seepage of oil along the west part of the inlet may also be significant. Cumulative impacts on water quality are attributed to a combination of all these factors and, overall, are considered to be minor to moderate. These impacts may lessen with time since oil and gas production in Cook Inlet is currently in decline. The incremental contribution of the Program to cumulative impacts on water quality in Cook Inlet would be small to medium.

Routine operations under the Program could result in localized and short-term minor to moderate impacts as a result of structure placement and construction (pipelines and platforms), operational discharges (produced water, bilge water, and drill cuttings), bottom disturbance, and waste discharges. Compliance with NPDES permits and USCG regulations would reduce the magnitude of most impacts. The effects of expected accidental oil spills (most of which are less than 1,000 bbl) would depend upon weather and sea conditions at the spill site, the type of oil spilled, the depth of the spill event, and the volume and rate of spillage; therefore, the incremental contribution of expected oil spills to cumulative water quality impacts could range from small to large. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from moderate to major if it were to occur. Spill response and cleanup activities could also contribute to water quality impacts. While small spills (less than 1,000 bbl) would result in short-term, localized impacts, impacts associated with larger spills (1,000 bbl or greater) or a CDE could persist for an extended period (especially in wetlands and low-energy environments).

4.6.2.5.2 Air Quality. Except for a few population centers such as Anchorage, the existing air quality in Alaska is relatively pristine with pollutant levels that are well within the ambient standards. Cumulative impacts on air quality in Cook Inlet are attributed to both offshore and onshore activities. Offshore activities in the region are mainly associated with the oil and gas industry, but also include various marine vessel traffic (shipping, fishing, cruise ships). Onshore emission sources include power generation, industrial plants, mining, commercial and home heating, on-road vehicles, and non-road engines (e.g., aircraft, locomotives, and construction equipment). Overall, cumulative impacts on air quality in Cook Inlet over the next 40 to 50 years are expected to be minor to moderate.

The incremental contribution of routine operations under the Program would be small, because they would not cause exceedance of the NAAQS in public access areas or affect visibility. Small accidental oil spills (less than 1,000 bbl) would have localized and temporary effects and are considered minor from an air quality standpoint. The effects of expected accidental oil spills would be localized and temporary due to dispersion; therefore, the incremental contribution of expected oil spills to cumulative air impacts could range from small to medium. Air quality impacts associated with an unexpected, low-probability CDE would also be reduced by these factors, and could be moderate if it were to occur. Spill response and cleanup activities could also contribute to air quality impacts.

4.6.2.5.3 Acoustic Environment. Ice, strong tidal fluctuations, and currents all play an important role in the ambient noise levels in Cook Inlet. The main sources of anthropogenic noise are aircraft overflights, marine vessel traffic, oil and gas activities (including seismic surveys and production operations), and other operations such as dredging and pile driving (for new docks). The quality of the acoustic environment in Cook Inlet would continue to be adversely affected by ongoing and future non-OCS program activities and by future OCS program activities (currently there are no existing OCS activities, although seismic studies and exploratory drilling have been conducted in the past). The magnitude of cumulative impacts in the inlet is time- and location-specific and could range from minor to major, depending on the ambient acoustic conditions and the nature and combination of noise sources from all OCS and non-OCS activities.

Routine operations under the Program would result in minor impacts to ambient noise levels mainly associated with seismic surveys, drilling and production, infrastructure placement and removal, and marine vessel traffic. Depending on the source, changes in ambient noise levels could be short-term and localized (e.g., from vessel traffic), long-term and localized (e.g., from production), or short-term and less localized (e.g., seismic surveys), and some may extend well beyond the survey boundary. The contribution of the Program to cumulative impacts could range from small to medium, depending on the timing of the disturbance and the location and characteristics of noise sources present (e.g., their frequency and duration). The incremental increase in adverse acoustic environmental impacts from expected accidental oil spills in Cook Inlet waters (mainly due to noise sources associated with response and cleanup) would be localized and temporary; therefore, the incremental contribution of expected oil spills to cumulative noise-related impacts would be small. Impacts associated with an unexpected, low-probability CDE could range from minor to moderate if it were to occur. Most of the impacts to the acoustic environment would be due to noise sources associated with response and cleanup activities.

4.6.2.6 Summary for Alaska – Arctic

4.6.2.6.1 Water Quality. Factors affecting the water quality in the Beaufort and Chukchi Seas include marine vessel traffic, wastewater discharge, oil and gas production (currently only in State waters), and military operations. Water quality is also affected by numerous other factors, including river inflows, mining, and municipal waste discharges. Cumulative impacts on water quality are attributed to a combination of all these factors and, overall, are considered to be moderate. Impacts related to marine vessel traffic in the Beaufort and Chukchi Seas (especially shipping and research vessels, icebreakers, and cruise ships) would likely increase in the coming decades as the open-water season begins earlier and ends later (an effect of climate change). The incremental contribution of the Program to cumulative impacts on water quality in Arctic waters would be small to medium.

Routine operations under the Program could result in localized and short-term minor to moderate impacts as a result of structure placement and construction (pipelines and platforms), operational discharges (produced water, bilge water, and drill cuttings), bottom disturbance, and waste discharges. Compliance with NPDES permits and USCG regulations would reduce the magnitude of most of these impacts. The effects of expected accidental oil spills (most of which are less than 1,000 bbl) would depend upon weather and sea conditions at the spill site, the type of oil spilled, the depth of the spill event, and the volume and rate of spillage; therefore, the incremental contribution of expected oil spills to cumulative water quality impacts could range from small to large. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from moderate to major if it were to occur. Spill response and cleanup activities could also contribute to water quality impacts. While small spills (less than 1,000 bbl) would result in short-term, localized impacts, impacts associated with larger spills (1,000 bbl or greater) or a CDE could persist for an extended period (especially in wetlands and low-energy environments).

4.6.2.6.2 Air Quality. The Arctic region has a low population. Barrow is the largest city in the North Slope Borough, with a population (in 2010) of just 4,600. The primary industrial emissions in the region are associated with the oil and gas industry, power generation, small refineries, paper mills, and mining. Currently, North Slope Borough is designated as an unclassified/attainment area for all criteria pollutants. The region does experience air pollution problems (e.g., Arctic haze), however, due to long-range transport of air pollutants from industrial parts of northern Eurasia and North America. Overall, cumulative impacts on air quality in the Arctic region over the next 40 to 50 years are expected to be minor to moderate. The incremental contribution of the Program would be small.

The incremental contribution of routine operations under the Program would be small, because they would not significantly increase onshore airborne pollutants or affect visibility. Small accidental oil spills (less than 1,000 bbl) would have localized and temporary effects and are considered minor from an air quality standpoint. The effects of expected accidental oil spills (most of which are less than 1,000 bbl) would be localized and temporary due to dispersion; therefore, the incremental contribution of expected oil spills to cumulative air impacts could range from small to medium. Air quality impacts associated with an unexpected, low-probability CDE would also be reduced by these factors (depending on the season), and could be moderate if it were to occur. Spill response and cleanup activities could also contribute to air quality impacts.

4.6.2.6.3 Acoustic Environment. Arctic waters are a unique acoustic environment, mainly because of the presence of ice, which can contribute significantly to ambient sound levels (e.g., ice cracking generates noise; ice deformation generates low-frequency noise). Ambient levels of natural sound can vary dramatically between and within seasons. During open-water season, wind and waves (and biological sounds) are important sources of ambient sounds. The main sources of anthropogenic noise are aircraft overflights, marine vessel traffic, oil and gas activities (including seismic surveys and production operations), human settlements, and military activities. The quality of the acoustic environment in the Beaufort and Chukchi Seas would continue to be adversely affected by ongoing and future non-OCS program activities and by future OCS program activities (currently there are no existing OCS activities, although seismic studies and exploratory drilling have been conducted in the past). The magnitude of cumulative impacts in the Beaufort and Chukchi Seas is time- and location-specific and could range from minor to major, depending on the ambient acoustic conditions and the nature and combination of noise sources from all OCS and non-OCS activities.

Routine operations under the Program would result in minor impacts to ambient noise levels mainly associated with seismic surveys, drilling and production, infrastructure placement and removal, and marine vessel traffic. Depending on the source, changes in ambient noise levels could be short-term and localized (e.g., from vessel traffic), long-term and localized (e.g., from production), or short-term and less localized (e.g., seismic surveys), and some may extend well beyond the survey boundary. The contribution of the Program to cumulative impacts could range from small to medium, depending on the timing of the disturbance and the location and characteristics of noise sources present (e.g., their frequency and duration). The incremental increase in adverse acoustic environmental impacts from expected accidental oil spills in Arctic waters (most of which are less than 1,000 bbl) would be localized and temporary; therefore, the incremental contribution of expected oil spills to cumulative noise-related impacts would be small. Impacts associated with an unexpected, low-probability CDE could range from minor to moderate if it were to occur. Most of the impacts to the acoustic environment would be due to noise sources associated with response and cleanup activities.

4.6.3 Marine and Coastal Habitats

4.6.3.1 Gulf of Mexico Region

4.6.3.1.1 Coastal and Estuarine Habitats. Section 4.4.6.1.1 discusses direct and indirect impacts on coastal and estuarine habitats in the GOM resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Section 4.4.6.1.1) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS activities. Table 4.6.1-2 presents the exploration and development scenario for the GOM cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the GOM are summarized in Table 4.6.1-5 and discussed below, as applicable.

A number of activities associated with the Program could result in impacts on coastal and estuarine habitats in the GOM (Section 4.4.6.1.1). These activities include construction of pipelines and shoreline facilities, maintenance dredging of inlets and channels, and vessel traffic. Impacts associated with these activities could include (1) losses of beach and dune habitat and indirect effects that contribute to reductions in beach habitat in areas of ongoing shoreline degradation; and (2) elimination of wetland habitat and indirect effects that contribute to reductions in wetland habitat. Similar activities would occur from previous and future sales during the life of the Program (see Table 4.6.1-2). Excluding the estimated number of offshore pipelines installed, which is not relevant to this analysis, the activities associated with the Program will be about 15–30% of the total amount of OCS program activity that will occur during the life of the Program.

Barrier Beaches and Dunes. Impacts on barrier beaches and dunes primarily result from factors that reduce sediment input to downdrift areas or that directly contribute to increased erosion of beaches and dunes. Construction projects may reduce the sediment contribution to the GOM barrier landforms from inflowing rivers, or they may restrict the movement of sediments to downdrift areas and natural replenishment of barrier beaches. Other activities may disturb barrier dune vegetation, thereby promoting dune erosion, or directly disturb beach and dune substrates, resulting in increased erosion of beaches and dunes. Increases in wave action can also contribute to beach erosion.

Ongoing non-OCS activities that could affect barrier beaches and dunes include those related to State oil and gas development, commercial shipping (and other marine vessel traffic), coastal development, and recreation (Table 4.6.1-5). These activities can be reasonably expected to continue into the future. A number of activities reduce the sediment supply to barrier beaches and dunes. Past activities that have contributed to sediment deprivation and submergence of coastal lands have contributed to erosion and land losses, particularly along the Louisiana coast, and are expected to continue into the foreseeable future. Channelization and diversion of Mississippi River flows, as well as the construction of Mississippi River dams and reservoirs, and subsequent reductions in sediment supply to deltaic areas to the west have resulted in the continued extensive erosion of coastal habitats. Past construction of dams on other rivers discharging to the western GOM has also resulted in a reduction in sediments delivered to the coast, which, along with natural causes of sediment supply reductions, have resulted in ongoing land loss along the Texas coast. The emplacement of groins, jetties, and seawalls for beach stabilization in much of the GOM contributes to the reduction of sediment inputs and the acceleration of coastal erosion in downdrift areas. Maintenance dredging of barrier inlets and bar channels, in combination with channel jetties, has resulted in impacts on adjacent barrier beaches down-current due to sediment deprivation, especially on the sediment-starved coastal areas of Louisiana. Maintenance dredging is an ongoing practice and is expected to continue to be an impact-producing factor into the future; this includes, for example, efforts to accommodate larger cargo vessels. The past construction of canals for pipelines and navigation has resulted in losses of coastal barrier habitat. Although new navigation canals from the GOM to inland areas are unlikely to be needed and current pipeline construction methods result in little, if any, impacts on barrier landforms, existing pipeline canals are expected to continue to be sediment sinks and to promote the reduction of adjacent barrier island dunes and beaches. However, the replenishment of barrier beaches with sand obtained from OCS sources and the beneficial use of dredged material are expected to continue to aid in the restoration of barrier islands.

The presence of pipelines, even after decommissioning, in some areas of the GOM may potentially result in the reduction or elimination of suitable sediment sources used for beach renourishment and restoration projects, due to the necessity of pipeline avoidance. Loss of sediment sources could potentially restrict restoration activities in some areas. In addition, at restoration sites, pipeline safety buffers can reduce areas available for restoration, and pipeline surveys divert funds otherwise available. However, as noted above, fewer than 12 new pipeline landfalls would be constructed under the Program. Pipeline disturbance widths are generally small with modern placement methods, and the rights-of-way would be less than 200 m (656 ft) in width. Operators are interested in protecting pipelines from coastal erosion, so a synergy could be developed with coastal restoration projects. Because of demand for OCS material for coastal restoration, BOEM is trying to cluster pipelines and to keep pipelines away from known marine mineral resources (BOEM 2012a; USDOI 2009). The impacts on barrier beaches and dunes from sediment removal activities associated with maintenance dredging under the Program would represent a very small contribution to the past, ongoing, and expected future degradation of barrier beaches and dunes from non-OCS activities.

Although coastal barrier islands in most of the Central Planning Area generally receive minimal recreational use, most barrier beaches in Texas, Alabama, and Florida are accessible and extensively used for recreation. Pedestrian and vehicular traffic on beaches and dunes can destabilize substrates, either by reducing vegetation density — and thus increasing erosion by wind, waves, and traffic — or by directly disturbing or displacing substrates. In addition, considerable private and commercial development has occurred on many barrier islands in the GOM, resulting in losses of beach and dune habitat. The impacts on barrier beaches and dunes from substrate-disturbance activities associated with pipeline construction under the Program are expected to be greatly minimized by non-intrusive construction techniques and would not be expected to appreciably add to the cumulative effects of other substrate-disturbing activities.

Activities that increase wave action along barrier beaches and dunes can contribute to their erosion. The construction of seawalls, groins, and jetties in Texas and Louisiana has contributed to coastal erosion in part by increasing or redirecting the erosional energy of waves. Vessel traffic related to shipping and transportation can result in wake erosion of channels between barrier islands. A large number of vessels use the navigation channels near the GOM coast. A portion of the impacts related to vessel traffic would be associated with the Program; however, activities conducted under the Program would contribute a relatively small number of vessel trips to the total.

Barrier beaches and dunes could be affected by accidental spills of oil or petroleum products resulting from ongoing and future activities in the GOM (Section 4.6.1.1). Although the majority of these spills would be small (less than 50 bbl), catastrophic releases can impact extensive areas of shoreline. Oil released into coastal waters as a result of the DWH event, April–July 2010, affected more than 1,046 km (650 mi) of the GOM coastal habitat, from the Mississippi River delta to the Florida panhandle, with the Louisiana, Mississippi, Alabama, and Florida coasts all affected (OSAT-2 2011; National Commission 2011). The greatest impacts were in Louisiana. More than 209 km (130 mi) of coastal habitat were moderately to heavily oiled, with only 32 km (20 mi) occurring outside of Louisiana (National Commission 2011). Little or no oil affected Texas coastal habitats. Heavy to moderate oiling occurred along a substantial number of Louisiana beaches, with the heaviest oiling on the Mississippi Delta, in Barataria Bay, and on the Chandeleur Islands (OSAT-2 2011). The majority of Mississippi barrier islands had light oiling to trace oil, although heavy to moderate oiling occurred in some areas. Some heavy to moderate oiling also occurred on beaches in Alabama and Florida, with the heaviest stretch of oiling extending from Dauphin Island, Alabama, to near Gulf Breeze, Florida (OSAT-2 2011). Light to trace oiling occurred from Gulf Breeze to Panama City, Florida. Deposition of oil occurred in the supratidal zone (above the high tide mark), deposited and buried during storm events; intertidal zone; and subtidal zone, there remaining as submerged oil mats (OSAT-2 2011). On Grand Isle, Louisiana, and Bon Secour, Alabama, oil was found up to 105 cm (41 in.) below the surface (OSAT-2 2011). Low-molecular-weight and volatile compounds were mostly depleted from oil that reached shorelines, due to weathering at sea (OSAT-2 2011). Although much of the oil remaining after cleanup is highly weathered, several constituents have the potential to cause toxicological effects (OSAT-2 2011).

Non-OCS activities, such as the domestic transportation of oil, foreign crude oil imports, and State oil and gas development may also result in accidental spills that could potentially affect coastal barrier beaches and dunes. The amount of oil contacting barrier islands from a spill would depend on a number of factors such as the location and size of the spill, waves and water currents, and containment actions. Naturally occurring seeps may also be a source of crude oil introduced into GOM waters (NRC 2003b; Kvenvolden and Cooper 2003). The magnitude of resulting impacts and the persistence of oil would depend on factors such as the amount of oil deposited, remediation efforts, substrate grain size, and localized erosion and deposition patterns. In areas of barrier beach erosion, such as Louisiana, remediation would likely include the minimization of sand removal or replacement of removed sand. The impacts of potential oil spills associated with the Program would be expected to add a small contribution to the impacts of other sources of oil.

Indirect effects on coastal barrier beaches and dunes could result from global climate change. Factors associated with global climate change include changes in temperature and rainfall, alteration in stream flow and river discharge, sea level rise, changes in hurricane frequency and strength, sediment yield, mass movement frequencies and coastal erosion, and subsidence (Yanez-Arancibia and Day 2004). Potential thermal expansion of ocean water and melting of glaciers and ice caps could result in a global rise in mean sea level (Section 4.6.1.6). Recent rates of sea level rise have been approximately 3 mm/yr (0.12 in./yr), but this rate may increase to 4 mm/yr (0.16 in./yr) by 2100 (Blum and Roberts 2009). Sea-level rise could result in increased inundation of barrier beaches and increases in losses of beach habitat. Effects of sea level rise include damage from inundation, floods and storms; and erosion (Nicholls et al. 2007). Effects of increased storm intensity include increases in extreme water levels and wave heights; increases in episodic erosion, storm damage, risk of flooding, and defense failure (Nicholls et al. 2007). Patterns of erosion and accretion can also be altered along coastlines (Nicholls et al. 2007). The small tidal range of the GOM coast increases the vulnerability of coastal habitats to the effects of climate change.

Hurricanes and other severe storm events can affect coastal barrier beaches and dunes. Increased wave action and intensity on barrier habitats may result in increased erosion and changes in beach and dune topography or losses of habitat. Hurricanes and tropical storms are inherent components of the GOM ecosystem that have long influenced coastal habitats and are expected to continue to be sources of impacts. Anthropogenic impacts on barrier beaches and dunes may be greatly exacerbated by severe storm events such as hurricanes. In 2005, Hurricanes Katrina and Rita caused extensive erosion of barrier landforms in the central and western GOM. Extreme storms such as these can result in relatively permanent change to these habitats, particularly in areas that are already experiencing erosion and retreat as a result of sediment deprivation, sea level rise, and coastal development.

Wetlands. Factors that affect coastal wetlands include the direct elimination of wetland habitat by excavation or filling, the reduction of sediment inputs, the erosion of wetland substrates, and the degradation of wetland communities by reduced water quality or hydrologic changes. Construction projects may fill wetlands for facility siting or excavate wetlands for the construction of canals or pipelines. Other projects may reduce the sediment delivered to coastal wetlands from inflowing rivers. A number of activities may degrade wetlands or promote wetland losses indirectly by causing changes to wetland hydrology or introducing contaminants. Routine OCS operations could have direct impacts on wetlands as a result of direct losses of habitat from construction activities, pipeline landfalls and channel dredging, and indirect impacts as a result of altered hydrology caused by channel dredging.

Ongoing non-OCS activities that could affect coastal wetlands include those related to State oil and gas development, commercial shipping (and other marine vessel traffic), coastal development, dredging operations, discharge of municipal wastes and other effluents, domestic transportation of oil and gas, and foreign crude oil imports (Table 4.6.1-5). These activities can be reasonably expected to continue into the future. A number of these activities result in the localized destruction of wetlands. The construction of pipelines and navigation channels would result in direct losses of wetlands that are crossed, due to excavation. In addition, the creation of spoil banks along canals would bury wetland habitat. Large areas of coastal wetlands are also lost by drainage and filling, due to urban development and agricultural use (Gosselink et al. 1979; Bahr and Wascom 1984). Although activities that affect wetlands are regulated by State and Federal agencies, construction of industrial facilities, commercial sites, and residential developments would be expected to result in continued wetland losses. Pipeline installation and vessel traffic outside of established traffic routes could have short-term impacts on seagrass communities, which are primarily located in the eastern GOM. The direct impacts on coastal wetlands from pipeline, navigation canal, or facility construction under the Program would represent a small contribution to the past, ongoing, and expected future losses of wetlands from non-OCS activities.

Indirect impacts on wetlands from non-OCS activities are expected to continue to contribute to wetland degradation and conversion of wetlands to open water. A major factor that has contributed to the ongoing loss of coastal wetlands, particularly in the Mississippi River Delta region of Louisiana, is the reduction in sediments provided to coastal marshes. Reductions in sediment supply, in combination with natural subsidence, have contributed significantly to the conversion of coastal marsh to open water. The construction of dams and levees and channelization along the Mississippi River restrict the sediment supply and overbank flow of floodwaters, limiting the release of sediments and fresh water to coastal marshes (LCWCRTF 1998, 2003; USACE 2004).

Coastal wetlands are also lost due to the effects of large storm events, and the continuing erosion of barrier islands reduces their capacity to act as buffers for coastal wetlands (LCWCRTF 2001). Construction of canals for pipelines and navigation would result in future continuing progressive losses from canal widening and failure of mitigation structures, which would contribute to the conversion of wetlands to open water. Canal construction and maintenance dredging of navigation canals result in hydrologic changes, primarily high levels of tidal and storm flushing and draining potential of interior wetland areas. Such alterations of water movement can result in erosion of marsh substrates and increase inundation levels, and can result in substantial impacts on the hydrologic basin. Construction and maintenance of canals through coastal wetlands can increase the impacts of coastal storms, such as hurricanes, in the conversion of wetlands to open water. Saltwater intrusion results from canal construction and reduced freshwater inputs due to river channelization, and causes considerable deterioration of coastal wetlands. Wetland losses due to subsidence have also been attributed to extraction of oil in some portions of the Mississippi River Delta, or the withdrawal of groundwater along the Texas coast. Changes in wetland hydrology, as well as increases in turbidity and sedimentation, as a result of construction projects, can affect wetlands.

Degradation of wetlands can result from water quality impacts due to stormwater discharges and discharges of waste water from vessels, municipal treatment plants, and industrial facilities. Water quality may also be affected by waste storage and disposal sites. The direct and indirect impacts on coastal wetlands under the Program would represent a small contribution to the past, ongoing, and expected future impacts on wetlands from non-OCS activities.

Accidental spills of oil or petroleum products from OCS activities (Section 4.4.6.1) could impact coastal wetlands. The majority of these spills would be small (less than 50 bbl). Should spills occur in shallow water from marine vessel accidents and pipelines, they could contact and affect coastal wetlands. Most spills that occur in deep water would be unlikely to contact and impact wetlands. Catastrophic releases in deep water, however, can impact extensive areas of shoreline. Oil released into coastal waters as a result of the DWH event, April–July 2010, affected more than 1,046 km (650 mi) of the GOM coastal habitat, from the Mississippi River delta to the Florida panhandle, with the Louisiana, Mississippi, Alabama, and Florida coasts all affected (OSAT-2 2011; National Commission 2011). Non-OCS activities, such as State oil and gas development, the domestic transportation of oil, and foreign crude oil imports, may also result in accidental spills that could potentially impact coastal wetlands. Naturally occurring seeps may also be a source of crude oil that could potentially affect coastal wetlands. The amount of oil contacting wetlands, the magnitude of resulting impacts, and the length of time for recovery would depend on a number of factors such as the location and size of the spill, containment actions, waves and water currents, type of oil, types of remediation efforts, amount of oil deposition, duration of exposure, season, substrate type, and extent of oil penetration. Impacts from oil spills would be expected to range from short-term effects on vegetation growth to permanent loss of wetlands and conversion to open water. The impacts of potential oil spills associated with the Program are expected to constitute a small addition to the impacts of all other sources of oil in the GOM.

Global climate change could result in indirect effects on coastal wetlands. Factors associated with global climate change include changes in temperature and rainfall, alteration in stream flow and river discharge, wetland loss, salinity, sea level rise, changes in hurricane frequency and strength, sediment yield, mass movement frequencies and coastal erosion, and subsidence (Yanez-Arancibia and Day 2004). Effects of sea level rise include damage from inundation, floods and storms; erosion; saltwater intrusion; rising water tables/impeded drainage; and wetland loss and change (Nicholls et al. 2007). Effects of increased storm intensity include increases in extreme water levels and wave heights; increases in episodic erosion, storm damage, risk of flooding, and defense failure (Nicholls et al. 2007). Patterns of erosion and accretion can also be altered along coastlines (Nicholls et al. 2007). The small tidal range of the GOM coast increases the vulnerability of coastal habitats to the effects of climate change. A study of coastal vulnerability along the entire U.S. GOM coast found that 42% of the shoreline mapped was classified as being at very high risk of coastal change due to factors associated with future sea level rise (Thieler and Hammar-Klose 2000). A revised coastal vulnerability index study of the coast from Galveston, Texas, to Panama City, Florida, indicated that 61% of that mapped coastline was classified as being at very high vulnerability, with coastal Louisiana being the most vulnerable area of this coastline (Pendleton et al. 2010). Potential thermal expansion of ocean water and melting of glaciers and ice caps could result in a global rise in mean sea level (Section 4.6.1.6). Sea level rise would result in greater inundation of coastal wetlands and likely result in an acceleration of coastal wetland losses, particularly in Louisiana, as wetlands are converted to open water. In addition, large changes in river flows into the GOM could affect salinity and water circulation in estuaries, which, in turn, could impact estuarine wetland communities.

Hurricanes and other severe storm events impact coastal wetlands through increased wave action and intensity, resulting in increased erosion of wetland substrates and conversion of coastal wetlands to open water. Hurricanes and tropical storms are inherent components of the GOM ecosystem that have long influenced coastal habitats and are expected to be continuing sources of impacts. However, impacts on wetlands as a result of human activities, such as those that create marsh openings that enhance tidal and storm-driven water movements, may be amplified by severe storm events such as hurricanes. In 2005, Hurricanes Katrina and Rita caused extensive impacts on wetlands in the Central and Western GOM. For example, up to 259 km^2 (100 mi^2) of coastal wetlands in Louisiana may have been converted to open water as a result of the storms, and up to 60,700 ha (150,000 ac) of coastal wetlands and bottomland forests were damaged in national wildlife refuges along the GOM coast (USFWS 2006). It is possible that extreme storms such as these could result in relatively permanent change to these habitats, particularly in areas that are already experiencing erosion and conversion of wetlands to open water as a result of sediment deprivation, sea-level rise, channelization, and coastal development.

Seagrass Beds. As identified in Section 4.4.6.1, the principal OCS activities under the Program that could potentially affect seagrass beds include placement of structures (e.g., pipelines) and vessel traffic within the vicinity of the beds. In addition, coastal development associated with OCS oil and gas activities could contribute to cumulative impacts on submerged seagrass beds. Most of the seagrass beds in the GOM are in the Eastern Planning Area, where no OCS activities are proposed during the Program.

Ongoing and future non-OCS activities that may contribute to cumulative effects on seagrass habitats include anchoring, fishing/trawling, offshore shipping (and other marine vessel traffic), diving, and continued onshore development (Table 4.6.1-5). The extensive seagrass beds located in the eastern GOM may be susceptible to impacts from non-OCS activities such as dredging and onshore development that contribute to increased sedimentation, turbidity, nutrient input, and various types of point and non-point source contamination.

As noted in Section 4.4.6.1, oil spills reaching coastal areas could affect submerged seagrass beds. The majority of these spills would be small (less than 50 bbl). Should spills occur in shallow water from vessel accidents and pipelines, they could contact and affect seagrass beds. Most spills that occur in deep water would be very unlikely to contact and impact seagrasses; however, catastrophic releases can impact extensive areas of shoreline. As identified in Table 4.6.1-4, it is assumed that up to 40 large oil spills (1,000 bbl or greater), up to 330 small-sized spills 50 to 999 bbl, and up to 1,950 small oil spills of less than 50 bbl could occur as a result of ongoing and future OCS activities. A catastrophic spill event would have an assumed spill size of 4 Bbbl. As discussed previously, non-OCS activities and oil seeps could also contribute substantially to releases of oil in the GOM. Oil spills in shallow water in the GOM from OCS and non-OCS activities could have significant effects on submerged seagrass beds. The magnitude and severity of potential effects on seagrass beds from oil spills would be a function of the location, timing, duration, and size of the spill; the proximity of the spill to seagrass beds; and the timing and nature of spill containment and cleanup activities. Releases that occur in the shallow portions of the eastern GOM have the potential to be of greatest significance, due to the more extensive growth of seagrasses along that coastline. It is unlikely that OCS spills would contact the extensive seagrass areas offshore Florida and along its coast because of the great distance between these resources and locations in the Central and Western Planning Areas where leasing will occur.

Conclusion. Ongoing OCS and non-OCS program activities in combination with naturally occurring events have resulted in considerable losses of coastal and estuarine habitats in the GOM; cumulative impacts on these resources, therefore, are considered to be moderate to major. Routine operations under the Program would result in minor localized impacts, primarily due to facility construction, pipeline landfalls, channel dredging, and vessel traffic; therefore, the incremental contribution of routine Program activities to cumulative impacts is expected to be small to medium (see Section 4.4.6.1.1).

The cumulative impacts of past, present, and future oil spills and natural seeps on submerged seagrass beds would be moderate to major. The incremental impacts of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program on these resources would be negligible to large, depending on the location, timing, duration, and size of the spill; the proximity of the spill to seagrass beds; and the timing and nature of spill containment and cleanup activities (see Section 4.4.6.1.1). The majority of these spills would be small (less than 50 bbl) and most of them would not likely contact and affect coastal and estuarine habitats. Large oil spills (1,000 bbl or greater) or an unexpected, low-probability CDE that occur in or reach shallower nearshore areas have the greatest potential to affect extensive areas of shoreline and coastal and estuarine habitats. Although these are rare events, the impacts of such releases on coastal and estuarine habitats could range from moderate to major if they were to occur.

4.6.3.1.2 Marine Benthic and Pelagic Habitats. Sections 4.4.6.2.1 and 4.4.6.3.1 discuss direct and indirect impacts, respectively, on marine benthic and pelagic habitats in the GOM resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Sections 4.4.6.2.1 and 4.4.6.3.1) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS activities. Table 4.6.1-2 presents the exploration and development scenario for the GOM cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the GOM are summarized in Table 4.6.1-5 and discussed below, as applicable.

Cumulative impacts on marine benthic and pelagic habitats could result from a number of activities associated with ongoing and future OCS and non-OCS activities in the GOM, including those of the Program. Activities with the potential to affect these resources include vessel traffic, seismic surveys, and construction (all noise-producing activities), well drilling, pipeline placement (trenching, landfalls, and construction), platform placement (anchoring, mooring, and removal, except in deep waters), and routine discharges (drilling, production, platform, and vessel). Accidental oil spills are also counted among OCS and non-OCS activities.

Up to 12,000 development and production wells and 2,000 oil platforms are anticipated to be built in the GOM under the cumulative scenario (Table 4.6.1-2). In addition, the construction of platforms and pipelines would disturb as much as 81,000 ha (200,200 ac) of bottom surface over the next 40 to 50 years (Table 4.6.1-2). Bottom disturbance resulting from the Program may degrade water quality by increasing water turbidity in the vicinity of the operations and adding contaminants to the water column. It also changes sediment composition as suspended sediments (and contaminants, if present) are entrained in currents and deposited in new locations. The increased amount of drilling anticipated under the Program will result in OCS discharges of drill muds, cuttings, and produced waters. Impacts of OCS routine operations (exploration, production and decommissioning activities) on marine benthic and pelagic habitat are discussed in detail in Sections 4.4.6.2.1 and 4.4.6.3.1. Overall, routine operations represent a negligible to moderate long-term disturbance, with the severity of the impacts generally decreasing dramatically with distance from the well site.

Ongoing and future non-OCS activities with the potential to affect marine benthic and pelagic habitats in the GOM include sediment dredging and disposal, sand mining, anchoring, fishing/trawling, and tankering of imported oil. Anchoring by non-OCS marine vessels could cause significant chronic disturbance the benthic habitat and biota and temporarily reduce water quality by generating turbidity in the water column. Anchoring could involve boats used for recreational and commercial fishing or scuba diving, and commercial ship traffic. The amount of damage that could result from anchoring activity would depend upon vessel size, the size of the anchor and chain, sea conditions at the time of anchoring, and the location or position of the anchor on the feature. Areas damaged by anchors may take more than 10 years to recover, depending upon the severity of the damage. Due to a lack of regulation of non-OCS activities on these features, there is a likelihood of damages increasing due to heavier usage of the resources in the future. Sand mining and dredging operations in conjunction with ship channel maintenance and construction, pipeline placement and burial, and support facility access occur throughout the GOM as part of non-OCS activities. Sediments dredged and sidecast or transported to approved dredged material disposal sites would alter bottom habitat and communities and remove, injure, or kill local biotic communities in addition to generating turbidity over the length of the water column. Similarly, bottom trawling degrades benthic habitats and temporarily increases the turbidity of the water (Jones 1992). Benthic habitat disturbances from OCS activities (e.g., pipeline trenching and placement and platform placement) would add to the existing impacts to benthic habitat from these non-OCS sediment-disturbing activities.

Other ongoing and future non-OCS activities with the potential to affect marine benthic and pelagic habitats include offshore marine transportation, and pollutant inputs from point and non-point sources. Vessel traffic is a source of chronic noise that could temporarily and episodically reduce local habitat quality by disturbing pelagic and shallow water benthic organisms. Multiple contaminant sources exist from nearshore point sources and contaminants can also be delivered to the continental shelf during storms and high river discharge. A primary example is the cultural eutrophication of the GOM, which has resulted in a large seasonal hypoxic zone off the coasts of Louisiana and Texas (see Figure 4.6.1-5) and restricts the use of benthic and bottom water habitat by marine biota over a wide area. In addition to non-point source pollution, LNG terminal operations (biocide-laden, cooled water), and activities related to the oil and gas industry, which operates hundreds of platforms in State and Federal waters, discharges large volumes of drilling wastes, produced water, and other industrial waste streams to GOM waters. Pollutant inputs into the GOM and their impact on water quality are discussed in Section 4.6.2.1. The impacts of these activities on marine pelagic habitat can be temporary or long term and could result in reduced habitat quality for marine biota.

In the benthic and pelagic habitats of the GOM, climate change may cause the temporal variability of key chemical and physical parameters — particularly hydrology, dissolved oxygen, salinity, and temperature — to change or increase, which could significantly alter the existing structure of the benthic and phytoplankton communities (Rabalais et al. 2010). For example, freshwater discharge into the GOM has been increasing and is expected to continue to increase as a result of the increased rainfall in the Mississippi River Basin (Dai et al. 2009). Such changes could result in severe long-term or short-term fluctuations in temperature and salinity that could reduce or eliminate sensitive species. Such changes are most likely to occur in the Mississippi Estuarine Ecoregion, where freshwater inputs are highest. In addition, greater rainfall may increase inputs of nutrients into the GOM, potentially resulting in more intense phytoplankton blooms that could promote benthic hypoxia (Rabalais et al. 2010). Hypoxic or anoxic conditions can reduce or eliminate the suitability of benthic habitat for marine organisms. The increased storm severity predicted to result from climate change may also increase disturbance to benthic habitats that are already stressed by trawling, anchoring, and dredging operations, as well as OCS-related pipeline trenching. See Sections 3.7.2.1 and 3.7.3.1 for a complete discussion of how climate change may affect marine benthic and pelagic habitat.

Marine benthic and pelagic habitat and biota could be affected by oil spills from both OCS and non-OCS activities, including the domestic transportation of oil, the import of foreign crude oil, and State development of oil. Storms, operator error, and mechanical failures may result in accidental oil releases from a variety of non-OCS related activities. Assumptions for oil spills for the GOM cumulative case are provided in Table 4.6.1-4; Table 4.4.2-2 presents assumptions for catastrophic spills. Large and potentially catastrophic spills could result from pipeline ruptures, tanker spills associated with an FPSO system, or loss of well control. In addition, crude oil enters the environment of the GOM from naturally occurring seeps. At least 63 seeps have been identified in the GOM (mostly off the coast of Louisiana) (MacDonald et al. 1996), and more than 350 naturally occurring and constant oil seeps that produce perennial slicks of oil at consistent locations may be present in the GOM (MacDonald et al. 2002, as cited in Kvenvolden and Cooper 2003). Seeps in the northern GOM have been estimated to discharge $0.4–1.1 \times 10^8$ L (252,000 to 692,000 bbl) per year of crude oil annually to overlying GOM waters (MacDonald et al. 2002).

For both OCS and non-OCS program-related oil spills, it is assumed that the magnitude and severity of the potential effects on benthic and pelagic habitat would be a function of the location, timing, duration, and size of the spill and the timing and nature of spill containment and cleanup activities. Detailed discussion of the impacts of OCS accidental hydrocarbon releases on marine benthic and pelagic habitat can be found in Sections 4.4.6.2.1 and 4.4.6.3.1.

Coral Reefs and Hard-Bottom Habitat. Sensitive coral reef and hard-bottom benthic habitats in the GOM may be more susceptible to OCS program-related impacts and take longer to recover if impacts were to occur. Consequently, these habitats receive special protection. Four coral reef and hard-bottom habitats are designated for the various protections: (1) banks offshore of Texas and Louisiana (including the FGBNMS), (2) the Pinnacle Trend off the Louisiana-Alabama coast, (3) seagrass and low-relief live-bottom areas primarily located in the Central and Eastern Planning Areas, and (4) potentially sensitive biological features of moderate to high relief that are not protected by (1) and (2). As identified in Section 4.4.6.2.1, NTL No. 2009-G39 has several protections in place to minimize and mitigate the adverse effects of oil and gas exploration and development on coral reefs and hard-bottom habitat.

Cumulative impacts on coral reef and hard-bottom habitat could result from a number of activities associated with ongoing and future activities in the GOM, including those of the Program. Activities with the potential to affect these resources include vessel traffic, seismic surveys, and construction (all noise-producing activities), as well as well drilling, pipeline placement (trenching, landfalls, and construction), chemical releases (drilling discharges, operation discharges, and sanitary wastes), and platforms placement (anchoring, mooring, and removal, except in deep waters). Impacts of OCS exploration, production and decommissioning activities on marine benthic and pelagic habitat are discussed in detail in Section 4.4.6.2.1. Overall, impacts on coral reef and live-bottom habitat from routine activities would be minimized by the protection stipulated by NTL 2009-G39. However, low-relief or small, isolated, unmapped live-bottom could be affected by direct mechanical damage and turbidity and sedimentation.

Ongoing and future non-OCS activities with the potential to affect these habitats include anchoring by non-OCS activity vessels, fishing/trawling, discharges by non-OCS offshore marine transportation, and tankering of imported oil. Anchoring could involve boats used for recreational and commercial fishing or scuba diving, and commercial ship traffic. The amount of damage that could result from anchoring activity would depend upon vessel size, the size of the anchor and chain, sea conditions at the time of anchoring, and the location or position of the anchor on the feature. Recovery of areas damaged by anchors may be long term, depending upon the severity of the damage. Due to a lack of regulation of non-OCS activities on these features, there is a likelihood of damages increasing due to heavier usage of the resources in the future.

Trawling activities are another source of damage to coral and hard-bottom habitat. Because anchoring and collection activities by scuba divers on the living reef areas of the Flower Garden Banks are prohibited, biota associated with the Flower Garden Banks are unlikely to be significantly affected by these activities. Similarly, use of spiny lobster and stone crab traps may also damage bottom substrate such as seagrasses and corals. Strings of traps deployed without buoys are sometimes retrieved by dragging 18-kg (40-lb) grapnels and chains across the bottom until the trap string is hooked, potentially damaging bottom habitats in the process.

Impacts could also occur due to discharges from other non-OCS activities, including tankers or other marine traffic passing in the vicinity of coral reef and hard-bottom habitat. Because water depths are typically greater than 20 m (66 ft) at the tops of most of the banks, dilution of discharges would greatly reduce concentrations of potentially toxic components before they could come in contact with these features; consequently, it is assumed that discharges from such activities would not be concentrated enough to reduce habitat quality.

Climate change has the potential to profoundly affect coral communities on coral and hard-bottom features in several ways including (Section 3.7.1.1.4):

- Increased frequency of bleaching as a stress response to warming water temperatures (Hoegh-Guldberg et al. 2007);

- Excessive algal growth on reefs and an increase in bacterial, fungal, and viral agents (Boesch et al. 2000; Twilley et al. 2001);

- Greater frequency of mechanical damage to corals from greater severity of tropical storms and hurricanes (Janetos et al. 2008);

- Decreases in the oceanic pH and carbonate concentration are expected to reduce the reef formation rate, weaken the existing reef structure, and alter the composition of coral communities (Janetos et al. 2008); and

- Climate change may allow the range expansion of non-native species.

Potential interactions between climate change and OCS activities could affect hard-bottom habitat. For example, ocean acidification and increases in water temperature may slow the recovery of corals exposed to drilling muds or oil from an accidental spill. Another potential interaction could occur between oil and gas platforms and climate change, in which new hard-bottom–associated species are able to expand northward due to warming and the availability of hard substrate in the form of active or decommissioned oil platforms. By acting as stepping stones across the GOM, oil platforms have been implicated in the introduction of a non-native coral species (*Tubastraea coccinea*) and fishes such as sergeant majors (*Abudefduf saxatilis*) and yellowtail snapper (*Ocyurus chrysurus*) into the FGB (Hickerson et al. 2008).

Oil spills from both OCS and non-OCS activities could affect coral reef and hard-bottom habitat and biota. Detailed discussion of the impacts of OCS accidental hydrocarbon releases on hard-bottom and coral reef habitat can be found in Section 4.4.6.2.1. It is assumed that accidental oil releases from most non-OCS activities would be at the surface or located sufficiently far from coral reef and hard-bottom habitat and biota that they would be unlikely to greatly affect these habitats. The magnitude and severity of potential effects on coral reef and hard-bottom habitat and biota from such exposure would be a function of the location, timing, duration, and size of the spill; the proximity of the spill to the features; and the timing and nature of spill containment and cleanup activities. Depending upon location, spills from non-OCS sources and releases from natural seeps could contribute to the overall exposure of communities associated with topographic features in the GOM OCS planning areas to oil, with corresponding lethal or sublethal effects.

High Density Deepwater Communities (HDDC). High density deepwater communities (HDDCs) include coldwater corals and chemosynthetic communities. Cumulative impact factors for HDDCs include both OCS and non-OCS cumulative activities. Potential impacts on HDDCs resulting from ongoing and future routine OCS program activities, including those of the Program, could result from noise, well drilling, pipeline placement (trenching, landfalls, and construction), chemical releases (drilling discharges, operation discharges, and sanitary wastes), and platform placement (anchoring, mooring, and removal, except in deep waters). Mitigation measures instituted to protect these HDDCs include Notice to Lessee (NTL) 2009-G40, which requires the avoidance of HDDCs or areas that have a high potential for supporting these community types, as interpreted from geophysical records. Impacts of OCS exploration, production, and decommissioning activities on HDDCs are discussed in detail in Section 4.4.6.2.1. Overall, impacts on HDDCs from exploration and site development activities are expected to be minor because of the provisions in NTL 2009-G40 that protect HDDCs from oil and gas development activities. However, small and unmapped HDDCs may be completely or partially destroyed by bottom-disturbing activities. In such cases, recovery would likely be long term, although permanent loss of the affected feature is also possible. For these HDDCs, impacts could be major.

Ongoing and future non-OCS activities that have the potential to adversely affect HDDCs include fishing/trawling, anchoring, and offshore marine transportation. Due to the water depths of these areas and the widely scattered nature of these habitats, such activities are unlikely to greatly affect HDDCs in the GOM. However, deepwater trawling could destroy HDDCs and recover could be long term or may not occur at all. Generally, commercially important deepwater fish species use *Lophelia* reefs as juveniles (SAFMC 1998).[53]

As climate change has the potential to affect warm water corals, it could affect coldwater *Lophelia* reefs (Section 3.7.2.1.7). The saturation depth of aragonite (the primary carbonate formed used by hard corals) appears to be a primary determinant of deepwater coral distribution, with reefs forming in areas of high aragonite solubility (Orr et al. 2005). The depth at which the water is saturated with aragonite is projected to become shallower over the coming century, and most coldwater corals may be in undersaturated waters by 2100 (Orr et al. 2005). Consequently, the spatial extent, density, and growth of deepwater corals may decrease, diminishing their associated ecosystem functions (Orr et al. 2005). There are potential interactions between climate change and OCS activities that could affect HDDC. For example, ocean acidification may slow the recovery of deepwater corals exposed to drilling muds or oil from an accidental spill.

Oil spills from both OCS and non-OCS activities could affect HDDCs. Detailed discussion of the impacts of OCS accidental hydrocarbon releases can be found in Section 4.4.6.2.1. The magnitude and severity of potential effects on biota associated with topographic features from such exposure would be a function of the location, timing, duration, and size of the spill, the proximity of the spill to the features, and the timing and nature of spill containment and cleanup activities. It is assumed that most accidental oil releases would be at the surface or located sufficiently far from HDDCs that they would be unlikely to greatly affect communities associated with the topographic features.

Conclusion. Impact-producing factors for marine benthic and pelagic habitats include those from both OCS and non-OCS activities. For OCS activities, planning and permitting procedures and stipulations that promote identification and avoidance of sensitive habitats would minimize the potential for direct impacts on sensitive seafloor areas during routine OCS activities. In the GOM, stipulations that are currently in place restrict OCS activities in the immediate vicinity of seafloor areas containing important topographic features, live bottom habitat, and HDDC, and there is relatively little likelihood that OCS activities would affect overall viability of ecological resources in such areas. Non-OCS activities with a potential to impact marine benthic and pelagic habitats in the GOM include oil and gas production in State waters, sediment dredging and disposal, sand mining, anchoring, fishing/trawling, and tankering of imported oil. Disturbances from these activities such as noise, marine vessel discharges, and bottom disturbance would occur in addition to similar impacts from OCS Program activities.

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[53] There is evidence that oil and gas extraction reduces the natural release of hydrocarbons that support deep-sea chemosynthetic communities (Quigley et al. 1999). However, *Lophelia* corals do not depend on hydrocarbon seepage to meet their metabolic requirements (Becker et al. 2009), and presumably would not be affected by a reduction in natural hydrocarbon release to marine waters.

Overall, the cumulative impacts on marine habitat would be moderate to major, considering OCS routine operations and the significant impacts to marine habitat from past, present, and future human activities. The incremental contribution of routine Program activities to cumulative impacts on marine habitat would range from negligible to medium (see Section 4.4.6.2.1).

Accidental oil spills could result from both OCS and non-OCS activities. Overall, the cumulative impacts on marine habitats from oil spills would range from minor to moderate. The incremental impacts of expected oil spills, most of which would be small (less than 1,000 bbl), would range from negligible to small, depending on the location, timing, duration, and size of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities (Section 4.4.6.2.1). Spills in deeper water, whether from OCS or non-OCS sources, are unlikely to have overall community-level effects on seafloor habitats because of the relatively small proportion of seafloor area that would come in contact with released oil at concentrations great enough to elicit toxic effects. Impacts associated with an unexpected, low-probability CDE affecting shallow and intertidal habitats could range from minor to moderate, depending on the habitats affected. Although pelagic habitat is likely to recover following a CDE, the recovery time for intertidal and shallow subtidal benthic habitat directly affected by such oil spills could be long term.

4.6.3.1.3 Essential Fish Habitat. Section 4.4.6.4.1 discusses direct and indirect impacts on EFH in the GOM resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Section 4.4.6.4.1) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS activities. Table 4.6.1-2 presents the exploration and development scenario for the GOM cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the GOM are summarized in Table 4.6.1-5 and discussed below, as applicable.

Cumulative impacts on EFH could result from ongoing and future OCS and non-OCS activities that have the potential to directly kill managed fish species, disturb ocean bottom habitats, increase sediment suspension, degrade water quality, or affect the food supply for fishery resources. Activities include seismic surveys (noise), well drilling, pipeline placement (trenching, landfalls, and construction), platform placement (anchoring, mooring, and removal, except in deep waters) and routine discharges (drilling, production, platform, and vessel). Accidental oil spills are also counted among OCS and non-OCS activities.

Routine OCS activities could disturb bottom areas due to the installation of platforms and pipelines and the anchoring of vessels and structures. Up to 12,000 development and production wells and 2,000 oil platforms are anticipated to be built in the GOM under the cumulative scenario (Table 4.6.1-2). In addition, the construction of platforms and pipelines over the period of the Program would disturb as much as 81,000 ha (200,200 ac) of bottom surface over the next 40 to 50 years (Table 4.6.1-2). Under the cumulative scenario, it is anticipated that less than 40 new pipeline landfalls could occur in the GOM (Table 4.6.1-2) with up to 12 of these resulting from the Program. As discussed in Section 4.4.6.4, deposition of drilling muds and cuttings could potentially affect EFH by altering grain-size distributions and chemical characteristics of sediments such that benthic prey of some managed fish species would be affected in the immediate area surrounding drill sites. Produced water will also be released into the GOM during the production phase.

Platform removals using explosives will likely kill some fish and shellfish, including managed species for which EFH has been established, and would remove platform-associated fouling communities that serve as prey for managed species. Up to 280 platforms may be removed under the Program compared with up to 1,200 platforms removed using explosives as a result of cumulative OCS activities during the life of the Program. If large numbers of fish are killed as the result of removal of platforms using explosives, there could be effects on managed species and their prey in the immediate vicinity of the removed platforms. Once a platform is removed, the fouling community that serves as a food source for some managed and prey fish species in the vicinity would no longer be available, and the associated fishes would be forced to relocate to other foraging areas. However, given the relatively small area that would be affected by such removals, GOM-wide effects on managed species are not anticipated.

See Section 4.4.6.4.1 for a detailed discussion of the impacts of routine operations on EFH and managed species in the GOM. Overall, it is expected that the incremental impacts of exploration and site development activities on marine EFH would be medium, and impacts are not expected to permanently reduce the EFH available to managed species or result in population-level impacts to managed species. The most sensitive benthic habitats, such as those associated with hard bottoms and topographic features, are not expected to be affected by routine operations, and effects would be minimized or eliminated by existing lease stipulations.[54]

There are also State oil and gas activities that can affect EFH. Louisiana and Texas have experienced substantial oil and gas development within their coastal areas including exploratory drilling, production platform installation, and pipeline installation. Factors that could affect EFH from these activities would be similar to those described above for OCS activities. However, the effects from non-OCS oil and gas activities could possibly be more severe than the effects from routine OCS activities because the activities are closer to shore and in shallower environments. As a consequence, more benthic EFH may be damaged, and resulting changes in sedimentation and turbidity could affect a greater proportion of the water column.

Other non-OCS activities that influence EFH may include commercial fishing, commercial shipping (and other marine vessel traffic), land development, water quality degradation, dredge and fill and dredge disposal operation, and construction of channel stabilization structures such as jetties could affect EFH (GMFMC 1998). As discussed below, these non-OCS activities when combined with OCS activities could result in cumulative impacts

[54] There is evidence that oil and gas extraction reduces the natural release of hydrocarbons that support deep-sea chemosynthetic communities (Quigley et al. 1999). However, *Lophelia* corals do not depend on hydrocarbon seepage to meet their metabolic requirements (Becker et al. 2009), and presumably would not be affected by a reduction in natural hydrocarbon release to marine waters.

on EFH over time, especially if these impacts occur frequently or are of sufficient magnitude that habitat recovery times are prolonged.

Barges carrying cargo arrive and depart through ports and travel through the GOM Intracoastal Water Way, which serves as a major route for needed goods and supplies. Discharges of treated wastes or hazardous chemicals could negatively affect water quality (Section 4.6.2.1.1), a component of EFH, as well as aquatic vegetation. Pollutants generated from boat maintenance activities on land and water could also negatively impact water quality. Oil and grease are commonly found in bilge water, especially in vessels with inboard engines, and these products may be discharged during vessel pump out (USEPA 1993).

Sand mining and routine dredging operations for channel construction and maintenance, pipeline emplacement, and creation of harbor and docking areas can affect EFH in the GOM by suspending sediments and affecting water quality. As suspended sediments settle to the bottom, the benthic prey of some managed fish species could be smothered. In most cases, benthic organisms would recolonize such areas unless maintenance dredging operations are repeated frequently. Dumping sites for dredge spoils in the GOM, most of which are located within State waters, could also alter water quality and affect benthic organisms that serve as prey for some managed fish species. Pipeline and platform placement that would occur as part of OCS activities would also add to the existing disturbance of benthic habitat from sand mining and dredging activities.

Commercial and recreational fisheries in the GOM also impact EFH. For example, most of the wild shrimp caught are harvested using bottom trawls. The nets are held open with bottom sled devices made from wood or steel. In addition to capturing and killing some nontarget fish and invertebrate species, the sleds, or “doors,” drag along the bottom, potentially digging up sediments and hard substrate. Such activities could disrupt the benthic community and increase the turbidity of the water (Jones 1992). Similarly, use of spiny lobster and stone crab traps may also damage bottom substrate such as seagrasses and corals. Pipeline and platform emplacement add to the disturbance of benthic habitat by temporarily increasing turbidity in disturbed regions.

Other potential interactions between fishing and OCS activities result from the presence of platforms, around which reef-associated fish species tend to congregate. Recreational fishing targeting platform areas increase fishing pressure on overfished species such as snapper and grouper. Explosive removal of platforms also likely results in higher proportional mortality of reef-associated fish.

Other events, including hurricanes, turbidity plumes, and hypoxia, could also affect various managed fish or their habitat, although the GOM fish community as a whole should be adapted to such events. For example, a hurricane or a series of hurricanes could temporarily degrade the quality of large areas of wetlands that serve as nursery and feeding areas for a variety of managed fish and invertebrate species.

Climate change could affect EFH in several ways. Climate change may cause the temporal variability of key chemical and physical parameters — particularly hydrology, dissolved oxygen, salinity, and temperature — to change or increase, which could significantly alter the existing structure of the benthic and phytoplankton communities (Rabalais et al. 2010). For example, freshwater discharge into the GOM has been increasing and is expected to continue to increase as a result of the increased rainfall in the Mississippi River Basin (Dai et al. 2009). Such changes could result in severe long-term or short-term fluctuations in temperature and salinity that could reduce or eliminate sensitive species. Such changes are most likely to occur in the Mississippi Estuarine Ecoregion, where freshwater inputs are highest. In addition, greater rainfall may increase inputs of nutrients into the GOM, potentially resulting in more intense phytoplankton blooms that could promote benthic hypoxia (Rabalais et al. 2010). Hypoxic or anoxic conditions can reduce or eliminate the suitability of benthic EFH for marine organisms. The increased storm severity predicted to result from climate change may also increase disturbance to benthic habitats that are already stressed by trawling, anchoring, and dredging operations and OCS-related pipeline trenching. See Sections 3.7.2.1 and 3.7.3.1 for a complete discussion of how climate change may affect marine benthic and pelagic habitat.

Climate change has the potential to profoundly affect coral and hard bottom EFH in several ways, including the following (Section 3.7.1.1.4):

- Increased frequency of bleaching as a stress response to warming water temperatures (Hoegh-Guldberg et al. 2007);
- Excessive algal growth on reefs and an increase in bacterial, fungal, and viral agents (Boesch et al. 2000; Twilley et al. 2001);
- Greater frequency of mechanical damage to corals from greater severity of tropical storms and hurricanes (Janetos et al. 2008);
- Decreases in the oceanic pH and carbonate concentration are expected to reduce the reef formation rate, weaken the existing reef structure, and alter the composition of coral communities (Janetos et al. 2008); and
- Range expansion of non-native species into the northern GOM.

Another primary impact expected to result from climate change is the loss of wetland habitat, which is an important EFH for many larval and juvenile stages of managed species. Wetland loss could be caused by several factors including erosion, sea level rise, discharging nutrient-laden waters to the environment, reduced sediment load of the Mississippi River, and human-induced subsidence from groundwater withdrawals, among others. Cumulative effects on wetlands are discussed in Section 4.6.3.1.1.

As climate change has the potential to affect warm water corals, it could affect coldwater *Lophelia* reefs (Section 3.7.2.1.7). The saturation depth of aragonite (the primary carbonate formed used by hard corals) appears to be a primary determinant of deepwater coral distribution, with reefs forming in areas of high aragonite solubility (Orr et al. 2005). The depth at which the water is saturated with aragonite is projected to become shallower over the coming century, and most coldwater corals may be in undersaturated waters by 2100 (Orr et al. 2005). Consequently, the spatial extent, density, and growth of deepwater corals may decrease, diminishing their associated ecosystem functions (Orr et al. 2005).

There are potential interactions between climate change and OCS activities that could affect EFH and managed species. For example, ocean acidification and increases in water temperature may slow the recovery of corals exposed to drilling muds or oil from an accidental spill. Another potential interaction could occur between oil and gas platforms and climate change in which new hard-bottom–associated species are able to expand northward due to warming and the availability of hard substrate in the form of active or decommissioned oil platforms. By acting as stepping stones across the GOM, oil platforms have been implicated in the introduction of a non-native coral species (*Tubastraea coccinea*) and fishes such as sergeant majors (*Abudefduf saxatilis*) and yellowtail snapper (*Ocyurus chrysurus*) into the FGB (Hickerson et al. 2008).

Oil spills from OCS and non-OCS activities may cumulatively affect several resources that contribute to EFH, including sediments, water quality, fish resources, coastal habitats, and seafloor habitats and benthic communities (see Sections 4.6.2 and 4.6.3). Large, potentially catastrophic spills could result from pipeline ruptures, tanker spills associated with an FPSO system, or loss of well control. Other potential sources of oil spills that could affect EFH include non-OCS oil and gas development activities and non-OCS tankering activities. Spills from import tankers could occur offshore in shipping lanes or in coastal waters as tankers prepare to make landfall.

Oil from shallow-water spills could impact life stages of managed fish species that use surface waters as part of their lifecycle, especially those that release pelagic eggs and have pelagic larvae. Unlike adult fish that can move away from oiled waters, pelagic eggs and larvae are largely transported by wind and water currents. Those that come into contact with surface oil could be injured or killed through smothering or an accumulation of oil on the gills. Thus, oiled surface waters would temporarily reduce the amount of EFH available for these life stages. Detailed discussion of the impacts of oil spills on fish can be found in Section 4.4.7.3.1.

In marine waters, several individual reefs and banks located offshore of the Louisiana-Texas border have been designated HAPCs by the GMFMC (NMFS 2010a). As identified in Section 4.4.6.2.1, NTL No. 2009-G39 has several protections in place to minimize and mitigate the adverse effects of oil and gas exploration and development on these banks. However, large or catastrophic spills could adversely affect hard-bottom HAPC by causing lethal or sublethal impacts to corals (Section 4.4.6.2.1). The HAPC for bluefin tuna extends from the 100 m (328 ft) isobath seaward to the EEZ. The HAPC could also be affected by oil spills, and population-level impacts to bluefin tuna could result from catastrophic spills. Habitat areas of particular concern in nearshore areas include intertidal and estuarine habitats with emergent and submerged vegetation, sand and mud flats, and shell and oyster reefs that may provide food and rearing for managed juvenile fish and shellfish. Shallow-water spills may reach these coastal EFH areas and have negative impacts. Shallow-water wave action could increase entrainment of oil and tar balls in the water column. This could temporarily diminish the quality and quantity of benthic EFH. Settled tar balls may be ingested by bottom-feeding fishes and may harm or prove fatal to them. During a spill, aquatic vegetation, which provides habitat for juveniles and for prey of some managed species, could become coated with oil. In such cases, organisms that are sessile or that have limited ability to avoid spills could be killed. These areas represent important nursery areas for fishes and invertebrates that contribute to estuarine, coastal, and shelf food webs. Loss of such habitat by oil spills would be compounded by the existing high natural loss of wetlands.

The actual locations of the spills will determine the degree to which EFH would be affected. The HAPC in the Eastern Planning Area that could be affected by oil spills from the Central or Western Planning Areas include the Florida Middle Grounds, the Madison-Swanson Marine Reserve. Pulley Ridge, and Tortugas North and South Ecological Reserve are also located in the southern tip of Florida, and are unlikely to be contacted by oil. Spills have the greatest potential to harm EFH resources if they occur in shallow waters, where benthic habitats or wetlands can be affected, or if they occur when large numbers of pelagic eggs and larvae of managed species are present. If the location of a spill coincided with the location of eggs and larvae, large numbers of these organisms would be injured or killed. Oil reaching the surface from deepwater pipeline spills and deepwater tanker spills could affect EFH for the eggs and larvae of federally managed pelagic fish species, neuston prey species, and *Sargassum* and its associated fauna. Pelagic eggs and larvae contacting the spilled oil would be smothered, and *Sargassum* within affected areas would be fouled and potentially killed.

Conclusion. Impact-producing factors for EFH include those from both OCS and non-OCS activities. Non-OCS activities with the potential to impact EFH in the GOM include oil and gas production in State waters, sediment dredging and disposal, and vessel traffic. Impacts from OCS activities would be limited by specific lease stipulations. Overall, the cumulative impacts on EFH would be moderate to major. The incremental contribution of routine Program activities to these impacts would range from negligible to medium (see Section 4.4.6.3.1).

Accidental oil spills could result from both OCS and non-OCS activities. Overall, the cumulative impacts on EFH from oil spills would range from moderate to major. The incremental impacts of expected oil spills would range from negligible to medium, depending on the location, timing, duration, and size of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities (Section 4.4.6.3.1). While most accidents related to OCS activities assumed under the cumulative scenario would be small (less than 50 bbl) and would have relatively small incremental impacts on EFH, spills that reach coastal wetlands could have more persistent impacts and could require remediation. Spills in deeper water, whether from OCS or non-OCS sources, are unlikely to have overall population-level effects on fish resources because of the relatively small proportion of similar available fish habitats that would come in contact with released oil at concentrations great enough to elicit toxic effects. Oil spills that have the greatest potential to impact EFH and managed species are those that occur in shallower subtidal and intertidal areas and spills that reach areas at the same time where substantial numbers of eggs or larvae of managed species are present. Impacts associated with an unexpected, low-probability CDE affecting shallow and intertidal habitats could be moderate to major, depending on the size, duration, timing, and location of the spill.

4.6.3.2 Alaska – Cook Inlet

4.6.3.2.1 Coastal and Estuarine Habitats. Section 4.4.6.1.2 discusses direct and indirect impacts on coastal and estuarine habitats in Cook Inlet resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Section 4.4.6.1.2), when added to impacts from ongoing and reasonably foreseeable future actions, including those of future OCS programs[55] and other non-OCS activities. Table 4.6.1-3 presents the exploration and development scenario for the Cook Inlet cumulative case, which takes into account activities associated with the Program in combination with those from future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in Cook Inlet are summarized in Table 4.6.1-6 and discussed below, as applicable.

A number of activities associated with the Program could result in impacts on coastal and estuarine habitats in the Cook Inlet Planning Area (Section 4.4.6.1.2). These activities include construction of pipelines and pipeline landfalls and operation of service vessels and existing facilities. Impacts could include losses of beach and wetland habitat and indirect effects that contribute to reductions in these habitats or impacts on biota. There are no past or ongoing OCS activities in the Cook Inlet Planning Area.

Pipeline landfalls could directly disturb tidal marshes, beaches, rocky shores, or other coastal habitats, depending on the location of the landfalls. Sedimentation from physical disturbance of substrates may affect biota in intertidal or shallow subtidal habitats. In addition, accidental spills may impact shoreline habitat.

Ongoing non-OCS activities that could affect coastal and estuarine habitats include those related to State oil and gas development, commercial shipping (and other marine vessel traffic), coastal development, discharge of municipal wastes and other effluents, domestic transportation of oil and gas, and logging (Table 4.6.1-6). These activities can be reasonably expected to continue into the future.

Factors that impact coastal wetlands include the direct elimination of wetland habitat by excavation or filling and the degradation of wetland communities by reduced water quality or hydrologic changes. The construction of pipelines, docks, or shore bases associated with State oil and gas exploration and development could result in direct losses of habitat. Habitats and associated biota within the Cook Inlet Planning Area could also be affected by routine discharges from marine vessels, discharges of municipal and industrial wastewater, or sedimentation from upland areas, including erosion from logging operations within the Cook Inlet watershed. Activities that increase wave action along beaches could contribute to their erosion. Barge and service vessel traffic supporting State oil and gas development may result in wake erosion. The direct and indirect impacts on wetlands from pipeline construction, service vessel operation, and operation of existing facilities under the Program would represent a very small contribution to

[55] Currently, there are no ongoing OCS activities within Cook Inlet.

the past, ongoing, and expected future impacts on coastal and estuarine habitats from non-OCS activities.

Accidental spills of oil or other liquid hydrocarbons, resulting from activities conducted under the Program, could impact shoreline habitats. The majority of these spills are assumed to be small (less than 50 bbl) for the cumulative case (Table 4.6.1-4). Spills from onshore pipelines and facilities could impact freshwater wetlands, or tidal wetlands if carried to coastal habitats by streams. Non-OCS activities, such as State oil and gas development, domestic transportation of oil or refined petroleum products, including LNG from Cook Inlet and the Alaska Peninsula, the production and storage of petroleum products and LNG, and commercial shipping (and other marine vessel traffic), may also result in accidental spills that could potentially impact shoreline habitats. Oil spills have resulted in past impacts on beaches and other intertidal habitats, as in the case of the *Exxon Valdez* oil spill. Spills can result in short- or long-term effects on vegetation growth and changes in the composition of intertidal or shallow subtidal communities, or extensive mortality of biota associated with shoreline habitats, and may persist in substrates for decades. The amount of oil contacting shoreline habitats from a spill depends on a number of factors such as the location and size of the spill, waves and water currents, and containment actions. Naturally occurring seeps may also be a source of crude oil introduced into nearshore waters (Kvenvolden and Cooper 2003). The magnitude of resulting impacts and the persistence of oil would depend on factors such as the amount of oil deposited, remediation efforts, substrate grain size, and localized erosion and deposition patterns. Recovery of affected wetlands could require several decades. The impacts of potential spills associated with the Program would be expected to add a small contribution to the impacts of other sources of oil in the planning area.

Indirect effects on coastal and estuarine habitats could result from global climate change. Potential thermal expansion of ocean water and melting of glaciers and ice caps could result in a global rise in mean sea level (Section 4.6.1.6). Sea-level rise could result in increased inundation of shorelines and erosion of beach habitat and conversion of wetlands to open water. In addition, large changes in river flows into nearshore marine waters could affect salinity and water circulation in estuaries, which, in turn, could impact estuarine wetland communities.

Conclusion. Future OCS program and ongoing and future non-OCS program activities in combination with naturally occurring events have resulted in losses of coastal habitats in Cook Inlet; cumulative impacts on these resources, therefore, are considered to be moderate to major. Operations under the Program would result in minor localized impacts, primarily due to facility construction, pipeline landfalls, channel dredging, and vessel traffic; therefore, the incremental contribution of routine Program activities to cumulative impacts would range from small to medium (see Section 4.4.6.2.2).

The cumulative impacts of past, present, and future oil spills on coastal and estuarine habitats would be moderate. The incremental impacts of expected accidental oil spills associated with the Program on these resources would be negligible to large, depending on the location, timing, duration, and size of the spill; the proximity of the spill to particular habitats; and the timing and nature of spill containment and cleanup activities (see Section 4.4.6.2.2). The majority of these spills would be small (less than 50 bbl). Impacts associated with large oil spills (1,000 bbl or greater) or an unexpected, low-probability CDE that occur in or reach shallower nearshore areas have the greatest potential to affect extensive areas of shoreline and coastal habitats. Although these are rare events, the impacts of such releases on coastal habitats could range from moderate to major if they were to occur.

4.6.3.2.2 Marine Benthic and Pelagic Habitats. Sections 4.4.6.2.2 and 4.4.6.3.2 discuss direct and indirect impacts, respectively, on marine benthic and pelagic habitats in Cook Inlet resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Sections 4.4.6.2.2 and 4.4.6.3.2), when added to impacts from ongoing and reasonably foreseeable future actions, including those of future OCS programs and other non-OCS activities.[56] Table 4.6.1-3 presents the exploration and development scenario for the Cook Inlet cumulative case, which takes into account activities associated with the Program in combination with those from future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in Cook Inlet are summarized in Table 4.6.1-6 and discussed below, as applicable.

Cumulative impact-producing factors for marine benthic and pelagic habitats in Cook Inlet Planning Area include both OCS and non-OCS activities. Potential impacts on marine benthic and pelagic habitat resulting from ongoing and future routine OCS program activities, including those of the Program, could result from noise (vessel, seismic surveys, construction, operations), well drilling, pipeline placement (trenching, landfalls, and construction), platform placement (anchoring, mooring, and removal), and discharges (drilling, vessel and platform). All these activities have the potential to adversely affect marine benthic habitats in the Cook Inlet Planning Area. Accidental oil spills are also counted among OCS program-related activities; assumptions for oil spills under the cumulative case scenario are provided in Table 4.6.1-4, and catastrophic spill assumptions are provided in Table 4.4.2-2.

Because there is no ongoing OCS activity in Cook Inlet Planning Area, the new OCS activities under the Program represent a 100% increase in all associated OCS activities in Cook Inlet. Over the life of the Program, up to 110 production wells and up to three oil platforms are anticipated. In addition, up to 241 km (150 mi) of new offshore pipeline is anticipated. Bottom disturbance resulting from OCS program activities degrades water quality by increasing water turbidity in the vicinity of the operations and adding contaminants to the water column. It also changes sediment composition as suspended sediments (and contaminants, if present) are entrained in currents and deposited in new locations. Construction of platforms in areas previously lacking hard substrate could have localized effects on the biodiversity and distribution of benthic communities by favoring organisms that prefer a hard substrate. Impacts of OCS routine operations (exploration, production and decommissioning activities) on marine benthic and pelagic habitat in the Cook Inlet Planning Area are discussed in detail in Sections 4.4.6.2.2 and 4.4.6.3.2. Overall, routine operations represent a negligible to moderate long-term disturbance, with the severity of the impacts generally decreasing dramatically with distance from the well site.

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[56] Currently, there are no ongoing OCS activities within Cook Inlet.

The increased amount of drilling in Cook Inlet anticipated under the Program will result in OCS discharges of drill muds and cuttings from exploration and delineation wells. Drilling muds and cuttings from production wells as well as all produced waters will be disposed of in the well rather than discharged into Cook Inlet. The OCS discharges of drill muds, cuttings, and produced waters could potentially affect benthic and pelagic habitat by increasing turbidity and altering grain size distributions and chemical characteristics of sediments. The impacts of drilling discharges on benthic and pelagic habitats are discussed in detail in Sections 4.4.6.2.3 and 4.4.6.3.3.

Various non-OCS activities in Cook Inlet, including State oil and gas programs, dredging and disposal of dredging spoils in OCS waters, anchoring, and commercial or sportfishing activities, and commercial shipping (including imported oil) could contribute to cumulative effects on pelagic and seafloor habitats, along with OCS activities. Drilling of wells in State waters could also require construction of platforms and pipelines in waters of Alaska. Effects on seafloor and pelagic habitat and biota would be similar to those described above for OCS oil and gas programs (Sections 4.4.6.2.2 and 4.4.6.3.2). Dredging operations in conjunction with ship channel maintenance and construction, pipeline placement and burial, and support facility access occur throughout the Cook Inlet Planning Area as part of non-OCS activities. Non-OCS dredging and marine disposal activities would involve excavation of nearshore sediments and subsequent disposal in offshore or nearshore areas, thereby disturbing seafloor habitats and generating temporary turbidity in the water column. Sediments dredged and sidecast or transported to approved dredged material disposal sites could cause smothering and some mortality of sessile animals in the vicinity of the activity. Anchoring of non-OCS activity vessels on these features could cause significant chronic disturbance to benthic and bottom water habitat and biota. Anchoring could involve boats used for recreational and commercial fishing and commercial ship traffic. The amount of damage that could result from anchoring activity would depend upon vessel size, the size of the anchor and chain, sea conditions at the time of anchoring, and the location or position of the anchor on the feature. Similarly, some fishing methods, such as trawling and shellfish dredging, could damage seafloor habitats and increase the turbidity of the water column (Jones 1992). The effects of dredging, anchoring, and trawling activities on marine benthic and pelagic habitats are expected to be similar to those described for OCS bottom disturbing activities (Sections 4.4.6.2.2 and 4.4.6.3.2). Impacts on pelagic habitat would be localized and temporary, while benthic habitat damaged by anchors may take more than 10 years to recover, depending upon the nature of the habitat and severity of the damage. Benthic habitat disturbances from OCS activities (e.g., pipeline trenching and placement and platform placement) would add to the existing impacts to benthic habitat from these non-OCS sediment-disturbing activities.

Cook Inlet is a heavily river-influenced system. Therefore, climate change relating to the temporal variability of key chemical and physical parameters could have important effects in the Cook Inlet Planning Area — particularly to hydrology, dissolved oxygen, salinity, and temperature. These changes could significantly alter the existing benthic and pelagic habitat and biota. A predicted increase in river discharge could change the salinity, temperature, and turbidity regimes in nearshore areas and alter the composition of existing phytoplankton and benthic communities. Other changes could result from:

- Ocean acidification from increasing CO_2 inputs into the ocean that may reduce the availability of calcite and aragonite to calcifying marine organisms.

- Reduction in landfast ice extent and duration expected as a result of rising temperatures which may reduce the scouring of intertidal and shallow subtidal habitats on the western side of Cook Inlet.

- Increases or decreases in phytoplankton productivity. Studies in the Gulf of Alaska suggest phytoplankton productivity is controlled by a number of factors, especially light, microzooplankton consumption, nutrients, and water column stratification, all of which could be affected by climate change (Strom et al. 2010). Therefore, climate change could increase or decrease phytoplankton productivity, potentially resulting in greater or lesser food inputs to benthic habitats and a subsequent increase or decrease in the productivity of benthic biota.

Oil spills from both OCS and non-OCS activities could affect benthic and pelagic habitat in Cook Inlet. The total number of oil spills and the extent of affected seafloor habitat would likely increase under the cumulative scenario, in conjunction with increased levels of petroleum exploration and production. Accidental hydrocarbon releases can occur at the surface from tankers or platforms or at the seafloor from the wellhead or pipelines. Non-OCS activities, such as oil and gas development in State waters, domestic transportation of oil or refined petroleum products, and commercial shipping (and other marine vessel traffic), may also result in accidental spills that could affect benthic and pelagic habitats within the Cook Inlet Planning Area.

For both OCS and non-OCS oil spills, it is assumed the magnitude and severity of potential impacts on benthic and pelagic habitat would be a function of the location (including habitats affected), timing, duration, and size of the spill and containment and cleanup activities. It is anticipated that most small to medium spills would have limited effects because of the relatively small areas likely to be exposed to high concentrations of hydrocarbons and the short period of time during which potentially toxic concentrations would be present. Oil spills would likely have the greatest impacts on benthic habitat and communities in shallow subtidal waters and in intertidal areas. Although pelagic habitat is likely to recover following an oil spill, the recovery time for intertidal and shallow subtidal benthic habitat directly affected by oil spills could be long term (Section 4.4.6.2.2). Multiple spills would further contribute to cumulative effects. Detailed discussion of the impacts of OCS accidental hydrocarbon releases on marine benthic and pelagic habitat can be found in Sections 4.4.6.2.2 and 4.4.6.3.2.

Impact-producing factors for marine benthic and pelagic habitats in Cook Inlet include those from both OCS and non-OCS activities. Non-OCS activities with the potential to impact these resources include oil and gas development in State waters, commercial fishing and sportfishing, sediment dredging and disposal, anchoring, and tankering of imported oil. Disturbances from these activities including noise, marine vessel discharges, and bottom disturbance would add to similar impacts from OCS activities. Overall, cumulative impacts on marine benthic and pelagic habitats, as a result of OCS and non-OCS program activities, would be moderate to major. The incremental contribution of routine Program activities to these impacts would range from negligible to medium (see Section 4.4.6.2.2).

Accidental oil spills could result from both OCS and non-OCS activities. Overall, the cumulative impacts on marine habitats from oil spills would range from minor to moderate. The incremental impacts of expected oil spills, most of which would be small (less than 1,000 bbl), would range from negligible to small, depending on the location, timing, duration, and size of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities (Section 4.4.6.2.2). Spills in deeper water, whether from OCS or non-OCS sources, are unlikely to have overall community-level effects on seafloor habitats because of the relatively small proportion of seafloor area that would come in contact with released oil at concentrations great enough to elicit toxic effects. Impacts associated with an unexpected, low-probability CDE affecting shallow and intertidal habitats could be minor to moderate, depending on the habitats affected. Although pelagic habitat is likely to recover following a CDE, the recovery time for intertidal and shallow subtidal benthic habitat directly affected by such oil spills could be long term.

4.6.3.2.3 Essential Fish Habitat. Section 4.4.6.4.2 discusses direct and indirect impacts on EFH in Cook Inlet resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Section 4.4.6.4.2) when added to impacts from ongoing and reasonably foreseeable future actions, including those of future OCS programs and other non-OCS activities.[57] Table 4.6.1-3 presents the exploration and development scenario for the GOM cumulative case, which takes into account activities associated with the Program in combination with those from future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in Cook Inlet are summarized in Table 4.6.1-6 and discussed below, as applicable.

Cumulative impacts on EFH could result from future OCS and ongoing and future non-OCS activities that have a potential to directly kill managed fish species, disturb ocean bottom habitats, increase sediment suspension, degrade water quality, or affect the food supply for fishery resources (there are no ongoing OCS programs in Cook Inlet). Future OCS activities (resulting from the Program) include seismic surveys (noise), well drilling, pipeline placement (trenching, landfalls, and construction), platform placement (anchoring, mooring, and removal), and routine discharges (drilling, platform, and vessel). Accidental oil spills are also counted among OCS and non-OCS activities.

Because there is no ongoing OCS activity in Cook Inlet Planning Area, the new OCS activities under the Program represent a 100% increase in all associated OCS activities in Cook Inlet. Over the life of the Program, up to 110 production wells and up to three oil platforms are anticipated. In addition, up to 241 km (150 mi) of new offshore pipeline are anticipated, as is one pipeline landfall. Implementation of the Program would also result in seismic survey activity and the release of drilling muds and cuttings to offshore areas (Table 4.6.1-3).

[57] Currently, there are no ongoing OCS activities within Cook Inlet.

Although there are is no oil and gas development in OCS waters, oil and gas operations have existed in State waters of Cook Inlet for decades. Impact-producing factors from OCS and non-OCS oil and gas activities would be similar. Overall, it is expected that the cumulative impacts of exploration and site development activities on marine EFH would be moderate, and impacts are not expected to permanently reduce the EFH available to managed species or result in population-level impacts on managed species. The most sensitive benthic habitats, such as those associated with hard-bottoms and kelp communities, are not expected to be affected by routine operations, and effects would be minimized or eliminated by existing protections. The construction of all platforms and pipelines would disturb bottom habitats to some degree. Deposition of drilling fluids and cuttings could potentially affect EFH by altering grain size distributions and chemical characteristics of sediments such that benthic prey of some managed fish species or water quality in offshore areas would be affected in the immediate area surrounding drill sites. Although muds and cuttings from exploration and delineation wells could be discharged to surrounding waters, it is assumed that muds, cuttings, and produced waters from production wells would be discharged into wells and not released to open waters. See Section 4.4.6.4.2 for a detailed discussion of the impacts of routine operations on EFH and managed species in Cook Inlet Planning Area.

Freshwater areas used by salmon and other anadromous fish are considered to be EFH and could be affected by nearshore OCS and non-OCS oil and gas activity such as pipeline dredging or by onshore pipelines that cross bodies of water, especially streams. The primary effects of pipeline crossings would be increasing turbidity and sedimentation of the benthic environment during construction and blocking migration of anadromous fish following construction. As a consequence, crossings of anadromous fish streams would be minimized and consolidated with other utility and road crossings of such streams. In addition, onshore pipelines would be designed, constructed, and maintained to reduce risks to fish habitats from a spill, pipeline break, or construction activities. Other non-OCS activities, such as logging, road construction, and development in general could also contribute to water quality degradation and blockage of fish passage in anadromous fish streams.

Other ongoing and future non-OCS activities that could impact fish communities include land use practices, point and non-point source pollution, logging, dredging, and disposal of dredging spoils in OCS waters, anchoring, and commercial or sportfishing activities, and commercial shipping (including imported oil). Many of these activities would result in bottom disturbance that would affect bottom dwelling fishes as well as their food sources in a manner similar to those described for OCS activities (Section 4.4.7.3.2). These non-OCS activities when combined with OCS activities could over time result in cumulative impacts on EFH and managed species especially if these impacts occur frequently or are of sufficient magnitude that habitat recovery times are prolonged. See Section 4.6.3.2.1 and Section 4.6.3.2.2 for a discussion of impacts of these non-OCS activities on benthic and pelagic EFH.

Logging could also degrade riverine habitats that are important reproductive and juvenile habitat for managed migratory fish species. Erosion from areas undergoing commercial logging could increase the silt load in streams and rivers, which could reduce levels of invertebrate prey species and adversely affect spawning success and egg survival. The introduction of fine sediments into spawning gravels may render these habitats unsuitable for salmon spawning.

Logging could also remove riparian canopies along some streams, which could increase solar heating of freshwater habitats. Downed timber could physically block salmon migrations. Because of past damage inflicted by commercial logging, improved forestry practices have been initiated, and timber harvests have been curtailed. Continued implementation of effective forest management techniques would help mitigate the adverse effects of logging in the future. Cumulative impacts on migratory species could also occur as a result of activities that obstruct fish movement in marine environments during migration periods.

Commercial fishing practices that are indiscriminate, such as trawling and pots, are responsible for significant amounts of bycatch that can injure or kill juveniles of many fish species. These types of fishing practices could damage future year classes, reduce available prey species, and damage benthic habitat for many Cook Inlet fish resources. A wide variety of methods are used to target numerous species of fishes and shellfishes, including longlines, seines, setnets, trawls, and traps. Some fisheries target particular fish species returning to their natal stream or river, while other fisheries take place in pelagic waters and target mixed stocks of fishes or shellfishes.

As a consequence of the pressure commercial fishing places on fishery resources, appropriate management is required to reduce the potential for depletion of stocks due to overharvesting. Fisheries in Alaskan waters and in adjacent offshore areas are managed by the Alaska Department of Fish and Game and the North Pacific Fishery Management Council of the National Marine Fisheries Service through implementation of fishing regulations such as fishing seasons and harvest limits and through hatchery production of some fishery resources (primarily salmon). Even with management, the possibility of overfishing still exists. Occasionally fisheries are closed when stocks are considered insufficient to support harvesting, and will sometimes remain closed for multiple seasons before stocks are deemed sufficient. While occasional or sustained declines in fishery stocks may not be fully attributable to commercial fishing, it appears that commercial fishing is an important factor in the abundance, or lack thereof, of fishery resources.

Although the magnitude of harvests is considerably smaller than for commercial fisheries (Fall et al. 2009), sportfishing also contributes to cumulative effects on the abundance of some fishery resources. Recreational fisheries are managed to prevent overharvesting, but recreational harvests can be a substantial portion of fisheries landings. Consequently, recreational fishing activities have a potential to result in overharvest of managed species over the life of the Program. However, recreational fishing methods are less destructive of EFH compared to commercial fisheries.

Subsistence fishing may also contribute to the cumulative effects on the abundance of some fishery resources. Alaska State law defines subsistence as the “noncommercial customary and traditional uses” of fish and wildlife. The Alaska Department of Fish and Game defines subsistence fishing to include “the taking of, fishing for, or possession of fish, shellfish, or other fisheries resources by a resident of the State for subsistence uses with gill net, seine, fish wheel, long line, or other means defined by the Board of Fisheries.” These fishing methods have more limited impacts on EFH compared to commercial fishing methods. Subsistence fishing is subject to harvest limits that reduce the potential for overfishing and much of Cook Inlet is defined as a nonsubsistence area, and subsistence fishing is therefore not authorized. Consequently, subsistence fishing makes a relatively minor contribution to the reduction in fish stocks compared to commercial fishing (Fall et al. 2009).

Another source of cumulative impacts to fishery resources are personal use fisheries which are a legally defined as "the taking, fishing for, or possession of finfish, shellfish, or other fishery resources, by Alaska residents for personal use and not for sale or barter, with gill or dip net, seine, fish wheel, long line, or other means defined by the Board of Fisheries." In the Cook Inlet Planning Area, there are areas designated for personal use fisheries for salmon, tanner crab, herring, and eulachon, all of which are managed species. All personal use fisheries are subject to harvest limits that reduce the potential for overfishing. Personal use fishing makes a relatively minor contribution to the reduction in fish stocks compared to commercial fishing.

See individual sections on water quality, coastal habitats, and marine and pelagic habitats for a discussion of the effects of climate change on EFH in the Cook Inlet Planning Area. As a heavily river-influenced system, climate change may cause the temporal variability of key chemical and physical parameters, which could significantly alter the existing benthic and pelagic habitat and biota. A predicted increase in river discharge could change the salinity, temperature, and turbidity regimes in nearshore areas and alter the composition of existing phytoplankton and benthic communities. Other changes could result from ocean acidification, reduction in landfast ice extent and duration, and increase phytoplankton productivity.

The total number of oil spills and the extent of affected EFH areas would likely increase under the Program in conjunction with increased levels of petroleum exploration and production. The Program would contribute 100% of the OCS spills in the Cook Inlet Planning Areas. See Table 4.6.1-4 for oil spill assumptions for Alaska. Catastrophic spills assumptions are provided in Table 4.4.2-2. Non-OCS activities, such as oil and gas development in State waters, domestic transportation of oil or refined petroleum products, and commercial shipping (and other marine vessel traffic), may also result in accidental spills that could potentially impact fish resources within the Cook Inlet Planning Area. While effects on EFH resources would depend on the timing, location, and magnitude of specific oil spills, it is anticipated that most small to medium spills that occur in OCS waters would have limited effects on EFH, due to the relatively small areas likely to be exposed to high concentrations of hydrocarbons and the short period of time during which potentially toxic concentrations would be present. See Section 4.4.6.4 for a detailed discussion of the impact of oil spills on EFH.

Because of the high concentrations of individuals likely to be present, EFH for anadromous salmon are at higher risk from an OCS oil spill in the Cook Inlet Planning Areas. The greatest potential for damage to salmon stocks would be if a spill were to occur along migration routes. However, because of the limited area affected by even large oil spills relative to the wide pelagic distribution and migratory patterns of salmonids, it is anticipated that most impacts would be limited to small fractions of exposed salmon populations. Oil spills occurring at constrictions in migration routes would have an increased potential for adversely affecting salmon. Adverse effects of oil spills on EFH for groundfishes of southern Alaska would also be a function of spill magnitude, location, and timing. Adult groundfishes are primarily demersal and would generally be subjected only to the insoluble oil and water-soluble fractions of oil that reach deeper strata. Insoluble oil fractions would sink to the bottom and be distributed diffusely as tar balls over a wide area, and would be unlikely to produce a reduction in the population of adult fishes. Egg and larval stages would be at greater risk of exposure to oil spills because spawning aggregations of many groundfish species produce pelagic eggs that could come into contact with surface oil slicks. Herring are also potentially susceptible to oil spills because they spawn in nearshore waters for protracted periods of time.

Managed shellfish stocks (such as tanner, snow, and red king crab) are unlikely to be exposed to surface oil. However, oil reaching shallow subtidal and intertidal shellfish or crab habitat could measurably reduce crab populations. Pelagic crab larvae could also be affected if a large surface oil spill occurred during the spring spawning season. However, because the area affected by most spills would be expected to be small relative to overall distributions of crab larvae, overall population levels are unlikely to be noticeably affected.

Conclusion. Impact-producing factors for EFH include those from both OCS and non-OCS activities. Non-OCS activities with the potential to impact EFH in the Cook Inlet Planning Area include oil and gas production in State waters, coastline development, commercial and recreational fishing, sediment dredging and disposal, and vessel traffic. Impacts from OCS activities would be limited by specific lease stipulations. Overall, the cumulative impacts on EFH would be minor to moderate, considering ongoing and future OCS and non-OCS activities. The incremental contribution of routine Program activities to these impacts would be negligible to medium (see Section 4.4.6.3.2).

Accidental oil spills could result from both OCS and non-OCS activities. Overall, the cumulative impacts on EFH from oil spills would range from minor to moderate. The incremental impacts of expected oil spills would range from negligible to medium, depending on the location, timing, duration, and size of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities (Section 4.4.6.3.2). While most accidents related to OCS activities assumed under the cumulative scenario would be small (less than 50 bbl) and would have relatively small incremental impacts on EFH, spills that reach coastal wetlands could have more persistent impacts and could require remediation. Spills in deeper water, whether from OCS or non-OCS sources, are unlikely to have overall population-level effects on fish resources because of the relatively small proportion of similar available fish habitats that would come in contact with released oil at concentrations great enough to elicit toxic effects. Oil spills that have the greatest potential to impact EFH and managed species are those that occur in shallower subtidal and intertidal areas and spills that reach areas at the same time where substantial numbers of eggs or larvae of managed species are present. Impacts associated with an unexpected, low-probability CDE affecting shallow and intertidal habitats could be moderate to major, depending on the size, duration, timing, and location of the spill.

4.6.3.3 Alaska Region – Arctic

4.6.3.3.1 Coastal and Estuarine Habitats. Section 4.4.6.1.3 discusses direct and indirect impacts on coastal and estuarine habitats in the Arctic region resulting from the

2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Section 4.4.6.1.3), when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS activities. Table 4.6.1-3 presents the exploration and development scenario for the Arctic region cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the Arctic are summarized in Table 4.6.1-7 and discussed below.

Coastal Barrier Beach and Dunes. Vessel traffic associated with the Program could result in indirect impacts on coastal barrier beaches and dunes in the Arctic region (Section 4.4.6.1.3). Onshore pipeline construction may impact sand beaches and dunes on the margins of lakes and rivers on the Arctic Coastal Plain (ACP). Similar activities are associated with current and planned OCS sales in the Alaska region and would occur during the life of the Program (see Table 4.6.1-5). In the Beaufort Sea and Chukchi Sea Planning Areas, vessel traffic associated with the Program would represent approximately 25–35% of such OCS activities, and onshore pipelines associated with the Program would represent approximately 30% for the Beaufort Sea Planning Area.

Impacts on barrier beaches and dunes primarily result from factors that contribute to increased erosion of beaches and dunes. Activities may disturb dune vegetation, thereby promoting dune erosion, or directly disturb beach and dune substrates, resulting in increased erosion of beaches and dunes. Increases in wave action could also contribute to the erosion of beaches. Sedimentation from physical disturbance of substrates or erosion may affect biota in intertidal or shallow subtidal habitats. In addition, accidental spills may impact beach or dune habitat.

Ongoing non-OCS activities that could affect barrier beaches and dunes include those related to State oil and gas development, commercial shipping (and other marine vessel traffic), and coastal development. These activities can be reasonably expected to continue into the future.

The construction of pipelines, docks, causeways, or shorebases associated with State oil and gas exploration and development could result in direct losses of beach or dune habitat. Construction of facilities on barrier islands could impact beach, dune, or tundra habitat. Erosion of beach or dune substrates adjacent to these constructions may result in additional habitat losses. Intertidal and shallow subtidal organisms in nearby areas may be buried by excavated materials or indirectly affected by turbidity and sedimentation. Sand beaches and dunes along lagoon shorelines and on the margins of lakes and rivers on the ACP may also be affected by pipeline construction. The impacts on barrier beaches and dunes from substrate-disturbance activities associated with construction under the Program would represent a small contribution to the past, ongoing, and expected future impacts on barrier beaches and dunes from non-OCS activities. Vegetated dunes in the Arctic region may be affected by vehicles associated with seismic activities (ADNR 2009d). Beaches and associated biota within the Beaufort Sea and Chukchi Sea Planning Areas could also be affected by routine discharges from marine vessels, discharges of municipal and industrial wastewater, or sedimentation from upland areas.

Activities that increase wave action along barrier beaches and dunes could contribute to their erosion. Barge and service vessel traffic supporting State oil and gas development may result in wake erosion along barrier islands in the Beaufort Sea and Chukchi Sea Planning Areas. A portion of the impacts related to vessel traffic would be associated with the Program; however, activities conducted under the proposed action would contribute a relatively small number of vessel trips to the total.

Accidental spills of oil or other liquid hydrocarbons, resulting from activities conducted under the proposed action, could impact beaches and dunes. Such spills would represent approximately 20–40% of the spills resulting from ongoing OCS activities and planned future sales in the Beaufort Sea and Chukchi Sea Planning Areas (Table 4.6.1-4). As under the Program, the majority of these spills would be small (less than 50 bbl). Non-OCS activities, such as State oil and gas development, domestic transportation of oil or refined petroleum products, and commercial shipping (and other marine vessel traffic), may also result in accidental spills that could potentially impact coastal barrier beaches and dunes. Spills can result in short- or long-term changes in the composition of intertidal or shallow subtidal communities, or extensive mortality of biota associated with coastal habitats, and may persist in substrates for decades. The amount of oil contacting beaches from a spill depends on a number of factors such as the location and size of the spill, waves and water currents, and containment actions. Naturally occurring seeps may also be a source of crude oil introduced into nearshore waters (Kvenvolden and Cooper 2003). The magnitude of resulting impacts and the persistence of oil would depend on factors such as the amount of oil deposited, remediation efforts, substrate grain size, and localized erosion and deposition patterns. The impacts of potential spills associated with the Program would be expected to add a small contribution to the impacts of other sources of beach degradation in the Arctic region.

Indirect effects on coastal barrier beaches and dunes could result from global climate change. Potential thermal expansion of ocean water and melting of glaciers and ice caps could result in a global rise in mean sea level (Section 4.6.1.6). Sea-level rise could result in increased inundation of barrier landforms and erosion of beach habitat. In the Arctic, greater wave activity during storms due to decreases in sea-ice cover, as well as changes in permafrost due to temperature increases, could result in increased coastal erosion.

Wetlands. A number of activities associated with the Program could result in impacts on coastal wetlands in the Alaska region (Section 4.4.6.1.3). These activities include construction of pipelines, road construction, and facility maintenance, and activities that result in poorer water and air quality and altered hydrology. Impacts associated with these activities could include elimination of wetland habitat and indirect effects that contribute to reductions in wetland habitat. Similar activities are associated with current and planned OCS lease sales in the Beaufort Sea and Chukchi Sea Planning Areas, and would occur during the life of the Program (see Table 4.6.1-3). In the Beaufort Sea Planning Area, the activities associated with the Program would represent approximately 30% of such OCS activities; the Program does not include new onshore pipelines in the Chukchi Sea Planning Area.

Factors that impact coastal wetlands include the direct elimination of wetland habitat by excavation or filling and the degradation of wetland communities by reduced water or air quality or hydrologic changes. Construction projects may fill wetlands for facility siting or excavate wetlands for the construction of pipelines, causeways, or shore bases or for gravel mining. A number of activities may degrade wetlands or promote wetland losses indirectly by causing changes to wetland hydrology or introducing contaminants.

Ongoing non-OCS activities that could affect coastal wetlands include those related to State oil and gas development, commercial shipping and other marine traffic, coastal development, discharge of municipal wastes and other effluents, and domestic transportation of oil and gas. These activities can reasonably be expected to continue into the future.

A number of these activities result in the localized destruction of wetlands. The construction of pipeline landfalls, docks, or shorebases associated with State oil and gas exploration and development could result in direct losses of tidal wetlands. The construction of onshore facilities to support State oil and gas development and the exploration of oil reserves on the NPR-A on the ACP have affected freshwater wetlands, and future impacts associated with oil and gas development are expected to continue. The construction of buried pipelines results in direct impacts on wetlands due to excavation, and the construction of gravel pads and gravel roads eliminates wetland habitat by filling. Current technology allows for smaller and fewer drilling pads, and some new developments in the Arctic region would not include interconnecting roads. On the ACP, gravel has been used in support of oil and gas development to construct pads for camps, drilling sites, operations and maintenance facilities, airports, and roads for facility access as well as the Dalton Highway/haul road, offshore islands, and causeways (MMS 2003a). Gravel mining operations often result in the excavation of wetland habitat in and near rivers and other water bodies. Over 730 ha (1,800 ac) of tundra have been removed by gravel mining on the ACP (MMS 2003a). The construction of vertical support members for elevated pipelines also contributes to small localized wetland losses. Although activities that impact wetlands are regulated by State and Federal agencies, construction of industrial facilities, commercial sites, and residential developments would be expected to result in continued wetland losses. On the ACP, over 3,900 ha (9,600 ac) of tundra habitat, most of which is wetland, have been affected by oil and gas development activities (MMS 2002b, 2003a). The direct impacts on coastal wetlands from pipeline construction under the Program would represent a very small contribution to the past, ongoing, and expected future losses of wetlands from non-OCS activities.

Indirect impacts of many activities have also resulted in wetland losses. The construction of gravel roads and pads has resulted in altered hydrology in some areas, by blocking natural drainage patterns, converting vegetated wetlands to open water, or drying wetlands by restricting water inflow. Snow accumulations adjacent to pads and roads can result in vegetation changes and thermokarst. Windblown dust near gravel pads and roads causes changes in plant communities, reduction of vegetation, and thermokarst, leading to wetland losses. Sedimentation from gravel pads, roads, gravel mining operations, and vehicular impacts on streambanks adversely affect wetlands and may result in losses of vegetation or other associated biota. Ice roads in the Arctic could result in compression of vegetation, microtopography, and tundra soils, altering wetland communities. Vehicles used for seismic surveys could compress microtopography and cause changes in the vegetation community. Organisms in wetland areas near construction activities may be buried by excavated materials or indirectly affected by turbidity and sedimentation. Degradation of wetlands could result from water quality impacts due to discharges of waste water from vessels, municipal treatment plants, and industrial facilities, and stormwater discharges. Water quality may also be affected by waste storage and disposal sites. Spills of produced water could kill vegetation and other biota in freshwater wetlands. Impacts on air quality near construction sites or industrial facilities could result in local effects on wetland vegetation, and may include sources such as fugitive dust, off-gassing from processing facilities, or exhaust emissions. Indirect impacts on wetlands from non-OCS activities are expected to continue to contribute to wetland degradation and losses in the Arctic region. The indirect impacts on wetlands from pipeline construction under the Program would represent a very small contribution to the past, ongoing, and expected future impacts on wetlands from non-OCS activities.

Accidental spills of oil or petroleum products as a result of activities conducted under the Program could impact tidal or freshwater wetlands (see Section 4.4.6.1.3). Such spills would represent approximately 20–40% of the spills resulting from ongoing OCS activities and planned future sales in the Beaufort Sea and Chukchi Sea Planning Areas (Table 4.6.1-4). Most of these spills (1,350–1,950) would be small (less than 50 bbl), as under the Program. Spills in shallow water, primarily those from vessel accidents and pipelines, would be most likely to affect coastal wetlands, whereas deepwater spills, such as those from platforms, would be less likely to impact wetlands. Spills from onshore pipelines and facilities could impact freshwater wetlands or tidal wetlands if carried to coastal habitats by streams. Non-OCS activities such as State oil and gas development, the domestic transportation of oil or refined petroleum products, the production and storage of petroleum products, and commercial shipping (and other marine vessel traffic) may also result in accidental spills that could potentially impact wetlands. Naturally occurring seeps may also be a source of crude oil that could potentially affect coastal wetlands. The amount of oil contacting wetlands, the magnitude of resulting impacts, and the length of time for recovery would depend on a number of factors such as the location and size of the spill, containment actions, waves and water currents, type of oil, types of remediation efforts, amount of oil deposition, duration of exposure, season, substrate type, and extent of substrate penetration. Impacts from oil spills would be expected to range from short-term effects on vegetation growth to extensive mortality. Recovery of affected wetlands could require several decades. The impacts of potential oil spills associated with the Program would be expected to constitute a small addition to the impacts of all other sources of oil in the Arctic region.

Global climate change could result in indirect effects on coastal wetlands. Potential thermal expansion of ocean water and melting of glaciers could result in a global rise in mean sea level (Section 4.6.1.6). Sea-level rise would result in greater inundation of coastal wetlands, and likely result in conversion of wetlands to open water. In addition, large changes in river flows into nearshore marine waters could affect salinity and water circulation in estuaries, which, in turn, could impact estuarine wetland communities.

Conclusion. Future OCS program and ongoing and future non-OCS program activities in combination with naturally occurring events have resulted in losses of coastal habitats in the Arctic region; cumulative impacts on these resources, therefore, are considered to be moderate to major. Operations under the Program would result in small localized impacts, primarily due to facility construction, pipeline landfalls, channel dredging, and vessel traffic; however, the incremental contribution of routine Program activities to cumulative impacts would be small to medium (see Section 4.4.6.1.3).

The cumulative impacts of past, present, and future oil spills on coastal and estuarine habitats would be moderate. The incremental impacts of expected accidental oil spills associated with the Program on these resources would be negligible to large, depending on the location, timing, duration, and size of the spill; the proximity of the spill to particular habitats; and the timing and nature of spill containment and cleanup activities (see Section 4.4.6.1.3). The majority of these spills would be small (less than 50 bbl) and most of them would not likely contact and affect coastal and estuarine habitats. Impacts associated with large oil spills (1,000 bbl or greater) or an unexpected, low-probability CDE have the greatest potential to affect extensive areas of shoreline and coastal habitats. Although these are rare events, the impacts of such releases on coastal habitats could range from moderate to major if they were to occur.

4.6.3.3.2 Marine Benthic and Pelagic Habitats. Sections 4.4.6.2.3 and 4.4.6.3.3 discuss direct and indirect impacts on marine benthic and pelagic habitats in the Arctic region resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Sections 4.4.6.2.3 and 4.4.6.3.3), when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS activities. Table 4.6.1-3 presents the exploration and development scenario for the Arctic region cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the Arctic are summarized in Table 4.6.1-7 and discussed below.

Cumulative impact-producing factors for marine benthic and pelagic habitats in Beaufort Sea and Chukchi Sea Planning Areas include those from both OCS and non-OCS activities. Potential impacts on marine benthic and pelagic habitat resulting from future routine OCS program activities, including those of the Program, could result from noise (vessel, seismic surveys, construction, operations), well drilling, pipeline placement (trenching, landfalls, and construction), discharges (drilling, vessel and platform), and platform placement (anchoring, mooring, and removal). All these activities have the potential to adversely affect marine benthic and pelagic habitats in the Beaufort Sea and Chukchi Sea Planning Areas. Accidental oil spills are also counted among OCS program-related activities; assumptions for oil spills under the cumulative case scenario are provided in Table 4.6.1-4, and catastrophic spill assumptions are provided in Table 4.4.2-2.

Potential environmental impacts associated with the building and operation of OCS facilities such as platforms, subsea wells, artificial islands, and pipelines would increase in conjunction with the increased number of wells (approximately 9 ha [22 ac] for artificial islands versus less than 1.5 ha [3.7 ac] for platforms) and complete burial of existing substrates during construction. Under the cumulative scenario, it is anticipated that up to 1,450 production wells, up to 26 oil platforms, and up to 922 km (573 mi) of new offshore pipeline would be constructed in the Beaufort Sea and Chukchi Sea Planning Areas. Bottom substrates would be significantly altered by the construction of artificial islands. Marine benthic and pelagic habitats would be affected by bottom disturbance, by temporary increases in turbidity, and by deposition of disturbed sediment. Construction of artificial islands would result in a more complete loss of benthic habitat, due to larger footprints. Bottom disturbance degrades water quality by increasing water turbidity in the vicinity of the operations and adding contaminants to the water column. It also changes sediment composition as suspended sediments (and contaminants, if present) are entrained in currents and deposited in new locations. Construction of platforms and artificial islands in areas previously lacking hard substrate could have localized effects on the biodiversity and distribution of benthic communities by favoring organisms that prefer a hard substrate. Impacts of OCS routine operations (exploration, production and decommissioning activities) on marine benthic and pelagic habitat in the Beaufort Sea and Chukchi Sea Planning Areas are discussed in detail in Sections 4.4.6.2.3 and 4.4.6.3.3. Regulations and mitigating measures would preclude construction of platforms or artificial islands and placements of pipelines or wells in environmentally sensitive areas, such as the Stefansson Sound Boulder Patch in the Beaufort Sea (Section 4.4.6.2.3). Overall, routine operations represent a negligible to moderate long-term disturbance, with the severity of the impacts generally decreasing dramatically with distance from the well site.

The increased amount of drilling anticipated under the Program will result in OCS discharges of drill muds and cuttings from exploration and delineation wells. Deposition of drilling fluids and cuttings could potentially affect benthic and pelagic habitat by increasing turbidity and altering grain size distributions and chemical characteristics of sediments. The impacts of drilling discharges on benthic and pelagic habitats are discussed in detail in Sections 4.4.6.2.3 and 4.4.6.3.3.

Along with future OCS activities, various ongoing and future non-OCS activities, including oil and gas activities in State waters, commercial shipping (including tankers), dredging and disposal of dredging spoils in OCS waters, and anchoring could contribute to cumulative effects on pelagic and seafloor habitats in the Beaufort Sea and Chukchi Sea Planning Areas. Drilling of wells and oil and gas activities in State waters could also require construction of artificial islands, platforms, and pipelines in waters of Alaska. Effects on seafloor and pelagic habitat and biota would be similar to those described above for OCS oil and gas programs (Sections 4.4.6.2.3 and 4.4.6.3.3). Dredging operations in conjunction with ship channel maintenance and construction, pipeline placement and burial, and support facility access occur throughout the Beaufort Sea and Chukchi Sea Planning Areas as part of non-OCS activities. Dredging and marine disposal activities would involve excavation of nearshore sediments and subsequent disposal in offshore or nearshore areas and could cause temporary turbidity in the water column and smothering of sessile animals in the vicinity of the activity. Anchoring of non-OCS activity vessels on these features could cause significant chronic disturbance to benthic and bottom water habitat and biota. The amount of damage that could result from anchoring activity would depend upon vessel size, the size of the anchor and chain, sea conditions at the time of anchoring, and the location or position of the anchor on the feature. Benthic habitat disturbances from OCS activities (e.g., pipeline trenching and placement and platform placement) would add to the existing impacts to benthic habitat from these non-OCS sediment-disturbing activities. The effects of dredging, anchoring, and trawling activities on marine benthic and pelagic habitats are expected to be similar to those described for the installation of pipelines (Sections 4.4.6.2.2 and 4.4.6.3.2). Impacts on pelagic habitat would be localized and temporary, with recovery time depending upon the nature of the habitat and severity of the damage.

Climate change is expected to have multiple effects on the Beaufort Sea and Chukchi Sea Planning Areas that could impact benthic and pelagic habitat. Increased river discharge could alter the salinity, temperature, and turbidity regimes in nearshore areas (Hopcroft et al. 2008). Several rivers flow into the Beaufort shelf, and this region may be more heavily affected than the western Chukchi shelf. The increase in total suspended solids due to coastal erosion and the greater riverine sediment loading could increase turbidity in the water column and consequently decrease the penetration of photosynthetically active radiation available for kelp production (Hopcroft et al. 2008).

Climate change is expected to decrease the spatial extent and temporal duration of sea ice and make the ice thinner. Several possible consequences could result, including:

- Reduction in the spatial and temporal extent of subtidal and intertidal benthic scouring, but an increase in wave generated subtidal and intertidal disturbance;

- An increase in the sloughing of sediments from shoreline during storms, adding to the sediment loads and changing water chemistry in nearshore areas;

- An overall increase in biological productivity in the open water with increasing temperature and ice retreat and a shift to a pelagic-based rather than a benthic-based food web (Hopcroft et al. 2008); and

- Reduction in the amount and seasonal availability of sea ice algae.

In addition, ocean acidification from increasing CO_2 inputs into the ocean is also predicted to continue in Arctic waters, which may reduce the availability of calcite and aragonite to calcifying marine organisms in the sediment and water column.

Oil spills from both OCS and non-OCS activities could affect benthic and pelagic habitat in the Beaufort Sea and Chukchi Sea Planning Areas. The total number of oil spills and the extent of affected seafloor habitat would likely increase under the cumulative scenario, in conjunction with increased levels of petroleum exploration and production. Accidental hydrocarbon releases can occur at the surface from tankers or platforms or at the seafloor from the wellhead or pipelines. The total number of oil spills and the extent of affected seafloor habitat would likely increase under the cumulative scenario, in conjunction with increased levels of petroleum exploration and production. Non-OCS activities, such as oil and gas development in State waters and domestic transportation of oil, may also result in accidental spills that could affect benthic and pelagic habitats within the Beaufort Sea and Chukchi Sea Planning Areas.

For both OCS and non-OCS oil spills, it is assumed the magnitude and severity of potential impacts on benthic and pelagic habitat would be a function of the location (including habitats affected), timing, duration, and size of the spill and containment and cleanup activities. It is anticipated that most small to medium spills would have limited effects because of the relatively small areas likely to be exposed to high concentrations of hydrocarbons and the short period of time during which potentially toxic concentrations would be present. However, oil spilled during periods of ice cover could persist months or years trapped in or under the ice until the ice melted. Oil could also be transported within the ice to areas far from the spill. Oil spills would likely have the greatest impacts on benthic habitat and communities in shallow subtidal waters and in intertidal areas. Although pelagic habitat is likely to recover following an oil spill, the recovery time for intertidal and shallow subtidal benthic habitat directly affected by oil spills could be long term. If a large amount of oil from a spill were to sink and inundate sensitive boulder communities, the recovery of sensitive species could be long term (Section 4.4.6.2.3). Detailed discussion of the impacts of accidental hydrocarbon releases on marine benthic and pelagic habitat potentially resulting from the Program in the Beaufort Sea and Chukchi Sea Planning Areas can be found in Sections 4.4.6.2.3 and 4.4.6.3.3.

Conclusion. Impact-producing factors for marine benthic and pelagic habitats include those from both OCS and non-OCS activities. Ongoing and future non-OCS activities with the potential to impact marine benthic and pelagic habitats in the Beaufort Sea and Chukchi Sea Planning Areas include oil and gas production in State waters, sediment dredging and disposal, and vessel traffic. Disturbances from these activities including noise, vessel discharges, and bottom disturbance would occur in addition to similar impacts from OCS activities. For OCS activities, planning and permitting procedures would minimize the potential for direct impacts on sensitive boulder habitats during routine OCS activities. Overall, the cumulative impacts on benthic and marine habitats would be moderate to major, considering ongoing and future OCS and non-OCS activities. The incremental contribution of routine Program activities to these impacts would be negligible to medium (see Section 4.4.6.2.3).

Accidental oil spills could result from both OCS and non-OCS activities. Overall, the cumulative impacts on marine habitats from oil spills would range from minor to moderate. The incremental impacts of expected oil spills, most of which would be small (less than 1,000 bbl), would range from negligible to small, depending on the location, timing, duration, and size of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities (Section 4.4.6.3.2). Spills in deeper water, whether from OCS or non-OCS sources, are unlikely to have overall community-level effects on seafloor habitats because of the relatively small proportion of seafloor area that would come in contact with released oil at concentrations great enough to elicit toxic effects. Impacts associated with an unexpected, low-probability CDEs affecting shallow and intertidal habitats could be minor to moderate, depending on the habitats affected. Although pelagic habitat is likely to recover following a CDE, the recovery time for intertidal and shallow subtidal benthic habitat directly affected by such oil spills could be long term.

Oil spills could result from both OCS and non-OCS activities. The impacts of accidental oil spills associated with the Program on these resources would be negligible to moderate, depending on the location, timing, duration, and size of spills; the proximity of spills to particular seafloor habitats; and the timing and nature of spill containment and cleanup activities (see Section 4.4.6.2.3). Spills in deeper water, whether from OCS or non-OCS sources, are unlikely to have overall community-level effects on seafloor habitats because of the relatively small proportion of seafloor area that would come in contact with released oil at concentrations great enough to elicit toxic effects. Catastrophic oil releases that affect shallow and intertidal habitats have the potential to be of greatest significance. Although pelagic habitat is likely to recover following an oil spill, the recovery time for intertidal and shallow subtidal benthic habitat directly affected by oil spills could be long term. The incremental contribution of accidental oil spills associated with the Program would range from small to medium.

4.6.3.3.3 Essential Fish Habitat. Section 4.4.6.4.3 discusses direct and indirect impacts on EFH in the Arctic region resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Section 4.4.6.4.3) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS activities. Table 4.6.1-2 presents the exploration and development scenario for the Arctic region cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the Arctic are summarized in Table 4.6.2-7 and discussed below.

Cumulative impacts on EFH could result from future OCS and ongoing and future non-OCS activities that have the potential to directly kill managed fish species, disturb ocean bottom habitats, increase sediment suspension, degrade water quality, or affect the food supply for fishery resources (there are only offshore exploratory drilling and seismic studies in Beaufort and Chukchi Seas). Future OCS activities (resulting from the Program) include seismic surveys (noise), well drilling, pipeline placement (trenching, landfalls, and construction), subsea production well and platform placement (anchoring, mooring, and removal), and routine discharges (drilling, platform, and vessel). Accidental oil spills are also counted among OCS and non-OCS activities.

Under the cumulative scenario it is anticipated that up to 1,450 production wells, up to 26 oil platforms, and up to 922 km (573 mi) of new offshore pipeline would be constructed in the Beaufort Sea and Chukchi Sea Planning Areas over the period of the Program. Drilling muds and cuttings from exploration wells would also be released in to OCS waters.

Overall, it is expected that the impacts of exploration and site development activities on marine EFH would be moderate, and impacts are not expected to permanently reduce the EFH available to managed species or result in population-level impacts on managed species. The most sensitive benthic habitats, such as those associated with hard-bottoms and kelp communities, are not expected to be affected by routine operations since impacts would be minimized or eliminated by existing protections. Although construction of platforms, artificial islands, and pipelines would all disturb bottom habitats to some degree, artificial islands (Beaufort and Chukchi Seas only) would result in a more complete loss of benthic habitat due to larger footprints (approximately 9 ha [22 ac] for artificial islands versus less than 1.5 ha [3.7 ac] for platforms) and complete burial of existing substrate. Deposition of drilling muds and cuttings could potentially affect EFH by altering sediment characteristics such that benthic prey of some managed fish species, certain stages of the managed species themselves, or water quality in offshore areas would be affected in the immediate area surrounding drill sites. See Section 4.4.6.4.3 for a detailed discussion of the impacts of routine operations on EFH and managed species in the Arctic.

Ongoing and future non-OCS activities, such as subsistence fishing, commercial shipping (including tankers and other marine vessels), coastal modifications, hardrock mining, dredging and disposal of dredging spoils in OCS waters, and anchoring could contribute to cumulative effects on pelagic and seafloor EFH in the Beaufort Sea and Chukchi Sea Planning Areas. Commercial fishing does not occur in the Beaufort Sea and Chukchi Sea Planning Areas and sportfishing is minor in the Arctic region, but could increase if regulations change and if warming temperatures allow an increase in vessel traffic. Impacts from these non-OCS activities including noise, vessel discharges, and bottom disturbance would occur in addition to similar impacts from OCS activities. Many of these activities would result in bottom disturbance that would affect bottom dwelling fishes as well as their food sources in a manner similar to those described for OCS activities (MMS 2008b; ADEC 2007a; Section 4.4.7.3.3).

EFH and managed species in the Beaufort and Chukchi Seas fall in the Kotzebue Sound and Northern Subsistence fishing areas (http://www.adfg.alaska.gov/index.cfm?adfg=subsistence.main). Subsistence fishing may contribute to the cumulative effects on the abundance of some fishery resources. Alaska State law defines subsistence as the "noncommercial customary and traditional uses" of fish and wildlife. The Alaska Department of Fish and Game defines subsistence fishing to include "the taking of, fishing for, or possession of fish, shellfish, or other fisheries resources by a resident of the State for subsistence uses with gill net, seine, fish wheel, long line, or other means defined by the Board of Fisheries." These fishing methods have more limited impacts on EFH compared to commercial fishing methods. In addition, subsistence fishing is subject to harvest limits that reduce the potential for overfishing. Consequently, subsistence fishing makes a relatively minor contribution to the reduction in fish stocks.

Cumulative impacts on anadromous or diadromous managed species could also occur as a result of activities that obstruct fish movement in marine environments during migration periods. For example, some structures along the Beaufort Sea mainland (e.g., the West Dock) have been shown to block the movements of diadromous fishes, particularly juveniles, under certain meteorological conditions (Fechhelm 1999; Fechelm et al. 1999). Causeways such as the 40 m (131 ft) wide and 60 m (197 ft) long structure associated with the Red Dog Mine may impede coastal movement either by directly blocking fish or by modifying nearshore water conditions to the point where they might become too cold and saline for some species (Fechhelm et al. 1999). Although the presence of causeways has been an issue associated with oil and gas development activities in the Beaufort Sea, the small size of the Red Dog causeway would likely have little effect on the coastal movements and distributions of Chukchi Sea fishes and shellfishes. However, it is anticipated that proper placement and design considerations for future causeway construction along the North Slope would alleviate the potential for such effects on fish movement.

There are several contaminant sources in the Beaufort Sea and Chukchi Sea Planning Areas. The Red Dog Mine in Alaska is the largest lead and zinc mine in the world, and is presently the only base-metal lode mine operating in northwest Alaska. A study for the National Park Service (Hasselbach et al. 2004) showed extensive airborne transport of cadmium and lead from Red Dog Mine; although the study was focused only on the limits of the Cape Krusenstern National Monument, these contaminants are probably carried out into the Chukchi Sea. There are also natural sources of metals and hydrocarbons. Sediments, peats, and soils from the Sagavanirktok, Kuparuk, and Colville Rivers are the largest source of dissolved and particulate metals and saturated and polycyclic aromatic hydrocarbons in the development area. However, concentrations of these contaminants in fish sampled in the Arctic planning areas are typically at background levels (Neff & Associates, LLC 2010).

There are also State oil and gas activities that can affect EFH in the Beaufort and Chukchi Seas. Factors that could affect EFH from these activities would be similar to those described above for OCS activities including underwater noise, habitat loss and disturbance, seismic survey and exploratory drilling, as well as other ancillary activities. However, the effects from non-OCS oil and gas activities could possibly be more severe than the effects from routine OCS activities because the activities are closer to shore and in shallower environments. As a consequence, more benthic EFH may be damaged, and resulting changes in sedimentation and turbidity could affect a greater proportion of the water column.

Freshwater areas used by salmon and other anadromous fish are considered to be EFH and could be affected by nearshore OCS and non-OCS oil and gas activities such as pipeline dredging or by onshore pipelines that cross bodies of water, especially streams. The primary effects of pipeline crossings would be increasing turbidity and sedimentation of the benthic environment during construction and blocking migration of anadromous fish following construction. Any pipeline route would be required to comply with various Alaska Coastal Management Program policies. As a consequence, crossings of anadromous fish streams would be minimized and consolidated with other utility and road crossings of such streams. In addition, onshore pipelines would be designed, constructed, and maintained to reduce risks to fish habitats from a spill, pipeline break, or construction activities.

See individual sections on water quality, coastal habitats, and marine and pelagic habitats for a discussion of the effects of climate change on EFH in the Beaufort Sea and Chukchi Sea Planning Areas. As a heavily river-influenced system, increased river discharge could alter the salinity, temperature, and turbidity regimes in nearshore areas (Hopcroft et al. 2008). Climate change is also expected to decrease the spatial extent and temporal duration of sea ice as well as make the ice thinner, an overall increase in biological productivity in the open water, and a shift to a pelagic-based rather than a benthic-based food web (Hopcroft et al. 2008). In addition, ocean acidification may reduce the availability of calcite and aragonite to marine organisms.

The total number of oil spills and the extent of affected EFH areas would likely increase under the Program in conjunction with increased levels of petroleum exploration and production. See Table 4.6.1-4 for oil spill assumptions for Alaska. Non-OCS activities, such as oil and gas development in State waters, domestic transportation of oil, and commercial shipping (and other marine vessel traffic), may also result in accidental spills that could potentially impact fish resources within the Arctic. While effects on EFH resources would depend on the timing, location, and magnitude of specific oil spills, it is anticipated that most small to medium spills that occur in OCS waters would have limited effects on EFH, due to the relatively small areas likely to be exposed to high concentrations of hydrocarbons and the short period of time during which potentially toxic concentrations would be present. Large or catastrophic spills could result in long-term impacts to EFH habitat quality and managed species populations. See Section 4.4.6.4 for a detailed discussion of the impact of oil spills on EFH.

Arctic fishes could also be susceptible to adverse effects of oil spills (see Section 4.4.6.4.2). Most offshore spills would be small and likely have little effect on overall populations, since the areas with significant hydrocarbon concentrations would be localized relative to the broad distributions of most marine and anadromous fishes of the Beaufort and Chukchi Seas. However, population level effect could occur if large amounts of oil from a catastrophic spill were to reach shallow subtidal and intertidal sediments. Some anadromous species of the Alaskan North Slope could be at greater risk because of their unique life-history cycles. Juveniles of some species of whitefish (including broad whitefish, humpback whitefish, and least cisco) are intolerant of highly saline marine conditions. During their summer feeding dispersals in the Beaufort Sea, these species tend to remain within a narrow band of warm, low-salinity water along the coast. Offshore barrier islands offer additional protection by helping to maintain low-salinity corridors. Thus, unlike most subarctic fishes, whitefish along the North Slope have a reduced capacity to bypass localized disruptions to their migration corridor by moving offshore and around the impasse. An oil spill, even one of limited area, could block the narrow nearshore corridor and prevent fishes from either dispersing along the coast to feed or returning to their overwintering grounds in rivers of the North Slope. If a spill were localized in the sensitive nearshore zone, its location would also make it more amenable to cleanup by environmental response teams. There is no tanker traffic on the North Slope, which eliminates the possibility of a collision spill in that area.

Oil from spills occurring under the ice in the Beaufort and Chukchi Seas could remain trapped there throughout the winter unless removed, which, while difficult, could be done. Water quality would be negatively affected, and overwintering eggs, larvae, and invertebrate prey would likely be killed in affected areas. Surface spills occurring in the summer months would temporarily reduce EFH for surface-dwelling eggs, larvae, and pelagic prey species. Oil reaching nearshore areas could travel short distances upriver in anadromous fish streams as a result of tidal water movements, and some oil could become trapped in the interstitial spaces of the sediments. In such cases, EFH for salmon eggs and larvae could be affected. See Section 4.4.3.3 for a detailed discussion of accidental oil spills in ice and ice-free conditions.

Conclusion. Impact-producing factors for EFH include those from both OCS and non-OCS activities. Non-OCS activities with a potential to impact EFH in the Beaufort Sea and Chukchi Sea Planning Areas include oil and gas production in State waters, sediment dredging and disposal, and vessel traffic. Impacts from OCS activities would be limited by specific lease stipulations. Overall, the cumulative impacts on EFH would be moderate to major, considering ongoing and future OCS and non-OCS activities. The incremental contribution of routine Program activities to these impacts would be negligible to medium (see Section 4.4.6.3.3).

Accidental releases of oil and gas from OCS and non-OCS activities could also have effects on EFH. The incremental contribution of accidental spills associated with the Program on EFH would be negligible to medium, depending on the location, timing, duration, and size of spills; the proximity of spills to particular fish habitats; and the timing and nature of spill containment and cleanup activities (see Section 4.4.6.3.2). While most accidents related to OCS activities assumed under the cumulative spill scenario would be small and would have relatively minor incremental impacts on EFH, oil that reaches coastal wetlands could have more persistent impacts and could require remediation. Spills in deeper water, whether from OCS or non-OCS sources, are unlikely to have overall population-level effects on fish resources because of the relatively small proportion of similar available fish habitats that would come in contact with released oil at concentrations great enough to elicit toxic effects. Oil spills that have the greatest potential to impact EFH and managed species are those that occur in shallower subtidal and intertidal areas and spills that reach areas at the same time substantial numbers of eggs or larvae of managed species are present. Impacts associated with an unexpected, low-probability CDE affecting shallow and intertidal habitats could be moderate to major, depending on the size, duration, timing, and location of the spill.

4.6.3.4 Summary for Gulf of Mexico Region

4.6.3.4.1 Coastal and Estuarine Habitats. Cumulative impacts on barrier beaches and dunes result from factors that reduce sediment input to downdrift areas and increase erosion of beach and dune sands. Past actions such as channelization and diversion of Mississippi River flows (through dams and reservoirs) and beach stabilization projects (using groins, jetties, and seawalls) have contributed to sediment deprivation and submergence of coastal lands, particularly along the Louisiana coast, and are expected to continue into the foreseeable future. Ongoing and future actions/trends that affect barrier beaches and dunes include those related to oil and gas development in State and OCS waters, coastal development (onshore industry and wastewater discharge), vessel traffic, recreation, and climate change. Cumulative impacts on barrier beaches and dunes in the GOM are considered to be moderate to major.

Cumulative impacts on wetlands result from direct elimination of wetland habitat by excavation or filling, reduction of sediment inputs, erosion of wetland substrates, and degradation of wetland communities (by reduced water quality or hydrologic changes). Construction of canals or pipelines may require filling or excavating of wetlands. Other projects may reduce the sediment delivered to coastal wetlands from inflowing rivers. Losses of coastal wetlands have been occurring along the GOM coast for decades (especially in Louisiana) and are expected to continue into the foreseeable future. Many factors contribute to coastal land loss, including the effects of large storm events, subsidence, sea level rise, saltwater intrusion, drainage and development, canal construction, and reduced flooding. Upstream alterations of the Mississippi River drainage system are also important factors because construction of dams on upstream tributaries has reduced the sediment loads to the GOM by as much as 50%. Ongoing and future actions/trends that affect wetlands include those related to oil and gas development in State and OCS waters, coastal development (onshore industry and wastewater discharge), vessel traffic, dredging operations, and climate change. In addition, a number of coastal habitat protection and restoration projects have been initiated along the GOM coast to address erosion and land loss. Cumulative impacts on coastal wetlands in the GOM are considered to be moderate to major.

Seagrass beds grow in shallow, relatively clear and protected waters with predominantly sand bottoms; they are uncommon where freshwater inflow is high and salinities average less than 20 ppt. Most seagrass beds are in the Eastern GOM, where there are no past or present OCS activities and none proposed as part of the Program. Seagrass beds are found only within a few scattered, protected locations in the Western and Central GOM, although seagrass meadows occur in nearly all bay systems along the Texas coast. The distribution of seagrass beds in coastal waters of Western and Central GOM has diminished in recent decades, possibly due to high turbidity caused by increased marine vessel traffic. Ongoing and future actions/trends that affect seagrass habitats include onshore development, commercial and recreational fishing (trawling and anchoring), vessel traffic (anchoring), recreation (diving), and climate change. Cumulative impacts on seagrass beds in the GOM are considered to be moderate to major.

Routine operations under the Program in the GOM would result in minor localized impacts primarily due to facility construction, pipeline trenching and landfalls, channel dredging, and marine vessel traffic. The contribution of the Program to cumulative impacts therefore would generally be small to medium. The effects of expected accidental oil spills on coastal and estuarine habitats could be negligible to large, depending on the location, timing, duration, and size of the spill, and the timing and nature of spill containment and cleanup activities. Most expected oil spills are small (less than 50 bbl) and would not likely contact and affect coastal and estuarine habitats. Impacts associated with large oil spills (1,000 bbl or greater) or an unexpected, low-probability CDE that occur in or reach shallower nearshore areas have the greatest potential to affect extensive areas of shoreline and coastal and estuarine habitats. Although these are rare events, the impacts of such releases on coastal and estuarine habitats could range from moderate to major if they were to occur.

4.6.3.4.2 Marine Benthic and Pelagic Habitats. Cumulative impacts on marine benthic and pelagic habitats in the GOM result from any activities that disturb ocean bottom or marine habitats, increase sediment suspension (turbidity), degrade water quality, or affect the food supply of biota living in these habitats. Ongoing and future actions/trends that affect these resources include oil and gas activities in State waters, commercial shipping (including tankers), dredging and disposal of dredging spoils in OCS waters, and anchoring. Ongoing and future State and OCS oil and gas activities could also affect seafloor and pelagic habitats; these activities include marine vessel traffic, seismic surveys, and construction (all noise-producing activities), well drilling, pipeline placement (trenching, landfalls, and construction), platform placement (anchoring, mooring, and removal, except in deep waters), and routine discharges (drilling, production, platform, and vessel). Accidental oil spills are included among these actions. Cumulative impacts on benthic and pelagic habitats in the GOM are considered to be moderate to major.

Routine operations under the Program in the GOM could result in mainly temporary and localized impacts from ground disturbance during drilling and pipeline and platform placement, as well as the discharge of drilling muds and cuttings and produced water (sensitive habitats could have long term affects depending on their proximity to these activities). The incremental contribution to cumulative impacts on marine benthic habitats could range from negligible to medium and would be limited by existing mitigation measures. The incremental impacts of expected accidental oil spills on benthic habitats (most of which are less than 1,000 bbl) could range from negligible to small, depending on the size, duration, timing, and location of the spill, and the nature (i.e., sensitivity) of the benthic habitat contacted by oil. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could result in minor to moderate impacts if they were to occur. Major impacts to coral reef habitats could occur if the Flower Gardens Banks are heavily oiled and high mortality occurs.

4.6.3.4.3 Essential Fish Habitat. Cumulative impacts on EFH in the GOM result from any activities that kill managed fish species, disturb ocean bottom habitats, increase sediment suspension (turbidity), degrade water quality, or affect the food supply for fishery resources. Ongoing and future actions/trends that affect these resources include commercial fishing, commercial shipping (and other marine vessel traffic), land development, water quality degradation, dredge/fill and disposal operations, the construction of channel stabilization structures such as jetties, and climate change. Ongoing and future State and OCS oil and gas activities affect EFH; these include the generation of noise, well drilling, pipeline placement, subsea production well and platform placement, and routine discharges. Accidental oil spills are also among these actions. Cumulative impacts on EFH in the GOM are considered to be moderate to major.

Routine operations under the Program in the GOM could result in moderate short- and long-term impacts to EFH and managed species, mainly as a result of bottom disturbance and the creation of artificial reefs by production platforms. The incremental contribution to cumulative impacts on EFH could be negligible to medium and would be limited by specific lease stipulations. The incremental impacts of expected accidental oil spills on EFH (most of which are less than 1,000 bbl) would range from negligible to small, depending on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could result in minor to moderate impacts if they were to occur.

4.6.3.5 Summary for Alaska – Cook Inlet

4.6.3.5.1 Coastal and Estuarine Habitats. Sensitive shoreline habitats in the lower Cook Inlet include marshes, sheltered tidal flats, sheltered rocky shores, and exposed tidal flats. Coastal habitats along Cook Inlet are influenced by dynamic tidal currents. Cumulative impacts on coastal and estuarine habitats result from the loss of beach and wetland habitat in Cook Inlet. While there are no past or ongoing OCS activities in the Cook Inlet Planning Area, other ongoing and future actions/trends that affect these resources include those related to State oil and gas development, commercial shipping (and other marine vessel traffic), coastal development, discharge of municipal wastes and other effluents, domestic transportation of oil and gas, logging, and climate change. These activities can be reasonably expected to continue into the future. Cumulative impacts on coastal and estuarine habitats in Cook Inlet are considered to be moderate.

Routine operations under the Program in Cook Inlet would result in minor localized impacts, primarily due to pipeline, road, and onshore facility construction, and marine vessel traffic. The contribution of the Program to cumulative impacts therefore would generally be negligible to medium. The effects of accidental oil spills on coastal and estuarine habitats could be negligible to medium, and depending on the location, timing, duration, and size of the spill, and the timing and nature of spill containment and cleanup activities. Most expected oil spills are small (less than 50 bbl) and would not likely contact and affect coastal and estuarine habitats. Impacts associated with large oil spills (1,000 bbl or greater) or an unexpected, low-probability CDE that occur in or reach shallower nearshore areas have the greatest potential to affect extensive areas of shoreline and coastal and estuarine habitats. Although these are rare events, the impacts of such releases on coastal and estuarine habitats could range from moderate to major if they were to occur.

4.6.3.5.2 Marine Benthic and Pelagic Habitats. Cumulative impacts on marine benthic and pelagic habitats in Cook Inlet result from any activities that disturb ocean bottom or marine habitats, increase sediment suspension (turbidity), degrade water quality, or affect the food supply of biota living in these habitats. Ongoing and future actions/trends that affect these resources include oil and gas activities in State waters, commercial shipping (including tankers), dredging and disposal of dredging spoils in OCS waters, and anchoring. State oil and gas activities (in upper Cook Inlet) and future OCS activities could affect seafloor and pelagic habitats; these include the generation of noise, well drilling, pipeline placement, subsea production well and platform placement, and routine discharges. Accidental oil spills are also among these actions. Cumulative impacts on benthic and pelagic habitats in Cook Inlet are considered to be moderate to major.

Routine operations under the Program in Cook Inlet could result in negligible to moderate impacts from ground disturbance during drilling and pipeline and platform placement, as well as the discharge of drilling muds and cuttings and produced water. The incremental contribution to cumulative impacts on marine benthic habitats could range from negligible to medium and would be limited by existing mitigation measures. The incremental contribution to cumulative impacts on marine benthic habitats could range from negligible to medium and would be limited by existing mitigation measures. The incremental impacts of expected accidental oil spills on benthic habitats (most of which are less than 1,000 bbl) could range from negligible to small, depending on the size, duration, timing, and location of the spill, and the nature (i.e., sensitivity) of the benthic habitat contacted by oil. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could result in minor to moderate impacts if they were to occur.

4.6.3.5.3 Essential Fish Habitat. Cumulative impacts on EFH in Cook Inlet result from any activities that kill managed fish species, disturb ocean bottom habitats, increase sediment suspension (turbidity), degrade water quality, or affect the food supply for fishery resources. Ongoing and future actions/trends that affect these resources include land use practices (e.g., logging), point and non-point source pollution, dredging and disposal operations, anchoring, fishing (commercial, subsistence, personal use, and sportfishing), and commercial shipping (including imported oil). Subsistence fishing is subject to harvest limits that reduce the potential for overfishing, and much of Cook Inlet is defined as a nonsubsistence area where subsistence fishing is not authorized. For this reason, the impacts related to subsistence are considered minor. State oil and gas activities (in upper Cook Inlet) and future OCS activities could affect EFH (there are no ongoing OCS activities in the inlet); these include the generation of noise, well drilling, pipeline placement, subsea production well and platform placement, and routine discharges. Accidental oil spills are also among these actions. Cumulative impacts on EFH in the Cook Inlet are considered to be minor to moderate.

Routine operations under the Program in Cook Inlet could result in moderate short- and long-term impacts to EFH and managed species, mainly as a result of bottom disturbance during the placement of pipelines and production platforms. The incremental contribution to cumulative impacts on EFH could be negligible to medium and would be limited by specific lease stipulations. The incremental impacts of expected accidental oil spills on EFH (most of which are less than 1,000 bbl) would range from negligible to small, depending on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could result in moderate to major impacts if they were to occur.

4.6.3.6 Summary for Alaska – Arctic

4.6.3.6.1 Coastal and Estuarine Habitats. Arctic coastal habitats are greatly influenced by a short growing season and extremely cold winters; onshore sediments are underlain by permanently frozen soil (permafrost). They are also greatly affected by the dynamics of sea ice, which dominates coastal habitats during most of the year. The Arctic coastline is highly disturbed due to the movement of sea ice that frequently is pushed onshore, scouring and scraping the coastline. The effects of climate change on Arctic habitats are also significant. These include decreases in sea ice cover, warming of permafrost, a longer growing season, and changes in precipitation. Portions of the coast have experienced considerable erosive losses (up to 457 m [1,500 ft]) over the past few decades; the erosion rate in areas of the Beaufort Sea coast more than doubled between 1955 and 2005. Projections for future climate change indicate that these changes are expected to continue.

Cumulative impacts on barrier beaches and dunes result from factors that increase erosion of beach and dunes, such as disturbance of dune vegetation or beach and dune substrates. Increases in wave action also contribute to the erosion of beaches. Accidental oil spills may also affect these resources. While there are no past or ongoing OCS activities in the Beaufort Sea and Chukchi Sea Planning Areas (other than exploratory drilling), other ongoing and future actions/trends that affect beaches and sand dunes include those related to State oil and gas development, commercial shipping (and other marine vessel traffic), coastal development, and climate change. These activities can be reasonably expected to continue into the future. Cumulative impacts on coastal and estuarine habitats in the Arctic region are considered to be moderate.

Routine operations under the Program in the Arctic region would result in minor localized impacts primarily due to pipeline, road, and onshore facility construction, and marine vessel traffic. The contribution of the Program to cumulative impacts therefore would generally be small to medium. The effects of expected accidental oil spills on coastal and estuarine habitats could be negligible to large, depending on the location, timing, duration, and size of the spill, and the timing and nature of spill containment and cleanup activities. Most expected oil spills are small (less than 50 bbl) and would not likely contact and affect coastal and estuarine habitats. Impacts associated with large oil spills (1,000 bbl or greater) or an unexpected, low-probability CDE, however, can affect extensive areas of shoreline and coastal and estuarine habitats. Although these are rare events, the impacts of such releases on coastal habitats could range from moderate to major if they were to occur.

4.6.3.6.2 Marine Benthic and Pelagic Habitats. Cumulative impacts on marine benthic and pelagic habitats in the Arctic region result from any activities that disturb ocean bottom or marine habitats, increase sediment suspension (turbidity), degrade water quality, or affect the food supply of biota living in these habitats. Ongoing and future actions/trends that affect these resources include oil and gas activities in State waters, commercial shipping (including tankers), dredging and disposal of dredging spoils in OCS waters, and anchoring. State oil and gas activities (especially along the Beaufort Sea coastline) and future OCS activities could affect seafloor and pelagic habitats; these activities include the generation of noise, well drilling, pipeline placement, subsea production well and platform placement, and routine discharges. Accidental oil spills are also among these actions. Cumulative impacts on benthic and pelagic habitats in the Arctic region are considered to be moderate to major.

Routine operations under the Program in the Arctic region could result in impacts from ground disturbance during drilling and pipeline and platform placement, as well as the discharge of drilling muds and cuttings and produced water (sensitive habitats could have long term affects depending on their proximity to these activities). The incremental contribution to cumulative impacts on marine benthic habitats could range from negligible to medium and would be limited by existing mitigation measures. The incremental impacts of expected accidental oil spills on benthic habitats (most of which are less than 1,000 bbl) would range from negligible to small, depending on the size, duration, timing, and location of the spill, and the nature (i.e., sensitivity) of the benthic habitat contacted by oil. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could result in minor to moderate impacts if they were to occur.

4.6.3.6.3 Essential Fish Habitat. Cumulative impacts on EFH in the Arctic region result from any activities that kill managed fish species, disturb ocean bottom habitats, increase sediment suspension (turbidity), degrade water quality, or affect the food supply for fishery resources. Ongoing and future actions/trends that affect these resources include subsistence fishing, commercial shipping (including tankers and other marine vessels), coastal modifications, hardrock mining, dredging and disposal operations, anchoring, and climate change. Commercial fishing does not occur in the Beaufort Sea and Chukchi Sea Planning Areas. Sportfishing in the Arctic region is currently a minor activity, but could increase if regulations change and warming temperatures allow an increase in marine vessel traffic. State oil and gas activities (especially along the Beaufort Sea coastline) and future OCS activities could affect EFH; these activities include the generation of noise, well drilling, pipeline placement, subsea production well and platform placement, and routine discharges. Accidental oil spills are also among these actions. Cumulative impacts on EFH in the Arctic region are considered to be moderate to major.

Routine operations under the Program in the Arctic region could result in moderate short- and long-term impacts to EFH and managed species, mainly as a result of bottom disturbance during the placement of pipelines and production platforms. The incremental contribution to cumulative impacts on EFH could be negligible to medium and would be limited by specific lease stipulations. The incremental impacts of expected accidental oil spills on EFH (most of which are less than 1,000 bbl) would range from negligible to small, depending on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH. Large spills (1,000 bbl or greater) and unexpected CDEs would also depend on these factors, and could result in minor to moderate impacts if they were to occur.

4.6.4 Marine and Coastal Fauna

Previous BOEM/MMS NEPA documents for OCS lease sales have addressed cumulative impacts on marine and coastal fauna. Unless referenced otherwise, the following cumulative impacts discussion includes information provided in those NEPA documents prepared for the GOM (see http://www.gomr.boemre.gov/homepg/regulate/environ/nepa/nepaprocess.html) and for Alaska (see http://alaska.boemre.gov/ref/eis_ea.htm).

4.6.4.1 Gulf of Mexico Region

4.6.4.1.1 Mammals. Section 4.4.7.1.1 discusses direct and indirect impacts on marine and terrestrial mammals in the GOM region resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Section 4.4.6.1.1) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS activities. Table 4.6.1-2 presents the exploration and development scenario for the GOM cumulative case, which takes into account activities associated with the Program in combination with those from other ongoing and future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the GOM are summarized in Table 4.6.1-5 and discussed below, as applicable.

Marine Mammals. The cumulative analysis considers past, ongoing, and foreseeable future human and natural activities that may occur and adversely affect marine mammals in the same general area. These activities include effects of the OCS Program (proposed action and prior and future OCS sales), oil and gas activities in State waters, commercial shipping, commercial fishing, recreational fishing and boating activities, military operations, scientific research, and natural phenomena. Specific types of impact-producing factors considered include noise from numerous sources, pollution, ingestion and entanglement in marine debris, vessel strikes, habitat degradation, military activities, industrial development, community development, climate change, and natural catastrophes. Section 4.4.7.1.1 provides the major impact-producing factors related to the Program.

Routine Activities.

OCS Activities. Marine mammals and their habitats in the GOM could be affected by a variety of exploration, development, and production activities as a result of the proposed and future OCS leasing actions (see Section 4.4.7.1.1). These activities include seismic exploration, offshore and onshore infrastructure construction, discharge of operational wastes, vessel and aircraft traffic, and explosive removal of platforms. Impacts on marine mammals from these activities may include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats.

Potential impacts (primarily behavioral disturbance) on marine mammals from OCS-related seismic activity would be short term and temporary, and not expected to result in population level impacts for any affected species with implementation of appropriate mitigation measures.

Impacts from OCS construction and operation activities could include the temporary disturbance and displacement of individuals or groups by construction equipment and long-term disturbance of some individuals from operational noise. No long-term, population-level effects are expected because individuals most affected by these impacts would be those in the immediate vicinity of the construction site or operational platform and disturbance of individuals during construction would be largely temporary.

Operational and waste discharges (e.g., produced water, drilling muds, and drill cuttings) would be disposed of through downhole injection into NPDES-permitted disposal wells, and would not be expected to result in any incremental impacts on marine mammals. Liquid wastes (such as bilge water) may also be generated by OCS support vessels and on production platforms. While these wastes may be discharged (if permitted) into surface waters, they would be rapidly diluted and dispersed, and are expected to result in minor incremental impacts on marine mammals. Drilling and production wastes may contain materials such as metals and hydrocarbons, which can bioaccumulate through the food chain into the tissues of marine mammals. Although the bioaccumulation of anthropogenic chemicals has been reported for a variety of marine mammals, adverse impacts or population-level effects resulting from such bioaccumulation have not been demonstrated (Norstrom and Muir 1994; Muir et al. 1999).

Marine mammals could be temporarily disturbed by OCS vessel traffic (all species) or incur injury or death from collisions with support vessels (primarily larger, slower moving cetaceans). The addition of up to 1,900 OCS vessel trips per week under the Program could result in minor to moderate incremental impacts to marine mammals, be largely short term, and not result in population-level effects. Noise from helicopter overflights would be transient. Impacts on marine mammals would be behavioral in nature, primarily resulting in short-term disturbance in normal activities, and would not be expected to result in population-level effects. Appropriate mitigation measures could lessen the potential for incremental impacts from vessel and helicopter traffic.

There have been no documented losses of marine mammals resulting from explosive removals of offshore oil and gas structures, but there are sporadic incidents reported of marine mammals being killed by underwater detonations (Continental Shelf Associates 2004b; MMS 2007e, 2008a). Harassment of marine mammals as a result of a non-injurious physiological response to the explosion-generated shock wave as well as to the acoustic signature of the detonation is also possible. However, explosive platform removals would comply with BOEM guidelines and would not be expected to adversely affect marine mammals in the GOM.

All of the marine mammals in the GOM are potentially exposed to OCS-industrial activities (particularly noise) due to the rapid advance into the GOM deep oceanic waters by the oil and gas industry in recent years; whereas, over two decades ago, the confinement of industry to shallower coastal and continental shelf waters generally only exposed the bottlenose dolphin, Atlantic spotted dolphin, and West Indian manatee to industry activities and their related sounds. Industry noise sources include seismic operations, fixed platforms and drilling rigs, drilling ships, helicopters, vessel traffic, and explosive operations (particularly for structure removal).

Non-OCS Activities. A number of non-OCS activities such as State oil and gas exploration and development, commercial and recreational fishing, marine vessel traffic, industrial and municipal discharges, climate change, and invasive species could also affect marine mammals in the GOM.

Oil and Gas Exploration and Development in State Waters. Exploration, construction, and operation activities associated with State leases would occur in nearshore and coastal areas, while OCS platforms and pipelines would be located away from coastal areas (with the exception of relatively few pipeline landfalls and onshore bases and processing facilities). Thus, State oil and gas leasing activities may be expected to have a greater potential for affecting marine mammals in coastal habitats than would the proposed OCS actions. The marine mammal species most likely affected by State leases are the bottlenose dolphin, Atlantic spotted dolphin, and the West Indian manatee.

Commercial Fisheries. Commercial fisheries are an impacting factor for marine mammals in the GOM. These fisheries employ a variety of methods, such as longlines, seines, trawls, and traps, which can result in the entanglement, injury, and death of mammal mammals. For more than a decade, however, few human-induced mortalities or serious injuries of marine mammals due to commercial fishery interactions have occurred in the GOM. The following interactions with commercial fisheries were reported by Waring et al. (2010):

- In 2008, one mortality and two serious injuries of Risso's dolphins in the GOM related to entanglement interactions with the pelagic longline fishery.

- In 2008, there was one killer whale released alive after an entanglement incident with the pelagic longline fishery.

- In 1999, there was one reported stranding of a false killer whale that was likely caused by fishery interactions or other human-related causes evidenced by its fins and flukes having been amputated.

- From 1998 through 2007, there were no reported fishing-related mortalities of short-finned pilot whales in the GOM. However, one animal was released alive after an entanglement interaction with the pelagic longline fishery.

- From 1998 through 2007, there were no reported fishing-related mortalities of beaked whales in the GOM. However, during 2007, one unidentified beaked whale was released alive after an entanglement interaction with the pelagic longline fishery.

- From 1998 through 2008, there were no reported fishing-related mortalities of sperm whales in the GOM. However, one animal was released alive with no serious injuries after an entanglement interaction with the pelagic longline fishery.

- Some bottlenose dolphins have suffered mortalities associated with the shark bottom longline fishery, pelagic longline fishery, shrimp trawl fishery, blue and stone crab trap/pot fisheries, menhaden purse seine fishery, and gillnet fishery. Strandings of bottlenose dolphins have also occurred throughout the northern GOM from both human-caused and natural events. Human-caused strandings result from gear entanglement, mutilation, gunshot wounds, vessel strikes, contaminants, and ingestion of foreign objects.

- Fishery interactions likely caused the stranding of two Atlantic spotted dolphins in 2004.

- A stranded spinner dolphin had monofilament line around its tail and abrasions around its flukes as though it had been towed. It also had possible propeller marks.

Marine Vessel Traffic. There are a number of non-OCS activities that are occurring in the GOM that could result in collisions between marine mammals and ships. These activities include dredging and marine disposal, the domestic transportation of oil and gas, State oil and gas development, foreign crude oil imports, commercial shipping and recreational boating, commercial fisheries, and military training and testing activities. Vessel traffic associated with these activities may also disturb normal behaviors with unknown long-term consequences. With all of these activities, the GOM is one of the world's most concentrated shipping areas (USACE 2010). The GOM also supports an extensive commercial fishery, as well as recreational boating. Because of the very large number of vessels typically present in the GOM, the potential for vessel-marine mammal collisions is high, and may be expected to increase for the foreseeable future. The amount of OCS-related vessel traffic anticipated as a result of the Program is provided in Table 4.4.1-1.

Contaminants. There are a number of non-OCS facilities or activities that discharge wastes to GOM waters, and thus may expose marine mammals to potentially toxic materials or solid debris that they could become entangled in or ingest. These facilities or activities include sewage treatment plants, industrial manufacturing or processing facilities, electric generating plants, cargo and tanker shipping, cruise ships, commercial fishing, and recreational pleasure craft. In addition, the Mississippi River (and to a lesser extent, other rivers and streams that discharge to the northern GOM) discharges waters containing suspended sediments, fertilizers, herbicides, and urban runoff (Rabalais et al. 2001, 2002a). While marine mammals are exposed to a variety of contaminants from these discharges, little is known about the levels of contaminants at which lethal or sublethal effects may be incurred. These discharges may also affect habitat quality in the vicinity of the discharges.

The role of exposure to toxins to marine mammal mortality is unknown. Elevated levels of chemicals such as polychlorinated biphenyls (PCBs) and pesticides have been measured in individuals sampled from waters that receive municipal, industrial, and agricultural inputs and have high concentrations of contaminants (Waring et al. 2010; see discussion on bottlenose dolphins, GOM eastern coastal stock). There is little information, however, regarding the level at which tissue concentrations of contaminants may result in lethal or sublethal effects.

Climate Change. Marine mammal populations throughout the GOM may be adversely affected by climate change and, to a lesser extent, by hurricane events. There is growing evidence that climate change is occurring, and potential effects in the GOM may include a change (i.e., rise) in sea level or a change in water temperatures. Such changes could affect the distribution, availability, and quality of feeding habitats and the abundance of food resources. It is not possible at this time to identify the likelihood, direction, or magnitude of any changes in the environment of the GOM due to changes in the climate, making it also difficult, if not impossible, to speculate on the climate change impacts on marine mammals. Such information is not, however, essential to a reasoned choice among the alternatives in this PEIS (see Section 1.4.2). Climate change is occurring independently of OCS Program activity, and choosing any alternative presented herein will likely have little or no effect on the occurrence of climate change.

Natural Catastrophes. Severe storm events such as hurricanes may result in direct or indirect mortality of manatees and have the potential to impact their nearshore habitats (Langtimm and Beck 2003). Heightened wave action and intensity could alter nearshore channels affecting the abundance and distribution of shallow-water habitats such as lagoons and bays, while sediments deposited into foraging habitats by storm waves may alter the thermal environment and affect aquatic vegetation in feeding habitats. Because hurricanes are annual events that are an inherent component of the overall GOM ecosystem, it may be assumed that marine mammals of the GOM have experienced hurricane impacts in the past and may be expected to continue to experience future hurricane events.

***Other Impacting Factors*.** Marine mammals may also be impacted by other factors such as unusual mortality events (UMEs) and invasive species. A UME is an unexpected stranding that involves a significant die-off of any marine mammal population, and demands immediate response (NMFS 2011b). Since establishment of the UME program in 1991 through December 2011, there have been 55 formally recognized UMEs in the U.S., with a third of them occurring in the GOM (NMFS 2011b). Species in the GOM most commonly involved in UMEs are bottlenose dolphins and manatees. An ongoing UME in the GOM is discussed in Section 3.8.1.1.1. Causes of UMEs have been determined for 26 of the UMEs, and include infections, biotoxins (particularly domoic acid and brevetoxin), human interactions, and malnutrition. Red tides in the GOM, caused by annual blooms of the dinoflagellate Karenia brevis, are the source of UMEs caused by biotoxins in the GOM (NMFS 2011b). Invasive species could affect some marine mammals by disrupting local ecosystems and fisheries of the GOM. As examples, the Australian jellyfish (Phylloriza punctata) introduced to the northern GOM may feed heavily on juvenile fish and fish eggs (Ray 2005), while exotic shrimp viruses may affect shrimp and other crustaceans such as copepods and crabs (Batelle 2001). These could affect the prey base for some marine mammals.

***Accidents*.** Marine mammals could be exposed to oil accidentally released from platforms, pipelines, and vessels (Table 4.4.2-1). Potential non-OCS sources of oil spills in the GOM include the domestic transportation of oil, State oil and gas development, and natural sources such as oil seeps. Accidental oil releases from OCS activities and other sources could expose marine mammals to oil by direct contact or through the inhalation or ingestion of oil or tar deposits. The magnitude and duration of exposure will be a function of the location, timing, duration, and size of the spill; the proximity of the spill to feeding and other important habitats; the timing and nature of spill containment; and the status of the affected animals. Depending on their location, as well as the location of non-OCS oil sources, accidental spills associated with the Program could contribute to the overall exposure of marine mammals in the northern GOM. Most expected small to medium spills (less than 1,000 bbl) would have limited effects on marine mammals due to the relatively small areas likely to incur high concentrations of hydrocarbons and the short period of time during which potentially toxic concentrations would be present. The magnitude of impact would be expected to increase should a spill occur in habitats important to marine mammals or affect a number of individuals from a population listed under the ESA. However, some spills from OCS activity may locally represent the principal source of oil exposure for some species, especially for spills contacting important coastal and island habitats.

Cumulative impacts on marine mammals in the GOM as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be minor to moderate over the next 40 to 50 years. Non-OCS activities or phenomena include climate change, natural catastrophes, contaminant releases, vessel traffic, commercial fishing, and invasive species. The incremental contribution of routine Program activities to these impacts would be negligible to medium (see Section 4.4.7.1.1).

Marine mammals may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS activities as well as naturally occurring seeps. The cumulative impacts of past, present, and future oil spills on marine mammals would be minor to moderate. The incremental impacts of expected accidental spills associated with the Program on marine mammals would be small to large, depending on the location, timing, and volume of the spills; the environmental settings of the spills; and the species exposed to the spills (Section 4.4.7.1.1). Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from moderate to major if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to the impacts of spills regardless of size, but their incremental contribution to cumulative impacts is generally expected to be small. A more detailed discussion of the effects of oil spills on marine mammals in the GOM is presented in Section 4.4.7.1.1.

Terrestrial Mammals. Under the Program, terrestrial mammals in the GOM are not expected to be affected by routine OCS-related activities (Section 4.4.7.1.1). The terrestrial mammals considered in the impact analysis for the Program are four federally endangered GOM coast beach mouse subspecies and the federally endangered Florida salt marsh vole. Because of the listing of these species under the ESA, as well as their occurrence in protected areas, the siting and construction of any onshore facilities associated with the Program would be required to take into account these species and their habitats, and construction activities would not be allowed in the habitats of these species.

Present beach mice habitat is no longer of optimal quality because of historical beach erosion, construction, and tropical storm damage. Dredge-and-fill activities occur throughout the nearshore areas of the U.S. and disrupt beach and transport, which could affect coastal systems of dunes where beach mice live. Coastal construction and traffic can be expected to threaten beach mice populations on a continual basis. Natural catastrophes including storms, floods, droughts, and hurricanes can substantially reduce or eliminate beach mice. Storms can wash large amounts of debris into dune and marsh habitats. Trash and debris may be mistakenly consumed by beach mice or may entangle them. Cleanup efforts to remove debris could result in adverse habitat impacts. Other activities that threaten beach mice and the Florida salt marsh vole include predation and competition, artificial lighting, and coastal spills. Predation from feral and free-ranging cats and dogs, feral hogs, coyotes, and red foxes, and competition with common house mice could reduce beach mice and Florida salt marsh vole populations. Isolation of small populations of beach mice due to habitat fragmentation can preclude gene flow between populations and cause a loss of genetic diversity. Separation of frontal dune habitat from scrub habitat by a highway can make a beach mouse especially vulnerable to hurricane impacts. Global climate change and sea level rise could also impact the Florida salt marsh vole and beach mice (Bird et al. 2009; USFWS 2008, 2009; Wooten 2008).

Activities in the GOM that could result in the accidental release of oil and may affect terrestrial mammals and their habitats include oil production from prior, proposed, and future OCS sales; domestic transportation of oil; State oil development; foreign crude oil imports; and military training activities involving open-water ship refueling. If spills from these activities occur in the vicinity of, or are transported by GOM currents to, the habitats of the beach mice or the Florida salt marsh vole, potential impacts would be similar in nature to those identified for the Program. Impacts associated with an oil spill may include loss of thermoregulatory ability from oiling of fur, lethal and sublethal toxic effects from inhalation or ingestion of oil or oil-contaminated foods, a decrease in food supply due to oiled vegetation, a decrease in habitat quantity and quality due to oiling of beach sands, and the fouling of burrows and nests. In addition, spill response activities could further impact habitats due to beach cleanup activities and vehicle and pedestrian traffic.

Given the relatively small number of spills that are expected under the Program and during the life of the Program (Table 4.6.1-4), the requirement under the *Oil Pollution Act of 1990* to prevent contact of protected or sensitive habitats (such as the habitats of the beach mice and the salt marsh vole) with spilled oil, and the need of a spill to be associated with environmental conditions (such as a storm surge sufficient to transport the spilled oil over foredunes) that could favor exposure of the species and their habitats, relatively minor cumulative impacts are expected from accidental oil spills from all potential sources, and the incremental contribution of spills associated with the Program is expected to be small.

Conclusion. Cumulative impacts on terrestrial mammals in the GOM as a result of ongoing and future OCS and non-OCS program activities could be minor to moderate over the next 40 to 50 years. Non-OCS activities or phenomena that may affect populations of terrestrial mammals include climate change, natural catastrophes, contaminant releases, vehicle traffic, and invasive and feral species. The incremental contribution of routine Program activities to these impacts would be negligible to medium (see Section 4.4.7.1.1).

Terrestrial mammals may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS operations. The cumulative impacts of past, present, and future oil spills on terrestrial mammals could be minor to moderate. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on terrestrial mammals would be small to large, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and other important habitats; the timing and nature of spill containment; and the status of the affected animals (see Section 4.4.7.1.). It is unlikely that the Florida salt marsh vole would be affected by an oil spill because its habitat is located far from areas where oil and gas leasing and development occur. However, if their habitat is oiled, the incremental contribution to cumulative impacts on this species could be small to medium (depending on the size of the spill).

An unexpected, low-probability CDE has a greater potential to affect the habitats of beach mice and the Florida salt marsh vole; therefore, impacts would range from moderate to major if one were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to the impacts of spills regardless of size, but their incremental contribution to cumulative impacts is generally expected to be small. A more detailed discussion of the effects of oil spills on terrestrial mammals in the GOM is presented in Section 4.4.7.1.1.

4.6.4.1.2 Marine and Coastal Birds. Section 4.4.7.2.1 discusses direct and indirect impacts on marine and coastal birds in the GOM resulting from the Program (OCS program activities from 2012 to 2017). Cumulative impacts on marine and coastal birds result from the incremental impacts of the Program when added to impacts from existing and reasonably foreseeable future OCS program activities (that are not part of the Program) and other non-OCS program activities. Table 4.6.1-1 presents the exploration and development scenario for the GOM cumulative case (encompassing the Program and other OCS program activities) over the next 40 to 50 years. A number of OCS program activities could affect GOM marine or terrestrial birds or their habitats; these include offshore structure placement and pipeline trenching, offshore structure removal, operational discharges and wastes, service vessel and aircraft traffic, construction and operation of onshore infrastructure (including new pipeline landfalls), and noise. Potential impacts on marine and coastal birds from service program activities include injury or mortality of birds from collisions with platforms, vessels, and aircraft; exposure to operational discharges and ingestion of trash or debris; loss or degradation of habitat due to construction activities; and behavioral disturbance due to the presence of, and noise generated by, equipment and human activity.

Non-OCS program activities affecting marine and coastal birds include dredging and marine disposal; coastal and community development; onshore and offshore construction and operations of facilities associated with State oil and gas development and with the extraction of nonenergy minerals; commercial and recreational boating; and small aircraft traffic. Potential impacts on marine and coastal birds from these activities are similar to those under the OCS program and include injury or mortality of birds from collisions with platforms associated with State oil and gas development and other onshore and offshore structures (e.g., radio, television, cell phone towers or wind towers); non-energy mineral mines (e.g., sand and gravel and other hard minerals mined in the northern part of the GOM; onshore industrial, commercial, and residential development; exposure to discharges from permitted point sources such as sewage treatment discharges and nonpoint sources such as irrigation runoff, or accidental releases (e.g., oil spills), as described in Section 4.6.2.1.1 and summarized in Table 4.6.1-5; exposure to emissions from various onshore and offshore sources (e.g., power generating stations, refineries, and marine vessels), as described in Section 4.6.2.1.2; ingestion of trash or debris; loss or degradation of habitat due to construction and operations activities; and behavioral disturbance due to the presence of noise generated by equipment and human activity. Other trends such as sea level rise and increasing seawater temperature brought on by global climate change, as well as extreme wind conditions from storm events, are also expected to adversely affect marine and coastal birds over the next 40 to 50 years.

Injury or Mortality from Collisions. Birds are drawn to lighted platforms and often circle the platform before moving on or stopping. This behavior increases the potential for platform collision (Russell 2005). Annual bird collision mortalities under the Program (estimated at about 10,000 to 22,500) represent less than 0.01% of the hundreds of millions of birds that annually migrate across the GOM (Russell 2005). Under the cumulative scenario, annual collision mortality (estimated at 200,000 birds under current OCS activities in the GOM) could increase by about 8%. During the life of the Program from 2012 to 2017, older platforms would be decommissioned and removed as new platforms are installed, so it is likely that the estimated 200,000 collision-related deaths per year would persist throughout the life of the program. The Program would likely result in a small incremental increase of the total annual bird collision mortality in the GOM that occurs from collisions with other OCS and non-OCS structures (Klem 1990; Kerlinger 2000).

Exposure to Wastewater Discharges and Air Emissions. The discharge of operational wastes and air emissions from current OCS- and non-OCS-related marine vessel traffic and platform operations is strongly regulated and would continue to be regulated over the next 40 to 50 years. However, such wastes and emissions would still expose marine and coastal birds to potentially toxic materials or to solid debris that could be ingested or result in entanglement. In addition, the Mississippi River, and, to a lesser extent, other rivers and streams annually discharge waters containing suspended sediments, agricultural fertilizers and herbicides, and urban runoff to the northern GOM (Rabalais et al. 2001, 2002b). Birds and their habitats in the vicinity of these discharges may be exposed to lethal and sublethal levels of contaminants. Operational wastewater discharges and air emissions associated with the Program would contribute to the overall cumulative risk of toxic exposure and debris ingestion or entanglement of existing OCS and non-OCS wastewater discharges and air emissions in the GOM, but the incremental increase in impact is expected to be small relative to these other activities.

Under the Program, marine and coastal birds could be exposed to oil accidentally released from platforms, pipelines, and marine vessels, and would be most susceptible to adverse impacts from spills occurring in coastal areas and affecting feeding and nesting areas. Accidental oil releases occur in the GOM from a variety of non-OCS related activities, such as the domestic transportation of oil, import of foreign crude oil, and State development of oil. Crude oil may also enter the environment of the northern GOM from naturally occurring seeps (MacDonald et al. 1996; MacDonald 1998; NRC 2003b). Oil releases from all sources may expose marine and coastal birds via direct contact or through the inhalation or ingestion of oil or tar deposits (see Section 4.4.7.2.1).

The spills that could occur in the cumulative scenario are shown in Table 4.6.1-3. Spills from non-OCS sources could occur from import tankers, State oil and gas operations, and coastal transportation of crude and refined petroleum products. Releases from natural seeps in the northern part of the GOM have been estimated at about 73,000 tons (526,000 bbl) per year (Kvenvolden and Cooper 2003). Most spills associated with the Program would be relatively small (less than 50 bbl) (Table 4.4.2-1). Depending on their location, accidental spills associated with the Program could represent a major component of the overall exposure of marine and coastal birds in the GOM OCS Planning Areas.

The magnitude and duration of exposure, and any subsequent adverse effects, would be a function of the location, timing, duration, and size of the spill; the proximity of the spill to feeding habitats; and the timing and nature of spill containment. Spills in nearshore coastal areas have the greatest potential for impacting high concentrations of bird populations. Most activities associated with the Program would take place in deep or ultra-deep waters. Some seabirds spend a significant amount of time offshore and could be exposed to accidental oil spills that occur in these deep waters, but even marine birds that remain in coastal waters could be exposed to accidental oil spills if they were to occur closer to shore.

Loss and Degradation of Habitat. Marine and coastal birds could be affected by platform construction and removal activities, and pipeline trenching, which could disrupt behaviors of nearby birds. Platforms constructed under the Program would increase the number of offshore platforms present in open-water areas of the northern GOM; and these structures may be used by birds to rest or avoid bad weather conditions during spring and fall migrations across the GOM (see Section 4.4.7.2). The Program would increase the number of platforms to be removed by only 9% of current OCS numbers, and up to 75% of the construction of new platforms would occur in deep water (i.e., 300 m [1,000 ft] or greater), well away from coastal areas. Under the Program, there would also be construction associated with no more than 12 new pipeline landfalls and offshore pipeline placement (Table 4.4.1-1). These platform and pipeline construction activities could add to the overall disturbance level of birds and their habitats from all construction sources in the GOM.

Platform construction and removal under the Program would be localized (primarily in deep water areas) and short in duration, and would result in only a small increase in the overall level of disturbance incurred by birds and their habitats from all construction activities in the GOM OCS Planning Areas. Pipeline trenching and landfall construction that would occur under the Program would similarly be of short duration and limited in extent (associated with no more than 12 new landfalls), and would be expected to contribute little to overall levels of bird disturbance that occur in coastal areas of the GOM on a much more regular basis from existing OCS and non-OCS construction activities, such as channel construction and maintenance, creation of harbor and docking areas and facilities, State oil and gas development (including platform construction and removal), non-energy minerals extraction, and pipeline emplacement.

Marine vessel traffic potentially disturbs, feeding and nesting birds with unknown long-term consequences. The GOM is one of the world's most concentrated commercial shipping areas (COE 2003a, b), and it supports extensive commercial fishing and recreational boating. As a result, OCS and non-OCS program-related vessel traffic disturbs birds on a daily basis. This trend is expected to increase as marine traffic in the GOM increases over the next 40 to 50 years (see Table 4.6.2-1). OCS program-related marine vessel traffic in the GOM could be as high as 1,900 trips per week over the next 40 to 50 years; marine vessel traffic associated with the Program represents about 27% of this traffic (Section 4.6.2.1). Non-OCS program traffic includes that related to crude oil and natural gas imports, commercial container vessels, military and USCG vessels, cruise ships, commercial fishing, and small watercraft. In 2010, the Port of New Orleans alone handled about 7,500 vessel calls (mainly tanker and dry bulk carrier), about 140 vessel calls per week (USDOT 2011b). Impacts on water quality from marine traffic arise from regular discharges of bilge water and waste, leaching of antifouling paints, and incidental spills (MMS 2001d), although operational discharges and spillage from marine vessels have declined substantially in the past few decades (NRC 2003b). Vessel traffic associated with the Program would result in a small increase in the overall disturbance of birds in the GOM region.

Disturbance Due to Noise. Noise generated during construction activities and normal operations (e.g., helicopter overflights) may disturb marine and coastal birds, causing a short-term change in normal behavior and potentially disrupting feeding and nesting activities. Non-OCS activities that currently generate noise in the GOM include construction and/or operation of offshore structures for State oil and gas development; offshore LNG facilities and tankers; marine mineral mining; dredging and marine disposal; commercial and recreational vessel traffic; small aircraft flight; and military training and testing activities. These activities are expected to continue or increase into the foreseeable future. Although noise generated as a result of the Program would likely add only a small increment to the overall (cumulative) noise levels in the GOM, locally it could represent the dominant noise in the environment, resulting in more moderate impacts on marine and coastal birds.

Climate Change and Storm Events. Populations of marine and coastal birds throughout the GOM may be adversely affected by climate change and, to a lesser extent, by storm events (including hurricanes). As discussed in Section 3.3, there is growing evidence that climate change is occurring, and potential effects in the GOM may include sea level rise and increases in water temperatures in the GOM. Over time these changes will result in a loss of wetlands in the GOM, important water bird habitat. Climate change could also affect the distribution, availability, and quality of feeding habitats and the abundance of food resources. It is not possible at this time to identify the likelihood, direction, or magnitude of any changes in the environment of the GOM due to changes in climate; therefore, it is not possible to predict the extent of effects on GOM populations of marine and coastal birds as a result of climate change. It should be noted that such information is not essential to a reasoned choice among OCS program alternatives, even in a cumulative analysis, because the information missing here is missing across the board for all action alternatives (see Section 1.4.2).

Severe storm events such as hurricanes may result in direct or indirect mortality of marine and coastal birds and may impact important coastal habitats. Heightened wave action and intensity could alter nearshore channels, affecting the abundance and distribution of shallow-water habitats such as lagoons and bays, while sediments deposited into foraging habitats by storm waves may alter the thermal environment and affect aquatic vegetation in feeding habitats. Extreme wind conditions could damage or destroy historic rookery sites or disrupt nesting birds. Because storms (including hurricanes) are annual events that are an inherent component of the overall GOM ecosystem, it could be assumed that marine and coastal birds have experienced and largely tolerated extreme weather conditions in the past and may be expected to continue to do so in the foreseeable future. The occurrences and aftermaths of Hurricanes Katrina and Rita in 2004, however, have impacted avian habitats on a large scale throughout the GOM. Large areas of coastal wetlands have been converted to open-water habitat, potentially affecting avian species that utilized the wetlands for foraging, nesting, and as stopover points during migration (Congressional Research Service 2005). Impacts on these habitats have the potential to result in population-level impacts affecting both abundance and distribution of some species.

Hurricane impacts on bottomland forest habitat along the Louisiana and Mississippi coasts represent further loss of avian habitat affecting many species. For example, all forested areas at the Big Branch Marsh National Wildlife Refuge were heavily damaged, with some areas that were previously densely forested left with few standing trees (USFWS 2007). These damaged areas provided habitat for a variety of avian species, and included cavity trees used by the endangered red-cockaded woodpecker. The long-term effects of avian habitat loss due to these hurricanes is not known, and agencies such as the USFWS and USGS are implementing numerous studies and monitoring programs to determine the extent and magnitude of impacts on affected avian populations. The occurrence of similar magnitude storms during the life of the 5-year OCS program could result in population-level impacts on some bird species.

Conclusion. Marine and coastal birds in the GOM could be adversely affected by activities associated with the Program as well as those associated with other OCS program and non-OCS program activities. Potential impacts include injury or mortality of birds from collisions with platforms associated with OCS and State oil and gas development and other onshore and offshore structures (e.g., radio, television, cell phone, or wind towers), non-energy mineral mines; onshore industrial, commercial, and residential development; exposure to discharges from permitted point sources or accidental releases; exposure to emissions from various onshore and offshore sources; ingestion of trash or debris; loss or degradation of habitat due to construction and operations activities; and behavioral disturbance due to the presence of, and noise generated by, equipment and human activity. Other trends such as sea level rise and increasing seawater temperature brought on by global climate change, as well as extreme wind conditions from storm events, are also expected to adversely affect marine and coastal birds over the next 40 to 50 years. While the cumulative impact of all OCS and non-OCS activities in the GOM is expected to be moderate (some impacts are unavoidable, but mitigation can help to alleviate some of the stress on species), the incremental contribution due to the Program would be negligible to medium as most impacts would be temporary and would not be expected to cause population-level impacts (see Section 4.4.7.2.1).

Marine and coastal birds may also be adversely affected by exposure to oil (via direct contact or through the inhalation or ingestion of oil or tar deposits) that is accidentally released from OCS and non-OCS activities, especially near coastal areas and affecting feeding and nesting areas. The incremental contribution of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on marine and coastal birds would be small to large, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and nesting areas; the timing and nature of spill containment; and the status of the affected birds (see Section 4.4.7.2.1). Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from moderate to major if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to the impacts of spills regardless of size, but their incremental contribution to cumulative impacts is generally expected to be small. A more detailed discussion of the effects of oil spills on marine and coastal birds in the GOM is presented in Section 4.4.7.2.1.

4.6.4.1.3 Fish. Section 4.4.7.3.1 discusses direct and indirect impacts on fish communities in the GOM resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Section 4.4.6.1.1) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS activities. Table 4.6.1-2 presents the exploration and development scenario for the GOM cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the GOM are summarized in Table 4.6.1-5 and discussed below, as applicable.

There are numerous fish species that inhabit different niches throughout the surface waters, water column, and benthic environments of the GOM. Routine activities will have varied cumulative effects on fish populations depending on their habitat and life history. Impacts on fish resulting from ongoing and future routine OCS program activities, including those of the

Program, could result primarily from noise (marine vessel traffic, seismic surveys, and construction), well drilling, pipeline placement (trenching, landfalls, and construction), platform placement (anchoring, mooring, and removal, except in deep waters) and routine discharges (drilling, production, platform, and vessel). Accidental oil spills are also counted among OCS program-related activities. Cumulative impacts could result from the combination of the Program and past, present, and reasonably foreseeable future OCS and non-OCS activities.

Routine OCS activities that temporarily disturb sediments and increase turbidity include installation of new pipelines and platforms and discharges of drill cuttings and associated fluids. This could cause soft-bottom fish such as Atlantic croaker, sand sea trout, Atlantic bumper, sea robins, and sand perch to temporarily move from or be attracted to the disturbed area. Fish species that are normally associated with reefs, such as snappers, groupers, grunts, and squirrelfishes, may also move from areas of increased turbidity. Sedimentation could smother eggs, larvae, and juvenile fishes as well as the benthic prey of some of these fish species (see Table 4.6.1-2 for bottom area of disturbance and drilling and operational discharges expected during the life of the Program). The impacts of routine activities (exploration and site development, production and decommissioning) on fish communities are discussed in detail in Section 4.4.7.3.1. Overall, routine activities would result in a minor impact, primarily from disturbance affecting demersal fishes, with the severity of the impacts generally decreasing dramatically with distance from bottom-disturbing activities.

Up to 2,000 new platforms could be constructed under ongoing and future OCS activities, including up to 450 from the Program (Table 4.6.1-2). The addition of new platforms may act as fish attracting devices (FADs) that will significantly alter local fish communities and food web relationships. Many reef species, as well as highly migratory species, use platforms as habitat. There has been some speculation that an increase in FADs could impact the migration patterns of highly migratory species. While many platforms may be allowed to remain as artificial reefs, removal of platforms will reduce available substrate and structures for these fish and some of their prey species. Some fish will be killed in the process of these platform removals, especially when explosives are used to accomplish the removals. A total of up to 1,200 platforms would be subject to explosive removal over the life of the Program, including up to 275 platforms under the Program. A detailed discussion of oil platforms as FADs can be found in Section 4.4.7.3.1.

Non-OCS actions may also negatively influence fish resources in various life stages and habitats. Non-OCS oil and gas exploration and production activities in GOM State waters occur primarily off Louisiana and Texas, and off Alabama in the vicinity of Mobile Bay. The States of Florida and Mississippi have had limited activities in State waters, with a moratorium on drilling activity now in effect in Florida waters. The increasing presence of offshore LNG facilities could lead to impacts associated with entrainment and impingement of eggs, larvae, and juvenile lifestages and discharges of water used in the vaporization process. In addition to the thermal discharge, biocides are also discharged from the facilities. Other non-OCS activities that could impact fish communities include non-OCS activities with a potential to impact marine benthic and pelagic habitats, such as sand mining, sediment dredging and disposal, anchoring, offshore marine transportation, and pollutant inputs from point and non-point sources. Many of these activities would affect bottom-dwelling fishes at various life stages as well as their food sources in a manner similar to OCS bottom-disturbing activities (Section 4.4.7.3.1).

Commercial fishing practices that are indiscriminate, such as some types of trawling and pots, are responsible for significant amounts of bycatch that can injure or kill juveniles of many fish species. These types of fishing practices could damage future year classes, reduce available prey species, and damage benthic habitat for many GOM fish resources. Sportfishing may also contribute significantly to cumulative effects on some fishery resources, and in some cases may affect fish stocks more than commercial fishing. As a consequence of the pressure fishing places on fishery resources, NOAA manages fish stocks using catch and gear limits and regulations in order to prevent the depletion of fish stocks due to overharvesting. A variety of natural and anthropogenic factors influence fish populations; these include food availability, climate, habitat loss, and pollution. Consequently, the possibility of fish stocks declining still exists even for managed species. Currently, gag, tray triggerfish, greater amberjack, and red snapper are overfished in the GOM (NOAA 2011e). OCS Program activities may interact with fishing activities. For example, continued platform placement may increase fishing pressure on overfished reef associated species like snapper and grouper. Large numbers of reef fish may also be killed by explosive platform removal.

The eutrophication that has contributed to the hypoxic zone in the GOM will continue to act as a source of lethal and sublethal stress to fish communities. In addition, natural events, including hurricanes and turbidity plumes, could also cause localized damage to important habitat areas and could affect individuals or populations. However, the GOM fish community as a whole should be adapted to such natural events.

Climate change could affect fish communities through direct physiological action, habitat loss, and by altering large-scale oceanographic and ecosystem processes (Section 3.8.4.1). At the level of individual behavior and physiology, increasing water temperature could increase the spread and virulence of new and existing pathogens, and alter reproductive rates by speeding growth and altering the timing of migrations (including reproductive movements). Fish in river-influenced systems such as the GOM would be particularly susceptible to changes in salinity, turbidity, and temperature linked to changes in the hydrology of the Mississippi River and Atchafalaya River. At larger scales, climate change could promote the range expansion of new species into the GOM, reduce or eliminate critical fish habitats including estuarine waters and coral reef due to sea level rise, and increase the size of the GOM “dead zone,” reducing the amount of benthic habitat available to demersal fishes (Rabalais et al. 2010). Physiological and ecosystem-level stressors related to climate change may interact with the non-climate anthropogenic stressors such as overfishing, pollution, and habitat loss discussed above. For example, a climate change related increase in water temperature that results in physiological stress could also make individuals more susceptible to pollution stress or the effects of an accidental oil spill. Another potential interaction could occur between oil and gas platforms and climate change, in which new hard-bottom associated species are able to expand northward due to warming and the availability of hard substrate in the form of active or decommissioned oil platforms. By acting as stepping stones across the GOM, oil platforms have been implicated in the introduction of a non-native fishes such as sergeant majors (*Abudefduf saxatilis*) and yellowtail snapper (*Ocyurus chrysurus*) into the FGB (Hickerson et al. 2008).

Oil spills resulting from both OCS and non-OCS activities could impact fish communities in the GOM. See Table 4.6.1-4 for anticipated oil spills over the life of the Program.

Catastrophic spill assumptions are provided in Table 4.4.2-2. Crude oil may also enter the environment from naturally occurring seeps. Large spills may also occur from tankers carrying imported oil in the GOM. The potential effects of spills from non-OCS activities would be similar to those described for OCS activities (Section 4.4.7.3.1). Most adult fish in marine environments are highly mobile and are capable of avoiding high concentrations of hydrocarbons, although they may be subject to sublethal exposures. However, eggs and larvae do not have the ability to avoid spills and may therefore suffer lethal or sublethal effects. Any oil spills reaching shallow seagrass, estuarine, or coastal marine habitats could affect fish species that use the affected areas as spawning or juvenile nursery habitat. Coastal pelagic fish and highly migratory species throughout the GOM could come into contact with surface oil, but would most likely move away from affected areas. Because of the wide dispersal of early life history stages of fishes in the GOM surface waters, it is anticipated that only a relatively small proportion of early life stages present at a given time would be impacted by a particular oil spill, which would limit the potential for population-level effects. However, the impact magnitude would also depend on the temporal and spatial scope of the oil spill. Since some species of fish spawn in a limited geographic area(s) during a small temporal window, a spill could have population-level impacts if the spill coincided in time and space with spawning activity. In addition, fish species such as tuna, swordfish, and billfish that currently have depressed populations and important spawning grounds in the GOM could experience population-level impacts if high numbers of early life stages were killed by a spill. The potential impacts of oil spills on fish communities are discussed in detail in Section 4.4.7.3.1.

In addition to effects on individuals and species, impacts to fish can result in ecosystem-level effects if the population impacts are significant. For example, fish in the GOM can occupy a number of trophic levels ranging from herbivore to top level carnivore. As such, fish are critical to energy flow within nearshore and marine food webs. They are also seasonally important food sources to transient carnivores. Consequently, impacts to fish can propagate throughout the food web, affecting sea turtles, birds, and marine mammals. In addition, many GOM fishes migrate between and within marine, estuarine, and freshwater habitats. In doing so, they transfer nutrients and carbon over a broad area and connect offshore and coastal ecosystems (Deegan et al. 2002; Kneib 2002; Haertel-Borer et al. 2004). Significant impacts to fish populations could reduce this transfer, resulting in local changes in productivity.

Fish Species Listed under the Endangered Species Act. Routine activities such as placement and removal of structures, discharges of operational wastes, and accidental spills of oil have the potential to physically harm or disturb individual Gulf sturgeon, smalltooth sawfish, or their respective habitats; cause sedimentation of areas that provide food; or elicit lethal or sublethal toxic effects. As described in Section 3.8.4.1.4, most routine activities would not take place in shallow nearshore habitat preferred by Gulf sturgeon. Gulf sturgeon are also not likely to be directly affected by routine operations that impact estuarine areas because the more vulnerable egg and larval stages are not present in estuarine areas and juveniles and adults will be able to avoid most disturbances. Consequently, it is anticipated that effects on Gulf sturgeon from routine OCS activities would be limited. Smalltooth sawfish are primarily found in peninsular Florida away from the Central and Western Planning Areas. Vulnerable early life stages of smalltooth sawfish exist only in shallow estuarine areas far removed from most routine OCS activities. Adults and larger juveniles do occupy coastal waters where OCS activities would occur. However, it is expected that, given their size, they will be able to avoid direct impacts from routine operations, although their habitat would be disturbed.

In addition to potential effects from OCS oil and gas activities identified above, Gulf sturgeon and smalltooth sawfish could be affected by non-OCS activities such as commercial fishing, water quality degradation, coastal and upland development, dredge and fill activities, and damming of major spawning rivers (Section 3.8.4.1.4). Even though it is illegal to fish for Gulf sturgeon or smalltooth sawfish, some individuals, particularly smalltooth sawfish, may be harmed or killed when captured as bycatch during trawling activities. Dredging and fill activities in estuaries may disturb smalltooth sawfish and Gulf sturgeon habitat. Increased barriers (e.g., locks or dams) to major spawning sites may result in Gulf sturgeon reproducing in less desirable locations. The eggs and fry of Gulf sturgeon are also susceptible to other fish and invertebrate predators as well as anthropogenic effects, such as artificially increased water temperatures due to the release of cooling water from power plants and exposure to pesticides and heavy metals.

Other events, including hurricanes, turbidity plumes, and hypoxia, could also affect Gulf sturgeon, smalltooth sawfish, or their habitat. Regardless, a severe event could cause localized damage to important habitat areas and could result in the introduction of contaminants via surface-water runoff. Therefore, such events could affect individual Gulf sturgeon or population levels for some period of time.

Oil is released in GOM waters by accidental oil spills (OCS and non-OCS) and natural seepage. Non-OCS oil and gas exploration and production activities in GOM State waters occur primarily off Louisiana and Texas, and off Alabama in the vicinity of Mobile Bay. The States of Florida and Mississippi have had limited activities in State waters, with a moratorium on drilling activity now in effect in Florida waters. Non-OCS spills in the GOM could have impacts similar to those for OCS spills. Smalltooth sawfish are primarily found in peninsular Florida and are uncommon in most of the Central and Western GOM Planning Areas. Therefore, oil spills in the GOM have the greatest potential to impact Gulf sturgeon populations. Most spills would be minor and are unlikely to reach estuarine and shelf habitat of adult sturgeon. Spills in shallow areas have the greatest potential to affect Gulf sturgeon. As identified in Section 3.8.4.1, eggs and larvae of Gulf sturgeon are typically located in freshwater areas, and oil from OCS-related spills are unlikely to come into contact with these life stages. Because adult sturgeons are benthic feeders, they are relatively unlikely to come into contact with surface oil in deeper waters.

Conclusion. Cumulative impacts on fish communities in the GOM as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be moderate to major over the next 40 to 50 years. Non-OCS activities or phenomena affecting these resources include oil and gas development in State waters, sand mining, sediment dredging and disposal, LNG facilities, hypoxia, anchoring, fishing/trawling, commercial shipping, and pollutant inputs from point and non-point sources. Many of these activities would affect bottom-dwelling fish at various life stages as well as their food sources in a manner similar to OCS bottom-disturbing activities. The incremental contribution of routine Program activities to these impacts (primarily as a result of disturbance affecting demersal fishes) would be negligible to small, with the severity of impacts generally decreasing with distance from the disturbance. Fish could also be affected by naturally occurring oil seeps and the environmental changes predicted to result from climate change.

Fish communities may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS activities as well as naturally occurring seeps. The cumulative impacts of past, present, and future oil spills on these resources would be minor to moderate. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on fish would be negligible to medium, depending on the location, timing, duration, and volume of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could range up to moderate if they were to occur. Oil from large spills or a CDE has the greatest potential to contact shoreline areas used for spawning or providing habitat for early life stages of fish and, therefore, could result in large-scale lethal and long-term sublethal effects on fish. Overall population levels for individual species would not likely be affected; however, fish species that currently have depressed populations or have critical spawning grounds present in the affected area could experience population-level impacts. A more detailed discussion of the effects of oil spills on fish in the GOM is presented in Section 4.4.7.3.1.

Although Gulf sturgeon may be affected by a variety of OCS and non-OCS activities, most OCS activities occur in deeper areas that are outside of the normal habitat areas used by Gulf sturgeon. Similarly, smalltooth sawfish are primarily found in peninsular Florida away from the Central and Western Planning Areas. Consequently, it is anticipated that the cumulative effects of OCS and non-OCS activities on Gulf sturgeon and smalltooth sawfish would be similar to the effects of non-OCS activities alone, and the Program is expected to contribute little if any overall incremental impacts on these species.

4.6.4.1.4 Reptiles. Section 4.4.7.4 discusses direct and indirect impacts on reptiles in the GOM coastal environment resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS activities. Table 4.6.1-2 presents the exploration and development scenario for the GOM cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the GOM are summarized in Table 4.6.1-5 and discussed below, as applicable.

Ongoing and future routine OCS program activities include seismic surveys, onshore and offshore construction (including pipeline trenching and removal of offshore structures), the discharge of operational wastes (such as produced water and ship wastes), and marine vessel traffic. All these activities have the potential to adversely affect reptiles in the GOM via physical injury or death, lethal or sublethal toxic effects, or loss of reproductive, nursery, and feeding habitats (Section 4.4.7.4). Accidental oil spills are also counted among OCS program-related activities; assumptions for oil spills under the cumulative case scenario are provided in Table 4.6.1-4.

Non-OCS program activities contributing to adverse cumulative impacts on reptiles include activities associated with offshore construction (e.g., seismic surveys, dredging and marine disposal, extraction of nonenergy minerals, State oil and gas development, domestic transportation of oil and gas, and foreign crude oil imports), onshore construction (e.g., coastal and community development), the discharge of municipal and other waste effluents, and vessel traffic (e.g., commercial shipping, recreational boating, and military training and testing activities).

Anthropogenic mortality in sea turtles has been attributed to a number of sources (NRC 1990; NOAA 2003). Human activities responsible for mortality of sea turtle eggs and hatchlings include (in descending order of relative importance) beach development, beach lighting, beach use, entanglement in trash and debris, and beach replenishment. Each of these activities is associated, either exclusively or to a large degree, with coastal development. In addition, the contributions of exposure of eggs and hatchlings to toxins and of the ingestion of plastics and debris by hatchlings are unknown (NRC 1990; NOAA 2003). Human activities responsible for mortality of juvenile and adult turtles include shrimp trawling and other fisheries, beach lighting, beach use, vessel collisions, dredging, entanglement, power plant entrainment, and oil platform removal (NRC 1999; NOAA 2003). The role of exposure to toxins in overall sea turtle mortality is unknown. However, this information is not necessary to make a reasoned choice among the alternatives (see Section 1.4.2).

Non-OCS offshore (deepwater and nearshore) construction activities in the GOM that could affect sea turtles include channel construction and maintenance activities (e.g., dredging) conducted by Federal, State, and local governments and the public; the offshore extraction of nonenergy minerals; State oil and gas development; and the transport of domestic and foreign oil and gas (requiring loading and offloading facilities). Potential impacts on sea turtles from these activities may include physical injury or death of individuals present in the immediate construction area. In addition, construction or removal of offshore OCS facilities may result in a relatively small incremental increase in the potential for adverse impacts on sea turtles within the GOM planning areas. However, the mitigation measures established by BOEM for construction and platform removal activities may be expected to reduce the contribution of these proposed activities to cumulative impacts to sea turtles from all offshore construction activities throughout the GOM planning areas (MMS 2003d, 2004a, 2005d).

Onshore construction activities can impact nesting habitat for sea turtles and the Alabama red-belly turtle, as well as impact terrestrial habitat for the gopher tortoise. Coastal development is an ongoing activity throughout the GOM and may be expected to continue or increase for the foreseeable future. Residential (i.e., housing developments) and commercial (i.e., casinos) development near nesting beaches may disrupt nesting adults and disorient emerging hatchlings, while increasing the potential for recreational human activities on nesting beaches. Compliance with regulatory requirements and the implementation of appropriate mitigation measures may be expected to reduce the potential for the siting, construction, and operation of onshore facilities.

There are a number of types of facilities or activities that discharge wastes to GOM waters and thus expose sea turtles to potentially toxic materials or solid debris that could entangle or be ingested by sea turtles. These facilities or activities include sewage treatment plants, industrial manufacturing or processing facilities, electric generating plants, cargo and tanker shipping, cruise ships, commercial fishing, pleasure craft, and vessel traffic associated with the Program. In addition, the Mississippi River (and to a lesser extent other rivers and streams that discharge to the northern GOM) annually discharges waters containing suspended sediments, agricultural fertilizers and herbicides, and urban runoff (Rabalais et al. 2001, 2002b). The exposure of sea turtles to these discharges may result in physical injury or death, or a variety of lethal or sublethal toxic effects on adults, juveniles, and hatchlings. These discharges may also affect habitat quality in the vicinity of the discharges.

Operational discharges and wastes associated with OCS activities could adversely affect sea turtles, especially those in the immediate vicinity of discharging platforms and vessels (Section 4.4.7.4). However, discharges from OCS program-related vessels and platforms would be strongly regulated under the Program (as they are for current OCS program-related discharges). Thus, the potential for sea turtles to be exposed to discharges under the Program may be expected to be much less than the potential of exposure to many of the nonpoint and non-OCS related discharge sources. Similarly, because of existing USCG and USEPA regulations, the nature of the OCS discharges that could occur are expected to be less toxic or less likely to cause entanglement than discharges from non-OCS program sources.

The GOM is one of the world's most concentrated shipping areas, with extensive commercial traffic transporting a variety of materials ranging from agricultural products to domestic and foreign oil (USACE 2003). For example, in 2003, the Port of New Orleans handled over 255,000 domestic and foreign container vessels, while the port at Gulfport, Mississippi, handled more than 161,000 foreign container vessels (USACE 2003b). The GOM also supports extensive commercial fisheries as well as recreational boating. For example, there were 2 million recreational watercraft between 4 and 20 m (12 and 64 ft) in length registered in the GOM States, many of which are used in GOM waters (USCG undated). The GOM also supports training by U.S. Navy vessels as well as routine USCG activities. Because of the very large number of vessels typically present in the GOM, the potential for sea turtles colliding with watercraft is high, and may be expected to continue and increase into the foreseeable future. In comparison with the overall level of vessel traffic in the GOM, the additional numbers of vessel trips that would occur to support OCS Program activities is expected to result in a minor incremental increase to the overall potential for sea turtle–vessel collisions in the GOM planning areas.

The information on the extent to which sea turtles may be affected by noise is very limited (Section 4.4.7.4). However, this information is not necessary to make a reasoned choice among the alternatives (see Section 1.4.2). Current noise generating activities in the GOM unrelated to OCS activities or the Program include the construction of offshore structures (such as those supporting State oil and gas development or nonenergy minerals extraction), dredging, commercial and recreational vessel traffic, and military training and testing activities. These may be expected to continue or increase in the foreseeable future.

Sea turtles could be exposed to OCS oil spills that could occur from platform, pipeline, and/or vessel accidents (see Section 4.4.7.4). Most spills associated with the Program would be relatively small (less than 50 bbl), and most would be expected to occur in water depths of 300 m (984 ft) or more (BOEMRE 2011a).

Storms, operator error, and mechanical failures may result in accidental oil releases from a variety of non-OCS related activities, such as the domestic transportation of oil, the import of foreign crude oil, and State development of oil. Crude oil may also enter the environment of the northern GOM from naturally occurring seeps. At least 63 seeps have been identified in the northern GOM (mostly off the coast of Louisiana) (MacDonald et al. 1996), and more than 350 naturally occurring and constant oil seeps that produce perennial slicks of oil at consistent locations may be present in the GOM (MacDonald et al. [2002], as cited in Kvenvolden and Cooper [2003]). Seeps in the northern GOM have been estimated to discharge more than 1.2 million gal of crude oil annually to overlying GOM waters (MacDonald 1998). Using remotely sensed satellite data, Mitchell et al. (1999) identified approximately 1,000 km^2 (390 mi^2) of floating oil in the northern GOM, presumably from natural seeps.

Accidental oil releases from these activities and from naturally occurring seeps could impact reptiles by oiling (fouling) nesting beaches and nest sites and hatchlings, and through the inhalation or ingestion of oil or tar deposits. The magnitude and severity of potential effects on reptiles from such exposure will be a function of the location, timing, duration, and size of the spill; the proximity of the spill to nesting beaches and feeding habitats; and the timing and nature of spill containment and cleanup activities. Depending on their location, as well as the location of spills from other sources and releases from natural seeps, accidental spills associated with the Program could contribute to the overall exposure of nest beaches, eggs, and hatchlings to oil, and subsequent lethal and sublethal effects, in the GOM planning areas. For example, the American crocodile and Alabama red-belly turtle might be affected by natural seepage and accidental releases of oil in the Eastern Planning Area, but probably only by catastrophic spills in the Central and Western Planning Areas.

Reptile populations throughout the GOM may be adversely affected by climate change or hurricane events. As previously discussed (Section 4.4.7.4), there is growing evidence that climate change is occurring, and potential effects in the GOM may include a change (i.e., rise) in sea level or a change in water temperatures. Climate change could affect the availability or quality of nesting beaches, the location and duration of current convergence areas utilized by hatchlings in the open waters of the GOM, and the distribution, availability, and quality of feeding habitats. For reptiles that rely on temperature to determine the gender of offspring in incubating eggs (referred to as temperature-dependent sex determination), including sea turtles and crocodilians, subtle increases in atmospheric temperatures could skew sex ratios of hatchlings, which could have future population implications (Walther et al. 2002).

Severe storm events such as hurricanes have the potential to impact nesting beaches if they result in a change in beach topography or in the composition of beach materials. Heightened wave action and intensity could erode nesting beach sites, storm surges could flood beaches and drown eggs and hatchlings, and sediments deposited onto beach surfaces by storm waves may alter the thermal and structural environment of nest sites, potentially decreasing the availability and/or quality of the nesting areas (Milton et al. 1994; Hays et al. 2001; Holloman and Godfrey 2005). Hurricanes Katrina and Rita adversely affected sea turtle habitats in 2005. Approximately 50 Kemp's ridley sea turtle nesting sites were destroyed along the Alabama coast (Congressional Research Service 2005; USFWS 2006). The loss of beaches through the affected coastal areas has probably affected other existing nests and nesting habitats of this species, as well as the loggerhead turtle. Similarly, impacts on seagrass beds may affect the local distribution and abundance of species that use these habitats, such as the green sea turtle and Kemp's ridley sea turtle. Although hurricanes are annual events that are an inherent component of the overall GOM ecosystem, including sea turtle nesting beaches, if hurricanes similar in magnitude to Katrina and Rita occur during the life of the Program, population-level impacts on reptiles could occur, particularly since the availability of nesting habitat (e.g. beaches) has become limited because of coastal residential and commercial development.

Conclusion. Cumulative impacts on reptiles in the GOM as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be moderate to major over the next 40 to 50 years. Non-OCS activities or phenomena include climate change, natural catastrophes, onshore and offshore construction, contaminant releases (through waste effluents), vessel traffic, power plant entrainment, and human-related activity (e.g., beach use, noise, and shrimp trawling). The incremental contribution of routine Program activities to these impacts would be small to medium (see Section 4.4.7.4).

Expected accidental oil spills under the Program (most of which are less than 1,000 bbl) would result in a comparatively negligible to medium incremental increase in the overall impact of exposure to oil from other anthropogenic activities (such as spills from foreign tankers) because such spills are relatively easy to contain and would only affect small areas of habitat (and few individuals). However, large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could potentially result in population-level effects. Although such spills are rare events, impacts would be major and long-term if multiple individuals and their habitat (especially nesting habitat) are exposed to oil. Additional impacts on reptiles may occur as a result of habitat loss or alteration due to climate change and hurricanes, and from exposure to oil from naturally occurring seeps.

4.6.4.1.5 Invertebrates and Lower Trophic Levels. Section 4.4.7.5.1 discusses direct and indirect impacts on invertebrates and lower trophic levels in the GOM resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Section 4.4.6.1.1) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS activities. Table 4.6.1-2 presents the exploration and development scenario for the GOM cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the GOM are summarized in Table 4.6.1-5 and discussed below, as applicable.

Cumulative impacts could result from the combination of the Program and past, present, and reasonably foreseeable future OCS and non-OCS activities. Routine activities would cumulatively have varied effects on invertebrate populations in the sediment and water column depending on their habitat and life history. Impacts resulting from ongoing and future routine OCS program activities, including those of the Program, could result primarily from noise (vessel, seismic surveys, and construction), well drilling, pipeline placement (trenching, landfalls, and construction), platform placement (anchoring, mooring, and removal, except in deep waters) and routine discharges (drilling, production, platform, and vessel). Accidental oil spills are also counted among OCS program-related activities.

Routine activities that temporarily disturb sediments and increase turbidity include installation of new pipelines and platforms and discharges of drill cuttings and associated fluids. Under the cumulative scenario, as much as 81,000 ha (32,780 ac) of sea bottom would be disturbed by construction of platforms and pipelines over the period of the Program (Table 4.6.1-1). Bottom-disturbing impacts would most directly affect benthic and near bottom invertebrates. The impacts of routine activities (exploration and site development, production and decommissioning) on invertebrate communities are discussed in detail in Section 4.4.7.5.1. Overall, routine activities represent up to a moderate disturbance, with the severity of the impacts generally decreasing dramatically with distance from bottom-disturbing activities.

The addition of up to 2,000 new platforms over the life of the Program (up to 450 new platforms under the Program) would allow the colonization of invertebrates requiring hard substrate. While many platforms may be allowed to remain as artificial reefs, removal of platforms will reduce available substrate and structures for invertebrates and injure or kill them during removal.

Non-OCS actions may negatively influence invertebrate resources in various life stages and habitats. Non-OCS oil and gas exploration and production activities in GOM State waters occur primarily off Louisiana and Texas, and off Alabama in the vicinity of Mobile Bay. The States of Florida and Mississippi have had limited activities in State waters, with a moratorium on drilling activity now in effect in Florida waters. The increasing presence of offshore LNG facilities could lead to impacts associated with discharges of water used in the vaporization process. In addition to the thermal discharge, biocides are also discharged from the facilities. Other non-OCS activities that could impact invertebrate communities include non-OCS activities with a potential to impact marine benthic and pelagic habitats, such as sand mining, sediment dredging and disposal, anchoring, fishing/trawling, offshore marine transportation, and pollutant inputs from point and non-point sources. Many of these activities would affect bottom-dwelling invertebrates at various life stages as well as their food sources in a manner similar to OCS bottom-disturbing activities (Section 4.4.7.5.1).

The eutrophication that has contributed to the hypoxic zone in the GOM will continue to act as a source of lethal and sublethal stress to invertebrate communities. Natural events, including hurricanes and turbidity plumes, could also cause localized damage to important habitat areas and could affect individuals or populations, although the invertebrate community as a whole should be adapted to such natural events.

Commercial fishing practices that are indiscriminate, such as some types of trawling and pots, are responsible for significant amounts of bycatch that can injure or kill large numbers of invertebrates. Bottom trawling also degrades benthic habitats and temporarily increases the turbidity of the water, both of which represent chronic disturbances to invertebrates. Bottom trawling is particularly common in the GOM because of the importance of the shrimp fishery.

Several major classes of invertebrates could be affected by the environmental changes predicted to result from climate change. Climate change could affect invertebrate communities through direct physiological action, habitat loss, and by altering large-scale oceanographic and ecosystem processes (Section 3.8.5.1). A significant loss of habitat-forming invertebrates like corals could result from increased water temperature and ocean acidification. The impacts of climate change on habitat-forming invertebrates are discussed in detail in Section 3.7.2.1. Potential impacts on benthic and water column invertebrates resulting from climate change include:

- An increase in the range and temporal variability of a water column's oxygen, salinity, and temperature, which could significantly alter the existing invertebrate community structure, particularly in nearshore areas;
- A reduction in important estuarine habitats from sea level rise;
- A range expansion of new invertebrate species into the GOM;
- An increase in the extent and duration of the GOM hypoxic zone that could kill or displace existing invertebrate communities and reduce the amount of suitable habitat available; and
- Reduced oceanic pH, which could reduce the fitness of calcifying marine organisms like corals, echinoderms, foraminiferans, and mollusks.

In addition, physiological and ecosystem-level stressors related to climate change may interact with non-climate-related anthropogenic stressors; these include overfishing, pollution, and habitat loss. For example, an increase in water temperature that results in physiological stress could make individuals more susceptible to stress from pollution or accidental oil spills.

Oil spills resulting from both OCS and non-OCS activities could impact invertebrate communities in the GOM. See Table 4.6.1-4 for anticipated oil spills over the life of the Program. Crude oil also enters the environment from naturally occurring seeps. Spills could occur from tankers carrying imported oil in the GOM. The potential effects of spills from non-OCS activities would be similar to those described for OCS activities (Section 4.4.7.5.1). In general, larger benthic and water column invertebrates that come into contact with oil would most likely move away from affected areas, while zooplankton and sessile or small infauna would not be able to avoid spills. Oil contacting invertebrates could have lethal or sublethal impacts. Any oil spills reaching shallow seagrass, estuarine, or coastal marine habitats could affect commercially important species such as shrimp, oysters, and blue crab that use these areas as spawning or juvenile nursery habitat. If they were to occur, deepwater surface spills could also affect invertebrate eggs and larvae, neuston communities such as jellyfish species, and *Sargassum*, together with any associated vertebrate and its invertebrate organisms. Because of the wide dispersal of invertebrates in the GOM surface waters, it is anticipated that only a relatively small proportion of early life stages present at a given time would be impacted by a particular oil spill event, which would limit the potential for population-level effects. The potential impacts of oil spills on invertebrate communities are discussed in Section 4.4.7.5.1.

Benthic and pelagic invertebrates are important trophic links that connect primary producers to higher-trophic-level organisms. Consequently, oil spill contamination on a large scale could result in contaminant transfer to higher trophic levels and/or reduce food availability to higher trophic levels if invertebrate populations were severely depressed by a CDE. Multiple investigations of the long-term impacts of the DWH event on invertebrates are ongoing and, over time, these studies will add to our understanding on of the impact of oils spills on invertebrates and will allow a better understanding of the potential for impacts to invertebrates at the population level. A description of these studies can be found at http://www.gulfspillrestoration.noaa.gov/oil-spill/gulf-spill-data.

Species Listed under the Endangered Species Act.

Elkhorn Coral. In much of its natural range, elkhorn coral has been adversely affected by the same anthropogenic stressors as other coral communities. Climate change may add to these stressors in the form of higher water temperatures, diseases, and ocean acidification, all of which can increase the frequency of bleaching. However, increasing surface water temperature may promote the northern expansion of elkhorn coral, increasing their abundance on the topographic features in the northern GOM. As discussed in Section 4.4.7.5.1, potential impacts from routine OCS operations would be minimized by existing stipulations, which prohibit exploration and development activities in the vicinity of the FGBNMS. Overall, the cumulative impacts on invertebrates would be moderate to major when considering OCS routine operations along with the significant impact to coral communities resulting from past, present, and future activities.

As discussed in Section 4.4.7.5.1, a CDE could also affect elkhorn corals, although the likelihood would be significantly reduced by the infrequency of a CDE and the stipulations prohibiting oil and gas activities in the vicinity of the FGBNMS. There is no evidence that elkhorn corals have been affected by oil spills either in the past or as a result of the recent DWH event. However, impacts to or extirpation of the elkhorn corals in the FGBNMS would not result in overall population-level impacts, as this species is primarily located in the southern GOM, Caribbean, and south Florida. Overall, the cumulative impacts of accidental spills on elkhorn coral would range up to moderate.

Conclusion. Cumulative impacts on invertebrate communities in the GOM as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be moderate to major over the next 40 to 50 years. Non-OCS activities or phenomena affecting these resources include offshore LNG facilities, sand mining, sediment dredging and disposal, hypoxia, anchoring, fishing/trawling, offshore marine transportation, and pollutant inputs from point and non-point sources. The incremental contribution of routine Program activities to these impacts (mainly due to bottom-disturbing activities) would be negligible to medium, with the severity of the impacts generally decreasing with distance from bottom-disturbing activities. Several major classes of invertebrates could also be affected by naturally occurring oil seeps and the environmental changes predicted to result from climate change.

Invertebrate communities may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS activities as well as naturally occurring seeps. The cumulative impacts of past, present, and future oil spills on these resources would be minor to moderate. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on invertebrates would be negligible to small, depending on the location, timing, duration, and size of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and would range up to moderate if they were to occur. Spills in deeper water, whether from OCS or non-OCS sources, are unlikely to have overall population-level effects on invertebrate resources because of the relatively small proportion of similar available habitats that would come in contact with released oil at concentrations great enough to elicit toxic effects. A more detailed discussion of the effects of oil spills on invertebrates in the GOM is presented in Section 4.4.7.5.1.

4.6.4.2 Alaska Region – Cook Inlet

4.6.4.2.1 Mammals.

Marine Mammals. The cumulative analysis considers past, ongoing, and foreseeable future human and natural activities that may occur and adversely affect marine mammals in the same general area. These activities include effects of the OCS Program (proposed action and prior and future OCS sales), oil and gas activities in State waters, commercial shipping, commercial and subsistence fishing, recreational fishing and boating activities, military operations, scientific research, and natural phenomena. Specific types of impact-producing factors considered include noise from numerous sources, pollution, ingestion and entanglement in marine debris, vessel strikes, habitat degradation, subsistence harvests, military activities, industrial development, community development, climate change, and natural catastrophes. Section 4.4.7.1.2 provides the major impact-producing factors for the Program in Cook Inlet.

Routine Activities.

OCS Activities. Marine mammals and their habitats in the Cook Inlet Planning Area could be affected by a variety of exploration, development, and production activities as a result of the proposed and future OCS leasing actions (see Section 4.4.7.1.2). These activities include seismic exploration, offshore and onshore infrastructure construction, the discharge of operational wastes, and vessel and aircraft traffic. Impacts on marine mammals from these activities may include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. The degree of impact at the population level depends greatly on the status of the population (reflected in its listing under the ESA) and the degree of disturbance or harm from OCS-related activities in areas important to species survival (i.e., feeding, breeding, molting, rookery, or haulout areas).

Potential impacts (primarily behavioral disturbance) on marine mammals from OCS-related seismic activity would be short-term and temporary and, therefore, would not result in greater than minor impacts on any affected species.

Impacts from OCS construction and operation activities could include the temporary disturbance and displacement of individuals or groups by construction equipment and long-term disturbance of some individuals from operational noise. No long-term, population-level effects would be expected because individuals most affected by these impacts would be those in the immediate vicinity of the construction site or operational platform and disturbance of individuals during construction would be largely temporary. In addition, appropriate mitigation measures could lessen the potential for impacts.

Operational and waste discharges (e.g., produced water, drilling muds, and drill cuttings) would be disposed of through downhole injection into NPDES-permitted disposal wells, and thus would not be expected to result in any incremental impacts on marine mammals. Liquid wastes (such as bilge water) may also be generated by OCS support vessels and on production platforms. While these wastes may be discharged (if permitted) into surface waters, they would be rapidly diluted and dispersed and would result in minor incremental impacts on marine mammals. Drilling and production wastes may contain materials such as metals and hydrocarbons, which can bioaccumulate through the food chain into the tissues of marine mammals. Although the bioaccumulation of anthropogenic chemicals has been reported for a variety of marine mammals, adverse impacts or population-level effects resulting from such bioaccumulation have not been demonstrated (Norstrom and Muir 1994; Muir et al. 1999).

Marine mammals could be temporarily disturbed by OCS vessel traffic (all species) or incur injury or death from collisions with support vessels (primarily larger, slower moving cetaceans). The low level of expected OCS vessel trips in the Cook Inlet Planning Area under the Program (one to three trips per week) would be a minor contribution to all vessel traffic occurring in the Cook Inlet. Noise from the one to three helicopter overflights expected each week would be transient in nature and be a minor component of all aircraft flights that occur within Cook Inlet. Overflights disturbing active rookery sites could result in decreased pup survival and in population-level impacts on some species, although overflight restrictions and flightline selection to avoid rookeries would greatly limit the potential for adversely affecting animals at these locations.

No platforms would be removed under the Program for the Cook Inlet Planning Area. It is possible that platforms would be removed from future lease sales or from platforms associated with oil and gas activities in State waters. There have been no documented losses of marine mammals resulting from explosive removals of offshore oil and gas structures, but there are sporadic incidents reported of marine mammals being killed by underwater detonations (Continental Shelf Associates 2004b; MMS 2007e, 2008a). Harassment of marine mammals as a result of a non-injurious physiological response to the explosion-generated shock wave, as well as to the acoustic signature of the detonation, is also possible. However, explosive platform removals would comply with appropriate BOEM or State guidelines and would not be expected to adversely affect marine mammals in Cook Inlet.

Non-OCS Activities. A number of non-OCS activities such as oil and gas exploration and development in State waters: commercial, subsistence, and recreational fishing; vessel traffic; and climate change could also affect marine mammals in the Cook Inlet Planning Area (or portions of the Gulf of Alaska that could be affected by activities in Cook Inlet). Many of the effects of these activities on marine mammals would be similar in nature to those resulting from OCS-related activities, namely, behavioral disturbance, habitat disturbance, injury or mortality, and exposure to toxic substances. Marine mammals may also be adversely affected by climate change.

Oil and Gas Exploration and Development in State Waters. The State of Alaska has made nearshore State lands available for leasing along the northern portion of Cook Inlet (above Homer). Exploration, construction, and operation activities associated with State leases would occur in nearshore and coastal areas, while OCS platforms and pipelines would be located away from coastal areas. Thus, State oil and gas leasing activities may be expected to have a greater potential for affecting marine mammals in coastal habitats than would the proposed OCS actions.

Commercial and Subsistence Fishing and Harvesting. Commercial and subsistence fishing has been identified as impacting many of the marine mammals in Alaskan waters (Allen and Angliss 2011). These fisheries employ a variety of methods, such as longlines, seines, trawls, and traps, and can result in the entanglement, injury, and death of individuals of marine mammal species. Fisheries also remove a portion of the prey base for some marine mammals. Subsistence harvest has targeted and continues to target some marine mammal species, especially some of the whale species.

The following are minimum reported estimated annual mortality rates incidental to commercial fisheries and subsistence harvests for marine mammals that occur in Cook Inlet and/or in the Gulf of Alaska that could be affected by the Program in Cook Inlet (Allen and Angliss 2011):

- The estimated minimum mortality rate for Western U.S. Stock of the Steller sea lion incidental to Alaska commercial fisheries is 26.2 animals per year. The best estimate of annual subsistence harvest of the Steller sea lion is 197 animals.

- The estimated minimum mortality rate for Eastern Pacific Stock of the northern fur seal incidental to Alaska commercial fisheries is 1.9 animals per year. The best estimate of annual subsistence harvest of the northern fur seal is 562 animals.

- The estimated minimum mortality rate for Gulf of Alaska Stock of the harbor seal incidental to Alaska commercial fisheries is 24 animals per year. The best estimate of annual subsistence harvest of the harbor seal is 807 animals.

- There are no reports of mortality incidental to commercial fisheries for the Cook Inlet Stock of the beluga whale. Annual subsistence harvest of Cook Inlet beluga whales ranged from 30 to over 100 between 1993 and 1999. Since 2000, subsistence harvests totaled only 11 whales, with no subsistence harvests allowed between 2008 and 2012 (Allen and Angliss 2011; NMFS 2008b).

- The estimated minimum mortality rate for the Alaska Resident Stock of the killer whale incidental to Alaska commercial fisheries is 1.2 animals per year. There are no reports of subsistence harvests of killer whales in Alaska.

- The estimated minimum mortality rate for the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient Stock of the killer whale incidental to Alaska commercial fisheries is 0.4 animal per year. There are no reports of subsistence harvests of killer whales in Alaska.

- There are no reports of mortality incidental to commercial fisheries or subsidence harvest for the ATI Transient Stock of the killer whale.

- There were no serious injuries or mortalities observed or reported incidental to commercial fisheries between 2002 and 2006 for the North Pacific Stock of the Pacific white-sided dolphin. However, between 1978 and 1991, thousands of individuals died annually incidental to high seas fisheries (these fisheries have not operated in the central North Pacific since 1991). There are no reports of subsistence harvests of Pacific white-sided dolphins.

- The estimated minimum mortality rate for the Gulf of Alaska Stock of the harbor porpoise incidental to commercial fisheries is 71.4 animals per year. There are no reports of subsistence harvests of the harbor porpoise. Two harbor porpoises were taken incidentally in subsistence gillnets in 1995.

- The estimated minimum mortality rate for the Alaska Stock of the Dall's porpoise incidental to commercial fisheries is 29.6 animals per year. There are no reports of subsistence harvests of the Dall's porpoise.

- The estimated minimum mortality rate for the North Pacific Stock of the sperm whale incidental to commercial fisheries in the Gulf of Alaska is 2.01 animals per year. There are no reports of subsistence harvests of the sperm whale. The sperm whale was the dominant species killed by the commercial whaling industry in the North pacific in the years following the Second World War.

- The estimated annual mortality rate for the Alaska Stock of Cuvier's beaked whale incidental to commercial fisheries is zero. There are no reports of subsistence harvests of the Cuvier's beaked whale.

- Serious injuries to or mortalities of Eastern North Pacific Stock of the gray whale occur throughout their range incidental to commercial fisheries and from strandings due to various causes. The annual mortality rate incidental to U.S. commercial fisheries is 3.3 whales. Annual subsistence take averaged 121 whales between 2003 to 2007. Russian Chukotka people take most of the gray whales. The U.S. Makah Indian Tribe has a yearly average quota of only 4 whales. In 2005, an unlawful subsistence hunt and kill of a gray whale occurred in Alaska.

- The Western North Pacific Stock of the humpback whale's feeding area includes the Gulf of Alaska. The estimated annual mortality incidental to U.S. commercial fisheries is 0.2 humpback whales per year based on one mortality observed in the Bering Sea sablefish pot fishery from 2002 through 2006. Bycatch in Japan and Korea average 1.1 to 2.4 humpback whales per year. The annual mortality rate for subsistence takes for the 2003 to 2007 period was 0.2 whales. The species received full protection in 1965; however, the Union of Soviet Socialist Republics (USSR) continued illegal catches until 1972. From 1961 through 1971, 6,793 humpback whales were illegally killed. Many of these were taken from the Gulf of Alaska and the Bering Sea.

- The Central North Pacific Stock of the humpback whale feeding area includes the Gulf of Alaska area that encompasses Cook Inlet. Based on observations from 2003 through 2007, the estimated annual mortality in Alaska is 3.4 animals per year from commercial fishery, 0.2 animals per year from recreational fishery, and 1.6 animals per year from vessel collisions. Subsistence harvesting is not allowed for humpback whales from the Central North Pacific Stock.

- There was one observed incidental mortality of a fin whale from the Northeast Pacific Stock in the Bering Sea/Aleutian Island pollock trawl fishery. No current or historical subsistence takes of this stock are reported from Alaska or Russia. Between 1925 and 1975, commercial whaling throughout the North Pacific killed 47,645 fin whales.

- For the Alaska Stock of the minke whale, the total estimated mortality and serious injury incidental to U.S. commercial fisheries for 2002 through 2006 was zero. Prior to that time, whale mortalities were very rare. Subsistence take by Alaska Natives is rare (e.g., only nine between 1930 and 1995).

- There are no records of North Pacific right whale mortalities incidental to U.S. commercial fisheries. There are no reported subsistence takes of the species in Alaska or Russia. Up to 37,000 North Pacific right whales were killed by whaling from 1839 to 1909; while 742 were killed by whaling from 1900 to 1999, in addition to 372 killed illegally, taken by the U.S.S.R., from 1963 through 1967, primarily in the Gulf of Alaska and Bering Sea, that left the population at an estimated 50 individuals (Allen and Angiss 2011; Encyclopedia of Life 2011).

- Based on commercial fisheries observer program results, fishing mortality and serious injury for the south central Alaska Stock of the northern sea otter is insignificant (i.e., approaches zero mortalities and serious injuries). The mean annual report of subsistence take for the stock from 2002 through 2006 was 346 animals.

- The total fishery mortality and serious injury rate for the Southwest Alaska stock of the northern sea otter is less than 10 animals per year. The mean annual report of subsistence take for the stock from 2002 through 2006 was 91 animals.

In addition to the above, no serious injuries or mortalities due to fisheries or subsistence have been reported for blue whales in Alaska (Carretta et al. 2011).

Climate Change. A concern regarding marine mammals in polar regions is the potential for climate change and associated changes in the extent of sea ice in some Arctic and subarctic waters. It is not possible at this time to identify the likelihood, direction, or magnitude of any changes in the environment of Cook Inlet waters due to changes in the climate, or how climate change could impact marine mammals in these waters. The current state of climate change and its impacts on marine mammals would also be further considered in any subsequent environmental reviews for lease sales or other OCS-related activities; therefore, this information is not essential to a reasoned choice among the alternatives presented in this PEIS (see Section 1.4.2).

Other Impacting Factors. Marine mammals in the Cook Inlet area may also be impacted by other factors such as UMEs and invasive species. A UME is an unexpected stranding that involves a significant die-off of any marine mammal population, and demands immediate response (NMFS 2011b). Since establishment of the UME program in 1991, there have been 55 formally recognized UMEs in the United States; two UMEs occurred in southern Alaska and involved sea otters (NMFS 2011b). Causes have been determined for 26 of the UMEs; they include infections, biotoxins (particularly domoic acid and brevetoxin), human interactions, and malnutrition. The cause of the UMEs in Alaska is undetermined (NMFS 2011b). Invasive species could affect some marine mammals by disrupting local ecosystems and fisheries of the area of Cook Inlet. For example, introduced northern pike (*Esox lucius*) consume salmon, trout, and whitefish, affecting total populations of these prey species where pike become established. The potential introductions of other invasive species of concern, such as the Chinese mitten crab (*Eriocheir sinensis*), which could eat and/or out compete native invertebrate species, could adversely affect natural communities (McClory and Gotthardt 2008). These and other invasive species could affect the prey base for some marine mammals. As climate change continues to warm Alaskan waters, Alaska may become more susceptible to invasive species (McClory and Gotthardt 2008).

Accidents. Marine mammals could be exposed to oil accidentally released from platforms, pipelines, and vessels in each of the areas offshore Alaska included in the proposed Program (Table 4.4.2-1). Non-OCS sources of oil in Cook Inlet may include the domestic transportation of oil, State oil and gas development, and natural sources such as seeps. Accidental oil releases from OCS activities and other sources could expose marine mammals to oil by body contact or through the inhalation or ingestion of oil or tar deposits. Indirect effects may occur as a result of loss or displacement of prey resources or habitat loss resulting from oil. The magnitude and duration of exposure will be a function of the location, timing, duration, and size of the spill; the proximity of the spill to feeding and other important habitats; the timing and nature of spill containment; and the status of the affected animals. Most expected small to medium spills (less than 1,000 bbl) would have limited effects on marine mammals due to the relatively small areas likely to incur high concentrations of hydrocarbons and the short period of time during which potentially toxic concentrations would be present. The magnitude of impact would be expected to increase should a spill occur in habitats important to marine mammals or affect a number of individuals from a population listed under the ESA, and, as such, a significant spill would have a high probability of producing significant, population-level cumulative impacts on Cook Inlet marine mammals.

Conclusion**.** Cumulative impacts on marine mammals in the Cook Inlet Planning Area as a result of future OCS program and ongoing and future non-OCS program activities could be minor to moderate over the next 40 to 50 years. Non-OCS program activities or phenomena include climate change, natural catastrophes, contaminant releases, vessel traffic, commercial fishing, subsistence harvests, and invasive species. The incremental contribution of routine Program activities to these impacts would be negligible to small (see Section 4.4.7.1.2).

Marine mammals may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS activities as well as naturally occurring seeps. The cumulative impacts of past, present, and future oil spills on marine mammals would be minor to moderate. The incremental impacts of expected accidental spills associated with the Program on marine mammals would be negligible to small, depending on the location, timing, and volume of the spills; the environmental settings of the spills; and the species exposed to the spills (Section 4.4.7.1.2). Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from minor to major if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to the impacts of spills regardless of size, but their incremental contribution to cumulative impacts is generally expected to be small. A more detailed discussion of the effects of oil spills on marine mammals in Cook Inlet is presented in Section 4.4.7.1.2.

Terrestrial Mammals. Terrestrial mammals and their habitats could be affected by a variety of activities associated with the proposed OCS actions (Section 4.4.7.1.2). These activities include the construction and operation of onshore pipelines and aircraft traffic. Impacts on terrestrial mammals may include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. There are currently no ongoing OCS activities in the Cook Inlet; thus all OCS development and any associated impacts on terrestrial wildlife in the Cook Inlet Planning Area would result from the Program and future actions.

Impacts from OCS pipeline construction and operation could include the injury or death of smaller mammals (such as mice and voles) and the disturbance and displacement of individuals or groups of larger species (such as deer and bear). Individuals most affected by these impacts would be those in the immediate vicinity of the pipeline. Because of the limited areal extent of new facilities under the Program, disturbance (primarily behavioral in nature) of most of these species during construction would be largely temporary, and no long-term population-level effects would be expected. However, careful siting of pipelines to avoid important habitats could minimize the potential impacts.

Under the Program, vehicle traffic associated with normal construction, operation, and maintenance of the onshore pipelines could disturb wildlife. Vehicle traffic could disturb wildlife foraging along pipelines or access roads, causing affected wildlife to temporarily stop normal activities (e.g., foraging, resting) or leave the area, while collision with vehicles could injure or kill some individuals. Because vehicle traffic would be infrequent, vehicle-related impacts associated with the Program would be minimal. In the Cook Inlet, vehicle traffic along any new access roads would be very light and infrequent and, thus, not expected to affect more than a few individuals or result in population-level impacts on wildlife.

In the Cook Inlet area, terrestrial mammals are mostly habituated to aircraft due to year-round military and civilian aircraft operations. Only up to three weekly helicopter trips are projected in the Cook Inlet Planning Area under the Program. Impacts on terrestrial mammals from helicopter overflights would be behavioral in nature, primarily resulting in short-term disturbance in normal activities, and would not result in population-level effects.

Terrestrial mammals could also be affected by a number of non-OCS activities, including oil and gas exploration and development in State waters, and coastal and community development. Many of the effects of these activities on terrestrial mammals would be similar in nature to those resulting from OCS-related activities, namely behavioral disturbance, habitat disturbance, and injury or mortality. The State of Alaska has made leases of State waters available along the northern portion of Cook Inlet (above Homer) since the 1950s. Impacts on terrestrial mammals that could result with oil and gas lease sales in State waters may exceed potential impacts that could occur under the OCS Program because of the greater extent of offshore and onshore development related to the State lease sales. In addition, much of the infrastructure is over 40 years old, and many of the pipes are aging and corroded (NMFS 2008c). Terrestrial mammals may be affected as a result of coastal and community development. Such development may result in the loss of habitat and the permanent displacement of some species from the developing areas. Implementation of the Program could increase coastal and community development, indirectly adding to impacts on terrestrial mammals and their habitats.

Terrestrial wildlife could be adversely affected by the accidental release of oil from an onshore pipeline, or by offshore spills contacting beaches and shorelines utilized by terrestrial mammals (such as Sitka black-tailed deer or brown bear). Impacts on terrestrial mammals from an oil spill would depend on such factors as the time of year, volume of the spill, type and extent of habitat affected, food resources used by the species, and home range or density of the wildlife species. Spills contacting high-use areas could locally affect a relatively large number of animals. It is anticipated that most of the spills would have limited effects on terrestrial mammals, due to the relatively small, mostly offshore, areas likely to be directly exposed to the spills and due to the small number and size of spills projected for the Program and for any future OCS oil and gas developments.

State oil and gas development poses a major potential for accidental oil releases in the Cook Inlet Planning Area. Because of the much greater level of oil and gas development in State waters and the aging infrastructure associated with many of these developments, accidental spills associated with the proposed OCS action could contribute relatively little to the overall potential exposure of terrestrial mammals to accidental oil releases in Cook Inlet.

Conclusion. Cumulative impacts on terrestrial mammals in the Cook Inlet Planning Area as a result of future OCS program and ongoing and future non-OCS activities could be minor to moderate over the next 40 to 50 years. Non-OCS activities or phenomena that may affect populations of terrestrial mammals include climate change, natural catastrophes, contaminant releases, and vehicle traffic. The incremental contribution of routine Program activities to these impacts would be negligible to small (see Section 4.4.7.1.2).

Terrestrial mammals may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS operations. The cumulative impacts of past, present, and future oil spills on terrestrial mammals would be minor to moderate. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on terrestrial mammals would be negligible to small, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and other important habitats; the timing and nature of spill containment; and the status of the affected animals (see Section 4.4.7.1.2).

An unexpected, low-probability CDE has a greater potential to affect terrestrial habitats; therefore, impacts could range from minor to major if one were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to the impacts of spills regardless of size, but their incremental contribution to cumulative impacts is generally expected to be small. A more detailed discussion of the effects of oil spills on terrestrial mammals in Cook Inlet is presented in Section 4.4.7.1.2.

4.6.4.2.2 Marine and Coastal Birds. Section 4.4.7.2.2 discusses impacts on marine and coastal birds in Cook Inlet resulting from the Program (OCS program activities from 2012 to 2017). Cumulative impacts on marine and coastal birds result from the incremental impacts of the Program when added to impacts from reasonably foreseeable future OCS program activities (that are not part of the Program) and other non-OCS program activities. Table 4.6.1-2 presents the exploration and development scenario for the Cook Inlet cumulative case (encompassing the Program and other OCS program activities) over the next 40 years. A number of OCS program activities could affect Cook Inlet marine or terrestrial birds or their habitats; these include offshore exploration, construction of offshore platforms and pipelines, construction of onshore pipeline landfalls and pipelines, operations of offshore and onshore facilities, and OCS-related marine vessel and aircraft traffic. Potential impacts on marine and coastal birds from OCS program activities include injury or mortality from collisions with platforms, vessels, and aircraft; lethal and sublethal exposure to operational discharges; injury or mortality from the ingestion of trash or debris from OCS vessels and platforms; loss or degradation of habitat due to construction; and behavioral disturbance due to the presence of, and noise generated by, equipment and human activity.

Non-OCS program activities affecting marine and coastal birds in Cook Inlet (both inside and outside of the Planning Area proper) include dredging and marine disposal; coastal and community development; onshore and offshore construction and operations of facilities associated with State oil and gas development and other industrial complexes (e.g., at Nikiski); commercial and recreational boating; and small aircraft traffic. Potential impacts on marine and coastal birds from these activities are similar to those under the OCS program and include injury or mortality of birds from collisions with platforms associated with State oil and gas development and other onshore and offshore structures (e.g., radio, television, or cell phone towers), onshore industrial, commercial, and residential development; exposure to discharges from permitted point sources such as sewage treatment discharges and nonpoint sources such as urban runoff, or accidental releases (e.g., oil spills), as described in Section 4.6.2.1.2 and Table 4.6.1-4; exposure to emissions from various onshore and offshore sources (e.g., power generating stations, refineries, and marine vessels), as described in Section 4.6.2.1.2; ingestion of trash or debris; loss or degradation of habitat due to construction and operations activities; and behavioral disturbance due to the presence of, and noise generated by, equipment and human activity. Other trends such as extensive melting of glaciers (and increasing river discharges) and increased precipitation brought on by global climate change are also expected to adversely affect marine and coastal birds over the next 40 years.

Injury or Mortality from Collisions. Under the cumulative scenario, annual collision injury or mortality in Cook Inlet could increase in the near term as platforms are built under the Program. Such impacts would be minor relative to those that currently involve non-OCS structures. Over time, the injury or mortality impacts from collisions could decrease as oil and gas production in the inlet declines.

Exposure to Wastewater Discharges and Air Emissions. The discharge of operational wastes and air emissions from current non-OCS related vessel traffic and platform operations in Cook Inlet is strongly regulated and would continue to be so regulated over the next 40 years. However, such wastes and emissions would still expose marine and coastal birds to potentially toxic materials or to solid debris that could be ingested or result in entanglement. These facilities and activities include sewage treatment plants, industrial manufacturing or processing facilities, electric generating plants, dredging and marine disposal, and vessel traffic (e.g., cargo and tanker ships, cruise ships, commercial fishing vessels, and recreational vessels). Operational wastewater discharges and air emissions associated with the Program would contribute to the overall cumulative risk of toxic exposure and debris ingestion or entanglement of existing non-OCS wastewater discharges and air emissions in the inlet, but the incremental increase in impact is expected to be small relative to these other activities.

Under the Program, marine and coastal birds could be exposed to oil accidentally released from platforms, pipelines, and vessels, and would be most susceptible to adverse impacts from spills occurring in coastal areas and affecting feeding and nesting areas. Most of the oil released to Cook Inlet is from commercial and recreational vessels (Section 4.6.2.2.1). Oil releases from all sources may expose marine and coastal birds via direct contact or through the inhalation or ingestion of oil or tar deposits (see Section 4.4.7.2.1).

Marine and coastal birds may become entangled in, or ingest, floating, submerged, and beached debris (Heneman and the Center for Environmental Education 1988; Ryan 1987, 1990). Entanglement may result in strangulation, injury or loss of limbs, entrapment, or the prevention or hindrance of the ability to fly or swim; all of these effects may be considered lethal. Ingestion of debris may irritate, block, or perforate the digestive tract, suppress appetite, impair digestion of food, reduce growth, or release toxic chemicals (Fry et al. 1985; Dickerman and Goelet 1987; Ryan 1988; Derraik 2002). Because the discharge or disposal of solid debris into offshore waters from OCS structures and vessels is prohibited by BOEM (30 CFR 250.40) and the USCG (MARPOL, Annex V, Public Law 100 220 [101 Statute 1458]), entanglement in or ingestion of OCS-related trash and debris by marine and coastal birds would not be expected under normal operations.

Oil Spills and Cleanup Activities. Oil spills under the cumulative scenario are shown in Table 4.6.1-3. No more than one large spill (between 1,000 and 5,300 bbl from either a platform or a pipeline) and 18 small spills (less than 1,000 bbl) would be expected as a result of the Cook Inlet Planning Area OCS program over the next 40 years. Previous modeling of similar-sized oil spills in Cook Inlet indicates that land segments with the highest chance of contact with an offshore platform or pipeline spill are generally along the western shore of lower Cook Inlet in Kamishak Bay and Shelikof Strait (MMS 2002b). A large number of seabird colonies occur in these areas (USGS undated) and could be affected by oil spills reaching these areas.

Nesting and brood-rearing seabirds, waterfowl, and a few shorebirds, as well as the many species of waterfowl/loons, seabirds, and shorebirds that molt, stage, migrate through, or overwinter in large numbers in south central Alaska would be vulnerable to the potential disturbance resulting from elevated vessel and aircraft activity associated with cleanup of an oil spill. For all species, the degree of impact depends heavily on the location of the spill and cleanup response and its timing with critical natural behaviors (e.g., breeding, molting, feeding). Survival and fitness of individuals may be affected, but this infrequent disturbance is not expected to result in significant population losses.

As a result of response to the *Exxon Valdez* oil spill of 1989, and subsequent study of its effect on regional bird populations, there exists an extensive literature concerning the effects of a large oil spill in the South Alaska region (e.g., Agler and Kendall 1997; Boersma et al. 1995; Day et al. 1997a, b; *Exxon Valdez* Oil Spill Trustee Council 2004; Irons et al. 2000; Klowsiewski and Laing 1994; Lanctot et al. 1999; Murphy et al. 1997; Piatt and Ford 1996; Piatt et al. 1990; Rosenberg and Petrula 1998; van Vliet and McAllister 1994; Wiens et al. 2001). An estimated 100,000 to 300,000 marine birds died as a result of this spill (Piatt and Ford 1996), which occurred in March, when substantial numbers of overwintering birds were present in Prince William Sound and downstream to the west, and large numbers of seabirds were aggregating near colonies from Prince William Sound to the western Gulf of Alaska, prior to the breeding season. Although surveys and other studies carried out every year since the spill occurred indicate that populations of some marine bird species have recovered from their initial losses (e.g., common murre, black oystercatcher [*Exxon Valdez* Oil Spill Trustee Council 2004]), or are recovering (e.g., marbled murrelet), several species have shown little or no recovery (e.g., common loon, three cormorant species, harlequin duck, pigeon guillemot) or the recovery status is unknown (Kittlitz's murrelet). Although the effect on a bird population that is observed immediately following a spill to have suffered a large mortality is quite obvious, without frequent monitoring of each species following a spill it usually is difficult to be certain whether changes in measured population parameters are the result of lingering spill effects or natural variations that generally occur in all populations over time (Wiens and Parker 1995; Wiens 1996; Wiens et al. 2001). For example, forage fish populations utilized by many marine bird species may have experienced lingering spill effects of severe mortality or interruption of the annual cycle, in turn affecting food availability following the spill and thus influencing the effect of the spill on these bird populations or their recovery from it.

In addition to the birds occupying the open water of bays and inlets, shorebirds numbering in the tens to hundreds of thousands are at risk of oiling where they occupy various shore habitats during their spring passage to northern breeding areas (Gill and Tibbitts 1999). Particularly large numbers would be at risk on the southern Redoubt Bay, Fox River Delta, northern Montague Island, Kachemak Bay, and Copper River Delta, but substantial numbers may be at risk along most shorelines of the region during this season (Gill and Senner 1996; Gill and Tibbitts 1999; Alaska Shorebird Working Group 2000). Based on the experience of the *Exxon Valdez* oil spill, where studies extending 15 years after the event continue to find oil or effects on organisms from exposure to oil, it is highly probable that not all oil spilled would be removed from the environment. Because substantial numbers of birds are present year round in the marine environment of south central Alaska, major effects are expected to result from a spill at any time of year.

Loss or Degradation of Habitat. Marine and coastal birds could be affected by platform construction and removal activities, and pipeline trenching, which could disrupt behaviors of nearby birds. Platforms constructed under the Program would increase the number of offshore platforms present in the inlet by three, and up to 241 km (150 mi) of new offshore pipeline could be constructed. Platform emplacement could disturb birds temporarily; pipeline trenching may also affect birds in nearshore coastal habitats if it occurs in or near foraging, overwintering, or staging areas, or near seabird colonies. About 169 km (105 mi) of new pipeline and one pipeline landfall may be constructed under the Program. The pipelines would likely result in the short- and/or long-term disturbance of a small amount of habitat along the pipeline routes.

While habitat impacts from the construction and operations of onshore facilities could be long term in nature, the areas disturbed would be largely limited to the immediate vicinity of the pipelines and represent a very small portion of habitat available in the Cook Inlet Planning Area. Siting new pipelines and facilities away from coastal areas would reduce the amount of marine or coastal bird habitat that could be affected. Potential habitat impacts could be further reduced by locating the new pipelines within existing utility or transportation rights-of-way, and by locating the new pipeline landfalls away from active colony sites or coastal staging areas of migratory birds. Because there are relatively few nesting colonies in Cook Inlet of Anchor Point (USGS undated), only a few seabird colonies could be affected by onshore construction activities in this area. The disturbance of birds in these colonies could be reduced or avoided by siting new pipelines and facilities away from colony sites, and by scheduling construction activities to avoid nesting periods. Overall, onshore construction activities are expected to affect only a relatively small number of birds and not result in population-level effects.

Only small numbers of nesting birds are likely to be displaced away from the vicinity of onshore pipeline corridors (a few hundred meters) by construction activity and support vessel traffic in the Cook Inlet Planning Area. Onshore habitat alteration is likely to be relatively minor in most of the development support centers. Offshore, disturbance of bottom habitats by platform placement may disrupt small areas of potential diving duck and seabird foraging habitat, but these small removals would be inconsequential.

Construction of landfalls, onshore pads, and roads is not expected to affect the relatively low numbers of loons, waterfowl, and shorebirds nesting in south central Alaska adjacent to likely oil development areas, particularly because construction may take place mainly during the winter season. Like loons and waterfowl that do not migrate out of State, seabirds disperse into nearshore or offshore waters in winter, away from likely development activity.

Disturbance Due to Noise. Noise and human activities (such as normal maintenance) could disturb birds arriving in the area during spring migration and later in the year during nesting, fall molting, and staging periods, causing them to avoid the area and nearby habitats. Because of the small number of new platforms (no more than three), the disturbance of birds in offshore waters by operational noise and human activity would likely be limited to the individuals that might be present around a platform. Potential impacts on colonies could be avoided or mitigated by siting platforms and onshore facilities away from colony sites. Noise from air guns and disturbance from survey vessel traffic could displace foraging seabirds in offshore waters, especially if exploration occurs in high seabird density areas such as the open waters adjacent to the Stevenson and Kennedy Entrances to Cook Inlet and off of the northwestern coast of Kodiak Island (MMS 2003b).

Nesting, staging, migrant, or overwintering loons, waterfowl, and seabirds occurring in areas closer to primary Cook Inlet support facilities on the Kenai Peninsula and vicinity, for example, are more likely to be overflown by aircraft than those in more distant lease areas. This is due to the convergence of routes from offshore sites to the support area, and is expected to be the case in the Gulf of Alaska, Kodiak Island, and Alaska Peninsula areas, where there are few communities capable of adequate support activity. Effects from noise disturbance would be greater in areas where higher concentrations of birds occurred and less where birds were more dispersed and in fewer numbers. The degree of effect is also dependent on whether birds are engaged in critical aspects of their seasonal activity, as well as the intensity and type of disturbance (aircraft overflights, seismic surveys, vessel traffic). In addition, several open-water areas in the vicinity of Kachemak and Kamishak Bays represent important wintering areas (December–April) for the threatened Steller eider (USFWS unpublished data), and disturbance during the winter in these areas has a greater potential to affect this listed species.

Effects on ESA-Listed Species in South Central Alaska. The cumulative effects of OCS and non-OCS program activities on the endangered short-tailed albatross, threatened

Steller's eider, formerly threatened Aleutian Canada goose, and proposed Kittlitz's murrelet are expected to be similar to those noted for nonlisted species over the next 40 years. Continued compliance with ESA regulations and coordination with the USFWS would ensure that lease-specific OCS operations would be conducted in a manner likely to avoid or greatly minimize the potential for affecting these species.

Short-tailed albatrosses occur in waters of south central Alaska, and particularly in continental shelf waters, which places them at considerable oil-spill risk. Although their small population is spread throughout the North Pacific Ocean and few would be expected to be present during any given oil-spill event, the species has a high oil vulnerability index (King and Sanger 1979), and the loss of a few individuals could be detrimental to their small population size (MM 2003b). Because Aleutian Canada geese are not known to occupy marine waters during migration to any great extent, their risk of oil-spill contact in that habitat is considered low. It is unlikely that infrastructure development would occur near the two nesting areas, thus avoiding disturbance and onshore spills that could contact the species.

Factors such as disturbance due to increased boat traffic related to wildlife cruises and offshore oil and gas development, impacts related to oil spills, and a high oil vulnerability index (King and Sanger 1979) make the Kittlitz's murrelet particularly vulnerable to population declines. Although impacts of oil spills have been documented (van Vliet and McAllister 1994; Carter and Kuletz 1995), little is known about potential impacts of disturbance on courtship behavior, foraging ecology and feeding, or energetics (Day et al. 1999). The relatively small population size, limited distribution, apparent periodic breeding failures and low reproductive potential (Beissinger 1995), in conjunction with the above factors, has led to Kittlitz's status as a candidate species (priority 5; 50 CFR Part 17) under the ESA.

Steller's eiders occupying nearshore areas of the eastern Aleutian Islands to Cook Inlet from late fall to early spring could be exposed to the disturbance of air and vessel traffic, seismic surveys, oil-spill cleanup, and pipeline construction. Such activities would be scattered in occurrence, as are the flocks of eiders, or confined to specific corridors in the case of aircraft and vessels, which the flocks are likely to avoid. In general, interactions are expected to result in short-term and localized displacement. Pipeline construction is expected to result in the loss of a small amount of eider nearshore bottom-feeding habitat. Steller's eiders could be killed or injured as a result of collisions with platforms. This is most likely during migration; when visual conditions are reduced, such as in foggy weather; and during movement among habitats on wintering grounds. Because they typically are present throughout the winter, they are at risk for oil-spill contact, particularly in the northern portion of the region including Cook Inlet, where development may first occur, and potentially in the Kodiak Archipelago. However, mortality from a spill is difficult to estimate because of the substantial variation in between-year, seasonal, or even weekly presence and distribution of eiders and uncertainties of where an oil spill might occur. Based on USFWS assumptions, there is greater potential for the majority of individuals affected by factors discussed above to be from the Russian breeding population rather than the ESA-listed Alaska breeding population.

Kittlitz's murrelets typically show a very patchy distribution and are generally found in the vicinity of glaciated fjords of Cook Inlet, Prince William Sound, and southeast Alaska

(Kendall and Agler 1998; Day et al. 1999; Kuletz et al. 2003a). Exploration and development activities are expected to be separated in time, so exposure to disturbing factors such as aircraft and vessel traffic, seismic surveys, and pipeline construction could be infrequent and localized in areas where this species concentrates. There is a greater potential for effects if disturbance occurs in areas where murrelets concentrate and displacement becomes a possibility. In addition, the potential impacts from oil spills vary depending on the timing and location of the spill. For example, oil spills in College or Harrison Fjords during peak breeding or post-breeding would have larger impacts and could cause population-level effects, especially if birds come in contact with spilled oil or larger numbers of breeding age females are impacted. A large spill is likely to spread over a sufficiently large area to contact one or more bays where they may be concentrated during the summer breeding season, or offshore areas where they may be wintering in the Gulf of Alaska. For example, the *Exxon Valdez* oil spill resulted in the loss of an estimated 500 to 1,000 individuals, probably a substantial proportion of the world population, and certainly a major effect on this species.

Conclusion. Marine and coastal birds in Cook Inlet, including those that are ESA-listed, could be adversely affected by activities associated with the Program, as well as those associated with future OCS and non-OCS program activities. Potential impacts include injury or mortality of birds from collisions with platforms associated with OCS and State oil and gas development and other onshore and offshore structures (e.g., radio, television, or cell phone towers), onshore industrial, commercial, and residential development; exposure to discharges from permitted point sources such as sewage treatment discharges and nonpoint sources such as urban runoff, or accidental releases (e.g., oil spills); exposure to emissions from various onshore and offshore sources; ingestion of trash or debris; loss or degradation of habitat due to construction and operations activities; and behavioral disturbance due to the presence of, and noise generated by, equipment and human activity. Other trends such as extensive melting of glaciers (and increasing river discharges) and increased precipitation brought on by global climate change are also expected to adversely affect marine and coastal birds over the next 40 to 50 years. While the cumulative impact of all OCS and non-OCS activities in Cook Inlet could be minor to moderate, the incremental contribution due to routine Program activities would be negligible to medium (see Section 4.4.7.2.2). Compliance with ESA regulations and coordination with the USFWS would ensure that lease-specific OCS operations would be conducted in a manner that is likely to avoid or to greatly minimize the potential for affecting these species.

Marine and coastal birds may also be adversely affected by exposure to oil (via direct contact or through the inhalation or ingestion of oil or tar deposits) that is accidentally released from OCS and non-OCS activities, especially near coastal areas and affecting feeding and nesting areas. The incremental contribution of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on marine and coastal birds would be small to large, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and nesting areas; the timing and nature of spill containment; and the status of the affected birds (see Section 4.4.7.2.2). Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from moderate to major if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to the impacts of spills regardless of size, but their incremental contribution to cumulative impacts is generally expected to be small. A more detailed discussion of the effects of oil spills on marine and coastal birds in Cook Inlet is presented in Section 4.4.7.2.2.

Whether net cumulative impacts are minor or moderate depends on the nature and duration of activities that reduce bird survival and productivity. Losses would be limited in areas occupied by scattered flocks during relatively brief staging and migration periods or scattered nest sites during the brief nesting season; however, in cases for which exposure to localized disturbance is greater, impacts have the potential to rise to the population level.

4.6.4.2.3 Fish. Section 4.4.7.3.2 discusses direct and indirect impacts on fish communities in Cook Inlet resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Section 4.4.6.1.1) when added to impacts from ongoing and reasonably foreseeable future actions, including those of future OCS programs and other non-OCS activities. Table 4.6.1-3 presents the exploration and development scenario for the Cook Inlet cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in Cook Inlet are summarized in Table 4.6.1-6 and discussed below, as applicable.

The primary routine OCS activities in the Cook Inlet Planning Area that could result in impacts on fish include seismic surveys, drilling, platform and pipeline placement; releases of permitted discharges from wells; and removal of existing structures. Potential environmental impacts associated with the building and operation of OCS facilities such as platforms and pipelines would increase in conjunction with the increased number of wells. The impacts of routine activities (exploration and site development, production, and decommissioning) on fish communities are discussed in detail in Section 4.4.7.3.2. Overall, routine activities represent up to a minor disturbance, primarily affecting demersal fishes, with the severity of the impacts generally decreasing dramatically with distance from bottom-disturbing activities.

In the Cook Inlet Planning Area, up to three platforms would be constructed, all of which would result from the Program. The addition of new platforms may act as FADs that would attract rockfish and cod-like fishes in Cook Inlet. While some platforms may be allowed to remain as artificial reefs, removal of platforms would reduce available substrate and structures for these fish and some of their prey species. Some fish would be killed in the process of these platform removals although the chance of mortality would be greatly reduced by the fact that explosives would not be used in removal.

Oil and gas exploration and development in State waters could also contribute to cumulative effects on fishery resources in the Cook Inlet. Drilling of wells in State waters could also require construction of platforms and pipelines in waters of Alaska. The effects on fish would be similar to those described above for OCS oil and gas programs (Section 4.4.7.3.2). Other non-OCS activities that could impact fish communities include land use practices, point and non-point source pollution, logging, dredging and disposal of dredging spoils in OCS waters, anchoring, and commercial or sportfishing activities, and commercial shipping (including imported oil). Many of these activities would result in bottom disturbance that would affect bottom-dwelling fishes as well as their food sources in a manner similar to those described for OCS activities (Section 4.4.7.3.2).

Logging could also degrade riverine habitats that are important reproductive and juvenile habitat for migratory fish species. Erosion from areas undergoing commercial logging could increase the silt load in streams and rivers, which could reduce levels of invertebrate prey species and adversely affect spawning success and egg survival. The introduction of fine sediments into spawning gravels may render these habitats unsuitable for salmon spawning. Logging could also remove riparian canopies along some streams, which could increase solar heating of freshwater habitats. Downed timber could physically block salmon migrations. Because of past damage inflicted by commercial logging, improved forestry practices have been initiated, and timber harvests have been curtailed. Continued implementation of effective forest management techniques should help mitigate the adverse effects of logging in the future. Cumulative impacts on migratory species could also occur as a result of activities that obstruct fish movement in marine environments during migration periods.

Commercial fishing practices that are indiscriminate, such as trawling and pots, are responsible for significant amounts of bycatch that can injure or kill juveniles of many fish species (Cooke and Cowx 2006). These types of fishing practices could damage future year classes, reduce available prey species, and damage benthic habitat for many Cook Inlet fish resources. A wide variety of methods are used to target numerous species of fishes and shellfishes, including longlines, seines, setnets, trawls, and traps. Some fisheries target particular fish species returning to their natal stream or river, while other fisheries take place in pelagic waters and target mixed stocks of fishes or shellfishes.

As a consequence of the pressure commercial fishing places on fishery resources, appropriate management is required to reduce the potential for depletion of stocks due to overharvesting. Fisheries in the Cook Inlet Planning Area are managed by State (Alaska Department of Fish and Game) and Federal (North Pacific Fishery Management Council of the National Marine Fisheries Service) agencies. Even with management, the possibility of overfishing still exists. Occasionally fisheries are closed when stocks are considered insufficient to support harvesting, and will sometimes remain closed for multiple seasons before stocks are deemed sufficient.

Although the magnitude of harvests is considerably smaller than for commercial fisheries (Fall et al. 2009), sportfishing also contributes to cumulative effects on the abundance of some fishery resources. Recreational fisheries have a potential to result in overharvest of managed species over the life of the Program. Recreational fishing is subject to harvest limits that reduce the potential for overfishing and recreational fishing methods are less destructive of EFH compared to commercial fisheries.

Subsistence fishing may also contribute to the cumulative effects on the abundance of some fishery resources. Alaska State law defines subsistence as the “noncommercial customary and traditional uses” of fish and wildlife. Subsistence fishing is subject to harvest limits that reduce the potential for overfishing. Also, much of Cook Inlet is defined as a nonsubsistence area and subsistence fishing is therefore not authorized. Consequently, subsistence fishing makes a relatively minor contribution to the reduction in fish stocks compared to commercial fishing (Fall et al. 2009).

Another source of cumulative impacts to fishery resources is the "personal use" fishery which is a legally defined as "the taking, fishing for, or possession of finfish, shellfish, or other fishery resources, by Alaska residents for personal use and not for sale or barter, with gill or dip net, seine, fish wheel, long line, or other means defined by the Board of Fisheries." In the Cook Inlet Planning Area, there are personal use fisheries for salmon, herring, and eulachon. Personal use fisheries are subject to harvest limits that reduce the potential for overfishing. Like subsistence fishing, the personal use fishery is a relatively minor contributor to the reduction in fish stocks compared to commercial fishing.

Climate change may affect fish communities in the Cook Inlet Planning Area and interact with past, present, and future OCS and non-OCS stressors. Physiological and ecosystem-level stressors related to climate change may interact with the non-climate-related anthropogenic stressors such as overfishing, pollution, and habitat loss discussed above. For example, a climate change–related increase in water temperature that results in physiological stress could make individuals more susceptible to stress from pollution or accidental oil spills. Fish respond directly to climate fluctuations, as well as to changes in their biological environment including predators, prey, species interactions, disease, and fishing pressure. Projected changes in hydrology and water temperatures, salinity, and currents could affect the growth, survival, reproduction, and spatial distribution of marine fish species and of the prey, competitors, and predators that influence the dynamics of these species (Watson et al. 1998). Changes in primary production levels in the ocean because of climate change may affect fish stock productivity.

Climate change could potentially affect large-scale ecological processes. Important coastal habitats could be reduced or eliminated by rising sea levels and increased storm damage. For species spawning in low-lying areas or the intertidal zone, or species using coastal estuaries as nursery grounds, rising sea levels could eliminate spawning or juvenile habitat. Anadromous fish and species using nearshore marshes are likely to be most affected. In addition, the current trend of steadily increasing sea surface temperature may favor higher trophic-level fish by increasing their local productivity or by promoting the expansion of large temperate predators into Alaskan waters (Litzow 2006). The establishment of temperate species and non-native fish introduced by human activities could come at the expense of native species, particularly forage fish like herring and capelin. However, given the complexity and compensatory mechanisms of the ecosystem, predictions about the indirect effects of climate change on specific fish species are subject to great uncertainty.

Oil spills could result from OCS and non-OCS activities. The total number of oil spills and the extent of affected areas would likely increase under the Program in conjunction with increased levels of petroleum exploration and production (Table 4.6.1-4). Non-OCS activities, such as oil and gas development in State waters, domestic transportation of oil or refined petroleum products, and commercial shipping, may also result in accidental spills that could potentially impact fish resources within the Cook Inlet Planning Area. While effects on fishery resources would depend on the timing, location, and magnitude of specific oil spills, it is anticipated that most small to medium spills that occur in OCS waters would have limited effects on fishery resources due to the relatively small areas likely to be exposed to high concentrations of hydrocarbons and the short period of time during which potentially toxic concentrations would be present. Most adult fish in marine environments are highly mobile and may avoid high concentrations of hydrocarbons, although they may be subject to sublethal exposures. However, eggs and larvae as well as small obligate benthic species do not have the ability to avoid spills and may therefore suffer lethal or sublethal effects. Oil from a catastrophic spill that reaches shallower, nearshore areas of these planning areas has the potential to be of greatest significance to fish communities. Impacts from such spills could result in long-term, population level impacts on fish communities. The potential impacts of OCS oil spills on fish communities in Cook Inlet are discussed in detail in Section 4.4.7.3.2.

Oil reaching salmon spawning areas, nursery areas, or migration routes has the greatest potential to reduce salmon stocks. However, because of the limited area affected by oil spills relative to the wide pelagic distribution and highly mobile migratory patterns of salmonids, it is anticipated that most impacts would be limited to small fractions of exposed salmon populations. Oil spills occurring at constrictions in migration routes would have an increased potential for adversely affecting salmon. However, the weathering and dispersal of the spilled oil would limit the length of time that an area would be affected. Pacific salmon are also able to detect and avoid oil spills in marine waters (Weber et al. 1981), which would help to reduce the potential for contact. Aggregations of salmon in marine waters typically consist of mixed stocks, so even in the unlikely event of contact with an oil spill, it is anticipated that only a small fraction of any unique spawning population would be adversely affected.

Adverse effects of oil spills on groundfishes of south central Alaska would also be a function of spill magnitude, location, and timing. Adult groundfishes are primarily demersal and would generally be subjected only to the insoluble oil and water-soluble fractions of oil that reach deeper strata. Insoluble oil fractions would sink to the bottom and be distributed diffusely as tar balls over a wide area, and would be unlikely to produce noticeable reductions in the overall numbers of adult fishes. Egg and larval stages would be at a greater risk of exposure to oil spills because spawning aggregations of many groundfish species (e.g., walleye pollock) produce pelagic eggs that could come into contact with surface oil slicks. Herring are also potentially susceptible to oil spills because they spawn in nearshore waters for protracted periods of time.

In addition to effects on individuals and species, impacts to fish can result in ecosystem-level effects if the population impacts are significant. For example, fish can occupy a number of trophic levels ranging from herbivore to top level carnivore. As such, fish are critical to energy flow within nearshore and marine food webs. They are also seasonally important food sources to transient carnivores. Consequently, impacts to fish can propagate throughout the food web, affecting birds and marine mammals. In addition, many Alaskan fishes, particularly salmonids, migrate between and within marine, estuarine, and freshwater habitats. In doing so, they transfer nutrients and carbon over a broad area and connect offshore and freshwater and terrestrial ecosystems (Naiman et al. 2002). Significant impacts to fish populations could reduce this transfer, resulting in local changes in productivity.

Conclusion. Cumulative impacts on fish communities in Cook Inlet as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be moderate to major over the next 40 to 50 years. Non-OCS activities or phenomena affecting these resources include oil and gas development in State waters, sediment dredging and disposal, logging, anchoring, fishing/trawling, commercial shipping, and pollutant inputs from point and non-point sources. Many of these activities would affect fish at various life stages as well as their food sources in a manner similar to OCS activities. The incremental contribution of routine Program activities to these impacts (primarily as a result of displacement, injury or mortality of fish and their food sources) would be negligible to small. Fish could also be affected by the environmental changes predicted to result from climate change.

Fish communities may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS activities as well as naturally occurring seeps. The cumulative impacts of past, present, and future oil spills on these resources would be minor to moderate. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on fish would be negligible to medium, depending on the location, timing, duration, and volume of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts associated with unexpected large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could range up to moderate if it were to occur. Oil from large spills or a CDE has the greatest potential to contact shoreline areas used for spawning or providing habitat for early life stages of fish and, therefore, could result in large-scale lethal and long-term sublethal effects on fish. Oil is slow to break down in Alaskan waters; therefore, oiling could measurably depress some fish populations for several years. A more detailed discussion of the effects of oil spills on fish in Cook Inlet is presented in Section 4.4.7.3.2.

4.6.4.2.4 Invertebrates and Lower Trophic Levels. Section 4.4.7.5.2 discusses direct and indirect impacts on invertebrates and lower trophic levels in Cook Inlet resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Section 4.4.6.1.1) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS activities. Table 4.6.1-3 presents the exploration and development scenario for the Cook Inlet cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the GOM are summarized in Table 4.6.1-6 and discussed below, as applicable.

The primary routine OCS activities that could result in impacts on invertebrates include seismic surveys, drilling, platform and pipeline placement; releases of permitted discharges from wells; and removal of existing structures. Potential environmental impacts associated with the building and operation of OCS facilities such as platforms and pipelines would increase in conjunction with the increased number of wells. The impacts of routine activities (exploration and site development, production and decommissioning) on invertebrate communities are discussed in detail in Section 4.4.7.5.2. Overall, routine activities represent up to a moderate disturbance, primarily affecting benthic infaunal invertebrates, with the severity of the impacts generally decreasing dramatically with distance from bottom-disturbing activities.

Up to three platforms could be constructed over the life of the Program, all of which would result from the Program, would allow the colonization of invertebrates requiring hard substrate. While some platforms may be allowed to remain as artificial reefs, removal of platforms will reduce available substrate and structures for invertebrates and injure or kill them during removal.

Oil and gas exploration and development in State waters could also contribute to cumulative effects on invertebrates in the Cook Inlet Planning Area. Drilling of wells in State waters could also require construction of platforms and pipelines in waters of Alaska. The effects on invertebrates would be similar to those described above for OCS oil and gas programs (Section 4.4.7.5.2). Other non-OCS activities that could impact invertebrate communities include land use practices, point and non-point source pollution, logging, dredging and disposal of dredging spoils in OCS waters, anchoring, commercial or sportfishing activities, and commercial shipping (including shipping of imported oil). Many of these activities would affect bottom-dwelling invertebrates at various life stages as well as their food sources in a manner similar to OCS bottom-disturbing activities (Section 4.4.7.5.2). Other non-OCS activities generating pollution and noise may contribute to general habitat degradation (Section 4.6.3.2.2).

Commercial fishing practices that are indiscriminate, such as trawling and pots, are responsible for significant amounts of bycatch that can injure or kill juveniles of many invertebrate species. These types of fishing practices could also damage benthic habitat for many Cook Inlet invertebrate resources.

Physical and chemical changes to invertebrate habitat resulting from climate change could alter the existing distribution, composition, and abundance of invertebrates in Cook Inlet, since physical and chemical parameters are the primary influence on invertebrate communities. For example, the increase in seawater temperature may facilitate a northward expansion of subarctic and temperate invertebrate species. Rising seawater temperatures are also expected to decrease winter ice extent and duration. Currently, ice formation primarily occurs on the western side of Cook Inlet, and changes in benthic invertebrate community structure could result from the reduction in ice scour. In addition, in heavily river influenced systems like Cook Inlet, the predicted hydrologic alterations associated with climate change can rapidly alter existing invertebrate communities in the water column and benthos if the new chemical conditions are not within the physiological tolerance of the existing communities. Another significant source of physiological stress is the expected increase in ocean acidification. Crustaceans, echinoderms, foraminiferans, and mollusks could have greater difficulty in forming shells, which could result in a reduction in their fitness, abundance, and distribution (Fabry et al. 2008).

Oil spills could result from OCS and non-OCS activities. The total number of oil spills and the extent of affected areas would likely increase under the Program in conjunction with increased levels of petroleum exploration and production (Table 4.6.1-3). Non-OCS activities, such as oil and gas development in State waters, domestic transportation of oil or refined petroleum products, and commercial shipping, may also result in accidental spills that could potentially impact invertebrate resources within the Cook Inlet Planning Area. While effects on invertebrate resources would depend on the timing, location, and magnitude of specific oil spills, it is anticipated that most small to medium spills that occur in OCS waters would have limited effects due to the relatively small areas likely to be exposed to high concentrations of hydrocarbons and the short period of time during which potentially toxic concentrations would be present. Large water column and benthic invertebrates are mobile and therefore have the potential to avoid high concentrations of hydrocarbons although they may be subject to sublethal exposures. However, zooplankton and infauna do not typically have the ability to avoid spills and may therefore suffer lethal or sublethal effects. Oil from catastrophic spills that reaches shallower, nearshore areas of the Cook Inlet Planning Area has the potential to be of greatest significance to invertebrate communities. Impacts from such spills could result in long-term, population-level impacts on intertidal invertebrate communities. Benthic and pelagic invertebrates are important trophic links that connect primary producers to higher-trophic-level organisms. Consequently, oil spill contamination on a large scale could result in contaminant transfer to higher trophic levels and/or in reduced food availability to higher trophic levels if invertebrate populations were severely depressed by a CDE. The potential impacts of OCS oil spills on invertebrate communities in Cook Inlet are discussed in detail in Section 4.4.7.5.2.

Commercial shellfish stocks (such as tanner, snow, and red king crab) are unlikely to be exposed to surface oil. Although soluble and insoluble hydrocarbon fractions could reach deeper strata, these fractions would be distributed diffusely over wide areas and would likely not constitute a threat to shellfish stocks. Pelagic crab larvae could be affected if a large surface oil spill occurred during the spring spawning season. However, because the area affected by most spills would be expected to be small relative to overall distributions of crab larvae, overall population levels are unlikely to be noticeably affected.

Conclusion. Cumulative impacts on invertebrate communities in the Cook Inlet Planning Area as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be moderate to major over the next 40 to 50 years. Non-OCS activities or phenomena affecting these resources include oil and gas production in State waters, sediment dredging and disposal, logging, anchoring, fishing/trawling, commercial shipping, and pollutant inputs from point and non-point sources. The incremental contribution of routine Program activities to these impacts (mainly due to bottom-disturbing activities) would be negligible to medium, with the severity of impacts generally decreasing with distance from the disturbance. Several major classes of invertebrates could also be affected by naturally occurring oil seeps and the environmental changes predicted to result from climate change. Invertebrate communities may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS activities as well as naturally occurring seeps. The cumulative impacts of past, present, and future oil spills on these resources would be minor to moderate. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on invertebrates would be negligible to small, depending on the location, timing, duration, and size of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could range up to moderate if it were to occur. Spills in deeper water, whether from OCS or non-OCS sources, are unlikely to have overall population-level effects on invertebrate resources because of the relatively small proportion of similar available habitats that would come in contact with released oil at concentrations great enough to elicit toxic effects. A CDE could also contaminate or reduce the abundance of seasonally abundant copepods, which may in turn impact higher trophic levels. A more detailed discussion of the effects of oil spills on invertebrates in Cook Inlet is presented in Section 4.4.7.5.2.

4.6.4.3 Alaska Region – Arctic

4.6.4.3.1 Mammals.

Marine Mammals. The cumulative analysis considers past, ongoing, and foreseeable future human and natural activities that may occur and adversely affect marine mammals in the Arctic Planning Areas. These activities include effects of the OCS Program (Programs and prior and future OCS sales), oil and gas activities in State waters, shipping, commercial fishing, recreational fishing, subsistence fishing, personal-use fishing, and boating activities, military operations, scientific research, and natural phenomena. Specific types of impact-producing factors considered include noise from numerous sources, pollution, ingestion and entanglement in marine debris, vessel strikes, habitat degradation, subsistence harvests, military activities, industrial development, community development, climate change, and natural catastrophes. Section 4.4.7.1.3 provides the major impact-producing factors related to the Program in Cook Inlet.

Routine Activities.

OCS Activities. Marine mammals and their habitats in the Arctic Planning Areas could be affected by a variety of exploration, development and production activities as a result of the proposed and future OCS leasing actions (see Section 4.4.7.1.3). These activities include seismic exploration, offshore and onshore infrastructure construction, the discharge of operational wastes, and vessel and aircraft traffic. Impacts to marine mammals from these activities may include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. The degree of impact at the population level depends greatly on the status of the population (reflected in its listing under the ESA) and the degree of disturbance or harm from OCS-related activities in areas important to species survival (i.e., feeding, breeding, molting, rookery or haulout areas).

Potential impacts (primarily behavioral disturbance) to marine mammals from OCS-related seismic activity would be short-term and temporary, and not expected to result in population level impacts for any affected species if appropriate mitigation measures are implemented.

Impacts from OCS construction and operation activities could include the temporary disturbance and displacement of individuals or groups by construction equipment and long-term disturbance of some individuals from operational noise. No long-term, population-level effects would be expected because individuals most affected by these impacts would be only those in the immediate vicinity of the construction site or operational platform and disturbance of individuals during construction would be largely temporary. In addition, appropriate mitigation measures could lessen the potential for impacts.

Operational and waste discharges (e.g., produced water, drilling muds, and drill cuttings) would be disposed of through downhole injection into NPDES-permitted disposal wells, and thus would not be expected to result in any incremental impacts to marine mammals. Liquid wastes (such as bilge water) may also be generated by OCS support vessels and on production platforms. While these wastes may be discharged (if permitted) into surface waters, they would be rapidly diluted and dispersed, and would not be expected to result in any incremental impacts to marine mammals from exposure to these wastes. Drilling and production wastes may contain materials such as metals and hydrocarbons, which can bioaccumulate through the food chain into the tissues of marine mammals. Although the bioaccumulation of anthropogenic chemicals has been reported for a variety of marine mammals, adverse impacts or population-level effects resulting from such bioaccumulation have not been demonstrated (Norstrom and Muir 1994; Muir et al. 1999).

Marine mammals could be temporarily disturbed by OCS vessel traffic (all species) or incur injury or death from collisions with support vessels (primarily larger, slower moving cetaceans). The low level of OCS vessel trips in the Arctic Planning Areas under the Program would likely limit potential cumulative impacts to a few individuals, be largely short-term in nature, and not result in population-level effects. Noise from helicopter overflights would be transient in nature. Impacts to marine mammals would be behavioral in nature, primarily resulting in short-term disturbance in normal activities, and would not be expected to result in population-level effects. Overflights and vessels could disturb pinnipeds on rookeries and haul-outs. In particular, disturbance of walruses can cause stampedes, where younger animals and calves can be killed, possibly causing population-level impacts to some species. Appropriate mitigation measures such as overflight restrictions and flightline selection to avoid rookeries and haul-outs would limit the potential for adversely affecting animals at these locations.

No platforms would be removed under the Program for the Arctic Planning Areas.

Non-OCS Activities. A number of non-OCS activities such as oil and gas exploration and development in State waters, subsistence harvests, vessel traffic, and climate change could also affect marine mammals in the Arctic Planning Areas. Many of the effects of these activities on marine mammals would be similar in nature to those resulting from OCS-related activities, namely, behavioral disturbance, habitat disturbance, injury, or mortality, and exposure to toxic substances. Marine mammals may also be adversely affected by climate change.

<u>Oil and Gas Exploration and Development in State Waters.</u> The State of Alaska has made nearshore State lands available for leasing along the Beaufort Sea coast. The exploration activities (and associated impacts to marine mammals) that could result with State oil and gas lease sales may greatly outnumber exploration activities (and potential impacts to marine mammals) that could occur under the OCS Program.

Exploration, construction, and operation activities associated with State leases would occur in nearshore and coastal areas, while OCS platforms and pipelines would be located away from coastal areas (with the exception of relatively few pipeline landfalls and onshore bases and processing facilities). Thus, State oil and gas leasing activities may be expected to have a greater potential for affecting marine mammals in coastal habitats than would the proposed OCS actions.

Subsistence Harvesting. Subsistence harvesting has been identified as impacting marine mammals in Alaskan waters (Allen and Angliss 2011). However, annual mortality from subsistence harvests is considered to have little adverse effect on most marine mammal populations or stocks. The following are the reported estimated annual Alaska-wide subsistence harvests for marine mammals that occur in the Beaufort and/or Chukchi Seas (Allen and Angliss 2011):

- The best estimate of annual subsistence harvest of spotted seals is 5,265 animals.

- The best estimate of annual subsistence harvest of bearded seals is 6,788 animals.

- The best estimate of annual subsistence harvest of ringed seals is 9,567 animals.

- The best estimate of annual subsistence harvest of ribbon seals is 193 animals.

- The best estimate of annual subsistence harvest for the Beaufort Sea beluga whale stock is 139 animals, which includes 25 individuals in Alaska and 114 individuals in Canada.

- The best estimate of annual subsistence harvest for the Eastern Chukchi Sea beluga whale stock is 59 animals.

- There are known subsistence harvests of narwhals by Alaska Natives.

- There are no known subsistence harvests of the Bering Sea stock of harbor porpoises by Alaska Natives. However, Suydam and George (1992) noted that individuals from this stock have been entangled in subsistence nets.

- Annual subsistence take of grey whales averaged 121 individuals between 2003 to 2007. Russian Chukotka people take most of the gray whales. The U.S. Makah Indian Tribe has a yearly average quota of 4 whales. In 2005, an unlawful subsistence hunt and kill of a gray whale occurred in Alaska.

- No subsistence takes of the Northeast Pacific stock of fin whales are reported from Alaska or Russia.

- Subsistence take of minke whales by Alaska Natives is rare (e.g., only nine between 1930 and 1995).

- Alaska Native subsistence hunters take 14 to 72 bowhead whales per year (0.1 to 0.5% of the population). Russian and Canadian subsistence hunters also take a few bowhead whales. The annual subsistence take from 2004 to 2008 for Alaska, Russian, and Canadian Natives averaged 41.2 bowhead whales. Several cases of fishing rope or net entanglement have been reported from whales taken in subsistence hunts.

- The 1925 to 1953 estimated annual Alaska harvests of polar bears for subsistence, handicrafts, and recreation was 120 animals. Recreational harvests by non-Native sports hunters using aircraft averaged 150 annually from 1951 to 1960 and 260 annually from 1960 to 1972. A prohibition on non-Native hunting became effective in 1973. The annual subsistence harvests for the Chukchi/Bering Seas stock was 92/year in the 1980s, 49/year in the 1990s, and 43/year in the 2000s.

- The annual harvests for the Southern Beaufort Sea polar bear stock was 39/year in the 1980s, 33/year in the 1990s, and 32/year in the 2000s.

- The estimated annual subsistence harvest mortalities for the Pacific walrus from 2003 to 2007 averaged from 4,960 to 5,457 animals/year. This includes 1,630 to 1,918 harvested in the United States; 1,247 harvested in Russia; and 2,083 to 2,292 struck and lost.

<u>Climate Change.</u> A concern regarding marine mammals in polar regions is the potential for climate change and associated loss in the extent of sea ice in some Arctic and subarctic waters. Some species, such as the bearded seal and polar bear, are dependent on sea ice for at least part of their life history, and may be more sensitive to changes in Arctic weather, sea-surface temperatures, or extent of ice cover (Allen and Angliss 2011). Ice edges are biologically productive systems where ice algae form the base of the food chain. The ice algae are crucial to Arctic cod, which is a pivotal species in the Arctic food web. As ice melts, there is concern that there will be loss of prey species of marine mammals, such as Arctic cod and amphipods, that are associated with ice edges (MMS 2004a). Changes in the extent, concentration, and thickness of the sea ice in the Arctic may alter the distribution, geographic ranges, migration patterns, nutritional status, reproductive success, and, ultimately, the abundance of ringed seals and other ice-dependent pinnipeds that rely on the ice platform for pupping, resting, and molting (MMS 2004a). Reductions in sea ice coverage would adversely affect the availability of pinnipeds as prey for polar bears. More polar bears may stay onshore during the summer (MMS 2004a). If the Arctic climate continues to warm and early spring rains become more widespread, ringed seal lairs might collapse prematurely, exposing ringed seal pups to increased predation by polar bears and Arctic foxes, negatively impacting the ringed seal population and, therefore, eventually the polar bear population (MMS 2004a).

The loss of sea ice could have several potential effects on bowhead whales. These would include increased noise and disturbance related to increased shipping, increased interactions with commercial fisheries, including noise and disturbance, incidental intake, and gear entanglement; changes in prey species concentrations and distribution; changes in subsistence-hunting practices; increased predation from expanding killer whale range; and competition from expanding fin, humpback, and other baleen whale ranges. Bowhead whale seasonal distribution may change with changes in seasonal ice distribution as well.

<u>Other Impacting Factors.</u> Marine mammals may also be impacted by other factors such as UMEs and invasive species. A UME is an unexpected stranding that involves a significant die-off of any marine mammal population, and demands immediate response (NMFS 2011b). Causes of UMEs include infections, biotoxins, human interactions, and malnutrition (NMFS 2011b). Since establishment of the UME program in 1991, there have been 55 formally recognized UMEs in the U.S., one of the ongoing UMEs involving pinnipeds includes the Arctic (NMFS 2011b). Section 3.8.1.3.1 discusses this UME. Invasive species could affect some marine mammals by disrupting local species and ecosystems, affecting the prey base for some marine mammals. Currently, invasive species are not a major factor in the Arctic Planning Areas. However, as climate change continues to warm Alaskan waters, the Arctic Planning Areas may become more susceptible to invasive species (e.g., from ballast discharges associated with increased vessel traffic).

Accidents. Marine mammals could be exposed to oil accidentally released from platforms, pipelines, and vessels from the Program (Table 4.4.2-1). Potential non-OCS sources of oil spills include the domestic transportation of oil, oil and gas development in State waters, and natural sources such as seeps. Accidental oil releases could expose marine mammals to oil by direct contact or through the inhalation or ingestion of oil or tar deposits. The magnitude and duration of exposure will be a function of the location, timing, duration, and size of the spill; the proximity of the spill to feeding and other important habitats; the timing and nature of spill containment; and the status of the affected animals. Most expected small to medium spills (less than 1,000 bbl) would have limited effects on marine mammals due to the relatively small areas likely to incur high concentrations of hydrocarbons and the short period of time during which potentially toxic concentrations would be present. The magnitude of impact would be expected to increase should a spill occur in habitats important to marine mammals or affect a number of individuals from a population listed under the ESA. Some spills from OCS activity may locally represent the principal source of oil exposure for some species, especially for spills contacting important coastal and island habitats or collecting along ice leads.

Conclusion. Cumulative impacts on marine mammals in the Beaufort and Chukchi Sea Planning Areas as a result of future OCS program and ongoing and future non-OCS program activities could be minor to moderate over the next 40 to 50 years. Non-OCS program activities or phenomena that may affect populations of marine mammals include climate change, contaminant releases, vessel traffic, subsistence harvests, and invasive species. The incremental contribution of routine Program activities to these impacts would be negligible to small (see Section 4.4.7.1.3).

Marine mammals may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS activities. The cumulative impacts of past, present, and future oil spills on marine mammals would be minor to moderate. The incremental impacts of expected accidental spills associated with the Program on marine mammals would be negligible to large, depending on the location, timing, and volume of the spills; the environmental settings of the spills; and the species (and number of individuals) exposed to the spills (Section 4.4.7.1.3). Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from minor to major if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to the impacts of spills regardless of size, but their incremental contribution to cumulative impacts is generally expected to be small. A more detailed discussion of the effects of oil spills on marine mammals in the Arctic is presented in Section 4.4.7.1.3.

Terrestrial Mammals. Terrestrial mammals and their habitats could be affected by a variety of activities associated with the proposed OCS actions (Section 4.4.7.1.3). These activities include construction and operation of onshore pipelines and vehicle and aircraft traffic. Impacts to terrestrial mammals from these activities may include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. In the Arctic Planning Areas, these impacts would be in addition to similar (in nature) impacts resulting from ongoing and planned OCS lease sales under previously approved 5-year programs.

Impacts from OCS construction and operation activities could include the injury or death of smaller mammals (such as mice and voles) and the disturbance and displacement of individuals or groups of larger species (such as caribou, muskoxen, and brown bear). Because of the limited areal extent of new pipeline under the Program, disturbance (primarily behavioral in nature) of most of these species during construction would be largely temporary, and no long-term population level effects would be expected. However, construction activities in the Arctic could disturb caribou in calving, foraging, or insect avoidance habitats, which could affect adult and calf survival. However, the potential for such impacts could be minimized by careful siting of new pipelines to avoid important habitats.

Species such as the Arctic fox that habituate to human activity and facilities could experience local increases in density, while bears may experience increases in mortality associated with defense of life and property killings. In the Arctic, pipelines and roads associated with the Program have the potential to incrementally affect local and seasonal movements of caribou.

Under the Program, vehicle traffic associated with normal operations and maintenance of onshore pipelines could disturb wildlife. Vehicle traffic could disturb wildlife foraging along pipelines or access roads, causing affected wildlife to temporarily stop normal activities (e.g., foraging, resting) or leave the area, while collision with vehicles could injure or kill some individuals. Because vehicle traffic would be infrequent, vehicle-related impacts associated with the Program would result in little incremental increase in vehicle-related impacts from current or ongoing OCS activities in the Arctic.

Up to 27 weekly helicopter trips would occur to platforms in the Arctic Planning Areas. Impacts to terrestrial mammals from helicopter overflights would be behavioral in nature, primarily resulting in short-term disturbance in normal activities, and would not be expected to result in population-level effects. Overflights disturbing active calving and overwintering sites could result in decreased survival of young or adults, and potentially result in population level impacts to some species. Selection of flight lines to avoid overflights of important habitats would greatly limit the potential for adversely affecting calving or overwintering animals.

Terrestrial mammals in the Arctic Planning Area could also be affected by a number of non-OCS activities, including oil and gas exploration and development in State waters, and coastal and community development, and climate change. Many of the effects of these activities on terrestrial mammals would be similar in nature to those resulting from OCS-related activities, namely behavioral disturbance, habitat disturbance, and injury or mortality. The State of Alaska has made leases of State waters available along much of the Beaufort Sea coast. Because these leases are closer to shore than those for the Program, impacts on terrestrial mammals may exceed the potential impacts that could occur under the OCS Program. Implementation of the Program could increase coastal and community development, indirectly adding to impacts to terrestrial mammals and their habitats. Terrestrial mammals could be adversely affected by the accidental release of oil from an onshore pipeline, or by offshore spills contacting beaches and shorelines utilized by terrestrial mammals (such as caribou or brown bears). Impacts to terrestrial mammals from an oil spill would depend on such factors as the time of year and volume of the spill, type and extent of habitat affected, and home range or density of the species. Spills contacting high-use areas (such as caribou calving areas) could locally affect a relatively large number of animals. It is anticipated that most of the spills would have limited effects on terrestrial mammals, due to the relatively small areas likely to be directly exposed to the spills, and the small number and size of spills projected for the Program and for current and planned OCS oil and gas developments. However, some spills may locally represent the principal source of oil exposure for some species, especially for spills contacting important calving or overwintering habitats.

Conclusion. Cumulative impacts on terrestrial mammals in the Beaufort and Chukchi Sea Planning Areas as a result of future OCS program and ongoing and future non-OCS activities could be minor to moderate over the next 40 to 50 years. Non-OCS activities or phenomena that may affect populations of terrestrial mammals include climate change, natural catastrophes, contaminant releases, and vehicle traffic. The incremental contribution of routine Program activities to these impacts would be negligible to small (see Section 4.4.7.1.3).

Terrestrial mammals may also be adversely affected by exposure to oil that is accidentally released from onshore (e.g., Prudhoe Bay) and State offshore oil and gas activities. The cumulative impacts of past, present, and future oil spills on terrestrial mammals would be minor to moderate. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on terrestrial mammals would be negligible to large, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and other important habitats; the timing and nature of spill containment; and the status of the affected animals (see Section 4.4.7.1.3).

An unexpected, low-probability CDE has a greater potential to affect terrestrial habitats; therefore, impacts could range from minor to major if one were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to the impacts of spills regardless of size, but their incremental contribution to cumulative impacts is generally expected to be small. A more detailed discussion of the effects of oil spills on terrestrial mammals in the Arctic region is presented in Section 4.4.7.1.3.

4.6.4.3.2 Marine and Coastal Birds. Section 4.4.7.2.3 discusses impacts to marine and coastal birds in the Arctic region resulting from the Program (OCS program activities from 2012 to 2017). Cumulative impacts on marine and coastal birds result from the incremental impacts of the Program when added to impacts from existing and reasonably foreseeable future OCS program activities (that are not part of the Program) and other non-OCS program activities. Table 4.6.1-2 presents the exploration and development scenario for the Beaufort and Chukchi Seas cumulative cases (encompassing the Program and other OCS program activities) over the next 50 years. A number of OCS program activities could affect Arctic marine or terrestrial birds or their habitats; these include offshore exploration, construction of offshore platforms and pipelines, construction of onshore pipelines, operations of offshore platforms, operational discharges and wastes, and OCS-related marine vessel and aircraft traffic. Potential impacts on marine and coastal birds from OCS program activities include injury or mortality of birds from collisions with platforms, vessels, and aircraft; exposure to operational discharges; ingestion of trash or debris; loss or degradation of habitat due to construction; and behavioral disturbance due to the presence of, and noise generated by, equipment and human activity.

Non-OCS program activities affecting marine and coastal birds in the Beaufort Sea and Chukchi Sea Planning Areas include dredging and marine disposal; coastal and community development; onshore and offshore construction and operations of facilities associated with State oil and gas development (mainly Prudhoe Bay); commercial and recreational boating; and small aircraft traffic. Potential impacts on marine and coastal birds from these activities are similar to those under the OCS program and include injury or mortality of birds from collisions with platforms associated with State oil and gas development and other onshore and offshore structures (e.g., radio, television, or cell phone towers); onshore industrial, commercial, and residential development; exposure to discharges from permitted point sources such as sewage treatment discharges and nonpoint sources such as snowmelt and stormwater runoff; or accidental releases (e.g., oil spills), as described in Section 4.6.2.1.3 and Table 4.6.2-4; exposure to emissions from various onshore and offshore sources (e.g., power generating stations and marine vessels), as described in Section 4.6.2.1.3; ingestion of trash or debris; loss or degradation of habitat due to construction and operations activities; and behavioral disturbance due to the presence of, and noise generated by, equipment and human activity. Other trends such as extensive melting of glaciers (and increasing river discharges), thawing of permafrost, and increased precipitation brought on by global climate change are also expected to adversely affect marine and coastal birds over the next 50 years.

Injury or Mortality from Collisions. Under the cumulative scenario, annual collision injury or mortality in the Beaufort and Chukchi Sea Planning Areas could increase in the near term as platforms are built under the Program. Such impacts would be minor relative to those that currently involve non-OCS structures. Over time, the injury or mortality impacts from collisions could decrease as oil and gas production in the inlet declines.

Exposure to Wastewater Discharges and Air Emissions. The discharge of operational wastes and air emissions from current non-OCS related vessel traffic and platform operations in the Beaufort and Chukchi Seas is strongly regulated and would continue to be so regulated over the next 50 years. Many wastes (such as produced water, drilling muds, and drill cuttings) would be disposed of through onsite injection into NPDES-permitted disposal wells. However, such wastes and emissions would still expose marine and coastal birds to potentially toxic materials or to solid debris that could be ingested or result in entanglement. These facilities and activities include sewage treatment plants, industrial manufacturing or processing facilities, electric generating plants, dredging and marine disposal, and vessel traffic (e.g., cargo and tanker ships and military and research vessels). Operational wastewater discharges and air emissions associated with the Program would contribute to the overall cumulative risk of toxic exposure and debris ingestion or entanglement of existing non-OCS wastewater discharges and air emissions in the inlet, but the incremental increase in impact is expected to be small relative to these other activities.

Under the Program, marine and coastal birds could be exposed to oil accidentally released from platforms, pipelines, and vessels, and would be most susceptible to adverse impacts from spills occurring in coastal areas and affecting feeding and nesting areas. Most of the oil released to Arctic waters is from leaks related to the oil industry (Section 4.6.2.3.1). Oil releases from all sources may expose marine and coastal birds via direct contact or through the inhalation or ingestion of oil or tar deposits (see Section 4.4.7.3.1).

Marine and coastal birds may become entangled in, or ingest, floating, submerged, and beached debris (Heneman and the Center for Environmental Education 1988; Ryan 1987, 1990). Entanglement may result in strangulation, injury or loss of limbs, entrapment, or the prevention or hindrance of the ability to fly or swim; all of these effects may be considered lethal. Ingestion of debris may irritate, block, or perforate the digestive tract, suppress appetite, impair digestion of food, reduce growth, or release toxic chemicals (Fry et al. 1985; Dickerman and Goelet 1987; Ryan 1988; Derraik 2002). Because the discharge or disposal of solid debris into offshore waters from OCS structures and vessels is prohibited by BOEM (30 CFR 250.40) and the USCG (MARPOL, Annex V, Public Law 100 220 [101 Statute 1458]), entanglement in or ingestion of OCS-related trash and debris by marine and coastal birds would not be expected under normal operations.

Oil Spills and Cleanup Activities. Oil spills under the cumulative scenario are shown in Table 4.6.1-3. No more than six large spills (between 1,000 and 5,300 bbl from either a platform or a pipeline) and 530 small spills (less than 1,000 bbl) would be expected as a result of the Beaufort Sea and Chukchi Sea Planning Areas OCS program over the next 50 years.

Loons, waterfowl, and shorebirds in onshore habitats are generally at low risk of contacting a spill while nesting, but risk of exposure increases as they leave the mainland nesting areas and concentrate in coastal or marine habitats for brood rearing, molting, or staging prior to southward migration. In addition, some species (e.g., red-throated loons) forage almost exclusively offshore and bring food back to their nestlings or young, so impacts of oil spills may be greater on these species (Eberl and Picman 1993). Likewise, species nesting on barrier islands, such as common eider, gulls, and terns, are at risk when post-nesting individuals join other species in lagoons and other nearshore habitats. Substantial numbers occupy Simpson and other Beaufort Sea lagoons, Harrison and Smith Bays, Kasegaluk Lagoon, and Peard and Ledyard Bays in the Chukchi Sea at this time. For example, tens of thousands of long-tailed ducks molting in Beaufort Sea lagoons, far outnumbering other species, are at risk in July and August, and in late August and early September, a large proportion of the Pacific flyway brant population could be exposed to a spill that enters Kasegaluk Lagoon. Substantial numbers of non-breeding, foraging, or staging birds that occupy offshore areas in both the Beaufort and Chukchi Seas, when open water beyond the barrier islands is available, could be exposed to an oil spill. Most brood rearing of loons, swans, and geese occurs on large lakes or coastal saltmarsh. Risk of oil spill contact is much greater for those using the latter habitat. The most important molting area for brant and several other species of geese (and to a lesser extent ducks) is the Teshekpuk Lake Special Area (Derksen et al. 1979, 1982). Beached oil along these coastlines could expose hundreds to low thousands or possibly greater numbers of shorebirds that pause along the coast during migration (Connors et al. 1979; Smith and Connors 1993; Andres 1994). In the southeastern Chukchi Sea, large numbers of murres and kittiwakes nesting in seabird colonies at Capes Lisburne and Thompson, together with nonbreeding individuals, form foraging flocks containing tens to hundreds of individuals that also could be exposed to an oil spill. Major effects on bird populations during the open water season are expected to follow a spill. A spill occurring in winter, when birds are virtually absent, still may have serious impacts if substantial quantities of oil are entrained in the ice and then released during the following breeding season.

Large flocks of long-tailed ducks molting in Beaufort Sea lagoons and common eiders occupying barrier islands or lagoons are particularly susceptible to oil spill impacts if they are nesting, brood rearing, or flightless. Likewise, brant staging in Kasegaluk Lagoon in the Chukchi Sea would be particularly vulnerable. For all species, the degree of impact depends heavily on the location of the spill and its timing with respect to critical natural behaviors (e.g., breeding, molting, feeding). Survival and fitness of individuals may be affected, but in many cases, this infrequent disturbance is not expected to result in significant population losses. However, effects may be greater if a spill and cleanup were to occur in the spring when large numbers of king and common eiders, long-tailed ducks, and other waterfowl, seabirds, and shorebirds are present following spring ice-lead systems. In addition, it is unlikely that all spilled oil would be removed from the environment, especially in winter; thus the remaining accumulations could move under the ice and into leads.

In addition to the potential impacts from spilled oil, the oil spill cleanup process may also affect marine and coastal birds in the Arctic region. The presence of large numbers of workers, boats, and additional aircraft during the breeding season following a spill is expected to displace waterfowl or other seabirds occupying affected offshore or nearshore waters, and shorebirds in coastal habitats for one to several seasons. Cleanup in coastal areas late in the breeding season may disturb brood-rearing, juvenile, or staging birds. Cleanup and the presence of oil can dramatically influence avian species composition and distribution (Piatt et al. 1990). It is extremely difficult to separate the effects of oiling and disturbance from cleanup activities, but either separately or together they have the potential to influence habitat use by birds (Wiens 1996). Survival and fitness of individuals may be affected to some extent, but this infrequent disturbance is not expected to result in significant population losses.

Loss or Degradation of Habitat. Marine and coastal birds could be affected by platform construction and removal activities, and pipeline trenching, which could disrupt behaviors of nearby birds. The Program would include the placement of up to 36 exploration and development wells and 9 offshore platforms; up to 652 km (405 mi) of new offshore pipeline and 129 km (80 mi) (0 in the Chukchi Sea) of onshore pipeline could be constructed (Table 4.4.1.1-4). Platform emplacement could disturb birds temporarily; pipeline trenching may also affect birds in nearshore coastal habitats if it occurs in or near foraging, overwintering, or staging areas, or near seabird colonies. No pipeline landfalls would be constructed under the Program. Depending on where they are sited, new offshore pipelines would likely result in the permanent elimination of a small amount of habitat along pipeline routes.

Any construction activities that take place in summer (one season) (e.g., platform installation for field development) could displace birds from within about 1 km (0.62 mi) of the construction site. However, localized burial of potential prey and destruction of a few square kilometers of foraging habitat as a result of pipeline trenching or island construction are not expected to cause a significant decline in prey availability. It is likely that much construction, particularly of gravel islands, roads, pads, and pipelines, would take place during winter when most birds are absent. Several studies speculate that increased predator populations sustained by scavenging opportunities around human habitation may indirectly contribute to long-term declines of common eiders and long-tailed duck populations currently in evidence (Day 1998; Johnson 2000; Troy 2000). The effect of any habitat loss on the species' productivity would likely be localized to these areas but may persist over the life of any offshore field and beyond. The potential exists for long-term adverse effects to occur (e.g., fecundity reduced after location to suboptimal habitat due to disturbance).

Gravel placement (for artificial islands) results in nesting and foraging habitat loss for most shorebirds (Troy 2000). On the North Slope, gravel is generally extracted from the floodplains of large rivers (Pamplin 1979; BLM 2002). The effects of gravel extraction/ placement would be reduced if areas where particular species seasonally concentrate are avoided.

Winter construction would also utilize ice roads to build and access gravel island construction sites. Ice roads may be constructed over both tundra habitats and frozen ocean habitats. Ice roads constructed in tundra habitats may delay ice-off and snow melt (NRC, 2003b), potentially reducing the availability of such areas for early nesting species. Ice roads could also flatten underlying vegetation, which may discourage use of the area by tundra-nesting birds (Walker et al., 1987a, b). Water removal from lakes and ponds for ice road construction may reduce the quality or quantity of aquatic habitats important for breeding and postmolting for some species. In each of these cases, the impacts to potential nesting habitat would be temporary and localized, and birds would likely respond by selecting other areas for nesting or postmolting.

Construction camps to support onshore construction activities would temporarily remove some areas from potential use by birds, and this loss may be short- or long-term depending on the nature and effectiveness of camp abandonment following completion of construction activities. Regardless of the duration of the effect, the amount of habitat that would be disturbed would be relatively small and not be expected to affect more than a few birds.

The construction and operation of up to 320 km (200 mi) of new overland pipelines would be expected to affect bird populations in a manner similar to that identified for the construction and operation of new onshore processing facilities and associated infrastructure (especially access roads). Potential nesting or post-molting habitat would be permanently lost within the footprint of the new pipelines, causing birds to select habitats in other locations.

Although pipeline trenching would also be carried out in winter when most seabird and waterfowl species are not present, seafloor trenching could locally disrupt benthic invertebrate communities that may serve as food sources for waterfowl during other seasons. The extent to which benthic food sources could be affected and the subsequent impact to waterfowl will depend on the type and amount of benthic habitat that would be permanently disturbed by trenching, the importance of the specific habitats in providing food resources to waterfowl, and the number of waterfowl that could be affected. Because no more than three new pipelines would be built under the Program within the entire Arctic region, relatively little benthic habitat would be disturbed (no more than 120 ha [297 ac] within the entire region). In addition, portions of the new pipelines would be in water depths down to 60 m (200 ft) and potentially unavailable for many marine birds and waterfowl. Thus, any impacts to food sources from pipeline trenching would be very localized and short-term, and not expected to result in population-level impacts to local waterfowl populations.

The construction of new facilities and pipelines would permanently eliminate potential bird habitat at the construction sites. While this habitat loss would be long-term, the areas disturbed would represent a small portion of the habitat present in the Arctic region. Careful siting of any new facilities to avoid important nesting or post-molting habitat would further reduce the magnitude of any potential effects on local bird populations.

Helicopter or fixed-wing aircraft overflights are generally conducted at low altitudes and could disturb birds in onshore and offshore locations (Ward and Stein 1989; Ward et al. 1994; Miller 1994; Miller et al. 1994). Helicopter and aircraft overflights during spring breakup of pack ice may disturb marine species feeding in open waters and waterfowl in coastal waters, causing birds to leave the area. Similarly, overflights in summer could displace waterfowl and seabirds from preferred foraging areas and waterfowl from coastal nesting or brood-rearing areas such as the lagoon systems of the Beaufort and Chukchi Seas. Molting and staging waterfowl may temporarily leave an area experiencing helicopter overflights (Derksen et al. 1992), while geese have been reported to exhibit alert behavior and flight in response to helicopter overflights (Ward and Stein 1989; Ward et al. 1994). The type of response elicited by the birds and the potential effect on the birds will depend in large part on the time of year for the overflights and the species disturbed. Birds experiencing frequent overflights may permanently relocate to less favorable habitats (MMS 2002b). In addition, the temporary absence of adult birds may increase the potential for predation of unguarded nests and young (NRC 2003b).

Marine vessel trips could disturb seabirds and waterfowl in preferred foraging, molting, and staging areas, causing them to leave the area and move to potentially less favorable habitats. Vessel traffic that displaces nesting seabirds or waterfowl may result in an increased predation rate on eggs and young, especially in areas near gull colonies (Day 1998; Johnson 2000; Noel et al. 2005). However, the amount of vessel and aircraft traffic that could occur under the Program would be relatively limited. Which birds could be affected, the nature of their response, and the potential consequences of the disturbance will be a function of a variety of factors, including the specific routes, the number of trips per day, the seasonal habitats along the routes, the species using the habitats and the level of their use, and the sensitivity of the birds to vessel traffic. Traffic over heavily used feeding or nesting habitats of sensitive species could result in population-level effects, while impacts from traffic over other areas with less sensitive species would largely be limited to a few individuals and not result in population-level effects.

Marine and coastal birds could be affected by accidental oil spills from offshore platforms and pipelines, as well as from onshore processing facilities and pipelines. In general, loons, waterfowl, seabirds, and shorebirds are not expected to survive moderate to heavy oil contact. Oiled feathers lose their insulative and water repellent characteristics, and birds die of hypothermia (Albers and Gay 1982). Swallowed oil is toxic and causes impaired physiological function and production of fewer young. Oiled eggs have significantly reduced hatching success (Albers 1980). Vulnerability of bird populations to an oil spill is highly variable because of their seasonally patchy distribution in areas where the probability of spill contact also is variable and depends on location, oceanography, weather patterns, and habitats typically occupied by and habits of, the particular species. Because they are unable to fly, molting birds probably are the most vulnerable. For all species, the degree of impact depends heavily on the location of the spill and its timing with respect to critical natural behaviors (e.g., breeding, molting, feeding).

If losses are substantial in a species with a low reproductive rate, including most marine species, recovery may take many years, or populations may not recover to their prespill size. Rate of recovery from oil spill mortality depends both on the numbers lost from a particular species population and its prevailing population trend, which in turn are determined by reproductive rate and survival rate. Population dynamics of wildlife recovering from an oil spill may be influenced by multiple factors including predation, prey availability, immigration of new individuals into the recovering population, and competition for resources (depends on the impact of the oil spill on competition within a species and among species) (Bodkin et al. 2002; Gilfillan et al. 1995; Golet et al. 2002). Oil contamination of food resources may influence recovery of a local population by affecting reproductive success and survival, with the degree of impact largely dependent on the patterns of prey distribution (Trust et al. 2000; Golet et al. 2002). Species dependent on widely dispersed prey would have more limited effects. However, seabirds, in particular, are attracted to patchy prey sources found on oceanic fronts (Piatt and Springer 2003) and would experience greater effects from prey reduction. In addition, nonbreeding individuals and those that have completed annual parental activities are better able to search for prey in uncontaminated areas. However, those individuals actively feeding young and dependent upon nearby food resources would be unable to seek uncontaminated prey elsewhere. If a leak in an onshore pipeline were to occur on a pad, the extent of the spill likely would be restricted by containment berms. If the spill occurred along the off-pad portion of the pipeline, the area covered may include several acres; if the spill were to enter streams or lakes, a larger area could be affected as the oil spreads over a water surface or is carried down a watercourse. From mid- to late summer, such an occurrence could contact broodrearing females and their young, as well as potentially large flocks of nonbreeding and postbreeding individuals undergoing wing molt.

Most bird species are absent from the Arctic region from late October to at least early April. During spring migration, substantial numbers of migrants moving north along the spring lead system in the Chukchi Sea are at risk if oil enters this habitat, since there are few alternatives until open water off river deltas is available as the ice breaks up in late spring. The most numerous species include king eider, common eider, long-tailed duck, brant, and murres. Likewise, a similar rather restricted open water situation exists in both the Beaufort and Chukchi Seas for migrants that pause awaiting further melting to the north or east, and for birds occupying delta waters and nearshore areas that have melted prior to general ice breakup and awaiting the availability of onshore habitats.

Disturbance Due to Noise. Noise and human activities (such as normal maintenance) could disturb birds. Operational facilities may provide additional nesting and feeding opportunities for some species. Unexpected noise can startle birds and potentially affect feeding, resting, or nesting behavior, and often causes flocks of birds to abandon the immediate area. Some species may react by avoiding nearby habitats, while other species may show little response or become habituated. Because of the small number of new onshore facilities (no more than four in the entire Arctic region), the disturbance of birds by operational noise and activity would likely be limited to relatively few individuals and would not be expected to result in population-level effects. Prolonged or repeated periods of maintenance activities could have a greater impact on nesting birds by increasing cooling periods of eggs, and on brood-rearing birds by increasing the time that young and adult birds are separated.

Effects on ESA-Listed Species in the Arctic Region. The cumulative effects of OCS and non-OCS program activities on ESA-listed species in the Arctic region, including the spectacled eiders and Steller’s eider, are expected to be similar to those noted for nonlisted species over the next 50 years. Continued compliance with ESA regulations and coordination with the USFWS would ensure that lease-specific OCS operations would be conducted in a manner likely to avoid or greatly minimize the potential for impacting these species.

The risk of oil contact to spectacled eiders using the spring lead system to move north into the Chukchi Sea during spring migration could be high if a spill entered the area of the leads. Since most spectacled eiders probably use overland routes from the Chukchi to complete their spring migration to nesting areas on the ACP, they are not likely to be contacted by an oil spill during migration. During the broodrearing period, when the young are led to watercourses and ultimately to nearshore marine environments for further development, staging, and fall migration, the risk of oil contact is much greater. Males could be exposed to an oil spill in any of the several bays and lagoons occupied for molting and staging in both the Beaufort and Chukchi Seas (Petersen et al. 1999). The period of highest exposure risk for a given individual migrating across the Beaufort is about 3–5 days. Females and young are at risk of contact primarily when they occupy Smith Bay in the Beaufort (Troy 2003) and Ledyard and Peard Bay (Laing and Platte 1994) in the Chukchi (this area is used by nonbreeding, failed breeding, and successful breeders, as well as both sexes) for the molt prior to fall migration (Petersen et al. 1999).

Ledyard Bay has been defined as critical habitat for spectacled eiders. Since most, if not all, of the successfully breeding females (and their young) from the ACP could be concentrated in Ledyard Bay critical habitat area during the molt period, a spill affecting this group in this location could have a long-term population-level effect.

The small ACP population of Steller's eider is not likely to be exposed to an oil spill during nesting or postnesting periods, since most presumably move to the Russian side of the Chukchi prior to migrating south to molting areas. However, there is some evidence to suggest use of Peard Bay by postbreeding Steller's eiders (Martin unpubl. data; Dau and Larned 2004, 2005).

Climate Change. Climate change could have dramatic impacts on the Beaufort Sea and Chukchi Sea Planning Areas. The expected changes in air temperature would have the most immediate effect on the distribution and biology of Arctic seabirds and the seabird species most dependent on the presence of ice and snow would be expected to be among the first affected. If temperature increases in the Arctic region are as high as predicted, the Beaufort Sea pack ice could retreat more than 100 km (62 mi) from mainland Alaska (Meehan et al. 1998). This sea ice retreat could have major adverse effects on seabirds that rely on prey associated with ice edges.

Conclusion. Marine and coastal birds in the Beaufort and Chukchi Sea Planning Areas, including those that are ESA-listed, could be adversely affected by activities associated with the Program as well as those associated with future OCS and non-OCS program activities. Potential impacts include injury or mortality of birds from collisions with platforms associated with OCS and State oil and gas development and other onshore and offshore structures (e.g., radio, television, or cell phone towers), onshore industrial, commercial, and residential development; exposure to discharges from permitted point sources such as sewage treatment discharges and nonpoint sources such as urban runoff, or accidental releases (e.g., oil spills); exposure to emissions from various onshore and offshore sources; ingestion of trash or debris; loss or degradation of habitat due to construction and operations activities; and behavioral disturbance due to the presence of, and noise generated by, equipment and human activity. Other trends such as extensive melting of glaciers (and increasing river discharges) and increased precipitation brought on by global climate change is also expected to adversely affect marine and coastal birds over the next 40 to 50 years. While the cumulative impact of all OCS and non-OCS activities in the Beaufort and Chukchi Seas could be minor to moderate, the incremental contribution due to the Program would be negligible to medium (see Section 4.4.7.2.3). Compliance with ESA regulations and coordination with the USFWS would ensure that lease-specific OCS operations would be conducted in a manner that is likely to avoid or to greatly minimize the potential for impacting ESA species.

Marine and coastal birds may also be adversely affected by exposure to oil (via direct contact or through the inhalation or ingestion of oil or tar deposits) that is accidentally released from OCS and non-OCS activities, especially near coastal areas and affecting feeding and nesting areas. The incremental contribution of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on marine and coastal birds would be small to large, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and nesting areas; the timing and nature of spill containment; and the status of the affected birds (see Section 4.4.7.2.3). Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from moderate to major if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to the impacts of spills regardless of size, but their incremental contribution to cumulative impacts is generally expected to be small. A more detailed discussion of the effects of oil spills on marine and coastal in the Arctic region is presented in Section 4.4.7.2.3.

Whether net cumulative impacts are minor or moderate depends on the nature and duration of activities that reduce bird survival and productivity. Losses would be limited in areas occupied by scattered flocks during relatively brief staging and migration periods or scattered nest sites during the brief nesting season; however, in cases where exposure to localized disturbance is greater, impacts have the potential to rise to the population level. Population-level effects could be incurred due to the tendency for large numbers of individuals of some bird species to concentrate in certain coastal Arctic locations.

4.6.4.3.3 Fish. Section 4.4.7.3.3 discusses direct and indirect impacts on fish communities in the Beaufort Sea and Chukchi Sea Planning Areas resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Section 4.4.6.1.1) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS activities. Table 4.6.1-3 presents the exploration and development scenario for the Arctic region cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in the Arctic are summarized in Table 4.6.1-7 and discussed below, as applicable.

The primary routine OCS activities that could result in impacts on fish include seismic surveys; construction of artificial islands, ice roads, drilling, platforms and pipeline placement; releases of permitted discharges from wells; and removal of existing structures. Potential environmental impacts associated with the building and operation of OCS facilities such as subsea production wells, platforms, artificial islands, and pipelines would increase in conjunction with the increased number of wells. Although all of these activities would disturb bottom habitats to some degree, artificial islands result in a more complete loss of benthic habitat due to larger footprints (approximately 9 ha for artificial islands versus less than 1.5 ha for platforms) and due to complete burial of existing substrate during construction. The impacts of routine activities (exploration and site development, production and decommissioning) on fish communities are discussed in detail in Section 4.4.7.3.3. Overall, routine activities represent up to a minor disturbance, primarily affecting demersal fishes, with the severity of the impacts generally decreasing with distance from bottom-disturbing activities.

Oil and gas exploration and development in State waters could also contribute to cumulative effects on fishery resources in the Beaufort and Chukchi Planning Areas. Drilling of wells in State waters could also require construction of platforms and pipelines in waters of Alaska. The effects on fish would be similar to those described above for OCS oil and gas programs (Section 4.4.7.3.2). Other non-OCS activities that could impact fish communities include subsistence fishing, hardrock mining, sediment dredging and disposal of dredging spoils in OCS waters, and commercial shipping (tanker vessels) and anchoring. Many of these activities would result in bottom disturbance that would affect bottom dwelling fishes as well as their food sources in a manner similar to those described for OCS activities (MMS 2008b; ADEC 2007a; Section 4.4.7.3.3). Commercial fishing does not occur in the Beaufort and Chukchi Sea Planning Areas, and sportfishing is minor in the Arctic but could increase if regulations change and if warming temperatures allow an increase in vessel traffic. Effects on fish resources from non-OCS dredging and marine disposal activities are expected to be similar to those described for OCS bottom disturbing activities (Section 4.4.7.3.3). Due to the small number and limited use of disposal sites in the vicinity of the Beaufort and Chukchi Sea Planning Areas, these activities are not expected to noticeably alter fish populations.

The Beaufort and Chukchi Seas fall in the Kotzebue Sound and Northern Subsistence fishing areas. Subsistence fishing may contribute to the cumulative effects on the abundance of some fishery resources. Alaska State law defines subsistence as the "noncommercial customary and traditional uses" of fish and wildlife. The Alaska Department of Fish and Game defines subsistence fishing to include "the taking of, fishing for, or possession of fish, shellfish, or other fisheries resources by a resident of the state for subsistence uses with gill net, seine, fish wheel, long line, or other means defined by the Board of Fisheries." These fishing methods have more limited impacts on fish and fish habitat compared to commercial fishing methods. In addition, subsistence fishing is subject to harvest limits that reduce the potential for overfishing. Consequently, subsistence fishing makes a relatively minor contribution to the reduction in fish stocks.

Cumulative impacts on diadromous species could also occur as a result of activities that obstruct fish movement in marine environments during migration periods. For example, some structures along the Beaufort Sea mainland (e.g., the West Dock) have been shown to block the movements of diadromous fishes, particularly juveniles, under certain meteorological conditions (Fechhelm 1999; Fechelm et al. 1999). Causeways such as the 40 m wide and 60 m long structure associated with the Red Dog Mine may impede coastal movement either by directly blocking fish or by modifying nearshore water conditions to the point where they might become too cold and saline for some species (Fechhelm et al. 1999). Although the presence of causeways has been an issue associated with oil development activities in the Beaufort Sea, the small size of the Red Dog causeway would likely have little effect on the coastal movements and distributions of Chukchi Sea fishes and shellfishes. However, it is anticipated that proper placement and design considerations for future causeway construction along the North Slope would alleviate the potential for such effects on fish movement.

There are several contaminant sources in the Beaufort and Chukchi Sea Planning Areas. The Red Dog Mine in Alaska is the largest lead and zinc mine in the world, and is presently the only base-metal lode mine operating in northwest Alaska. A study for the National Park Service (Hasselbach et al. 2004) showed extensive airborne transport of cadmium and lead from Red Dog Mine; although the study was focused only on the limits of the Cape Krusenstern National Monument, these contaminants are probably carried out into the Chukchi Sea. There are also natural sources of metals and hydrocarbons. Sediments, peats, and soils from the Sagavanirktok, Kuparuk and Colville Rivers are the largest source of dissolved and particulate metals and saturated and polycyclic aromatic hydrocarbons in the development area. However, concentrations of metals and organics in fish sampled in the Arctic Planning Areas are typically at background levels (Neff & Associates, LLC 2010).

Climate change may affect fish communities in the Beaufort and Chukchi Sea Planning Areas and interact with past, present, and future OCS and non-OCS stressors. Physiological and ecosystem level stressors related to climate change may interact with the non-climate-related anthropogenic stressors such as overfishing, pollution, and habitat loss discussed above. For example, a climate change–related increase in water temperature that results in physiological stress could make individuals more susceptible to stress from pollution or accidental oil spills. Climate would only be one of several factors that regulate fish abundance and distribution. Many fish populations are already subject to stresses, and global climate change may aggravate the impacts of ongoing and future human use of the coastal zone. Fish respond directly to climate fluctuations, as well as to changes in their biological environment including predators, prey, species interactions, and disease. Projected changes in hydrology and water temperatures, salinity, and currents can affect the growth, survival, reproduction, and spatial distribution of marine fish species and of the prey, competitors, and predators that influence the dynamics of these species (Watson et al. 1998). Changes in primary production levels in the ocean because of climate change may affect fish stock productivity. Climate change may have a number of effects on fish communities, including:

- Changes in the timing of seasonal fish migrations;

- Increased storm damage to nearshore areas as the amount of open water increases and their reduction or elimination by rising sea levels;

- Reduction in habitat for sea ice dependent species; and

- Replacement of true Arctic species such as Arctic cod and capelin by the range expansions of subarctic species.

Large-scale changes in oceanographic and ecosystem processes resulting from climate change could indirectly affect fish populations in the Arctic in several ways. For example, under the existing temperature regime, the Chukchi Sea has a food web dominated by benthic consumers and cryopelagic (sea ice-associated) fishes. The loss of sea ice and the increased surface water temperature may promote a shift to a pelagic-based food web with high phytoplankton and zooplankton productivity and greater numbers of predatory fish (Loeng 2005; Hopcroft et al. 2008). Ultimately, however, predictions about the indirect and cascading ecological impacts of climate change on specific species are subject to great uncertainty, given the complexity of the ecosystem.

Oil spills could result from OCS and non-OCS activities. The total number of oil spills and the extent of affected areas would likely increase under the Program in conjunction with increased levels of petroleum exploration and production. The potential impacts of OCS oil spills on fish communities in the Beaufort and Chukchi Sea are discussed in detail in

Section 4.4.7.3.3. Non-OCS activities, such as oil and gas development in State waters, domestic transportation of oil or refined petroleum products, and commercial shipping (including tankering), may also result in accidental spills that could potentially impact fish resources within the Beaufort and Chukchi Sea Planning Areas. While effects to fishery resources would depend on the timing, location, and magnitude of specific oil spills, it is anticipated that most small to medium spills that occur in OCS waters would have limited effects on fishery resources due to the relatively small areas likely to be exposed to high concentrations of hydrocarbons and the short period of time during which potentially toxic concentrations would be present. In general, adult fish in marine environments are highly mobile and capable of avoiding high concentrations of hydrocarbons although they may be subject to sublethal exposures. However, fish eggs and larvae as well as small benthic obligate fish species do not typically have the ability to avoid spills and may therefore suffer lethal or sublethal effects. Oil from large and catastrophic spills that reaches shallower, nearshore areas of these planning areas has the potential to be of greatest significance to fish communities. The potential impacts of OCS oil spills on fish communities in the Beaufort and Chukchi Sea Planning Areas are discussed in detail in Section 4.4.7.3.3.

Some diadromous species of the Beaufort and Chukchi Sea Planning Areas could be at greater risk from oil spills because of their unique life-history cycles. Oil spills occurring at constrictions in migration routes, nursery areas, and spawning areas would have an increased potential for adversely affecting diadromous fishes, and catastrophic spills could result in long-term, population-level impacts on diadromous fish communities. Pacific salmon are also able to detect and avoid oil spills in marine waters (see Section 4.4.7.3.2), which would help to reduce the potential for contact. Aggregations of salmon in marine waters typically consist of mixed stocks, so even in the unlikely event of contact with an oil spill, it is anticipated that only a small fraction of any unique spawning population would be adversely affected. Juveniles of some species of whitefish (including broad whitefish, humpback whitefish, and least cisco) are intolerant of highly saline marine conditions. During their summer feeding dispersals in the Beaufort Sea, these species tend to remain within a narrow band of warm, low-salinity water along the coast. Thus, unlike most subarctic fishes, North Slope whitefish have a reduced capacity to bypass localized disruptions to their migration corridor by moving offshore and around the impasses. An oil spill, even one of limited area, could block the narrow nearshore corridor and prevent fishes from either dispersing along the coast to feed or returning to their overwintering grounds in North Slope rivers.

In addition to effects on individuals and species, impacts to fish can result in ecosystem-level effects if the population impacts are significant. For example, fish can occupy a number of trophic levels ranging from herbivore to top level carnivore. As such, fish are critical to energy flow within nearshore and marine food webs. They are also seasonally important food sources to transient carnivores. Consequently, impacts to fish can propagate throughout the food web, affecting sea turtles, birds and marine mammals. In addition, many Alaskan fishes, particularly salmonids, migrate between and within marine, estuarine, and freshwater habitats. In doing so, they transfer nutrients and carbon over a broad area and connect offshore and coastal ecosystems (Naiman et al. 2002). Therefore, significant impacts to fish populations could reduce this transfer resulting in local changes in productivity.

Conclusion. Cumulative impacts on fish communities in the Beaufort Sea and Chukchi Sea Planning Areas as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be moderate to major over the next 40 to 50 years. Non-OCS activities or phenomena affecting these resources include oil and gas development in State waters, domestic transportation of oil or refined petroleum products, commercial shipping, and pollutant inputs from point and non-point sources. Many of these activities would affect bottom-dwelling fish at various life stages as well as their food sources in a manner similar to OCS bottom-disturbing activities. The incremental contribution of routine Program activities to these impacts (primarily as a result of disturbance affecting demersal fishes) would be negligible to small, with the severity of impacts generally decreasing with distance from the disturbance. Fish could also be affected by the environmental changes predicted to result from climate change.

Fish communities may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS activities as well as naturally occurring seeps. The cumulative impacts of past, present, and future oil spills on these resources would be minor to moderate. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on fish would be negligible to medium, depending on the location, timing, duration, and volume of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDEs would also depend on these factors, and could range up to moderate if they were to occur. Oil from large spills or a CDE has the greatest potential to contact shoreline areas used for spawning or providing habitat for early life stages of fish and, therefore, could result in large-scale lethal and long-term sublethal effects on fish. A more detailed discussion of the effects of oil spills on fish in Arctic waters is presented in Section 4.4.7.3.3.

4.6.4.3.4 Invertebrates and Lower Trophic Levels. Section 4.4.7.5.3 discusses direct and indirect impacts on invertebrates and lower trophic levels in the Beaufort Sea and Chukchi Sea Planning Areas resulting from the 2012-2017 Program under the proposed action (Alternative 1). Cumulative impacts on these resources result from the incremental impacts of the Program (described in Section 4.4.6.1.1) when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS activities. Table 4.6.1-3 presents the exploration and development scenario for the Arctic region cumulative case, which takes into account activities associated with the Program in combination with those from ongoing and future OCS programs. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in Arctic waters are summarized in Table 4.6.1-8 and discussed below, as applicable.

The primary routine OCS activities that could result in impacts on invertebrates include seismic surveys, drilling, the placement of subsea wells, platforms, and pipelines; releases of permitted discharges from wells; and removal of existing structures. Potential environmental impacts associated with the building and operation of OCS facilities such as platforms, and pipelines would increase in conjunction with the increased number of wells. The impacts of routine activities (exploration and site development, production and decommissioning) on invertebrate communities are discussed in detail in Section 4.4.7.5.3. Overall, routine activities represent up to a moderate disturbance, primarily affecting benthic infaunal invertebrates, with the severity of the impacts generally decreasing dramatically with distance from bottom-disturbing activities.

The placement of new platforms over the life of the Program would allow the colonization of invertebrates requiring hard substrate. While some platforms may be allowed to remain as artificial reefs, removal of platforms will reduce available substrate and structures for invertebrates and injure or kill them during removal.

Oil and gas exploration and development in State waters could also contribute to cumulative effects on invertebrates in the Beaufort and Chukchi Sea Planning Areas. Drilling of wells in State waters could also require construction of platforms and pipelines in waters of Alaska. The effects on invertebrates would be similar to those described above for OCS oil and gas programs (Section 4.4.7.5.3). Other non-OCS activities that could impact invertebrate communities include land use practices, point and non-point source pollution, logging, dredging/ and disposal of dredging spoils in OCS waters, and anchoring. Commercial fishing does not occur in the Arctic and therefore is not expected to add to cumulative impacts on invertebrate communities. However, this could change if regulations change and if warming temperatures allow an increase in vessel traffic. Effects on invertebrates from non-OCS dredging and marine disposal activities are expected to be similar to those described for OCS bottom disturbing activities (Section 4.4.7.5.3). Recovery of benthic invertebrates at the dredge and disposal sites to their pre-disturbance composition would likely take multiple years. Many of these activities would affect bottom dwelling invertebrates at various life stages as well as their food sources in a manner similar to OCS bottom disturbing activities (Section 4.4.7.5.1). Other non-OCS activities generating pollution and noise may contribute to general habitat degradation (Section 4.6.3.2.2).

There are several contaminant sources in the Beaufort and Chukchi Sea Planning Areas. The Red Dog Mine in Alaska is the largest lead and zinc mine in the world, and is presently the only base-metal lode mine operating in northwest Alaska. A study for the National Park Service (Hasselbach et al. 2004) showed extensive airborne transport of cadmium and lead from Red Dog Mine; although the study was focused only on the limits of the Cape Krusenstern National Monument, these contaminants are probably carried out into the Chukchi Sea. There are also natural sources of contaminants. Sediments, peats, and soils from the Sagavanirktok, Kuparuk and Colville Rivers are the largest sources of dissolved and particulate metals and saturated and polycyclic aromatic hydrocarbons in the development area. However, contaminant concentrations in the benthic invertebrates collected in the Beaufort and Chukchi Sea Planning Areas are typically at background levels (Neff & Associates, LLC 2010).

It is predicted that physical and chemical changes to Arctic and subarctic invertebrate habitat could result from climate change (Section 3.3). These changes could alter the existing distribution, composition, and abundance of invertebrates, since physical and chemical parameters are the primary influence on invertebrate communities. In general, the increase in seawater temperature will facilitate a northward expansion of subarctic invertebrate species from the Bering Sea. Weslawski et al. (2011) identified the Bering Strait as a major corridor through which new invertebrate species will expand their range northward. Such expansion will likely increase overall invertebrate species diversity in the Arctic, but the new species may displace existing species or alter existing inter-specific species interactions. The change in species composition may be greatest in the eastern Beaufort Sea where Arctic species currently predominate. It is predicted that a decrease in sea ice habitat would result from increasing water temperature. This may have several impacts on invertebrate communities in the Arctic including:

- Loss of habitat for invertebrates specialized to inhabit sea ice;
- An increase in the productivity of water column invertebrates with increasing temperature and open water;
- An increase in the abundance of benthic invertebrates in nearshore areas with the reduction in ice scour extent and duration (Weslawski et al. 2011); and
- An increase in benthic disturbance from severe weather as the amount of open water increases.

Changes in the magnitude, frequency, and timing of river discharge into the Beaufort/Chukchi Shelf Ecoregion are expected to result from climate change (Arctic Council and IASC 2005). Invertebrates in marine ecoregions with strong riverine inputs — like the Beaufort Neritic Ecoregion — would likely be affected by alterations in the salinity, temperature, and sediment delivery regime. Hydrologic change can rapidly alter existing invertebrate communities in the water column and benthos, if the new chemical conditions are not within the physiological tolerance of the existing communities. The greater variability in hydrologic conditions could favor tolerant and opportunistic species, thereby homogenizing invertebrate species composition and decreasing overall species diversity in the Beaufort and Chukchi Seas (Weslawski et al. 20011).

The expected increase in ocean acidification is considered to be another significant source of physiological stress. Crustaceans, echinoderms, foraminiferans, and mollusks could have greater difficulty in forming shells, which could reduce their fitness, abundance, and distribution (Fabry et al. 2008).

Oil spills could result from OCS and non-OCS activities. The total number of oil spills and the extent of affected areas would likely increase under the Program in conjunction with increased levels of petroleum exploration and production (Table 4.6.1-3). The potential impacts of OCS oil spills on invertebrate communities in the Beaufort and Chukchi Sea are discussed in detail in Section 4.4.7.5.3. Non-OCS activities, such as oil and gas development in State waters, domestic transportation of oil or refined petroleum products, and commercial shipping, may also result in accidental spills that could potentially impact invertebrate resources within the Beaufort and Chukchi Sea Planning Areas. While effects to invertebrates would depend on the timing, location, and magnitude of specific oil spills, it is anticipated that most small to medium spills that occur in OCS waters would have limited effects due to the relatively small areas likely to be exposed to high concentrations of hydrocarbons.

Oil from catastrophic spills that reaches shallower, nearshore areas of these planning areas has the potential to be of greatest significance to invertebrate communities. Large, mobile epifaunal invertebrates are capable of avoiding high concentrations of hydrocarbons although they may be subject to sublethal exposures. However, infauna and invertebrate eggs and larvae do not typically have the ability to avoid spills and may therefore suffer lethal or sublethal effects. Catastrophic spills could result in long-term alterations in the abundance of intertidal and shallow subtidal invertebrate communities. Benthic and pelagic invertebrates are important trophic links connecting primary producers to higher-trophic-level organisms. Consequently, oil spill contamination on a large scale could result in contaminant transfer to higher trophic levels and/or reduce food availability to higher trophic levels if invertebrate populations were severely depressed by a CDE. The potential impacts of OCS oil spills on invertebrate communities in the Arctic planning areas are discussed in detail in Section 4.4.7.5.3.

Conclusion. Cumulative impacts on invertebrate communities in the Beaufort Sea and Chukchi Sea Planning Areas as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be moderate to major over the next 40 to 50 years. Non-OCS activities or phenomena offshore marine transportation and pollutant inputs from point and non-point sources. The incremental contribution of routine Program activities to these impacts (mainly due to bottom-disturbing activities) would be negligible to medium, with the severity of the impacts generally decreasing with distance from bottom-disturbing activities. Several major classes of invertebrates could also be affected by the environmental changes predicted to result from climate change.

Invertebrate communities may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS activities. The cumulative impacts of past, present, and future oil spills on these resources would be minor to moderate. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on invertebrates would be negligible to small, depending on the location of the spill and the season in which the spill occurred. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could range up to moderate if it were to occur. Spills in deeper water, whether from OCS or non-OCS sources, are unlikely to have overall population-level effects on invertebrate resources because of the relatively small proportion of similar available habitats that would come in contact with released oil at concentrations great enough to elicit toxic effects. A CDE could also contaminate or reduce the abundance of seasonally abundant copepods and euphausiids, which may in turn impact higher trophic levels. Oil from a CDE occurring under ice is more difficult to locate and clean than surface spills and may have more persistent effects on water column and sea ice-associated invertebrates. A more detailed discussion of the effects of oil spills on marine mammals in the Arctic region is presented in Section 4.4.7.5.3.

4.6.4.4 Summary for Gulf of Mexico Region

4.6.4.4.1 Marine Mammals. All marine mammals in U.S. waters are protected under the Marine Mammal Protection Act of 1972. The marine mammals in the GOM are diverse and widely distributed throughout the northern GOM. Their distribution and abundance are influenced by oceanographic circulation patterns (which are largely wind-driven, but affected locally by freshwater discharge). There are 21 species of cetaceans (whales) and one species of Sirenian (manatees), several of which are listed as federally endangered under the ESA. Ongoing and future activities or phenomena that affect marine mammals in the GOM include onshore and offshore oil and gas development (and infrastructure), natural phenomena (e.g., hurricanes and diseases), marine vessel traffic, commercial fishing, pollution, military operations, catastrophes, climate change, and invasive species. Cumulative impacts on marine mammals in the GOM region are considered to be minor to moderate.

Routine oil and gas-related activities (e.g., seismic surveys, facility construction, normal operations, and, eventually, decommissioning) would result in minor to moderate impacts on marine mammals. Impacts on marine mammals from these activities could include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. The contribution of Program activities to cumulative impacts on marine mammals would be negligible to medium. The incremental impacts of expected accidental oil spills (most of which are less than 1,000 bbl) would be small to large, depending on the location, timing, and volume of the spills; the environmental settings of the spills; and the species exposed to the spills. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from moderate to major if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.

4.6.4.4.2 Terrestrial Mammals. The terrestrial mammals considered in this report are those likely to be present in coastal habitats of the northern GOM. These include the federally endangered GOM coast beach mouse subspecies, which lives in mature coastal barrier sand dunes, and the federally endangered Florida salt marsh vole, which lives in areas vegetated by saltgrass, especially in Dixie and Levy Counties. Ongoing and future activities or phenomena that affect terrestrial mammals include onshore and offshore oil and gas development (and infrastructure), natural phenomena (e.g., hurricanes and tropical storms), industrial and residential development, vehicle traffic, recreation, trash and debris, artificial lighting, climate change (including sea level rise), and invasive and feral species. Present beach mice habitat is no longer of optimal quality because of historical beach erosion, habitat loss and fragmentation from beach front development, and tropical storm damage. The Florida salt marsh vole is rare and has a very restricted range, so catastrophic events could result in its extinction. Cumulative impacts on terrestrial mammals in the GOM region are considered to be minor to moderate.

Routine oil and gas-related activities (e.g., facility construction, normal operations, and, eventually, decommissioning) are not expected to significantly affect the four federally endangered beach mouse subspecies and the federally endangered Florida salt marsh vole. Negligible to minor impacts may result from consumption of or entanglement in beach trash and debris originating from Program activities. The contribution of the Program activities to cumulative impacts therefore would be negligible to medium. The effects of expected accidental oil spills (most of which are less than 1,000 bbl) on these terrestrial mammals would be small to large, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and other important habitats; the timing and nature of spill containment; and the status of the affected animals. An unexpected, low-probability CDE has a greater potential to affect the habitats of beach mice and the Florida salt marsh vole; therefore, impacts would range from moderate to major if one were to occur. Oil impacts on beach mice would be more likely if a storm surge transports the oil over foredunes.

4.6.4.4.3 Marine and Coastal Birds. The GOM is an important pathway for migratory birds. Most migrant birds either directly cross the GOM or move north or south by traversing the GOM or the Florida peninsula. A diverse range of habitats support migratory and resident bird species along the northern GOM coast. Cumulative impacts on migratory and resident bird species result from direct injury or mortality of marine and coastal birds due to collisions with onshore and offshore structures, ingestion of trash or debris, or exposure to discharges or emissions; loss or degradation of habitat due to coastal development, climate change, or construction and operations activities; and behavioral disturbance due to commercial and recreational boating and small aircraft traffic. Many bird species are currently experiencing a loss or degradation of habitat due to land development and climate change, and these impacts are expected to continue into the foreseeable future. Ongoing and future actions/trends that affect marine and coastal birds in the GOM region include those related to oil and gas development (and infrastructure), coastal development, marine vessel traffic, dredging operations, and climate change. Cumulative impacts on marine and coastal birds in the GOM region are considered to be moderate.

Routine operations may result in localized short-term impacts due to infrastructure construction and marine vessel and aircraft traffic. The contribution of Program activities to cumulative impacts on marine and coastal birds therefore would be negligible to medium. Birds may also be adversely affected by exposure to oil, especially near coastal areas and affecting feeding and nesting areas. The incremental contribution of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on marine and coastal birds would be small to large, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and nesting areas; the timing and nature of spill containment; and the status of the affected birds. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from moderate to major if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.

4.6.4.4.4 Fish. Fish in the northern GOM live in the water column (pelagic) and on the seafloor or near bottom waters (demersal) along the gradient from the continental shelf to the abyssal plain. Demersal species are much more abundant and diverse in the hard-bottom habitats found in the eastern GOM. Some fish migrate between saltwater and freshwater habitats. For example, anadromous species (such as the Gulf sturgeon and striped bass) spend most of their adulthood in saltwater but spawn in freshwater; catadromous species (such as the American eel) live primarily in freshwater and spawn in saltwater. Cumulative impacts on fish result from activities that generate lethal or sublethal impacts on individuals as well as habitat loss or degradation. Ongoing and future actions/trends that affect fish in the GOM include oil and gas development, commercial and recreational fishing, noise, dredging and trawling operations, explosive platform removal, land loss, and coastal hypoxia. Climate change is also expected to affect fish habitat, productivity, and community structure. Cumulative impacts on fish in the GOM are considered to be moderate to major. The incremental contribution of routine Program activities to these impacts (primarily as a result of disturbance affecting demersal fishes) would be negligible to small, with the severity of impacts generally decreasing with distance from the disturbance.

Fish communities may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS activities as well as naturally occurring seeps. The cumulative impacts of past, present, and future oil spills on these resources would be minor to moderate. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on fish would be negligible to medium, depending on the location, timing, duration, and volume of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could range up to moderate if it were to occur.

4.6.4.4.5 Reptiles. Five species of sea turtles are known to inhabit the GOM. The federally protected American crocodile also lives in the eastern GOM, along Florida's southern coast (in mangrove swamps, brackish bays, and inshore freshwater habitats). Hurricanes in 2005 adversely affected sea turtle nesting sites, and the DWH event caused sea turtle mortality and fouling of habitats. Cumulative impacts on sea turtles result from activities that generate lethal and sublethal impacts, or that alter or eliminate habitat required for reproduction, feeding, and early life stage development. Ongoing and future actions/trends that affect sea turtles and crocodiles in the GOM include climate change, oil and gas development, marine vessel traffic, coastal development, dredging, commercial fishing, and land loss. Cumulative impacts on reptiles in the GOM are considered to be moderate to major. The incremental contribution of routine Program activities to these impacts would be small to medium.

Expected accidental oil spills under the Program (most of which are less than 1,000 bbl) would result in a comparatively negligible to medium incremental increase in the overall impact of exposure to oil from other anthropogenic activities (such as spills from foreign tankers) because such spills are relatively easy to contain and would only affect small areas of habitat (and few individuals). However, large spills (1,000 bbl or greater) or an unexpected CDE could potentially result in population-level effects. Although such spills are rare events, impacts would be major and long-term if multiple individuals and their habitat (especially nesting habitat) are exposed to oil.

4.6.4.4.6 Invertebrates and Lower Trophic Levels. Invertebrates (animals without a backbone) occupy multiple habitat types from the intertidal zone to the deep sea. Benthic invertebrates burrow into bottom sediments or move along the sediment surface; pelagic invertebrates either drift with the current or actively swim. In the GOM, invertebrates and lower trophic level organisms include prokaryotes, viruses, protozoa, sponges, jellyfish, worms, mollusks (bivalves, squid, octopi), echinoderms (sea urchins and sea star), and crustaceans (barnacles, crabs, shrimp) among others. Cumulative impacts on invertebrates and lower trophic organisms result from activities that generate lethal or sublethal impacts on individuals as well as habitat loss or degradation. Ongoing and future actions/trends that affect invertebrates and lower trophic organisms in the GOM include oil and gas development, dredging, trawling, land loss, coastal hypoxia, and climate change (especially in terms of ocean acidification). Cumulative impacts on invertebrates and lower trophic organisms in the GOM are considered to be moderate to major.

Routine operations would result in minor to moderate localized impacts primarily due to bottom-disturbing activities and platform placement and removal. The contribution of the Program to cumulative impacts (mainly due to bottom-disturbing activities) would be negligible to medium, with the severity of the impacts generally decreasing with distance from bottom-disturbing activities. Invertebrate communities may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS activities as well as naturally occurring seeps. The cumulative impacts of past, present, and future oil spills on these resources would be minor to moderate. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on invertebrates would be negligible to small, depending on the location, timing, duration, and size of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could range up to moderate if they were to occur.

4.6.4.5 Summary for Alaska – Cook Inlet

4.6.4.5.1 Marine Mammals. All marine mammals in U.S. waters are protected under the Marine Mammal Protection Act of 1972. Currently, there are 17 marine mammal species in Cook Inlet or nearby waters of the Gulf of Alaska, including whales, sea lions, sea otters, harbor porpoises, and harbor seals; nine of these species are listed as threatened or endangered. Ongoing and future activities or phenomena that affect marine mammals in the inlet include onshore and offshore oil and gas development (and infrastructure); marine vessel traffic; commercial, recreational, and subsistence fishing; subsistence marine mammal harvests; pollution (and marine debris); military operations; development; climate change; and invasive species. Cumulative impacts on marine mammals in the Cook Inlet are considered to be minor to moderate.

Routine oil and gas-related activities (e.g., seismic surveys, facility construction, normal operations, and, eventually, decommissioning) would result in minor to moderate impacts on marine mammals. Impacts on marine mammals from these activities could include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. The contribution of Program activities to cumulative impacts on marine mammals would be negligible to small. The incremental impacts of expected accidental oil spills (most of which are less than 1,000 bbl) would be negligible to small, depending on the location, timing, and volume of the spills; the environmental settings of the spills; and the species exposed to the spills. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from minor to major if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.

4.6.4.5.2 Terrestrial Mammals. There are about 40 species of terrestrial mammals in south central Alaska, many of which use the coastal habitats in the Cook Inlet region. These include bison, bears, sheep, beaver, river otters, and wolverine, among others. Ongoing and future activities or phenomena that affect terrestrial mammals in the inlet include onshore and offshore oil and gas development (and infrastructure), aircraft traffic, marine vehicle traffic, coastal and community development, timber harvests, hunting, pollution, climate change, and natural catastrophes. Cumulative impacts on terrestrial mammals in Cook Inlet are considered to be minor to moderate.

Routine oil and gas-related activities (e.g., facility construction including onshore pipelines, normal operations including aircraft and marine vessel traffic, and, eventually, decommissioning) would result in minor impacts on terrestrial mammals. Impacts on terrestrial mammals from these activities could include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. The contribution of Program activities to cumulative impacts would be negligible to small. The effects of expected accidental oil spills (most of which are less than 1,000 bbl) on terrestrial mammals would be negligible to small, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and other important habitats; the timing and nature of spill containment; and the status of the affected animals. An unexpected, low-probability CDE has a greater potential to affect the terrestrial habitats; therefore, impacts would range from minor to major if one were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.

4.6.4.5.3 Marine and Coastal Birds. There are more than 492 naturally occurring bird species in Alaska. Annual use patterns of Cook Inlet are characterized by the sudden and rapid occurrence of very large numbers of birds in early May followed by a sudden and rapid departure in mid- to late-May. Cumulative impacts result from direct injury or mortality of marine and coastal birds due to collisions with onshore and offshore structures, ingestion of trash or debris, or exposure to discharges or emissions; loss or degradation of habitat due to coastal development, climate change, or construction and operations activities; and behavioral disturbance due to commercial and recreational boating and small aircraft traffic. Many bird species are currently experiencing a loss or degradation of habitat due to land development and climate change, and these impacts are expected to continue into the foreseeable future. Ongoing and future actions/trends that affect marine and coastal birds in the inlet include those related to oil and gas development (and infrastructure), coastal development, marine vessel traffic, dredging operations, and climate change. Cumulative impacts on marine and coastal birds in the Cook Inlet region are considered to be minor to moderate.

Routine operations may result in localized short-term impacts due to infrastructure construction and marine vessel and aircraft traffic. The contribution of the Program to cumulative impacts on marine and coastal birds therefore would be negligible to medium. Birds may also be adversely affected by exposure to oil, especially near coastal areas and affecting feeding and nesting areas. The incremental contribution of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on marine and coastal birds would be small to large, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and nesting areas; the timing and nature of spill containment; and the status of the affected birds. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from moderate to major if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.

4.6.4.5.4 Fish. The waters of south central Alaska support at least 314 fish species; most of these species can be found in Cook Inlet. Some fish live in the water column (pelagic), others, on the seafloor or near bottom waters (demersal). There are also anadromous species (such as Pacific salmon) that spend most of their adulthood in saltwater but spawn in fresh water. Cumulative impacts result from activities that generate lethal or sublethal impacts to individuals as well as the loss or degradation of fish habitat. Ongoing and future actions/trends that affect fish in the inlet include oil and gas development, commercial and recreational fishing, noise, dredging operations, and wastewater discharge. Climate change is also expected to affect fish habitat, productivity, and community structure. Cumulative impacts on fish in Cook Inlet are considered to be moderate to major. The incremental contribution of routine Program activities to these impacts (primarily as a result of displacement, injury or mortality of fish and their food sources) would be negligible to small.

Fish communities may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS activities as well as naturally occurring seeps. The cumulative impacts of past, present, and future oil spills on these resources would be minor to moderate. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on fish would be negligible to medium, depending on the location, timing, duration, and volume of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could range up to moderate if they were to occur.

4.6.4.5.5 Invertebrates and Lower Trophic Levels. Invertebrates (animals without a backbone) occupy the rocky and sandy substrates in the intertidal and subtidal zones. Water column invertebrates in Cook Inlet are composed of a mix of oceanic and coastal species. Several species of copepods (small crustaceans) dominate the macrozooplankton assemblage, peaking in late spring and summer. In lower Cook Inlet, benthic invertebrate communities vary spatially as a result of differences in ice formation, with Arctic species being more common on the western side of the inlet and temperate species being more common on the eastern side. Invertebrates and lower trophic level organisms in the rocky and sandy intertidal zone include echinoderms (sea urchins and sea stars), mollusks (bivalves, limpets, and snails), polychaetes (worms), and crustaceans (barnacles, crabs, and amphipods); clams and polychaetes are predominant in subtidal sandy and muddy sediments. Cumulative impacts on invertebrates and lower trophic organisms result from activities that generate lethal or sublethal impacts to individuals as well as habitat loss or degradation. Ongoing and future actions/trends that affect invertebrates in the inlet include oil and gas development, dredging, trawling, and wastewater discharge. Climate change (especially in terms of ocean acidification) is also expected to affect habitat, productivity, and community structure. Cumulative impacts on invertebrates in Cook Inlet are considered to be moderate to major.

Routine operations would result in minor to moderate localized impacts primarily due to bottom-disturbing activities and platform placement and removal. The contribution of the Program to cumulative impacts (mainly due to bottom-disturbing activities) would be negligible to medium, with the severity of the impacts generally decreasing with distance from bottom-disturbing activities. Invertebrate communities may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS activities as well as naturally occurring seeps. The cumulative impacts of past, present, and future oil spills on these resources would be minor to moderate. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on invertebrates would be negligible to small, depending on the location, timing, duration, and size of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could range up to moderate if they were to occur.

4.6.4.6 Summary for Alaska – Arctic Region

4.6.4.6.1 Marine Mammals. All marine mammals in U.S. waters are protected under the Marine Mammal Protection Act of 1972. In the Arctic region, marine mammals are among the most important subsistence resources for coastal Alaskan Natives. There are 15 species of marine mammals in the Arctic region, four of which are listed as threatened or endangered. These include whales, seals, and polar bears. Polar bears are considered a marine mammal because they inhabit the sea ice surface rather than adjacent land. Ongoing and future activities or phenomena that affect marine mammals in Arctic waters include onshore and offshore oil and gas development (and infrastructure); marine vessel traffic; commercial, recreational, and subsistence fishing; marine mammal subsistence harvests; pollution (and marine debris); development; climate change (including temporal and spatial changes in sea ice); diseases; and natural catastrophes. Cumulative impacts on marine mammals in the Arctic region are considered to be minor to moderate.

Routine oil and gas-related activities (e.g., seismic surveys, facility construction, normal operations, and, eventually, decommissioning) would result in minor to moderate impacts on marine mammals. Impacts on marine mammals from these activities could include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. The contribution of Program activities to cumulative impacts would be negligible to small. The incremental impacts of expected accidental oil spills (most of which are less than 1,000 bbl) would be negligible to large, depending on the location, timing, and volume of the spills; the environmental settings of the spills; and the species (and number of individuals) exposed to the spills. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from minor to major if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.

4.6.4.6.2 Terrestrial Mammals. There are about 30 species of terrestrial mammals in the Arctic region. These include the brown bear, caribou, muskox, the Arctic fox, brown lemming, and wolverine, among others. Ongoing and future activities or phenomena that affect terrestrial mammals in the Arctic region include onshore and offshore oil and gas development (and infrastructure), aircraft traffic, marine vehicle traffic, coastal and community development, timber harvests, hunting, pollution, climate change, and natural catastrophes. Cumulative impacts on terrestrial mammals in the Arctic region are considered to be minor to moderate.

Routine oil and gas-related activities (e.g., facility construction including onshore pipelines, normal operations including vehicle and aircraft traffic, and, eventually, decommissioning) would result in minor impacts on terrestrial mammals. Impacts on terrestrial mammals from these activities could include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. The contribution of Program activities to cumulative impacts would be negligible to small. The effects of expected accidental oil spills (most of which are less than 1,000 bbl) on terrestrial mammals would be negligible to large, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and other important habitats; the timing and nature of spill containment; and the status of the affected animals. An unexpected, low-probability CDE has a greater potential to affect the terrestrial habitats; therefore, impacts would range from minor to major if one were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.

4.6.4.6.3 Marine and Coastal Birds. There are more than 492 naturally occurring bird species in Alaska. Because of the limited seasonal nature of open water and snow-free conditions, the Beaufort and Chukchi Seas support a much smaller number of birds than lower parts of Alaska. Most of the birds occurring in the Arctic region are migratory, being present for all or part of the period between May and early November. Cumulative impacts result from direct injury or mortality of marine and coastal birds due to collisions with onshore and offshore structures, ingestion of trash or debris, or exposure to discharges or emissions; loss or degradation of habitat due to coastal development, climate change, or construction and operations activities; and behavioral disturbance due to commercial and recreational boating and small aircraft traffic. Many bird species are currently experiencing a loss or degradation of habitat due to land development and climate change, and these impacts are expected to continue into the foreseeable future. Ongoing and future actions/trends that affect marine and coastal birds in the Arctic region include those related to oil and gas development (and infrastructure), coastal development, marine vessel traffic, and climate change. Cumulative impacts on marine and coastal birds in the Arctic region are considered to be minor to moderate.

Routine operations may result in localized short-term impacts due to infrastructure construction and marine vessel and aircraft traffic. The contribution of the Program to cumulative impacts on marine and coastal birds therefore would be negligible to medium. Birds may also be adversely affected by exposure to oil, especially near coastal areas and affecting feeding and nesting areas. The incremental contribution of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on marine and coastal birds would be small to large, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and nesting areas; the timing and nature of spill containment; and the status of the affected birds. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from moderate to major if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.

4.6.4.6.4 Fish. The Beaufort and Chukchi Seas support at least 98 fish species, with the greatest number found in Chukchi Sea. Fish in the Arctic region must survive extended seasonal periods of frigid and harsh conditions such as reduced light, seasonal darkness, prolonged low temperatures, and ice cover. Food resources tend to be scare during winter months, so most of a fish's yearly food supply must be acquired during the brief Arctic summer. Many species found in the Beaufort and Chukchi Seas are at the northern limits of their range. Subsistence fishing has a long history in the region (commercial fishing occurred infrequently in the past). Cumulative impacts result from activities that generate lethal or sublethal impacts to individuals as well as the loss or degradation of fish habitat. Ongoing and future actions/trends that affect fish in Arctic waters include oil and gas development, noise, dredging operations, and the potential effects of climate change such as the loss of sea ice, habitat alteration, and changes in fish productivity and community structure. Cumulative impacts on fish in Arctic waters are considered to be moderate to major. The incremental contribution of routine Program activities to these impacts (primarily as a result of disturbance affecting demersal fishes) would be negligible to small, with the severity of impacts generally decreasing with distance from the disturbance.

Fish communities may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS activities as well as naturally occurring seeps. The cumulative impacts of past, present, and future oil spills on these resources would be minor to moderate. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on fish would be negligible to medium, depending on the location, timing, duration, and volume of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could range up to moderate if they were to occur.

4.6.4.6.5 Invertebrates and Lower Trophic Levels. Invertebrates (animals without a backbone) occur in various intertidal and deepwater habitats in the Beaufort and Chukchi Seas. Benthic invertebrates are predominantly echinoderms, polychaetes, sponges, anemones, bivalves, gastropods, and bryozoans. The most common water column macroinvertebrates in the Arctic region are the copepods. Larger invertebrates tend to be sparse in much of the Beaufort Sea relative to the Chukchi Sea, where echinoderms, crabs, and shrimp are more abundant. Zooplankton productivity is highly seasonal. At the lowest trophic levels, microbes such as bacteria and protists are important in Arctic waters for breaking down and recycling nutrients and organic matter. Cumulative impacts on invertebrates and lower trophic organisms result from activities that generate lethal or sublethal impacts to individuals as well as habitat loss or degradation. Ongoing and future actions/trends that affect invertebrates and lower trophic organisms in Arctic waters include oil and gas development, dredging, trawling, and the potential effects of climate change (such as the loss of sea ice), changes in invertebrate habitat, and changes in invertebrate productivity and community structure. Cumulative impacts on invertebrates in Arctic waters are considered to be moderate to major.

Routine operations would result in negligible to moderate localized impacts primarily due to bottom-disturbing activities and platform placement and removal. The contribution of the Program to cumulative impacts (mainly due to bottom-disturbing activities) would be negligible to medium, with the severity of the impacts generally decreasing with distance from bottom-disturbing activities. Invertebrate communities may also be adversely affected by exposure to oil that is accidentally released from OCS and non-OCS activities. The cumulative impacts of past, present, and future oil spills on these resources would be minor to moderate. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on invertebrates would be negligible to small, depending on the location of the spill and the season in which the spill occurred. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could range up to moderate if they were to occur.

4.6.5 Social, Cultural, and Economic Resources

4.6.5.1 Gulf of Mexico Region

4.6.5.1.1 Areas of Special Concern. Section 4.4.8.1 identified potential effects of the Program on Areas of Special Concern in the GOM. This section identifies activities that could affect such areas in the GOM, including non-OCS activities and current and planned OCS activities that would occur during the life of the Program, and the potential incremental effects of implementing the Program.

National Marine Sanctuaries. The FGBNMS is the only National Marine Sanctuary located in the Western and Central GOM Planning Areas. The Flower Gardens Bank sanctuary is protected from direct mechanical damage due to oil and gas exploration and development by an MMS Topographic Features Stipulation, which includes a No Activity Zone (Section 4.4.6.2).

Additional OCS activities that could affect the marine sanctuaries include discharges of drilling cuttings, drilling muds, and produced waters. However, as identified in Section 4.4.6.2, the Topographic Features Stipulation does not allow discharges from OCS activities to be released within the vicinity of the FGBNMS. Consequently, it is anticipated that the sanctuary would not be affected by discharges from OCS activities.

Non-OCS activities that could affect the marine sanctuaries include fishing, diving, offshore marine transportation, and tankering. Natural events such as hurricanes could also impact the sanctuaries. Fishing and diving impacts are controlled by sanctuary guidelines regulating these activities. The distance of the Flower Garden Banks from shore (over 160 km [99 mi]) serves to reduce the number of visitors to the sanctuary, further reducing the potential for impacts from fishing and diving activities. Sanctuary regulations also prohibit collecting activities and ban anchoring within the sanctuary in order to minimize structural damage to the reef system from commercial and recreational vessels.

Climate change has the potential to profoundly affect coral communities on topographic features in several ways, including:

- Increased frequency of bleaching as a stress response to warming water temperatures (Hoegh-Guldberg et al. 2007);

- Excessive algal growth on reefs and an increase in bacterial, fungal, and viral agents (Boesch et al. 2000; Twilley et al. 2001);

- Greater frequency of mechanical damage to corals from greater severity of tropical storms and hurricanes (Janetos et al. 2008);

- Decreases in the oceanic pH and carbonate concentration are expected to reduce the reef formation rate, weaken the existing reef structure, and alter the composition of coral communities (Janetos et al. 2008); and

- Invasive species may expand their range into the GOM due to climate change.

Impacts on the marine sanctuaries could occur due to surface hydrocarbon discharges from platform spills, OCS and non-OCS tankers, or other marine traffic passing in the vicinity of the sanctuary. Discharges in the vicinity of the FGBNMS should be greatly diluted before they could reach reef features because water depths within the sanctuary are greater than 20 m (66 ft). Consequently, it is anticipated that concentrations of contaminants within such discharges would be diluted to levels unlikely to have toxic effects on reef organisms. Oil spills could also impact the Flower Garden Banks communities. The No Activity Zone mandated in the Topographic Features Stipulation and adopted as a regulation for the Flower Garden Banks precludes placement of platforms or pipelines immediately adjacent to the marine sanctuary and reduces the likelihood that oil from a pipeline leak would reach bank communities. If oil from a series of subsurface spills were to reach one of these banks, sensitive biota could be affected. Potential impacts have been discussed in Section 4.4.6.2. It is anticipated that impacts of a large oil spill reaching coral reef or hard-bottom habitat may be long-term.

National Parks, Reserves, and Refuges. As identified in Section 4.4.8.1, routine OCS activities potentially affecting parks, reserves, and refuges include placement of structures, pipeline landfalls, operational discharges and wastes, and vessel and aircraft traffic. It is assumed that pipeline landfalls, shore bases, and waste facilities would not be located in National Parks, NWRs, or National Estuarine Research Reserves because of the special status and protections afforded these areas. Consequently, there would be no direct impacts from these activities on any GOM national parks, reserves, or refuges.

It is possible that future pipeline landfalls, shore bases, and waste facilities could be located in one or more estuaries in the Western or Central GOM Planning Area that are included in the National Estuary Program. This includes Corpus Christi Bay (Coastal Bend Bays and Estuaries), Galveston Bay, Barataria-Terrebonne Estuarine Complex, and Mobile Bay. Under the cumulative scenario, it is anticipated that less than 40 new pipeline landfalls could occur in the GOM, with less than 12 of these resulting from the Program (Table 4.4.1-1). In addition, gas-processing facilities could be built in the GOM area under the cumulative scenario. It is assumed that new onshore facilities and structures would be subject to additional evaluations under the NEPA and that they would be sited to avoid national parks, reserves, and refuges and to limit impacts on estuarine and coastal habitats.

Trash and debris are a recognized problem affecting enjoyment and maintenance of recreational beaches along the GOM coast. From extensive aerial surveys conducted by NMFS over large areas of the GOM, floating offshore trash and debris was characterized by Lecke-Mitchell and Mullin (1997) as a ubiquitous, GOM-wide problem. Not surprisingly, such trash and debris frequently wash up on beaches, including those associated with Areas of Special Concern such as the Padre Island National Seashore. Trash and debris can detract from the aesthetic quality of beaches, can be hazardous to beach users and wildlife, and can increase the cost of maintenance programs.

Marine vessel wakes from a large number of vessel trips can, over time, erode shorelines along inlets, channels, and harbors. The GOM is one of the world's most concentrated shipping areas, and the Port of New Orleans supports extensive commercial shipping traffic. The GOM also supports extensive commercial fisheries as well as recreational boating. The GOM also supports training by U.S. Navy vessels as well as routine USCG activities (Section 4.3). The additional vessel activity that would occur under the Program will result in an increase in the overall potential for wakes to affect sensitive shorelines in the GOM OCS Planning Areas.

Overall, it is assumed that there could be 1,400–1,900 OCS-related vessel trips (to new facilities) per week in the GOM under the cumulative scenario; 300 to 600 of these would occur as a result of OCS activities attributable to the Program (Table 4.4.1.1-1). The majority of such vessel trips would occur in offshore waters, thereby precluding effects on shorelines associated with national parks, reserves, and refuges. Existing regulations typically limit vessel speeds in the sensitive inland waterways of Areas of Special Concern. With these measures in place, most impacts due to vessel traffic in such areas would be avoided.

Under the Program, National Parks, NWRs, National Estuarine Research Reserves, or National Estuary Program sites could be exposed to oil accidentally released from platforms, pipelines, and vessels (see Section 4.4.8.1). In addition to the potential for spills from OCS sources, storms, operator error, and mechanical failures could also result in accidental oil releases from a variety of non-OCS-related activities including domestic transportation of oil, importing foreign crude oil, and development of oil production under State programs. The potential exists for impacts to National Parks, Reserves, and Refuges that could result from both oiling of the shoreline and mechanical damage during the cleanup process. Most spills associated with the Program would be relatively small (less than 50 bbl), and most would be expected to occur in waters depths of 200 m (656 ft) or more (Table 4.4.2-1) where they are not likely to affect coastal areas. Because of the expected distribution of leasing activities, it is assumed that such spills would occur in either the Western or Central GOM Planning Area.

Based on the expected distribution of activities and facilities associated with current or proposed activities under OCS leasing programs, it is assumed that any accidental oil spills from OCS-activities would occur in either the Western or Central GOM Planning Area. In contrast, non-OCS spills could occur anywhere in the GOM. Thus, while it is considered likely that only national seashores, NWRs, national estuarine research reserves, and National Estuary Program sites in the Western or Central GOM are at risk from spills due to ongoing or proposed OCS activities, any of these types of properties located along the GOM coast has a potential to be affected by non-OCS accidental spills. Regardless of the source, oil from a large or catastrophic spill that reached the shoreline of any of these sites could have adverse effects on resources or resource values.

Hurricanes and tropical storms occur regularly in the GOM area. The natural environments that parks and refuges preserve and maintain have developed in a setting of regular occurrences of severe storms. In 2004 and 2005, however, Hurricanes Katrina, Rita, and Ivan severely impacted numerous national parks, NWRs, and national estuaries. In 2004, Hurricane Ivan damaged 10 NWRs between the Florida Panhandle and Louisiana. In 2005, Hurricane Katrina affected 16 refuges in the same area, temporarily closing all of them. Impacts included damage to beaches, dunes, vegetation and infrastructure. Breton NWR in Louisiana was reduced to about one-half its pre-Katrina size. Many impacted refuges remain impacted by huge quantities of debris and hazardous gases and liquids spread over large areas of wetlands within the sanctuaries. Should storms of similar strength and size occur during the life of the Program, long-term impacts on Areas of Special Concern in the GOM could occur.

Conclusion. Cumulative impacts on Areas of Special Concern in the GOM are considered to be negligible to moderate. In addition to OCS activities, non-OCS activities that could affect National Sanctuaries, Parks, Reserves and Refuges include fishing, diving, trash and debris, marine vessel traffic (and wakes), tankering, and oil and gas activities in State waters. Hurricanes and tropical storms also occur regularly in the GOM area potentially causing damage. Due to existing protections, it is anticipated that the FGBNMS would not be affected by OCS activities. Development of OCS onshore facilities within National Park lands is considered unlikely, making impacts from routine Program activities unlikely in these areas. Offshore construction of pipelines and platforms could contribute to cumulative effects on wildlife and on scenic values for park visitors. Impacts could also include increases to the amount of trash or debris that currently washes up on shorelines, and increases in shoreline erosion due to increased vessel traffic in inshore waters. Routine operations under the Program could result in a negligible to medium incremental increase in effects on Areas of Special Concern (see Section 4.4.8.1).

Expected oil spills (most of which are less than 1,000 bbl) that may occur during the Program could result in a negligible to small incremental contribution to cumulative impacts on Areas of Special Concern, depending on spill frequency, location, and volume; the type of product spilled; weather conditions; effectiveness of cleanup operations; and other environmental conditions at the time of the spill. Large spills (1,000 bbl and greater) or an unexpected, low-probability CDE in areas adjacent to the National Parks, NWRs, or National Forests, whether from OCS or non-OCS sources, would also depend on these factors, and could result in moderate impacts if they were to occur. Such spills could negatively impact the FGBNMS and coastal habitats and fauna, and could also affect subsistence uses, commercial or recreational fisheries, and tourism.

4.6.5.1.2 Population, Employment, and Income. Section 4.4.9.1 discusses the potential impacts from the Program on population, employment, and income in the GOM coast region. Cumulative impacts on these resources result from the incremental impacts of the Program when added to impacts from ongoing and reasonably foreseeable future OCS program activities (that are not part of the Program) and other non-OCS program activities. Specific types of impact-producing factors related to OCS program activities considered in this analysis include total employment and regional income for counties in the 23 LMAs in the five States in the GOM coast region (described in Section 3.10). Non-OCS program activities affecting the region include employment and earnings related to various other industrial sectors (e.g., construction, manufacturing, services, and State and local government) and the high unemployment rates in the five GOM coast States.

The population in the GOM coast counties increased at an average annual rate of 1.6% between 1980 and 1990, 1.2% between 1990 and 2000, and 1.5% between 2000 and 2009. During each of these periods, the greatest increases consistently occurred in Texas (with an average annual increase of 2.1% between 2000 and 2009) and Florida (with an average annual increase of 1.6% between 2000 and 2009). The components of population increase include the natural increase due to births and net positive domestic and international migration; these trends will likely continue in the GOM coast region over the next 40 to 50 years.

Although the Program would add an average of 128,150 to 196,350 direct and indirect jobs annually between 2012 and 2017, this increase is considered minor (but positive) since it would amount to between 1.2% and 1.8% of forecasted total GOM coast regional employment in 2015. The largest increases would occur in Louisiana and Texas. Likewise, direct and indirect income produced in the region would range from $6,705 million to $10,220 million, with the greatest impacts occurring in Louisiana and Texas.

Population increases of 175,473 to 261,202 would be expected in Texas on average in each year of the Program, with increases of 129,953 to 202,797 occurring in Louisiana. Smaller population increases of 16,382 to 27,519 would occur in Florida, with increases of 6,087 to 10,360 in Alabama and 4,015 to 6,669 in Mississippi. These increases also represent small changes (between 1.3% and 1.9% in the region overall in 2015), assuming a 1.5% average annual increase in population between 2009 and 2017.

Employment impacts of oil spills reaching landfall can vary considerably depending upon the total volume of oil reaching land, land area affected, and sensitivity of local environmental conditions to oil impacts. The primary impacts of oil spills would most likely fall on such coastal activities as beach recreation, diving, commercial fishing, recreational fishing, and sightseeing. Oil spills reaching land can have both short- and long-term effects on these activities. Past studies (Sorenson and McCreary 1990) have shown that there could be a one-time seasonal decline in tourist visits of 5 to 15% associated with a major oil spill. Since tourist movement to other coastal areas in the region often offsets a reduction in the number of visits to one area, the associated loss of business tends to be localized. As discussed in Section 4.4.9, the employment and regional income impact from an oil spill related to the Program would likely be greatest in Texas and Florida and this would likely continue over the next 40 to 50 years. Oil spills would generate only temporary employment (and population) increases during cleanup operations, because such operations are expected to be of short duration.

Hurricanes are recurring events in the GOM area to which the demographic and economic patterns have adjusted. In 2005, however, Hurricanes Katrina and Rita resulted in major socioeconomic changes throughout the GOM region, affecting population, employment, and regional income. Katrina-related flooding affected 49 counties in Alabama, Louisiana, and Mississippi, resulting in estimated damage of more than $155 billion (Burton and Hicks 2005). Damage or loss of hundreds of thousands of homes has resulted in the out-migration of hundreds of thousands of individuals from the region, with varying levels of long-term population displacement. Estimated declines in employment due to hurricane damage and population displacement have ranged from 150,000 to 500,000 jobs, although employment is expected to increase as reconstruction of impacted areas proceeds (Congressional Budget Office 2005). Estimated declines in the 2005 total annual personal income in the GOM range from $10 million in Texas to more than $18 million in Louisiana (Bureau of Economic Analysis 2006).

Conclusion. The cumulative impacts of ongoing and future OCS program and non-OCS program activities would be considered beneficial because these activities would increase employment and earnings in the region over the next 40 to 50 years. The Program would add to these beneficial impacts, especially in Texas and Louisiana. The incremental contribution of the Program is expected to be negligible, however, because the added employment demands are less than 2% of the total GOM coast regional employment (see Section 4.4.9.1).

In areas with a large proportion of impact-sensitive industry (such as tourism), the cumulative impacts of accidental oils spills could be moderate to major, depending on the total volume of oil reaching land, the land area affected, and the sensitivity of local environmental conditions to oil impacts. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be negligible to small relative to those associated with ongoing and future OCS program and non-OCS program activities. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in minor to moderate impacts if they were to occur. In the short-term, impacts of a CDE could be large as a result of loss of employment, income, and possible shortages of commodities or services in both coastal and inland areas affected by the spill. Longer-term impacts could be smaller unless the fishing and tourism suffered as a result of real or perceived impacts of the event (see Section 4.4.9.1).

4.6.5.1.3 Land Use and Infrastructure. Localized impacts to land use and existing infrastructure are anticipated as a result of the construction of new OCS program oil and gas facilities in the GOM over the next 40 to 50 years. Depending on the location, onshore development may necessitate minimal changes of existing or potential future uses, as well as minor increases in demands on roads, utilities, and public services (MMS 2007c). Land use generally would evolve over time, with a majority of change to occur from general, regional economic, and demographic growth rather than from activities associated with ongoing and future OCS programs and/or State oil and gas development (BOEMRE 2011a).

Recently, deepwater gas production has increased while gas production along the coast has substantially decreased. These trends have combined to lower the need for new gas processing facilities along the GOM coast. As a result, BOEM has concluded that spare capacity at existing facilities is sufficient to satisfy new gas production for many years (although a new gas processing facility could be needed at some future date) (BOEMRE 2011a). With some modifications, current facilities and land use classifications would be expected to support oil and gas production associated with new OCS leases. Likewise, service-based infrastructure would be able to support offshore petroleum-related activities in both the Federal OCS and State waters (BOEMRE 2011a).

Ongoing non-OCS program activities that could affect land use and onshore infrastructure are expected to continue into the foreseeable future. These include offshore and onshore construction, the discharge of municipal and other waste effluents, and marine vessel traffic (MMS 2007c).

Activities within the GOM may be affected by post-DWH event conditions. A significant amount of information has been generated regarding the consequences of the oil spill and subsequent drilling moratorium. As the post-DWH event situation is dynamic, BOEM has been conducting ongoing monitoring of post-DWH event impacts on land use and coastal infrastructure. BOEM will continue to conduct targeted and peer-reviewed research, as long as the monitoring identifies long-term impacts of concern (BOEMRE 2011a).

Accidental oil releases may occur as a result of both OCS and non-OCS activities and from naturally occurring seeps. The extent of the impacts associated with accidental oil spills would depend on the location and size of the releases, but could include stresses of spill response on the community infrastructure, increased traffic to respond to cleanup (both onshore and offshore), and restricted access to affected lands while cleanup is conducted. In general, these releases would be expected to have only a temporary impact on land use and infrastructure (MMS 2007c).

Conclusion. Localized impacts to land use and existing infrastructure are anticipated over the next 40 to 50 years as a result of ongoing and future OCS program and non-OCS program activities in the GOM. These impacts could range from minor to major depending on the location and nature (extent and duration) of the land use change. The incremental contribution of routine operations under the Program to cumulative impacts in the GOM would be negligible to small because the existing infrastructure is considered sufficient to handle the small increases in demands for roads, utilities, and public services related to the Program. Activities within the GOM also may be affected by the post-DWH event conditions; BOEM continues to monitor the region to identify long-term impacts of concern (see Section 4.4.10.1).

Land use–related impacts resulting from expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program include stresses of spill response on community infrastructure, increased traffic in the response area (both onshore and offshore), and temporary restricted access to affected lands (while cleanup is conducted). Such spills would result in a negligible to small incremental contribution to cumulative impacts on land use and existing infrastructure. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in minor to moderate impacts if they were to occur.

4.6.5.1.4 Commercial and Recreational Fisheries.

Commercial Fisheries. Routine OCS activities over the next 40 to 50 years could harm or kill individual fishes, resulting in temporary movements of fishes away from areas where activities were being conducted. Impacts would vary depending on the nature of a particular structure, the phase of operation, the fishing method or gear, and the target species group. Impacts would be higher for drifting gear such as purse nets, bottom longlines, and pelagic longlines than for trawls and handlines (MMS 2005f). Nevertheless, areas in which commercial fishing would be affected are small relative to the entire fishing area available to surface longliners or purse seiners. Although long-term effects on populations of most fishes in the GOM as a whole are not anticipated, populations of rare fishes or those that have highly limited distributions within the GOM could be more substantially affected if activities occurred in areas with high concentrations of individuals.

Offshore oil and gas structures placed within the depth range 0 to 60 m (0 to 200 ft) would increase annual commercial fishing costs by between $1,993 and $3,819 in the Western Planning Area, while reducing costs by between $2,507 and $11,243 in the Central Planning Area. Currently, there are no data available on the placement of offshore platforms in the Eastern Planning Area; consequently, we can draw no conclusions regarding their impact on commercial fishing costs.

Depending upon the location, magnitude, and timing of accidental oil spills from OCS platforms or pipelines, lethal or sublethal toxic effects could occur, especially for species that have pelagic eggs and larvae. If spills occurred in areas with high concentrations of eggs or larvae of a particular species, the abundance of a particular year-class could be affected. The effects of spilled oil on commercial fisheries include fishing ground area closures, contaminated fish, fouled fishing gear and associated equipment, and degradation of fishing grounds. Accidental oil releases from non-OCS activities are possible anywhere on the OCS or in State waters (e.g., from vessel collisions or transfer/lightering operations); crude oil also enters the environment from naturally occurring seeps. Although such releases typically occur in deeper water, the released oil should rise to the surface relatively quickly, and although it is anticipated that most adult fish would be able to avoid the resulting plumes of oil, larvae or eggs of some fish species could be affected and commercial fishing gear could become fouled with oil. In many cases, commercial fisheries would be able to return to the area after slicks have been cleaned up or dispersed. However, shallow coastal spills could contaminate tissues of target organisms (e.g., oyster beds and shallow benthic fishes), and affected commercial fisheries could be closed for one or more seasons.

Non-OCS program activities and factors that could affect fish populations in the GOM include State oil and gas activities, commercial shipping (and other marine vessel traffic), land development, dredging and dredge-disposal operations, marine mineral mining, and water quality degradation from both point and nonpoint pollution sources. In particular, space-use conflicts resulting from exploration and delineation activities and establishment of development and production platforms could affect commercial fisheries, with some areas precluded from commercial fisheries. There are temporary exclusions from fishing in areas during exploration and delineation activities. Underwater OCS structures such as pipelines could also cause space- and gear-related conflicts, and increased vessel traffic to and from the rigs and platforms will also increase the amount of marine traffic and possible conflicts with commercial fishers. The potential for spatial preclusion also exists in both nearshore and offshore waters with increased levels of seismic survey activity.

Recreational Fisheries. While space-use conflicts with recreational fisheries caused by routine OCS operations would be minimal, there is recreational shrimp trawling for wild shrimp, and trawls could become entangled with OCS structures in the water. Deepwater recreational rod-and-reel anglers typically target oil and gas platforms because these structures usually attract target species. Noise from rig and platform installation and from seismic surveys during exploration and delineation activities could scatter target species away from some recreational fishing areas while activities are occurring and potentially for some period afterward. Temporary reductions in hook-and-line captures have been reported in some areas following seismic surveys. This may result in decreased recreational catch. Platform removal using explosives may also impact recreational fisheries. The noise would drive some fish away, some fish would be killed, and a structure that may be targeted as a fishing location by recreational anglers could be eliminated.

Oil spills from OCS or non-OCS sources could affect recreational fisheries by fouling gear with oil, tainting the catch, and degrading water quality and fishing grounds. Accidental oil releases from non-OCS activities are possible anywhere on the OCS or in State waters, and crude oil also enters the environment from naturally occurring seeps. The OCS oil spills most likely to affect recreational anglers would be shallow water spills, since recreational anglers are less likely to venture far offshore. Non-OCS oil and gas activities likely pose a greater risk in terms of potential oil spills that could affect recreational fisheries, because such activities are located closer to shore. Closure of some areas to fishing, perhaps for multiple seasons, could occur as a result of oil spills. In addition, public perception of the effects of a spill on marine life and its extent could result in a loss of revenue for the fishing-related recreation industry. Party and charter boat recreational fisheries often have losses of income because of reduced interest in fishing when a spill has occurred. Local hotels, restaurants, bait-and-tackle shops, and boat rental companies associated with recreational fisheries may experience reduced sales because of public perception related to an oil spill.

Conclusion. Cumulative impacts on commercial and recreational fisheries in the GOM as a result of ongoing and future OCS and non-OCS activities and natural phenomena are expected to be minor over the next 40 to 50 years. Non-OCS activities affecting fisheries in the GOM include State oil and gas activities, commercial shipping (and other marine vessel traffic), land development, dredging and dredge-disposal operations, marine mineral mining, and water quality degradation from both point and nonpoint pollution. The incremental contribution of routine operations under the Program to these impacts would be small since these activities would be unlikely to have population- or community-level effects on fishery resources because of the limited time frame over which most individual activities would occur and because a small proportion of habitat relative to similar available habitat would be affected during a given period. In addition, existing stipulations are in place to prevent or reduce impacts on sensitive habitats such as hard-bottom areas and topographic features. Construction of new platforms could represent a small increase in the availability of desirable recreational fishing locations for recreational anglers (see Section 4.4.11.1).

Commercial and recreational fisheries may be adversely affected by accidental oil releases from OCS and non-OCS activities (e.g., State oil and gas development, domestic transportation of oil or refined petroleum products, and commercial shipping). The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be medium, depending on the location, timing, and volumes of spills (among other environmental factors). Small spills are unlikely to affect a large number of fish or have a substantial effect on recreational fishing before dilution and weathering reduced concentrations of oil in the water. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be moderate if they were to occur. Spills of this scale could have significant localized effects on commercial fishing as a result of reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods, and on recreational fishing as a consequence of contamination of fish tissues, degradation of aesthetic values that attract fishers, or temporary closure of fishing areas. Large spills or a CDE have a greater potential to contact intertidal habitat and subsequently contaminate or reduce the abundance of commercial and recreational species that depend on nearshore habitat. These impacts could be long term, but are not expected to result in the long-term loss of fisheries in the GOM.

4.6.5.1.5 Tourism and Recreation. Noise from platform installation and platform removal can affect recreational fishing by temporarily disturbing fish and by causing fish kills if explosives are used to remove platforms. Platforms installed within 16 km (10 mi) of coastal recreation areas, such as beaches, parks, and wilderness areas, can affect recreational experiences by affecting ocean views. Transportation of oil and gas, combined with other commercial, industrial, and recreational vessel traffic that continues to occur within the GOM, can affect recreational experiences through increased noise, boat wake disturbances, visual intrusions, and increased trash and debris washing ashore. In addition to transportation and oil and gas, other activities contribute to the trash and debris found on the beaches including (but not limited to) beach visitors, commercial and recreational fishing, merchant shipping, naval operations, and cruise lines.

Non-OCS activities that might impact recreation and tourism include offshore construction (e.g., dredging and dredge-disposal operations, marine mineral mining, State oil and gas development, domestic transportation of oil and gas, and foreign crude oil imports), onshore construction (e.g., coastal and community development), the discharge of municipal and other waste effluents, and marine vessel traffic (e.g., commercial shipping, recreational boating, and military training and testing).

Accidental oil releases may occur as a result of both OCS and non-OCS activities, and oil is also released from naturally occurring seeps. The magnitude of the impacts would depend on the location and size of the releases, as well as their timing with respect to peak tourism seasons. These releases are expected to have a temporary impact on recreation and tourism in the GOM region. Closures of recreational areas for up to 6 weeks could occur to accommodate cleanup operations. Most of the releases identified under the Program are anticipated to be small and would occur in waters greater than 200 m (660 ft) in depth. These releases would be a small addition to releases associated with other OCS and non-OCS activities.

Severe storm events such as hurricanes have the potential to impact the recreation and tourism economy if they result in severe beach damage and/or destruction of existing public infrastructure. While hurricanes are regularly occurring events in the GOM, Hurricanes Katrina and Rita in 2005 caused unusually large amounts of damage to the tourism and recreation infrastructure in the area. These storms destroyed recreational beaches, public piers, hotels, casinos, marinas, recreational pleasure craft and charter boats, and numerous other recreational infrastructure. Almost 70% of the recreational fishing assets in Mississippi alone were damaged by Katrina (Posadas 2005). Of the 13 casino-barge structures present along the Mississippi coast prior to Katrina, most suffered severe external damage, seven broke completely free of their moorings, two partially broke free and damaged adjoining structures, one sank, and one was deposited inland by the storm surge (NIST 2006). The full extent of impacts to tourism and recreation by the hurricanes has yet to be fully quantified, but it will likely take years for tourism and recreation to return to pre-hurricane levels.

Conclusion. Cumulative impacts on tourism and recreation in the GOM as a result of ongoing and future OCS and non-OCS activities and natural phenomena are expected to be minor over the next 40 to 50 years. Non-OCS activities or phenomena affecting these resources include offshore construction (e.g., dredging and dredge-disposal operations, marine mineral mining, State oil and gas development, domestic transportation of oil and gas, and foreign crude oil imports), onshore construction (e.g., coastal and community development), the discharge of municipal and other waste effluents, and marine vessel traffic. The incremental contribution of routine operations under the Program to these impacts would be small, with potential adverse aesthetic impacts on beach recreation and sightseeing and potential positive impacts on diving and recreational fishing (see Section 4.4.12.1).

Tourism and recreation may be adversely affected by accidental oil releases from OCS and non-OCS activities (e.g., State oil and gas development, domestic transportation of oil or refined petroleum products, and commercial shipping). The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be negligible to small, depending on the size, location, and timing of the spill (being greatest if it occurred during the peak recreational season). Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be moderate to major if they were to occur. Short-term impacts would include beach and coastal access restrictions; restrictions on visitation, fishing, or hunting while cleanup is being conducted; and aesthetic impacts associated with the event itself and with cleanup activities. Longer-term impacts could be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event.

4.6.5.1.6 Sociocultural Systems. The GOM coastal commuting zone is ethnically and culturally diverse and includes a well-established oil and gas industry focused mainly in Louisiana and Texas (Section 3.14.1.1). For the most part, oil and gas development on the OCS will make use of existing pipelines and onshore infrastructure. Increases in activities associated with the Program are anticipated to be incremental and qualitatively similar to current patterns. However, as deepwater drilling expands, jobs that require longer, unbroken periods of offshore work will increasingly attract a more international workforce promoting sociocultural heterogeneity in coastal support communities, particularly in Texas and Louisiana.

Non-OCS program activities and processes affecting sociocultural systems are expected to continue. These include oil and gas development in State waters, coastal habitat changes, coastal land loss, regional economic changes, and recovery from storms and major oil spills. These activities and processes can lead to major impacts related to population change, job creation and loss, and changes in social institutions including family, government, politics, and education.

Accidental oil and other spills over the next 40 to 50 years could result from both OCS and non-OCS activities. The magnitude of spill impacts depends on their size, location, and timing. With the exception of major spills (such as occurred with the DWH event), oil spills are expected to have only temporary physical and economic effects and therefore should not significantly alter sociocultural systems.

The wetlands that supply subsistence resources are susceptible to oil spills. The Louisiana parishes of St. Mary, Terrebonne, and Lafourche are home to populations engaged in renewable resource harvesting, and are also areas of heavy to moderate concentrations of oil and gas industry facilities. As discussed in Section 3.7, the wetlands in coastal Louisiana are rapidly diminishing because of engineering projects to control the Mississippi River, natural subsidence, the development of the oil and gas industry, and climate change (Field et al. 2007). Because of the construction of flood-control structures, the Mississippi River no longer floods Louisiana's wetlands; these floods previously deposited new silt to offset coastal erosion. Extraction of oil and gas from coastal areas may have resulted in some subsidence of bayou lands. In many areas, Louisiana's coastal wetlands have been cut by a network of canals constructed to lay pipes bringing oil and gas to onshore refining facilities (Field et al. 2007). Cut in straight lines from the shore, these canals exacerbate the erosive force of tides and storm surges. Climate change has resulted in slowly increasing sea levels and an increased intensity of coastal storms and hurricanes. The end result has been an overall decrease in Louisiana's wetlands and a reduction in fresh and brackish wetlands and the subsistence species they support, along with an increase in salt marshes. Cumulatively, these changes constitute major impacts on a way of life that was once common along the GOM coast.

It is anticipated that global climate change will result in increased temperatures and rising relative sea levels along the GOM coast and these changes will be accompanied by an increase in severe storms in the coming decades. Rising relative sea levels and increased erosion have been observed all along the coast (Field et al. 2007). Those who rely at least in part on harvesting renewable resources from the sea, either as subsistence or commercial fishers and shrimpers, are predicted to be most vulnerable to adverse effects resulting from these changes (Nicholls et al. 2007).

Conclusion. Cumulative impacts on sociocultural systems in the GOM as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be moderate over the next 40 to 50 years. Non-OCS activities or phenomena affecting these resources include oil and gas development in State waters, coastal habitat changes, coastal land loss, regional economic changes, and recovery from storms and major oil spills. In terms of subsistence and renewable resource harvesting, non-OCS activities such as flood control along the Mississippi River and natural trends such as global climate change have produced major adverse impacts on the GOM coast region. The incremental contribution of routine operations under the Program to these impacts would be small, since they are more likely to support the existing industry than to create industry growth. Any expansion of deepwater activities will result in jobs that require longer, unbroken periods of work offshore, specialized skills, and potential in-migration of part of the workforce (see Section 4.4.13.1).

Sociocultural systems may be adversely affected by accidental oil releases from OCS and non-OCS activities (State oil and gas development, domestic transportation of oil or refined petroleum products, and commercial shipping). The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program would be small to medium, especially on localized intertidal resources used by subsistence harvesters. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be moderate to major if they were to occur, especially if oil were to reach the shore. Such spills could lead to long-term closure of fisheries, resulting in social and cultural stress. GOM subsistence harvesters make up a relatively small segment of the coastal population and replacement food resources are more available than for subsistence harvesters in Alaska, so while the impact of the loss of subsistence resources would be moderate for the coastal population as a whole, it would be locally major for populations that depended on subsistence harvesting for a significant proportion of their diet.

4.6.5.1.7 Environmental Justice. Over the next 40 to 50 years, air emissions from OCS and non-OCS onshore facilities and helicopter and marine vessel traffic traversing coastal areas would be highest in States such as Texas and Louisiana that contain the greatest amounts of infrastructure. Lesser amounts of infrastructure would occur in Mississippi and Alabama. No onshore infrastructure supporting OCS operations currently exists in Florida, and none will be built as a result of the Program. It is assumed that 75% of the activity from the Program will occur in deep and ultra-deep waters, with offshore air emissions greatest in the coastal areas of Texas and Louisiana, the areas with the greatest amounts of oil and gas activity, with lesser amounts in occurring in Mississippi and Alabama. The coastal areas of Florida are located so far from OCS activities that no environmental justice issues from offshore air emissions are expected to impact the coastal parts of the State. The effects of the OCS program on air quality have been analyzed in Section 4.4.4. This analysis concluded that routine operations associated with the Program would result in NO_2, SO_2, PM_{10}, and CO levels that are well within the NAAQS. Disproportionate impacts on low-income or minority populations would be minor, because the coastal effects from offshore activities are expected to be small, based on the established and increasing trend toward movement of oil and gas activities into deeper waters of the GOM.

The Program would result in levels of infrastructure use and construction similar to those that have already occurred in the GOM coast region during previous OCS programs. These activities are not expected to expose residents to notably higher risks than currently occur. While the distribution of offshore-related activities and infrastructure indicates that some places and populations in the GOM region would continue to be of environmental justice concern, the incremental contribution of the Program is not expected to affect those places and populations.

Non-OCS activities and processes that are ongoing and expected to continue into the foreseeable future, and include non-OCS oil and gas development, coastal habitat changes, coastal land loss, economic development, regional economic changes, and recovery from storms. These activities and processes could disproportionately impact low-income and minority populations.

In addition to oil and chemical spills that could occur with the Program, oil releases and spills could also occur from other non-OCS sources such as natural oil seeps, State oil and gas activity, and petrochemical refining and processing. While the timing and location of these spills cannot be determined and some low-income and minority populations are resident in some areas of the GOM coast, in general the coasts are home to more affluent groups. Low-income and minority groups are not more likely to bear more negative impacts than are other groups.

Conclusion. In the GOM, ongoing and future OCS and non-OCS program activities in combination with the effects of storm and hurricane damage and regional economic issues would result in disproportionate moderate to major adverse cumulative impacts on low-income and minority populations. The incremental contribution of routine operations under the Program to these impacts would be negligible (see Section 4.4.14.1).

The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be negligible to medium because of the movement of oil and gas activities farther away from coastal areas and the demographic pattern of more affluent groups (and fewer low-income and minority populations) living in coastal areas. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in moderate to major impacts, depending on the location, size, and timing of the event.

4.6.5.1.8 Archeological and Historic Resources. Section 4.4.1.5 discusses the direct and indirect impacts from the Program in onshore and offshore environments in the GOM. Cumulative impacts on archeological and historic resources result from the incremental impacts of the Program when added to impacts from ongoing and reasonably foreseeable future OCS program activities (that are not part of the Program) and other non-OCS program activities. Table 4.6.1-2 presents the exploration and development scenario for the GOM cumulative case (encompassing the Program and other OCS program activities). Specific types of impact-producing factors related to OCS program activities considered in this analysis include drilling rig and platform emplacement, pipeline emplacement, anchoring, new onshore facilities, ferromagnetic debris associated with OCS activities, and oil spills. Non-OCS program activities include trawling, sport diving, commercial treasure hunting, and channel dredging. Natural phenomena such as waves, currents, and tropical storms are also considered.

Prehistoric Resources. Offshore development could result in an interaction between a drilling rig, platform, pipeline, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy artifacts or site features and could disturb the stratigraphic context of the site. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for the Americas and the Caribbean.

Since 1973 when the Environment Studies Program (ESP) was initiated, the USDOI has required that an archaeological survey be conducted prior to development of mineral leases determined to have potential for cultural resources including prehistoric archaeological sites. High-probability areas for the occurrence of prehistoric sites in the GOM include the region of the OCS shoreward of the 45-m (50-ft) isobath. Although an archaeological survey would identify most of the cultural resources in the APE for the project and routine operations related to OCS program activities would avoid all known cultural resources, it is likely that impacts to prehistoric resources have already occurred as a result of OCS program and non-program activities that took place before implementation of the 1973 archaeological survey requirement.

Onshore development could result in direct physical contact between the construction of new onshore facilities or pipeline trenches and previously unidentified prehistoric sites. This direct physical contact with a prehistoric site could cause physical damage to or complete destruction of information on the prehistory of the region and North America. Federal and State laws and regulations initiated in the 1960s began requiring archaeological surveys prior to permitting any activity that might disturb a significant archaeological site. Therefore, it can be assumed that, since the introduction of the archaeological resource protection laws, most coastal archaeological sites have been located, evaluated, and mitigated prior to construction. However, impacts to coastal prehistoric resources may have already occurred as a result of various onshore construction activities prior to enactment of the archaeological resource protection laws.

Trawling activity in the GOM affects only the uppermost portion of the sediment column (Garrison et al. 1989). This zone would already have been disturbed by natural factors relating to the destructive effects of marine transgression and continuing effects of wave and current action. Therefore, the effect of future trawling on most prehistoric archaeological sites is expected to be minor.

Tropical storms and hurricanes are yearly occurrences in the GOM and may be increasing in intensity as a result of global climate change (Section 3.3.1). Past storm events have affected all areas of the GOM, from west Texas to south Florida, and broad areas are affected by each storm (DeWald 1980). Prehistoric sites in shallow waters or coastal beach sites are exposed to the destructive effects of wave action and scouring currents during these events. Under such conditions, it is highly likely that artifacts would be dispersed and the site context disturbed, resulting in the loss of archaeological information. Overall, a significant loss of data from nearshore and coastal prehistoric sites may have occurred, and will continue to occur, from the effects of tropical storms and hurricanes. It is assumed that some of the data lost have been significant and/or unique, resulting in a moderate to major level of impact.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for prehistoric archaeological sites, as they are associated with drowned river valleys, which are known to have a high probability for prehistoric sites. It is assumed that some of the archaeological data that have been lost as a result of dredging have been significant and unique; therefore, the impact to prehistoric archaeological sites as a result of past channel dredging activities has probably been moderate to major. In many areas, the USACE now requires remote-sensing surveys prior to dredging activities to minimize such impacts (Espey, Huston & Associates 1990).

An accidental oil spill could affect coastal prehistoric archaeological sites, but the direct impact of oil on most sites is uncertain. Protection of such sites during an oil spill event requires specific knowledge of its location, condition, nature, and extent prior to impact; however, the GOM coastline has not been systematically surveyed for archaeological sites. Existing information indicates that, in coastal areas of the GOM, prehistoric sites occur frequently along the barrier islands and mainland coast and along the margins of bays and bayous. Thus, any spill that contacts land would involve potential impacts on prehistoric sites.

Heavy oiling of a coastal area could conceal intertidal sites that may not be recognized until they are inadvertently damaged during cleanup (Whitney 1994). Crude oil may also contaminate organic material used in ^{14}C dating, and, although there are methods for cleaning contaminated ^{14}C samples, greater expense is incurred (Dekin et al. 1993). The major source of potential impacts from oil spills is the harm that could result from unmonitored shoreline cleanup activities. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. Damage or loss of significant archaeological information could result from the contact between an oil spill and a prehistoric archaeological site; therefore, cumulatively the level of impacts from oil spills (past, present, and future) to prehistoric archaeological sites ranges from moderate to high.

Historic Resources. Direct physical contact between a routine activity and a shipwreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the time period from which the ship dates.

Since 1973 when the ESP was initiated, the USDOI has required archaeological (historical) surveys be conducted prior to development of mineral leases determined to have potential for historic-period shipwrecks. The high-probability areas for the occurrence of historic-period shipwrecks in the GOM consist of nearshore areas, port vicinities, and ship-specific polygons. Based on experience from the last 10 years (as reported by Church and Warren [2008]; Ford et al. [2008]; Atauz et al. [2006]), archaeological surveys are now also being requested for the APE that includes any potential bottom-disturbing activities in deepwater areas that could be affected by a project. Although an archaeological survey would identify most of the cultural resources in the area of potential effect (APE) for the project and routine operations related to OCS program activities would avoid all known cultural resources, it is likely that impacts on historic-period shipwrecks may have already occurred as a result of OCS program and non-program activities that took place before implementation of the archaeological survey requirement in 1973.

Onshore development could result in direct physical contact between the construction of new onshore facilities or pipeline trenches and previously unidentified historic sites. Federal and State laws and regulations initiated in the 1960s began requiring archaeological surveys prior to permitting any activity that might disturb a significant archaeological site. Therefore, it can be assumed that, since the introduction of the archaeological resource protection laws, most coastal archaeological sites have been located, evaluated, and mitigated prior to construction. However, impacts to coastal historic sites may have already occurred as a result of various onshore construction activities prior to enactment of the archaeological resource protection laws.

Trawling activities in the GOM only affect the uppermost portion of the sediment column (Garrison et al. 1989). On many wrecks, this zone would already have been disturbed by natural factors and would contain only artifacts of low specific gravity (e.g., ceramics and glass) which have lost all original contexts. Therefore, the effect of future trawling on most historic shipwreck sites would be minor.

Sport diving and commercial treasure hunting are significant factors in the loss of historic data from shipwreck sites. While commercial treasure hunters generally affect wrecks having intrinsic monetary value, sport divers may collect souvenirs from all types of shipwrecks. It is assumed that some of the data lost have been significant and/or unique. The known extent of these activities suggests that they have resulted in a major impact to historic-period shipwrecks.

Tropical storms and hurricanes are yearly occurrences in the GOM and may be increasing as a result of global climate change (Section 3.3.1). Past storms have affected all areas of the GOM, from west Texas to south Florida, and broad areas are affected by each storm (DeWald 1980). Shipwrecks in shallow waters and coastal historic sites are exposed to greatly intensified longshore currents and high-energy waves during tropical storms (Clausen and Arnold 1975). Under such conditions, it is highly likely that artifacts of low specific gravity would be dispersed. Some of the original information contained in the site would be lost in this process, but a significant amount of information may also remain. BOEM-sponsored studies conducted specifically to examine the effect of hurricanes on shipwrecks in the GOM found that storm effects on wrecks varied, with some wrecks being damaged, some unaffected, and others protected because the storm caused sediment to be deposited on the wreck (Gearhart et al. 2011).

Overall, a significant loss of data from historic sites has probably occurred, and will continue to occur, from the effects of tropical storms and hurricanes. It is assumed that some of the data lost has been significant and/or unique, resulting in a moderate to major level of impact.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for historic shipwrecks, and the greatest concentrations of historic wrecks are likely to be associated with these features (Garrison et al. 1989). Assuming that some of the data lost have been unique, the impact to historic sites as a result of past channel dredging activities has probably been moderate to major. In many areas, the USACE requires remote-sensing surveys prior to dredging activities, to minimize such impacts (Espey, Huston & Associates 1990).

Past, present, and future oil and gas exploration and development on the OCS will result in the deposition of tons of ferromagnetic debris on the seafloor. This modern marine debris tends to mask the magnetic signatures of historic shipwrecks, particularly in areas that were developed prior to requiring archaeological surveys. Such masking of the signatures characteristic of historic shipwrecks increases the potential that significant or unique historic information may be lost. However, BOEM requires avoidance or investigation of any unidentified magnetic anomaly that could be related to a shipwreck site prior to permitting bottom-disturbing activities. The impacts to historic shipwrecks from magnetic masking could range from minor to moderate.

An accidental oil spill could affect a coastal historic site, but the direct impact of oil on most historic sites is uncertain. The primary source of potential impacts from oil spills is unmonitored shoreline cleanup activities (Bittner 1996; see Section 4.4.15.1.2). Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. Damage or loss of significant historic information could result from oil spill cleanup activities; therefore, the cumulative impact from oil spills (past, present, and future) on historic sites could range from moderate to major.

Conclusion. The cumulative impacts of ongoing and future OCS and non-OCS program activities on prehistoric and historic archaeological sites in the GOM are currently unknown, but could range from minor to moderate, mainly because activities occurring on the OCS prior to the USDOI's survey requirement (in effect since 1973) may already have affected significant archaeological sites. Other important impact-producing factors that likely have had, and will continue to have, an impact on both prehistoric and historic archaeological sites are channel dredging, tropical storms, and hurricanes. Commercial treasure hunting and sport diving may also result in a loss of artifacts at historic-period shipwreck sites. The incremental contribution of routine operations under the Program is expected to be negligible to large, depending on whether significant resources are located in the area of effect. Archaeological surveys that would identify significant cultural resources to be avoided could reduce these impacts (see Section 4.4.15.1).

Cumulative impacts on prehistoric and historic archaeological sites due to expected accidental oil spills and related cleanup activities could range from negligible to major, depending on the location of the spill in relation to sensitive resources. The incremental contribution of oil spills associated with the Program could be small to large relative to those associated with ongoing and future OCS and non-OCS program activities. Impacts associated with an unexpected, low-probability CDE would also depend on location, and could range from minor to major if it were to occur. There is a greater likelihood that more of the resources would be affected at a major level during a CDE. A more detailed discussion of the effects of oil spills on archaeological and historic resources in the GOM is presented in Section 4.4.15.1.

4.6.5.2 Alaska – Cook Inlet

4.6.5.2.1 Areas of Special Concern. Section 4.4.8.2 identifies potential impacts that could result from routine activities or accidents related to the proposed leasing program on Areas of Special Concern adjacent to and in the Cook Inlet Planning Area. In considering the potential cumulative effects of OCS activities on these areas, the level of routine activities and the potential for accidental spills under the Program must be considered with other past, present, and reasonably foreseeable future actions that would occur during the 40-year life of the proposed program. Overall cumulative impacts on these Areas of Special Concern in Cook Inlet consider impacts from both OCS and non-OCS activities.

National Park Service Lands. As identified in Section 4.4.8.2, NPS lands are potentially susceptible to cumulative impacts from activities related to OCS oil and gas development as a consequence of the proposed 5-year leasing program in Cook Inlet. The potentially affected lands include the Lake Clark National Park and Preserve and the Katmai National Park and Preserve and Aniachak National Monument. Kenai Fjords National Park is east of Cook Inlet on the GOA, but it could be affected by an oil spill associated with OCS activities in Cook Inlet.

Impacts from routine OCS operations could come from facilities developed to support oil drilling and production, and could include effects from pipeline landfalls, dredging, air pollution, and the construction of roads and new facilities. Onshore oil facilities are permissible only on private acreage within each National Park. All of these National Parks, Monuments, and Preserves contain privately held acreage, and development of onshore oil support facilities is possible in these areas. Because of the more confined nature of Cook Inlet, OCS construction of facilities within the Cook Inlet Planning Area could have some negative effects on scenic values for some users if the facilities were visible from shore or air during flightseeing. It is assumed that pipeline landfalls, shore bases, and waste facilities would not be located in National Parks, because of the special status and protections afforded these areas.

Increased traffic (i.e., land, sea, and air) and development within the vicinity of NPS lands could also contribute to cumulative impacts on these areas. Because the amount of traffic is restricted and activities within the parks regulated, traffic would likely create a minor addition to cumulative impacts on the NPS lands. It is anticipated that noise generated by OCS offshore construction activities would be at low levels and intermittent, and would not persist for more than a few months at any one time. It is considered unlikely that these additional activities would noticeably affect wildlife or park user values compared to current (non-OCS) activities within the considered planning areas. Increased traffic may also affect air quality (see Section 4.4.4.2 and Section 4.6.2.1.2). Air quality in Alaska is expected to remain good, with pollutant concentrations associated with offshore and onshore emission sources well within applicable State and Federal standards. The contribution of OCS program activities to cumulative air quality impacts would be small. Air quality impacts from oil spills and fires would be localized and short in duration.

Impacts on these areas could occur due to accidental releases of oil spilled from onshore facilities and offshore drilling rigs (Table 4.6.1-3). Non-OCS activities, such as oil and gas development in State waters, the domestic transportation of oil or refined petroleum products including LNG from Cook Inlet and the Alaska Peninsula, the production and storage of petroleum products and LNG, and commercial shipping, could also result in accidental spills that could affect park lands. In addition to affecting the National Parks mentioned above, oil spills from tankering to and from Valdez could also affect Kenai Fjords NP and Wrangell St Elias NPP. Naturally occurring seeps may also be a source of crude oil introduced into nearshore waters (Kvenvolden and Cooper 2003). An oil spill would have the greatest effect if it came into contact with shoreline habitats. Impacts would depend primarily on the spill location, size, and time of year. In general, directly affected coastal fauna could include invertebrates; marine mammals; fishes that reproduce in, inhabit, or migrate through coastal areas; terrestrial mammals that feed on these fishes; and marsh birds and seabirds. Spilled oil could also affect subsistence harvests in those parks in which subsistence hunting and fishing are allowed (see Section 4.6.5.2) and could affect the number of park visitors.

National Wildlife Refuges. NWRs in the vicinity of Cook Inlet are identified in Section 3.9.2.2. NWRs potentially affected by OCS activities in the Cook Inlet Planning Area include the Alaska Peninsula NWR, Becharof NWR, Kodiak NWR, Kenai NWR, and Izembek NWR. These refuges could be contaminated by oil spilled from offshore projects or could be subject to negative effects from routine operations associated with the development of onshore oil and gas support facilities. They could also be affected by non-OCS activities within or adjacent to refuges, including oil and gas development in State waters, the domestic transportation of oil or refined petroleum products including LNG from Cook Inlet and the Alaska Peninsula, the production and storage of petroleum products and LNG, and commercial shipping. Numerous refuge lands have been conveyed to private owners and Native corporations. Section 22(g) of ANCSA requires that new development on these lands must be in accordance with the purpose for which the refuge was formed. Thus, while development of onshore oil and gas support facilities is technically possible, such development would be subject to intensive review (as would any other development).

The potential cumulative effects of routine operations and accidental events on these NWRs are essentially the same as those discussed above for the NPS lands. In addition, subsistence hunting and fishing are permitted on all refuges in Alaska and could, therefore, be affected by accidents and routine operations in the immediate vicinity of refuge properties.

National Forests. The only National Forest within the vicinity of the Cook Inlet Planning Area is the Chugach National Forest, which is located mainly on the eastern side of the Kenai Peninsula (Figure 3.9.2-1). Because there would be no OCS-related development, such as pipelines or other onshore facilities, within the Chugach National Forest, it would not be affected by routine OCS activities associated with lease sales in the Cook Inlet Planning Area. Because of the forest location, oil spills from OCS platforms or pipelines within the Cook Inlet Planning Area would not be expected to affect shoreline areas or other resources within Chugach National Forest.

The Chugach National Forest is adjacent to the Gulf of Alaska. It also borders Prince William Sound and is close to Valdez. The Chugach National Forest is, therefore, potentially susceptible to cumulative effects of routine oil-related operations from transport and tanker loading of oil produced (OCS and non-OCS) in other regions (e.g., the Beaufort Sea Planning Area) and transported by pipeline to the Port of Valdez. Potential effects include increased noise and air pollution from tanker traffic.

Additional, non-OCS-related cumulative impacts in the National Forest could result from mining operations (e.g., for gold or gravel/stone), hunting, flightseeing, ski resorts, trains, and tourism. However, the impacts of these activities are regulated through a permitting process following an approved resource use plan.

The Chugach National Forest would be potentially susceptible to oil (mostly non-OCS) spilled from tankers that utilize the loading facilities at the Port of Valdez. Oil spills that reached the coastline could affect coastal fauna; subsistence, recreational, and commercial fishing; and tourism. Impacts would depend on the size and timing of a spill and would be expected to be minor to moderate.

Other Areas of Special Concern. There are multiple State parks and State recreation areas near the Cook Inlet Planning Area, many of which border Cook Inlet or are located in areas that could be contacted by accidental oil spills. Such areas include Captain Cook State Recreation Area, Clam Gulch State Recreation Area, Chugach State Park, Kachemak Bay State Park and State Wilderness Park, and Ninilchik State Recreation Area. In addition, the Kachemak Bay National Estuarine Research Reserve is located in Cook Inlet on the southern end of the Kenai Peninsula. Cumulative impacts from offshore activities would be similar to those described above for National Parks and Refuges. Existing protections and restrictions on uses should limit the direct terrestrial cumulative impacts from OCS and non OCS activities on these areas. There is existing oil and gas infrastructure in State waters of Cook Inlet and the addition of OCS infrastructure and activities could have negative effects on scenic values for some users if the facilities were visible from shore or the air during flightseeing. It is assumed that pipeline landfalls, shore bases, and waste facilities would not be located in the State parks and recreation areas. Increased traffic (i.e., land, sea, and air) and development within the vicinity of State parks lands could also contribute to cumulative impacts on these areas. It is anticipated that noise generated by OCS offshore construction activities would be at low levels, intermittent, and would not persist for more than a few months at any one time. It is considered unlikely that these additional activities would noticeably affect wildlife or park user values compared to current (non-OCS) activities within the considered planning areas.

As described above, impacts on State parks and recreational areas could occur due to accidental releases of oil spilled from onshore facilities and offshore drilling rigs. An oil spill contacting shoreline habitats could affect subsistence harvests in those parks in which recreation and subsistence hunting and fishing are allowed and could affect the number of park visitors. Impacts would depend primarily on the spill location, size, and time of year.

Conclusion. Cumulative impacts on Areas of Special Concern in Cook Inlet are considered to be negligible to moderate. Routine operations under the Program could result in negligible to medium incremental increases in effects on National Sanctuaries, Parks, Refuges, and Estuarine Research Reserves (see Section 4.4.8.2). Development of onshore facilities within NPS lands in the vicinity of the areas included in the Program is considered unlikely, thereby making impacts from routine Program activities unlikely in these areas. Offshore construction of pipelines and platforms could contribute to cumulative effects on wildlife and on scenic values for park visitors due to noise and activity levels, particularly in the vicinity of Cook Inlet. However, such effects would be localized, intermittent, and temporary.

Expected oil spills (most of which are less than 1,000 bbl) that occur during the Program could result in a negligible to small incremental contribution to cumulative impacts on Areas of Special Concern, depending on spill frequency, location, and volume; the type of product spilled; weather conditions; effectiveness of cleanup operations; and other environmental conditions at the time of the spill. Large spills (1,000 bbl and greater) or an unexpected, low-probability CDE in areas adjacent to the National Parks, NWRs, or National Forests, whether from OCS or non-OCS sources, would also depend on these factors, and could result in moderate impacts if they were to occur. Such spills could negatively impact coastal habitats and fauna, and could also affect subsistence uses, commercial or recreational fisheries, and tourism.

4.6.5.2.2 Population, Employment, and Income. Section 4.4.9 discusses the potential impacts from the Program on population, employment, and income in the south-central Alaska region. Cumulative impacts on these resources result from the incremental impacts of the Program when added to impacts from reasonably foreseeable future OCS program activities (there are no ongoing OCS program activities) and ongoing and future non-OCS program activities. Specific types of impact-producing factors related to OCS program activities considered in this analysis include total employment and regional income for the south Alaska region, which corresponds to the Cook Inlet Planning Area (described in Section 3.10). Non-OCS program activities affecting the region include employment and earnings related to various other industrial sectors (e.g., construction, manufacturing, services, and State and local government).

The population in the Cook Inlet Planning Area increased at an average annual rate of 3.2% between 1980 and 1990, 1.3% between 1990 and 2000, and 1.2% between 2000 and 2009. During each of these periods, the greatest increases consistently occurred on the Kenai Peninsula (with an average annual increase of 1.1% between 2000 and 2009) and in Anchorage (also with an average annual increase of 1.1% between 2000 and 2009). The components of population increase include the natural increase due to births and net positive domestic and international migration; these trends would likely continue in south central Alaska over the next 40 to 50 years.

Although the Program would add an average of 1,372 to 3,792 direct and indirect jobs annually in Alaska between 2012 and 2017, this increase is considered minor (but positive) since it would amount to less than 2% of total Alaska employment. Likewise, direct and indirect income produced in the region would range from $87 million to $256 million annually in south central Alaska, which constitutes less than 2% of income in Alaska overall.

Employment impacts of oil spills reaching landfall can vary considerably depending upon the total volume of oil reaching land, the land area affected, and the sensitivity of local environmental conditions to oil impacts. The primary impacts of oil spills would most likely fall on such activities as beach recreation, commercial fishing, recreational fishing, and sightseeing. Oil spills reaching land can have both short- and long-term effects on these recreational coastal activities. Past studies (Sorenson 1990) have shown that there could be a one-time seasonal decline in tourist visits of 5% to 15% associated with a major oil spill. Since tourist movement to other coastal areas in the region often offsets a reduction in the number of visits to one area, the associated loss of business tends to be localized. Although an oil spill could occur anywhere in the lease sale area, cleanup-related employment would likely occur in the area directly affected, generally in locations remote from communities. Oil spills will generate only temporary employment (and population) increases during cleanup operations, because such operations are expected to be of short duration.

Conclusion. The cumulative impacts of future OCS program and ongoing and future non-OCS program activities would be considered beneficial because these activities would increase employment and earnings in the region over the next 40 to 50 years. The Program would add to these beneficial impacts, especially on the Kenai Peninsula and in Anchorage. The incremental contribution of the Program is expected to be small, however, because the added employment demands are less than 2% of total Alaska employment (see Section 4.4.9.2).

In areas with a large proportion of impact-sensitive industry (such as commercial and recreational fishing), the cumulative impacts of accidental oils spills could be moderate to major, depending on the total volume of oil reaching land, the land area affected, and the sensitivity of local environmental conditions to oil impacts. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be negligible to small relative to those associated with future OCS program and ongoing and future non-OCS program activities. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in minor to moderate impacts. In the short term, impacts of a CDE could be large as a result of loss of employment, income, and property value; increased traffic congestion; increased cost of service provision; and possible shortages of commodities or services. Longer-term impacts could be smaller unless the fishing and tourism suffered as a result of real or perceived impacts of the event (see Section 4.4.9.1).

4.6.5.2.3 Land Use and Infrastructure. Localized impacts to land use and existing infrastructure are anticipated as a result of the construction of new OCS program oil and gas facilities in Cook Inlet over the next 40 to 50 years. Impact-producing factors from OCS program activities would include increased aircraft traffic (e.g., helicopter trips); modifications to current land use designations to incorporate new facilities, if they are needed; and some infrastructure expansion. Ongoing non-OCS program activities affecting land use and onshore infrastructure are expected to continue into the foreseeable future. These include offshore construction, onshore construction, and marine vessel traffic. Where land is largely undeveloped and no established oil and gas infrastructure is present, development could result in land use impacts, such as the conversion of existing land use (e.g., undeveloped, residential, or commercial) to industrial land use to accommodate oil and gas production (MMS 2007e).

Accidental oil releases may occur as a result of both OCS and non-OCS activities, and oil is also released from naturally occurring seeps. The extent of the impacts would depend on the location and size of the releases, but could include stresses of spill response on the community infrastructure, increased traffic to respond to cleanup, and restricted access to particular lands while cleanup is conducted. In general, these releases would be expected to have a temporary impact on land use and infrastructure (MMS 2007c).

Conclusion. Localized impacts to land use and existing infrastructure are anticipated over the next 40 to 50 years as a result of future OCS and ongoing and future non-OCS program activities in Cook Inlet. These impacts could range from minor to major depending on the location and nature (extent and duration) of the land use change. The incremental contribution of routine operations under the Program to cumulative impacts in Cook Inlet would be negligible to small because the Program would not introduce new kinds of activities that would alter existing land uses (see Section 4.4.10.2).

Land use–related impacts resulting from expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program include stresses of spill response on community infrastructure, increased traffic in the response area (both onshore and offshore), and temporary restricted access to affected lands (while cleanup is conducted). Such spills would result in a small incremental contribution to cumulative impacts on land use and existing infrastructure. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in moderate impacts if they were to occur.

4.6.5.2.4 Commercial Fisheries and Recreational Fisheries. Some OCS exploration, development, and production activities have the potential to result in space-use conflicts with fishing activities over the next 40 to 50 years. In some cases, fishing vessels could be excluded from normal fishing grounds for safety reasons during construction periods or after facilities are in place. In other instances, fishery crews or anglers could decide to avoid certain areas to reduce the potential for gear loss. Such conflicts can sometimes be avoided by conducting construction activities or seismic surveys during closed fishing periods or seasons. A potential also exists for loss of gear or loss of access to fishing areas when floating drill rigs used for exploration are being moved and during other vessel operations.

Offshore construction of platforms or artificial islands could infringe on commercial fishing activities by excluding commercial fishing from adjacent areas due to safety considerations. Drilling discharges associated with exploration activities would likely affect only a small area near drilling platforms or islands, and are not expected to interfere with commercial fishing. During development and production phases, potential effects of such discharges would cease because all muds, cuttings, and produced waters would be discharged into wells instead of being released to open waters. Potential effects of platform construction and operation are expected to be highly localized. Because only a very small area of the individual planning areas would be affected, interference with commercial fisheries is expected to be small.

The impacts of oil and gas development on commercial fishing costs would vary considerably by placement depth. In the Kodiak area, the largest cost increases would occur with structures located in water between 300 and 1,500 m (984 and 4,921 ft) deep, with an annual increase of $43 in costs from a single structure; a single structure in each depth range would increase annual costs by $44. In the Cook Inlet area, the largest increase would come with a single structure placed in water between 150 and 300 m (492 and 984 ft), with an overall increase in costs of $57 per year. Cost impacts in the Gulf of Alaska area would be the largest, at $93 per year with a structure in each depth range, the largest cost increases occurring with a structure placed at between 300 to 1,500 m (984 and 4,921 ft). In each of the areas, single structures would have relatively insignificant impacts compared to fishery revenues in each depth range.

Various non-OCS activities, including State oil and gas programs, dredging and dredge-disposal operations, logging operations, and commercial or sport fishing activities, could also contribute to cumulative impacts on fisheries. Drilling of wells under State oil and gas programs would also require construction of pipelines and artificial islands or platforms in Alaskan waters. Potential effects on fishery resources and on space-use conflicts from State oil and gas activities would be similar to those described above for OCS program oil and gas activities. Dredging and marine disposal activities would involve excavation of nearshore sediments and subsequent disposal in offshore or nearshore areas, thereby disturbing seafloor habitats in some areas and burying benthic organisms that help to support fishery resources. Logging operations have a potential to contribute to cumulative effects on fishery resources by degrading riverine habitats that are important for salmon reproduction and the rearing of juveniles.

Non-OCS activities, such as State oil and gas development, domestic transportation of oil or refined petroleum products, and commercial shipping (and other marine vessel traffic), may also result in accidental spills that could affect fisheries within the waters of the south central Alaska region. Fisheries resources could become exposed to oil as a consequence of accidental oil spills, which could cause declines in subpopulations of some species inhabiting the affected planning areas. It is anticipated that there would be no long-term effects on overall fish populations in Alaskan waters as a result of such spills. However, even localized decreases in stocks of fish could have effects on some fisheries by reducing catches or increasing the amount of effort or the distances that must be traveled to obtain adequate catches.

Even if fish stocks are not reduced as a consequence of a spill, specific fisheries could be closed due to actual or perceived contamination of fish or shellfish. It is anticipated that most small to medium spills would have limited effects on fisheries because of the relatively small areas likely to be exposed to high concentrations of hydrocarbons and the short period of time during which oil slicks would persist. In the event of a large spill, commercial, recreational, or subsistence fisheries for shellfish in nearshore subtidal and intertidal areas that become oiled are likely to be affected. Fisheries for shellfish that occur in deeper waters, where oil concentrations would likely be too low to cause direct effects on biota, are less likely to be affected. Regardless, even shellfish from deeper areas could become commercially unacceptable for market due to actual or perceived contamination and tainting.

Oil spills that enter nearshore waters could also damage setnet fisheries, as evidenced by the *Exxon Valdez* oil spill of 1989. While only a relatively small volume of weathered oil entered the lower Cook Inlet region as a result of that spill, the commercial salmon fishery was closed to protect both gear and harvest from possible contamination. Within the Cook Inlet Planning Areas, a spill the size of the assumed largest OCS spill could result in temporary closures to commercial and subsistence setnet fishing until cleanup operations or natural processes reduced oil concentrations to levels considered safe.

Although pelagic fishes likely would be less affected than fishes in shallow subtidal or intertidal areas, spilled oil could contaminate gear used for pelagic fishing, such as purse seines and drift nets. A large oil spill before or during the season when such fishing gears are in use could result in closures of some short-period, high-value commercial fisheries in order to protect gear or harvests from potential contamination. Lines from longline fisheries for halibut, Pacific cod, black cod, and other fish species in the Cook Inlet Planning Area could also be affected by oil. Some lines and buoys fouled with small amounts of oil could be unfit for future use. Although it is unlikely that a trawler would be operating in an oiled area, the trawl catches could be contaminated by oil and rendered unfit for consumption and unprofitable if passed through such an area.

Conclusion. Cumulative impacts on commercial and recreational fisheries in Cook Inlet as a result of ongoing and future OCS and non-OCS activities and natural phenomena are expected to be minor over the next 40 to 50 years. Non-OCS activities affecting fisheries in the inlet include State oil and gas programs, dredging and dredge-disposal operations, logging operations, and commercial or sport fishing activities. The incremental contribution of routine Program activities to these impacts would be small. Routine operations under the Program would be unlikely to have population-level effects on fishery resources or result in long-term loss of fishery resources (see Section 4.4.11.2).

Commercial and recreational fisheries may be adversely affected by accidental oil releases from OCS and non-OCS activities (e.g., State oil and gas development, domestic transportation of oil or refined petroleum products, and commercial shipping). The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be negligible to medium, depending on the location, timing, and volumes of spills (among other environmental factors). Small spills are unlikely to affect a large number of fish or have a substantial effect on recreational fishing before dilution and weathering reduced concentrations of oil in the water. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be moderate if they were to occur. Large spills or a CDE could have significant localized effects on commercial fishing as a result of reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods, and on recreational fishing as a consequence of contamination of fish tissues, degradation of aesthetic values that attract fishers, or temporary closure of fishing areas. Large spills or a CDE have a greater potential to contact intertidal habitat and subsequently contaminate or reduce the abundance of commercial and recreational species that depend on nearshore habitat. These impacts could be long-term, but are not expected to result in the long-term loss of fisheries in Cook Inlet.

4.6.5.2.5 Tourism and Recreation. Platform, pipeline, causeway, and facility construction and vessel traffic could interfere with water-based recreational activities (fishing, boating, sightseeing, cruise ships) and could result in some disruption to land-based activities (hiking, picnicking, hunting, visiting Native communities, camping, wildlife viewing, and sightseeing), depending on the location of recreational activities relative to proposed development; increases in amounts of trash and debris from OCS activities; and possible competition between workers and tourists for local services, such as air transport, hotel accommodations, and other visitor services. Non-OCS activities that could have an impact on tourism and recreation include offshore construction (e.g., State oil and gas development, domestic transportation of oil and gas), onshore construction (e.g., coastal and community development), and marine vessel traffic (e.g., commercial shipping, recreational boating, military training and testing).

Non-OCS activities and proposed and future OCS activities represent a continuation of existing onshore and offshore oil and gas construction trends close to the Cook Inlet Planning Area. Substantial infrastructure for related oil and gas development already exists in this area (especially in the upper inlet), including platforms, exploration and production wells, pipelines to transport oil from offshore platforms to common-carrier pipeline systems onshore, and processing facilities. Therefore, there should not be additional visual disruption for the tourists in these areas. Pipeline construction would present a temporary disruption to tourism and recreation due to workers competing with tourists for short-term housing (hotels) and air transport; aesthetic impacts (visual and auditory) associated with construction sites; and possible temporary prevention of access to some recreational or wilderness areas. In addition, the new pipeline in the Arctic region could create road access into previously undeveloped lands used primarily for subsistence, creating a potential conflict between subsistence practices and recreational hunting or other possible tourist activities.

Oil spills associated with OCS and non-OCS activities, as well as oil from naturally occurring seeps, could also affect recreation and tourism, and could result in both short-term and long-term effects, depending on public perception and reaction. Potential cumulative impacts include direct land impacts (e.g., oil contamination of a national wildlife refuge or recreational port); aesthetic impacts of the spill and associated cleanup; increased traffic to respond to cleanup operations; and restricted access to particular lands while cleanup is being conducted.

Conclusion. Cumulative impacts on tourism and recreation in Cook Inlet as a result of ongoing and future OCS and non-OCS activities and natural phenomena would be minor over the next 40 to 50 years. Non-OCS activities or phenomena affecting these resources include offshore construction (e.g., State oil and gas development, domestic transportation of oil and gas), onshore construction (e.g., coastal and community development), and marine vessel traffic. The incremental contribution of routine operations under the Program to these impacts would be small, with potential adverse aesthetic impacts on sightseeing, boating, fishing, and hiking activities in the inlet (see Section 4.4.12.1).

Tourism and recreation may be adversely affected by accidental oil releases from OCS and non-OCS activities (e.g., State oil and gas development, domestic transportation of oil or refined petroleum products, and commercial shipping). The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program would be negligible to small, depending on the size, location, and timing of the spill (being greatest if it occurred during the peak recreational season). Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be minor to moderate if they were to occur. Short-term impacts would include beach and coastal access restrictions; restrictions on visitation, fishing, or hunting while cleanup is being conducted; and aesthetic impacts associated with the event itself and with cleanup activities. Longer-term impacts could be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event.

4.6.5.2.6 Sociocultural Systems. The area surrounding the Cook Inlet Planning Area is demographically diverse and includes relatively remote Native villages that rely on subsistence harvesting, towns that rely on commercial fishing, and ethnically diverse cities (Section 3.14.1.2). Future non-OCS activities affecting sociocultural systems include oil and gas development on State submerged lands, changes in commercial fishing patterns and maritime shipping, and limited industrialization; these activities are expected to continue in the foreseeable future.

The Cook Inlet Planning Area is already the location of offshore oil and gas development (in State waters). Supporting infrastructure and a trained workforce are already available in relative proximity. As part of this industrial mix, development of the OCS is likely to have minor cumulative impacts relative to development in the region. No new shore bases are planned and only one new pipeline is projected under the Program (Table 4.6.1-3).

Oil spills can cause damage to resources important to subsistence harvesters, affect fish populations important to commercial fishers, and have sociological impacts in affected communities. Most spills projected to result from exploration and development of the OCS would be a relatively minor component of the existing mix of impacts from oil and gas development and commercial shipping. However, as the *Exxon Valdez* event has shown, coastal communities are susceptible to sociocultural disruption as the result of large-scale spills that disrupt commercial fishing and subsistence harvesting.

OCS program development could temporarily displace fish and sea mammal populations harvested by subsistence hunters and fishers. Helicopter flights associated with development could disturb nesting and roosting sites of birds that are harvested, and temporarily and locally disturb terrestrial game animals.

Conclusion. Cumulative impacts on sociocultural systems in Cook Inlet as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be minor to moderate over the next 40 to 50 years. Important impacting factors include the displacement of fish and sea mammal populations and the disturbance of nesting and roosting sites and terrestrial game animals (e.g., by noise). Non-OCS activities or phenomena affecting these resources include oil and gas development in State waters, changes in commercial fishing patterns and maritime shipping, air traffic, and limited industrialization. The incremental contribution of routine Program activities to these impacts would be small, since they would not introduce new kinds of activities that would alter existing socioeconomic systems. In addition, the relatively small number of new residents that would come into the area because of the Program should likewise not alter existing sociocultural systems (see Section 4.4.13.2).

Sociocultural systems may be adversely affected by accidental oil releases from OCS and non-OCS activities. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be small to large, especially in intertidal and estuarine zones used by subsistence harvesters. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be major if they were to occur, especially if resources important to subsistence harvesters, including intertidal resources, migrating fishes, and fishes with strong ties to the shore, were affected.

4.6.5.2.7 Environmental Justice. Although no new pipe yards, pipeline landfalls, or gas processing facilities would be built as a result of the proposed 5-year OCS program, additional offshore construction could include increased noise and traffic, air and water pollution, impacts to residential property values, and land use changes. Much of the Alaska Native population resides in the coastal areas of Alaska. New offshore infrastructure resulting from this program could be located near areas where subsistence hunting occurs. The OCS program would result in levels of infrastructure use and construction similar to what is occurring in south central Alaska. These activities are not expected to expose residents to notably higher risks than currently occur.

Any adverse environmental impacts to fish and mammal subsistence resources from installation of infrastructure and routine operations of these facilities could have disproportionately higher health or environmental impacts to Alaska Native populations. OCS activities could potentially disrupt marine mammal harvests (primarily walrus, seals, and beluga whales) by diverting marine migrations or by causing other behavioral changes such as increased wariness.

Air emissions from onshore facilities and helicopter and vessel traffic traversing coastal areas will be highest in areas containing the greatest amounts of infrastructure. It is assumed that the majority of the activity from the Program would occur in deep waters, with offshore air emissions greatest in the coastal areas with the greatest amounts of oil and gas activity, with lesser amounts occurring elsewhere. The effects of the OCS program on air quality have been analyzed in Section 4.4.4.2. This analysis concluded that routine operations associated with the proposed 5-year program would result in NO_2, SO_2, PM_{10}, and CO levels that are well within the NAAQS. Disproportionate impacts on low-income or minority populations of the inlet would be minor, because coastal effects from offshore activities are expected to be small, based on the established and increasing trend toward movement of oil and gas activities into deeper waters of the inlet.

Oil spill events in the region and related cleanup activities pose the greatest potential for cumulative effects on low-income and minority population groups. It is reasonable to expect that most of these spills will occur in deepwater areas located away from the coast, based on the established trend for oil and gas activity to move into deep waters located for the most part at a substantial distance from the coast. The magnitude of impacts from such spills cannot be predicted, should they contact the coast, and depends on their location, size, and timing. While the location of possible oil spills cannot be determined and while low-income and minority populations are resident in some areas of the coast, in general, the coasts are home to more affluent groups. Low-income and minority groups are not more likely to bear more negative impacts than are other groups.

Conclusion. In the Cook Inlet Planning Area, future OCS program and ongoing and future non-OCS program activities in combination with the effects of onshore and offshore construction, increased marine vessel and helicopter traffic, and land use changes would result in disproportional moderate to major adverse cumulative impacts on low-income and minority populations (especially those dependent on subsistence harvesting and fishing). The incremental contribution of routine operations under the Program to these impacts would be small (see Section 4.4.14.2).

The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be negligible to small. Large spills (1,000 bbl or greater) and unexpected CDEs could result in moderate to major impacts on the Alaska Native population, especially if subsistence resources were diminished or tainted as a result of the spill. Mitigation measures, cooperative agreements between Native and industry groups, and government-to-government consultations are designed to limit the effects from oil spills and routine operations.

4.6.5.2.8 Archeological and Historic Resources. Section 4.4.15.2 discusses the indirect and direct impacts from the Program (OCS program activities from 2012 to 2017) on archeological and historic resources in the Cook Inlet Planning Area. Cumulative impacts on archeological and historic resources result from the incremental impacts of the Program when added to impacts from existing and reasonably foreseeable future OCS program activities (that are not part of the Program) and other non-OCS program activities. Table 4.6.1-3 presents the exploration and development scenario for the Cook Inlet cumulative case (encompassing the Program and future OCS program activities). Specific types of impact-producing factors related to OCS program activities considered in this analysis include drilling rig and platform emplacement, pipeline emplacement, new onshore facilities, and oil spills. Non OCS-program activities (e.g., oil and gas industry in State waters) and natural geologic processes such as ice gouging and erosion due to high-energy waves/currents and thermokarst collapse are also considered.

Archeological Resources. Offshore development could result in an interaction between a drilling rig, platform, pipeline, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy artifacts or site features and could disturb the stratigraphic context of the site. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts between northeast Asia and the Americas.

Since 1973 when the ESP was initiated, the USDOI has required that an archaeological survey be conducted prior to development of mineral leases determined to have potential for cultural resources, including prehistoric archaeological sites. Relative sea-level data, which are used to define the portion of the continental shelf having potential for prehistoric sites, suggest that the portion of the continental shelf shoreward of about the 60-m (200-ft) isobath would have potential for prehistoric sites. Although an archaeological survey would identify most of the cultural resources in the APE for the project and routine operations related to OCS program activities would avoid all known cultural resources, it is likely that impacts to prehistoric resources have already occurred as a result of non-OCS program activities prior to the implementation of the 1973 archaeological survey requirement.

Onshore development could result in direct physical contact between the construction of new onshore facilities or pipeline trenches and previously unidentified prehistoric sites. This direct physical contact with a prehistoric site could cause physical damage to or complete destruction of information on the prehistory of the region and North America. Federal and State laws and regulations initiated in the 1960s began requiring archaeological surveys prior to permitting any activity that might disturb a significant archaeological site. Therefore, it can be assumed that, since the introduction of the archaeological resource protection laws, most coastal archaeological sites have been located, evaluated, avoided, or mitigated prior to construction. However, impacts to coastal prehistoric resources may have already occurred as a result of various onshore construction activities prior to enactment of the archaeological resource protection laws.

Trawling activity in Cook Inlet only affects the uppermost portion of the sediment column (Krost et al. 1990). This zone would already be disturbed by natural factors relating to the destructive effects wave and current action (Cook Inlet is a high-energy wave environment; see Section 4.2.3.2.2). Therefore, the effect of trawling on most prehistoric archaeological sites would be minor.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for prehistoric archaeological sites, as they are often associated with drowned river valleys, which are known to have a high probability for prehistoric sites. It is assumed that some of the archaeological data that have been lost as a result of dredging have been significant and unique; therefore, the impact to prehistoric archaeological sites as a result of past channel dredging activities has probably been moderate to major. In many areas, the USACE now requires remote-sensing surveys prior to dredging activities to minimize such impacts (Espey, Huston & Associates 1990).

Natural geologic processes such as ice gouging and thermokarst erosion may affect prehistoric archaeological sites associated with Cook Inlet. No specific studies examining the effects of geological processes on archaeological sites have been conducted in Cook Inlet. However, coastal prehistoric sites are exposed to the erosional effects of high-energy waves and thermokarst erosion. These natural processes could cause artifacts to be dispersed and the site context to be disturbed or even completely destroyed, resulting in the loss of archaeological information. Cook Inlet is a high-energy area affected by strong tidal movements. The seafloor of lower Cook Inlet contains characteristics such as lag gravels, sand ribbons, and sand wave fields (MMS 2003a). These features are formed only in areas of high energy. High-energy water movement may have removed the potential for archaeological resources to be present. Additional research is needed to determine the extent of the disturbance. Studies conducted in the Beaufort Sea indicate that seafloor sediments have been affected by ice gouging and by increased river flows resulting from glaciation (Darigo et al. 2007). It is likely that similar processes have operated in Cook Inlet and that they have affected the integrity of archaeological sites. Overall, some loss of data from submerged and coastal prehistoric sites has probably occurred, and will continue to occur, from the effects of natural geologic processes. It is assumed that some of the data lost have been significant and/or unique, resulting in a major level of impact. Additional studies specifically addressing these topics are required.

An accidental oil spill could affect coastal prehistoric archaeological sites, but the direct impact of oil on most sites is uncertain. Protection of such sites during an oil spill requires specific knowledge of their location, condition, nature, and extent prior to impact; however, the Cook Inlet coastline has not been systematically surveyed for archaeological sites.

Heavy oiling of a coastal area could conceal intertidal sites that may not be recognized until they are inadvertently damaged during cleanup (Whitney 1994). Crude oil may also contaminate organic material used in ^{14}C dating, and although there are methods for cleaning contaminated ^{14}C samples, greater expense is incurred (Dekin et al. 1993). The major source of potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup activities. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. Damage or loss of significant archaeological information could result from the contact between an oil spill and a prehistoric archaeological site; therefore, cumulatively the level of impacts from oil spills (past, present, and future) to prehistoric archaeological sites ranges from moderate to high.

Historic Resources. Direct physical contact between a routine activity and a shipwreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the time period from which the ship dates.

Since 1973 when the ESP was initiated, the USDOI has required archaeological (historical) surveys be conducted prior to development of mineral leases when a historic-period shipwreck is reported to lie within or adjacent to the lease area. Although an archeological survey would identify most of the cultural resources in the APE for the project and routine operations related to OCS activities would avoid all known cultural resources, it is likely that impacts on historic-period shipwrecks may have already occurred as a result of non-OCS program activities that took place before implementation of the 1973 archaeological survey requirement.

Onshore development could result in direct physical contact between the construction of new onshore facilities or pipeline trenches and previously unidentified historic sites. Federal and State laws and regulations initiated in the 1960s began requiring archaeological surveys prior to permitting any activity that might disturb a significant archaeological site. Therefore, it can be assumed that, since the introduction of the archaeological resource protection laws, most coastal archaeological sites that would have been impacted have been located, evaluated, avoided, or mitigated prior to construction. However, impacts to coastal historic sites may have resulted from onshore construction activities prior to enactment of the archaeological resource protection laws, but the magnitude of this possible impact is impossible to quantify.

Trawling activity in south central Alaska affects only the uppermost portion of the sediment column (Krost et al. 1990). On many wrecks, this zone would already be disturbed by natural factors and would contain only artifacts of high specific gravity which have lost all original context. Therefore, the effect of trawling on most historic shipwreck sites would be minor.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for historic shipwrecks. Assuming that some of the data lost have been unique, the impact on historic sites as a result of past channel dredging activities has probably been moderate to major. In many areas, the USACE now requires remote-sensing surveys prior to dredging activities to minimize such impacts (Espey, Huston & Associates 1990).

Natural geologic processes such as ice gouging and erosion due to high-energy waves/currents and thermokarst collapse affect historic sites in Cook Inlet. No specific studies addressing this topic have been undertaken. Coastal historic sites are exposed to the erosional effects of wave energy and thermokarst erosion, which can cause artifacts to be dispersed and the site context to be disturbed or even completely destroyed. Cook Inlet is a high-energy area affected by strong tidal movements. The seafloor of lower Cook Inlet contains seafloor characteristics such as lag gravels, sand ribbons, and sand wave fields (MMS 2003a). These features are only formed in areas of high energy. High-energy water movement may have removed the potential for historic resources to be present. Additional research is needed to determine the extent of the disturbance. Overall, a significant loss of data from submerged and coastal historic sites may have already occurred from the effects of natural geologic processes. It is assumed that some of the data lost have been significant and/or unique, resulting in a major level of impact. Additional studies specifically addressing these topics are required.

An accidental oil spill could affect a coastal historic site, but the direct impact of oil on most historic sites is uncertain. The primary source of potential impacts from oil spills is unmonitored shoreline cleanup activities (Bittner 1996; see Section 4.4.14.2.2). Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. Damage or loss of significant historic information could result from oil spill cleanup activities; therefore, the cumulative impact of oil spills (past, present, and future) on historic sites could range from moderate to major.

Conclusion. The cumulative impacts of future OCS program and ongoing and future non-OCS program activities on prehistoric and historic archaeological sites in Cook Inlet are currently unknown, but could range from minor to moderate, mainly because activities occurring on the OCS prior to the USDOI's survey requirement (in effect since 1973) may already have affected significant archaeological sites. Other important impacting factors that have had, and will continue to have, an impact on both prehistoric and historic archaeological sites are channel dredging and geologic processes, such as ice gouging and erosion due to high-energy waves/currents and thermokarst collapse. Commercial treasure hunting and sport diving may also result in a loss of artifacts at historic-period shipwreck sites. The incremental contribution of routine operations under the Program is expected to be negligible to large, depending on the presence of significant resources in the area of potential effect. Archaeological surveys that would identify significant cultural resources to be avoided could reduce these impacts (see Section 4.4.15.2).

Cumulative impacts on prehistoric and historic archaeological sites due to expected accidental oil spills and related cleanup activities could range from negligible to major. The incremental contribution of oil spills associated with the Program could be negligible to large relative to those associated with future OCS program and ongoing and future non-OCS program activities. Impacts associated with an unexpected, low-probability CDE would also depend on location, and could range from minor to major if they were to occur. There is a greater likelihood that more of the resources would be affected at a major level during a CDE. A more detailed discussion of the effects of oil spills on archaeological and historic resources in Cook Inlet is presented in Section 4.4.15.2.

4.6.5.3 Alaska Region – Arctic

4.6.5.3.1 Areas of Special Concern. Cumulative impacts to these Areas of Special Concern include impacts from both OCS and non-OCS activities. Section 4.4.8.3 identifies potential impacts that could result from routine activities or accidents related to the proposed leasing program on Areas of Special Concern adjacent to and in the Beaufort Sea and Chukchi Sea Planning Areas.

National Park Service Lands. In the Arctic, activities associated with the Red Dog Mine and its port facility south of Kivalina on the Chukchi Sea would contribute to cumulative impacts on the Cape Krusenstern National Monument. The road from the mine (located just outside the monument) to the port crosses the northern boundary of the monument. Impacts from this facility, such as habitat loss or disturbance, are expected to be minor due to the limited activity associated with the mine.

There is minor land and air traffic in the Arctic and most visitors would arrive by sea. Because the amount of traffic is restricted and activities within the parks regulated, traffic would likely create a minor addition to cumulative impacts on the NPS lands. It is anticipated that noise generated by OCS offshore construction activities would be at low levels, intermittent, and would not persist for more than a few months at any one time. It is considered unlikely that these additional activities would noticeably affect wildlife or park user values compared to current (non-OCS) activities within the Beaufort and Chukchi Sea Planning Areas.

Impacts on these areas could occur due to accidental releases of oil spilled from onshore facilities and offshore drilling rigs. Non-OCS activities, such as oil and gas development in State waters, the domestic transportation of oil or refined petroleum products, the production and storage of petroleum products, and commercial shipping (tanker traffic) could also result in accidental spills that could affect park lands. Naturally occurring seeps may also be a source of crude oil introduced into nearshore waters (Kvenvolden and Cooper 2003). Noatak National Preserve, Kobuuk River National Preserve, Cape Krusenstern National Monument, and Bering Land Bridge National preserve all have coastlines on or near the Chukchi Sea and could potentially be affected by spills from tanker traffic. Although not an NPS land, the National Petroleum Reserve is managed by BLM and has a large shoreline component that borders the Chukchi Sea. An oil spill would have the greatest effect if it came into contact with shoreline habitats. Impacts would depend primarily on the spill location, size, and time of year. In general, directly affected coastal fauna could include marine mammals; fishes that reproduce in, inhabit, or migrate through coastal areas; terrestrial mammals that feed on these fishes; and marsh birds and seabirds. Spilled oil could also affect subsistence harvests in those parks in which subsistence hunting and fishing are allowed and could affect the number of park visitors.

National Wildlife Refuges. NWRs in the vicinity of the Beaufort Sea and Chukchi Sea Planning Areas are identified in 3.9.3.2 for the Beaufort and Chukchi Seas. NWRs (including three units of the Alaska Maritime NWR) potentially affected by OCS activities include the Arctic National Wildlife Refuge (ANWR) and the Alaska Maritime NWR (Chukchi Sea Unit, Gulf of Alaska Unit, Alaska Peninsula Unit).

Oil drilling and facility development are prohibited in the ANWR and are discretionary on all other refuges; however, refuges could potentially be affected by OCS oil and gas development from adjacent regions under the cumulative case scenario. These refuges could be contaminated by oil spilled from offshore projects, or could be subject to negative effects from routine operations associated with the development of onshore oil and gas support facilities. They could also be affected by non-OCS activities within or adjacent to refuges including State oil and gas development, the domestic transportation of oil or refined petroleum products, the production and storage of petroleum products and LNG, and commercial shipping. Numerous refuge lands have been conveyed to private owners and Native corporations. Section 22(g) of the Arctic Native Claims Settlement Act (1971) requires that new development on these lands must be in accordance with the purpose for which the refuge was formed. Thus, while development of onshore oil and gas support facilities is technically possible, such development would be subject to intensive review (as would any other development).

The potential cumulative effects of routine operations and accidental events on these NWR's are essentially the same as those discussed above for the NPS lands. In addition, subsistence hunting and fishing are permitted on all refuges in Alaska and could, therefore, be affected by accidents and routine operations in the immediate vicinity of refuge properties.

National Forests. There are no National Forests in the Beaufort Sea and Chukchi Sea Planning Areas.

Conclusion. Cumulative impacts on Areas of Special Concern in Arctic waters are considered to be negligible to moderate. Routine operations under the Program could result in negligible to medium incremental increases in effects on National Parks and Wildlife Refuges (see Section 4.4.8.3). Development of onshore facilities within NPS lands in the vicinity of the areas included in the Program is considered unlikely, thereby making impacts from routine Program activities unlikely in these areas. Offshore construction of pipelines and platforms could contribute to cumulative effects on wildlife and on scenic values for park visitors due to noise and activity levels. However, such effects would be localized, intermittent, and temporary. It is anticipated that lease stipulations applied at the lease sale stage could minimize the potential for cumulative impacts from routine operations on these areas.

Expected accidental oil spills (most of which are less than 1,000 bbl) that occur during the Program could result in a negligible to medium incremental contribution to cumulative impacts on Areas of Special Concern, depending on spill frequency, location, and volume; the type of product spilled; weather conditions; effectiveness of cleanup operations; and other environmental conditions at the time of the spill. Large spills (1,000 bbl and greater) or an unexpected CDE in areas adjacent to the National Parks or NWRs, whether from OCS or non-OCS sources, would also depend on these factors, and could result in moderate impacts if they were to occur. Such spills could also negatively impact coastal habitats and fauna, and could also affect subsistence uses.

4.6.5.3.2 Population, Employment, and Income. Section 4.4.9.2 discusses the potential impacts from the Program on population, employment, and income in the Arctic region. Cumulative impacts on these resources result from the incremental impacts of the Program when added to impacts from reasonably foreseeable future OCS program activities (there are no ongoing OCS program activities) and ongoing and future non-OCS program activities. Specific types of impact-producing factors related to OCS program activities considered in this analysis include total employment and regional income for the North Slope Borough, which corresponds to the Beaufort Sea and Chukchi Sea Planning Areas (described in Section 3.10). Non-OCS program activities affecting the region include employment and earnings related to various other industrial sectors (e.g., construction, manufacturing, services, and State and local government).

The population in the Beaufort Sea and Chukchi Sea Planning Areas is concentrated in Barrow. It increased at an average annual rate of 3.6% between 1980 and 1990, and 2.1% between 1990 and 2000; it decreased by 1.0% between 2000 and 2009. The components of population increase include the natural increase due to births and net positive domestic migration; the population trend is uncertain over the next 50 years and will likely depend on the availability of jobs. Most communities in the borough have a high percentage of American Indian or Alaska Natives.

The Program would add an average of 3,457 to 12,665 direct and indirect jobs in Alaska annually between 2012 and 2017, an increase that is considered moderate (but positive) since it would amount to less than 6% of total Alaska employment. Likewise, direct and indirect income produced in Alaska would range from $233 million to $904 million annually, which constitutes less than 6% of income in Alaska overall. Most of the workers directly associated with OCS oil and gas activities would work offshore or onshore in worker enclaves separated from local communities, and most workers will likely commute to work sites from Alaska's larger population centers or from outside the immediate area. While OCS jobs would be available to the local populations in all areas, rural Alaskan employment in the petroleum industry, especially among Alaska Natives, would likely remain relatively low. However, a contingent of Alaska Natives from the Fairbanks area and members of the Doyon Corporation do work in the oil fields of the North Slope, and these jobs are important to them.

Employment impacts of oil spills reaching landfall can vary considerably depending upon the total volume of oil reaching land, the land area affected, and the sensitivity of local environmental conditions to oil impacts. The primary impacts of oil spills would most likely fall on such activities as beach recreation, commercial fishing, recreational fishing, and sightseeing. Oil spills reaching land can have both short- and long-term effects on these recreational coastal activities. Although an oil spill could occur anywhere in the lease sale area, cleanup-related employment would likely occur in the area directly affected, generally in locations remote from communities. The hiring of cleanup workers would have a regional and State of Alaska emphasis. Oil spills will generate only temporary employment (and population) increases during cleanup operations, because such operations are expected to be of short duration. Employment generated by spills will be a function of the size and frequency of spills.

Conclusion. The cumulative impacts of future OCS program and ongoing and future non-OCS program activities would be considered beneficial because these activities would increase employment and earnings in the region over the next 40 to 50 years (although rural Alaskan employment in the petroleum industry, especially among Alaska Natives, would likely remain relatively low). The Program would add to these beneficial impacts. The incremental contribution of routine operations under the Program is expected to be small, however, because the added employment demands are less than 10% of total Alaska employment (see Section 4.4.9.3).

The cumulative impacts of accidental oil spills could be minor to major, depending on the total volume of oil reaching land, the land area affected, and the sensitivity of local environmental conditions to oil impacts. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be negligible to small relative to those associated with ongoing and future OCS program and non-OCS program activities. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in minor to moderate impacts if they were to occur. In the short term, impacts of a CDE could be large as a result of loss of employment, income, and possible shortages of commodities or services in both coastal and inland areas affected by the spill. Longer-term impacts could be smaller unless recreational activities and tourism suffered as a result of real or perceived impacts of the event (see Section 4.4.9.1).

4.6.5.3.3 Land Use and Infrastructure. Localized impacts to land use and existing infrastructure are anticipated as a result of the construction of new oil and gas facilities in the Beaufort Sea and Chukchi Sea Planning Areas over the next 40 to 50 years. Impact-producing factors from OCS program activities would include increased vehicular traffic (e.g., helicopter trips); modifications to current land use designations to incorporate new facilities, if they are needed; and some infrastructure expansion.

Ongoing non-OCS program activities that could affect land use and onshore infrastructure are expected to continue into the foreseeable future. These include offshore construction, onshore construction, and vessel traffic. Where land is largely undeveloped and no established oil and gas infrastructure is present, development could result in land use and infrastructure impacts, such as the conversion of existing land use (e.g., undeveloped, residential, or commercial) to industrial land use to accommodate oil and gas production (MMS 2007e).

Accidental oil releases may occur as a result of both OCS and non-OCS activities. The extent of impacts would depend on the location and size of the releases, but could include stresses of spill response on the community infrastructure, increased traffic to respond to cleanup, and restricted access to particular lands while cleanup is conducted. In general, these releases would be expected to have a temporary impact on land use and infrastructure (MMS 2007c).

Conclusion. Localized impacts to land use and existing infrastructure are anticipated over the next 40 to 50 years as a result of future OCS program and ongoing and future non-OCS program activities in the Beaufort and Chukchi Seas. These impacts could range from minor to major depending on the nature (extent and duration) of the land use change. The incremental contribution of routine operations under the Program in the Arctic to cumulative impacts would be small to medium because the existing infrastructure is considered sufficient to handle the land use changes needed for new onshore pipeline construction and transportation network (see Section 4.4.10.3).

Land use–related impacts resulting from expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program include stresses of spill response on community infrastructure, increased traffic in the response area (both onshore and offshore), and temporary restricted access to affected lands (while cleanup is conducted). Such spills would result in a small incremental contribution to cumulative impacts on land use and existing infrastructure. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in moderate to major impacts if they were to occur.

4.6.5.3.4 Commercial and Recreational Fisheries. There currently is no commercial fishing and little data on recreational fishing in the Beaufort or Chukchi Sea (although the North Pacific Fishery Management Council has concluded that there are few recreational fisheries in these waters). Sport fishing likely occurs in coastal areas of larger population centers such as Barrow. Subsistence fishing is widespread in coastal areas of the Arctic. Given the importance of this fishing to local villages in the Arctic region, any impacts from the Program may directly affect the local economy by causing declines in salmon availability for harvest. Greater declines in the harvest would lead to greater impacts on local communities. However, it is anticipated that impacts from routine OCS operations would be minor as a result of adherence to mitigation measures and compliance with Federal, State, and local requirements.

The Program would represent a small increment to the potential for overall cumulative effects on fishing by local villages in the Arctic region. Routine OCS program activities would be unlikely to have cumulative population- or community-level effects on local fishery resources because of the limited time frame over which most individual activities would occur; because a small proportion of habitat, relative to similar available habitat, could be affected during a given period; and because of existing stipulations that are in place to avoid impacts to sensitive habitats such as hard bottom areas and topographic features. Non-OCS activities, including State oil and gas development and sportfishing, could also contribute to cumulative effects on local fisheries.

Depending on specific conditions during a large oil spill, there could be substantial economic losses for commercial fisheries as a consequence of reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods. Non-OCS sources of spills, including State oil and gas production, have a potential to cause similar effects. The occurrence of a catastrophic spill, such as could occur from a tanker accident, could have substantially greater effects on fisheries.

Conclusion. Cumulative impacts on fisheries in the Beaufort and Chukchi Seas as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be moderate to major over the next 40 to 50 years. Non-OCS activities affecting fisheries include State oil and gas development and sportfishing. The incremental contribution of routine operations under the Program to these impacts would be small, since these activities would not occur in the immediate area where fisheries are located (see Section 4.4.11.3).

Fisheries may be adversely affected by accidental oil releases from OCS and non-OCS activities (e.g., State oil and gas development, domestic transportation of oil or refined petroleum products, and commercial shipping). The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be medium, depending on the location, timing, and volumes of spills (among other environmental factors). Small spills are unlikely to affect a large number of fish or have a substantial effect on fishing before dilution and weathering reduced concentrations of oil in the water. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be moderate if they were to occur. Large spills or a CDE could have significant localized effects on fishing as a result of reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods, and on recreational fishing as a consequence of contamination of fish tissues, degradation of aesthetic values that attract fishers, or temporary closure of fishing areas. Large spills or a CDE have a greater potential to contact intertidal habitat and subsequently contaminate or reduce the abundance of commercial and recreational species that depend on nearshore habitat. These impacts could be long term, but are not expected to result in the long-term loss of fisheries in Arctic waters.

4.6.5.3.5 Tourism and Recreation. Platform, pipeline, causeway, and facility construction and vessel traffic could interfere with water-based recreational activities (fishing, boating, sightseeing, cruise ships); cause some disruption to land-based activities (hiking, picnicking, hunting, visiting Native communities, camping, wildlife viewing, and sightseeing), depending on the location of recreational activities relative to proposed development; increase amounts of trash and debris from OCS activities; and cause possible competition between workers and tourists for local services, such as air transport, hotel accommodations, and other visitor services. Non-OCS activities that could have an impact on tourism and recreation include offshore construction (e.g., State oil and gas development, domestic transportation of oil and gas), onshore construction (e.g., coastal and community development), and vessel traffic (e.g., commercial shipping, recreational boating, military training and testing).

Non-OCS activities and proposed and future OCS activities represent a continuation of existing onshore and offshore oil and gas construction trends in the Beaufort Sea and Chukchi Sea Planning Areas. Substantial infrastructure for related oil and gas development already exists in both of these areas, including platforms, exploration and production wells, pipelines to transport oil from offshore platforms to common-carrier pipeline systems onshore, and processing facilities; therefore, there should not be additional visual disruption for the tourists in these areas. Pipeline construction would present a temporary disruption to tourism and recreation due to workers competing with tourists for short-term housing (hotels) and air transport; aesthetic impacts (visual and auditory) associated with construction sites; and possible temporary prevention of access to some recreational or wilderness areas. In addition, the new pipeline in the Arctic region could create road access into previously undeveloped lands used primarily for subsistence, creating a potential conflict between subsistence practices and recreational hunting or other possible tourist activities.

Oil spills associated with OCS and non-OCS activities, as well as oil releases from naturally occurring seeps, could also affect recreation and tourism, and could result in both short-term and long-term effects, depending on public perception and reaction. Potential cumulative impacts include direct land impacts (e.g., oil contamination of a National Wildlife Refuge); aesthetic impacts of the spill and associated cleanup; increased traffic to respond to cleanup operations; and restricted access to particular lands while cleanup is being conducted.

Conclusion. Cumulative impacts on tourism and recreation in the Beaufort Sea and Chukchi Sea Planning Areas as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be moderate to major over the next 40 to 50 years because they would be noticeable to the recreation and tourism community, as no similar infrastructure yet exists in that region, and competition for accommodations and air transport may slow tourism for a time. Non-OCS activities or phenomena affecting these resources include offshore construction (State oil and gas development, domestic transportation of oil and gas), onshore construction (e.g., coastal and community development), and marine vessel traffic. The incremental contribution of routine operations under the Program to these impacts would be small, with potential adverse aesthetic impacts on sightseeing, hiking, and rafting activities (see Section 4.4.12.1).

Tourism and recreation may be adversely affected by accidental oil releases from OCS and non-OCS activities. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be negligible to small, depending on the size, location, and timing of the spill (being greatest if it occurred during the peak recreational season). Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be minor to moderate if they were to occur. Short-term impacts would include beach and coastal access restrictions; restrictions on visitation, fishing, or hunting while cleanup is being conducted; and aesthetic impacts associated with the event itself and with cleanup activities. Longer-term impacts could be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event.

4.6.5.3.6 Sociocultural Systems. Small, primarily Alaska Native communities along the Arctic coast are heavily dependent on subsistence harvesting of sea mammals, fish, and terrestrial fauna Enclaves of workers at Prudhoe Bay and nearby oil fields are employed by the oil and gas industry. They commute from mostly south-central Alaska, Fairbanks, and States outside of Alaska. For the most part, these two communities (Alaska Native communities and worker enclaves) have had little interaction because of the physical distance that separates them. The exception is Nuiqsuit. Further development of the oil and gas industry, increases in marine shipping as a result of the diminishing polar ice caps, and the effects of climate change coupled with development of oil and gas resources on the OCS could contribute to cumulative effects on the subsistence harvesting and sociocultural structure of the region.

A primary concern of Alaska Natives is the health and accessibility of sea mammals including whales, walrus, and seals, which could be affected by the cumulative effects of climate change, increased industrial activity, and increased shipping along the northern coast of Alaska. Warming climatic conditions have resulted in the early retreat of the polar ice pack, less shore-fast ice, and more young ice. Ice flow haulouts used by seals and walrus are thus farther from shore, increasing the effort required for subsistence hunters to harvest them. Young ice is less thick and less able to support hunting and whale butchering, making the subsistence harvest more difficult. More ice-free lanes along the coast have resulted in an increase in marine traffic, including cargo shipping and tourist cruise ships, through the Bering Strait and the Chukchi and Beaufort Seas, a pattern that is likely to continue. Increased commercial and tourist shipping added to increased vessel traffic supporting new oil and gas development would likely exacerbate adverse effects on subsistence resources. Noise from increased shipping would disturb bowhead and beluga whale migration patterns, already affected by the noise of seismic survey vessels during oil and gas exploration and to a lesser extent drilling and operation of wells. Increased shipping could increase the number of ship strikes on marine mammals; the risk of introduction of alien aquatic nuisance species from bilge water and other discharges; and chances of spills of fuel and other hazardous materials from shipping accidents. Eco-tourists seek many of the same species as subsistence hunters and can make them more wary and more difficult to hunt. The effects of increased shipping would be particularly acute in narrow ice-free corridors along the Beaufort and Chukchi coast and in narrow passages, such as the Bering Strait, where migrating sea-mammals and Arctic shipping would share the same narrow waterway. In addition, the likely concomitant increase in the use of ice breakers has the potential for disrupting Native travel across the ice in pursuit of marine mammals, potentially cutting them off from the shore, and leading whales following open water farther offshore (Arctic Council 2009). The whale harvest is central to Alaska Native culture in terms of the food it provides, the inter-community ties built on barter and exchange of whale products, and its association with Native cultural identity and spirituality. Oil and gas exploration and development combined with increased shipping and the effects of climate change would have an adverse cumulative effect on subsistence harvesting.

Warming temperatures have also reduced the amount of permafrost underlying Arctic communities, resulting in increased coastal erosion and less stable sediments, rendering traditional ice cellars cut into the permafrost useless, further stressing the subsistence harvest through loss of storage facilities, and in some cases requiring villages to move back from the coast (USGCRP 2003).

The construction and operation of linear features such as oil and gas pipelines and roads can deflect migration patterns of terrestrial mammals such as caribou that are an important part of the subsistence harvest. As onshore oil and gas development expands from Prudhoe Bay, Native communities such as Nuiqsut feel increasingly cut off from traditional subsistence resource harvesting areas. To the extent that offshore oil development requires onshore support infrastructure, it contributes to a cumulative negative impact on onshore access to subsistence resources. As the distance between Native communities and oil and gas worker enclaves decreases, the interaction between these two groups is likely to increase, raising the potential for cross-cultural conflicts and changes in traditional culture.

Conclusion. Cumulative impacts on sociocultural systems in the Arctic Planning Areas as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be moderate over the next 40 to 50 years. Important impacting factors include early retreat of the polar ice pack (due to warming climate conditions), increased marine shipping (due to more ice-free lanes along the coast), and increased noise (due to increased shipping, increased tourism, seismic surveys and other oil and gas activities) — all of which could disturb sea mammals and their migration patterns. Some factors, such as the loss of polar ice are beyond the control of local communities, BOEM, or oil and gas developers and may be considered unavoidable at the local community level. They would require some adjustment in subsistence harvesting patterns, a moderate effect. Effects would only be major if a subsistence resource were eliminated or rendered unavailable. The effects of other factors, such as increased shipping and ice breaking, can be mitigated through conflict avoidance agreements and regulation of coastal shipping. The incremental contribution of routine operations under the Program to these impacts would range from small to medium, especially if subsistence-related activities, central to the well-being of Alaska Natives who inhabit the area, are affected. Many of these potential effects are mitigatable (see Section 4.4.13.3).

Onshore linear features (e.g., pipelines and roads) affect the migration patterns of terrestrial mammals. Because of the high level of dependence on subsistence harvesting, the incremental contribution of the Program to cumulative impacts on subsistence activities near the Beaufort and Chukchi Seas would be expected to be small to medium (see Section 4.4.13.3). It is likely that onshore subsistence harvesting practices would have to be adjusted. Effects would be major only if important resources were eliminated or made unavailable. Design stipulations and operational procedures could reduce the impact of onshore development.

Sociocultural systems may be adversely affected by accidental oil releases from OCS and non-OCS activities. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program would be small to medium, depending on the location, volume, and timing (i.e., season) of the spill. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be major if they were to occur, especially if they disrupt sea mammal harvest or resulted in the IWC reducing or eliminating whale quotas in the Alaska Arctic. A CDE would prove challenging for existing response capacity and capability, especially if the spill were under ice or in broken ice. The cleanup process itself has the potential to cause displacement of subsistence resources and subsistence hunters, and would have major impacts in the short term depending on the timing and duration of the displacement. The associated influx of cleanup workers would likely overwhelm the resources of local communities and could result in cross-cultural conflicts.

4.6.5.3.7 Environmental Justice. Additional offshore construction under the Program could include increased noise and traffic, air and water pollution, impacts on residential property values, and land use changes. Much of the Alaska Native population resides in the coastal areas of Alaska. New offshore infrastructure resulting from this program could be located near areas where subsistence hunting occurs. The proposed 5-year program will result in levels of infrastructure use and construction similar to what has occurred in the south Alaska region during previous programs. These activities are not expected to expose residents to notably higher risks than currently occur.

Any adverse environmental impacts on fish and mammal subsistence resources could have disproportionately higher health or environmental impacts on Alaska Native populations. OCS activities could potentially disrupt marine mammal harvests (primarily walrus, seals, and beluga whales) by diverting marine migrations or by causing other behavioral changes, such as increased wariness or having to go further from shore because of the diminishing polar ice cap, and whales migrating further from shore or the synergistic effects of all these factors combined.

Air emissions from onshore facilities and helicopter and vessel traffic traversing coastal areas will be highest in areas containing the greatest amounts of infrastructure. It is assumed that the majority of the activity from the proposed 5-year program will occur in waters no more than 100 m (30 ft) deep, with the most offshore air emissions occurring in the coastal areas with the greatest amounts of oil and gas activity and with fewer emissions occurring elsewhere. The effects of the OCS program on air quality have been analyzed in Section 4.4.4. This analysis concluded that routine operations associated with the proposed 5-year program would result in NO_2, SO_2, PM_{10}, and CO levels that are well within the NAAQS. Coastal effects from offshore activities are expected to be small, based on the established and increasing trend toward movement of oil and gas activities into deeper waters.

Oil spill events in the region, and related cleanup activities, pose the greatest potential for impacts on low-income and minority population groups. It is reasonable to expect that most of these spills would occur in deepwater areas located away from the coast, based on the established trend for oil and gas activities to move into deep waters located for the most part at a substantial distance from the coast. The magnitude of impacts from such spills cannot be predicted, should they contact the coast, and depends on their location, size, and timing. However, according to MMS (2002b), the probability that an offshore oil spill occurring and impacting coastal populations is low. While the location of possible oil spills cannot be determined, low-income and minority populations are resident in some areas of the coast. Low-income and minority groups could bear more negative impacts than other population groups.

Conclusion. In the Beaufort Sea and Chukchi Sea Planning Areas, OCS and non-OCS program activities in combination with the effects of increased marine traffic and climate change could result in moderate to major adverse cumulative impacts on human health and the environment, especially if a large oil spill were to occur, because oil spill contamination of subsistence foods is the main concern regarding potential effects on Native health. Impacts on marine and terrestrial ecosystems in the region (described in Section 4.6.4) could affect subsistence resources, traditional culture, and community infrastructure; indigenous communities that are subsistence-based would likely experience disproportionate, highly adverse environmental and health effects. However, the incremental change due to impacts from Program activities is expected to be small.

The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be negligible to small. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in moderate to major impacts on the Alaska Native population, especially if subsistence resources were diminished or tainted as a result of the spill. Mitigation measures, cooperative agreements between Native and industry groups, and government-to-government consultations are designed to limit the effects from oil spills and routine operations.

4.6.5.3.8 Archeological and Historic Resources. Section 4.4.15.3 discusses the potential impacts from the Program on onshore and offshore environments in the Beaufort Sea and Chukchi Sea Planning Areas. Cumulative impacts on archeological and historic resources result from the incremental impacts of the Program when added to impacts from ongoing and reasonably foreseeable future OCS program activities (that are not part of the proposed action) and other non-OCS program activities. Table 4.6.1-3 presents the exploration and development scenario for the Arctic region cumulative case (encompassing the proposed and future OCS program activities). Specific types of impact-producing factors related to OCS program activities considered in this analysis include drilling rig and platform emplacement, pipeline emplacement, new onshore facilities, and oil spills. Non-OCS program activities (e.g., oil and gas industry in State waters) and natural geologic processes such as ice gouging and thermokarst erosion are also considered (see also Section 4.2.2.2).

Archeological Resources. Offshore development could result in an interaction between a drilling rig, platform, pipeline, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy artifacts or site features and could disturb the stratigraphic context of the site. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts between northeast Asia and the Americas.

Since 1973 when the ESP was initiated, the USDOI has required that an archaeological survey be conducted prior to development of mineral leases determined to have potential for cultural resources, including prehistoric archaeological sites. Relative sea-level data, which are used to define the portion of the continental shelf having potential for prehistoric sites, suggest that the portion of the continental shelf shoreward of about the 60-m (200-ft) isobath would have potential for prehistoric sites. Although an archaeological survey would identify all cultural resources in the APE for the project and routine operations related to OCS program activities would avoid all known cultural resources, it is likely that impacts to prehistoric resources may have already occurred as a result of non-OCS program activities prior to the implementation of the archaeological survey requirement.

Onshore development could result in direct physical contact between the construction of new onshore facilities or pipeline trenches and previously unidentified prehistoric sites. This direct physical contact with a prehistoric site could cause physical damage to or complete destruction of information on the prehistory of the region and North America. Federal and State laws and regulations initiated in the 1960s began requiring archaeological surveys prior to permitting any activity that might disturb a significant archaeological site. Therefore, it can be assumed that, since the introduction of the archaeological resource protection laws, most coastal archaeological sites have been located, evaluated, avoided, or mitigated prior to construction. However, impacts to coastal prehistoric resources may have already occurred as a result of various onshore construction activities prior to enactment of the archaeological resource protection laws.

Trawling activity in the Arctic region affects only the uppermost portion of the sediment column (Krost et al. 1990). This zone would already be disturbed by natural factors relating to the destructive effects of ice gouging and scouring (see Section 4.2.2). Therefore, the effect of trawling on most prehistoric archaeological sites would be minor.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for prehistoric archaeological sites, as they are often associated with drowned river valleys, which are known to have a high probability for prehistoric sites. It is assumed that some of the archaeological data that have been lost as a result of dredging have been significant and unique; therefore, the impact to prehistoric archaeological sites as a result of past channel dredging activities has probably been moderate to major. In many areas, the USACE now requires remote-sensing surveys prior to dredging activities to minimize such impacts (Espey, Huston & Associates 1990).

Natural geologic processes such as ice gouging and thermokarst erosion have caused and will continue to cause a significant loss of prehistoric archaeological data in the Alaska region. For example, ice gouges on the Beaufort Sea shelf can create a furrow up to 67 m (220 ft) wide and 4 m (13 ft) deep; however, the average ice gouge is about 8 m (26 ft) wide and 0.5 m (1.6 ft) deep (Barnes 1984). Coastal prehistoric sites are exposed to the destructive effects of thermokarst erosion. These natural processes would cause artifacts to be dispersed and the site context to be disturbed or even completely destroyed, resulting in the loss of archaeological information. Overall, a significant loss of data from submerged and coastal prehistoric sites has probably occurred, and will continue to occur, from the effects of natural geologic processes. It is assumed that some of the data lost have been significant and/or unique, resulting in a major level of impact.

An accidental oil spill could affect coastal prehistoric archaeological sites, but the direct impact of oil on most sites is uncertain. Protection of such sites during an oil spill requires specific knowledge of their location, condition, nature, and extent prior to impact; however, the Beaufort Sea and Chukchi Sea coastlines have not been systematically surveyed for archaeological sites.

Heavy oiling of a coastal area could conceal intertidal sites that may not be recognized until they are inadvertently damaged during cleanup (Whitney 1994). Crude oil may also contaminate organic material used in ^{14}C dating, and, although there are methods for cleaning contaminated ^{14}C samples, greater expense is incurred (Dekin et al. 1993). The major source of potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup activities. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. Damage or loss of significant archaeological information could result from the contact between an oil spill and a prehistoric archaeological site; therefore, the cumulative impact from oil spills to prehistoric archaeological sites could range from moderate to major.

Historic Resources. Direct physical contact between a routine activity and a shipwreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the time period from which the ship dates.

Since 1973 when the ESP was initiated, the USDOI has required archaeological (historical) surveys be conducted prior to development of mineral leases when a historic-period shipwreck is reported to lie within or adjacent to the lease area. Although an archeological survey would identify all cultural resources in the APE for the project and routine operations related to OCS activities would avoid all known cultural resources, it is likely that impacts to historic-period shipwrecks may have already occurred as a result of non-OCS program activities that took place before implementation of the 1973 archaeological survey requirement.

Onshore development could result in direct physical contact between the construction of new onshore facilities or pipeline trenches and previously unidentified historic sites. Federal and State laws and regulations initiated in the 1960s began requiring archaeological surveys prior to permitting any activity that might disturb a significant archaeological site. Therefore, it can be assumed that, since the introduction of the archaeological resource protection laws, most coastal archaeological sites that would have been impacted have been located, evaluated, avoided, or mitigated prior to construction. However, impacts to coastal historic sites may have resulted from onshore construction activities prior to enactment of the archaeological resource protection laws.

Trawling activity in the Alaska subregion only affects the uppermost portion of the sediment column (Krost et al. 1990). On many wrecks, this zone would already be disturbed by natural factors and would contain only artifacts of high specific gravity which have lost all original context. Therefore, the effect of trawling on most historic shipwreck sites would be minor.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for historic shipwrecks. Assuming that some of the data lost have been unique, the impact to historic sites as a result of past channel-dredging activities has probably been moderate to major. In many areas, the USACE now requires remote-sensing surveys prior to dredging activities to minimize such impacts (Espey, Huston & Associates 1990).

Natural geologic processes such as ice gouging and thermokarst erosion may cause a loss of historic data in the Beaufort and Chukchi Seas (see study conducted in the Beaufort Sea by Darigo et al. [2007]). For example, ice gouges on the Beaufort Sea shelf can create furrows up to 67 m (220 ft) wide and 4 m (13 ft) deep; however, the average ice gouge is about 8 m (26 ft) wide and 0.5 m (1.6 ft) deep (Barnes 1984). Darigo et al. (2007) suggest that areas close to islands and the shore may be protected from the effects of ice gouging. Coastal historic sites are exposed to the erosional effects of wave energy and thermokarst erosion, which would cause artifacts to be dispersed and the site context to be disturbed or even completely destroyed. No specific studies have examined the effect of geological processes on site integrity. Overall, a significant loss of data from submerged and coastal historic sites may have already occurred from the effects of natural geologic processes. It is possible that some of the data lost may have been significant and/or unique, resulting in a major level of impact. Additional studies are needed to assess the effect of geological processes on cultural resources.

An accidental oil spill could affect a coastal historic site, but the direct impact of oil on most historic sites is uncertain. The primary source of potential impact from oil spills is unmonitored shoreline cleanup activities (Bittner 1996; see Section 4.4.15.3.2). Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. Damage or loss of significant historic information could result from oil spill cleanup activities; therefore, the cumulative impact from oil spills (past, present, and future) on historic sites could range from moderate to major.

Conclusion. The cumulative impacts of future OCS program and ongoing and future non-OCS program activities on prehistoric and historic archaeological sites in the Beaufort and Chukchi Seas are currently unknown, but could range from minor to moderate, mainly because activities occurring on the OCS prior to BOEM's survey requirement (in effect since 1973) may already have affected significant archaeological sites. Other important impact-producing factors that likely have had, and will continue to have, an impact on both prehistoric and historic archaeological sites are channel dredging and geologic processes, such as ice gouging and thermokarst erosion. Commercial treasure hunting and sport diving may also result in a loss of artifacts at historic-period shipwreck sites. The incremental contribution of routine operations under the Program is expected to be negligible to large. Archaeological surveys that would identify significant cultural resources to be avoided could reduce these impacts (see Section 4.4.15.3).

Cumulative impacts on prehistoric and historic archaeological sites due to expected accidental oil spills and related cleanup activities could range from negligible to major, depending on the location of the spill in relation to sensitive resources. The incremental contribution of oil spills associated with the Program could be small to large relative to those associated with future OCS program and ongoing and future non-OCS program activities. Impacts associated with an unexpected, low-probability CDE would also depend on location, and could range from minor to major if they were to occur. There is a greater likelihood that more of the resources would be affected at a major level during a CDE. A more detailed discussion of the effects of oil spills on archaeological and historic resources in Arctic waters is presented in Section 4.4.15.3.

4.6.5.4 Summary for Gulf of Mexico Region

4.6.5.4.1 Areas of Special Concern. In the GOM, Areas of Special Concern are federally managed areas such as marine protected areas, National Marine Sanctuaries, National Parks, and National Wildlife Refuges. In addition to these areas, a number of locations have been given special designations by Federal, State, and nongovernmental organizations. These include the National Estuarine Research Reserves, National Estuary Program Sites, and the Military and NASA Use Areas. Cumulative impacts on these resources result from activities that could potentially cause damage to or degradation of fauna or habitats within these areas. Ongoing and future activities or trends that affect Areas of Special Concern in/near the GOM include fishing, diving, dredging operations, marine vessel traffic (and wakes), tankering, trash and debris accumulation (from various sources), onshore infrastructure (e.g., roads and vehicle traffic), and oil and gas development and infrastructure (e.g., pipeline landfalls and onshore facilities). Extreme weather events such as hurricanes and tropical storms also occur regularly in the GOM region and potentially cause damage by increasing shoreline erosion. Climate change has the potential to profoundly affect coral communities within these areas (e.g., in the FGBNMS, the only marine sanctuary in the GOM). Cumulative impacts on Areas of Special Concern in the GOM are considered to be negligible to moderate. The impacts of activities taking place within the Areas of Special Concern located onshore, such as National Parks and National Forests, are regulated through permitting processes. The cumulative impacts from spills would be minor to major, depending on spill frequency, location, and size; the type of product spilled; weather conditions; effectiveness of cleanup operations; and other environmental conditions at the time of the spill.

Routine operations under the Program could result in a negligible to medium incremental increase in effects on Areas of Special Concern. Expected oil spills (most of which are less than 1,000 bbl) that may occur during the Program could result in a small incremental contribution to cumulative impacts on Areas of Special Concern, depending on spill frequency, location, and volume; the type of product spilled; weather conditions; effectiveness of cleanup operations; and other environmental conditions at the time of the spill. Impacts associated with large spills (1,000 bbl and greater) or an unexpected, low-probability CDE in areas adjacent to the National Parks, NWRs, or National Forests, whether from OCS or non-OCS sources, would also depend on these factors, and could result in moderate impacts if they were to occur. Such spills could negatively impact the FGBNMS and coastal habitats and fauna, and could also affect subsistence uses, commercial or recreational fisheries, and tourism.

4.6.5.4.2 Population, Employment, and Income. Population in counties of the GOM coastal region has been steadily increasing since 1980, with the highest growth occurring in Texas. Most of the employment (and earnings) in the region is concentrated in Florida and Texas, which together provide about 81% of the employment in the GOM region. The largest employing sectors are in services, retail and wholesale trade, and State and local government. Cumulative economic impacts result from direct employment and income created through the development of offshore oil and gas resources, and the indirect employment and income produced through the spending of wages and salaries, and from the procurement of materials and services in the Gulf coast region. In-migration of workers and their families into the region produces population impacts. Oil and gas development has created employment and income in the coastal economies of the GOM coast, and this has led to rapid increases in population. Small incremental increases in employment, income, and population are expected with the development of offshore oil and gas resources in the GOM under the Program.

The cumulative impacts of ongoing and future OCS program and non-OCS program activities would be considered beneficial because these activities would increase employment and earnings in the region over the next 40 to 50 years. The Program would add to these beneficial impacts, especially in Texas and Louisiana. The incremental contribution of the Program is expected to be negligible, however, because the added employment demands are less than 2% of the total GOM coast regional employment. In areas with a large proportion of impact-sensitive industry (such as tourism), the cumulative impacts of accidental oil spills could be moderate to major, depending on the total volume of oil reaching land, the land area affected, and the sensitivity of local environmental conditions to oil impacts. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be negligible to small relative to those associated with ongoing and future OCS program and non-OCS program activities. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in minor to moderate impacts if they were to occur. In the short term, impacts of a CDE could be large as a result of loss of employment, income, and possible shortages of commodities or services in both coastal and inland areas affected by the spill.

4.6.5.4.3 Land Use and Infrastructure. Most of the equipment and facilities supporting offshore oil and gas operations are located in the western and central GOM. Currently, there are hundreds of onshore facilities that support offshore industry. These include ports, refineries, and waste management facilities, among others. Cumulative impacts on land use and infrastructure result from demands on roads, utilities, and public services and the need to develop additional onshore facilities to accommodate ongoing and future activities in the GOM. Oil spill response also places stresses on community infrastructure and increases traffic in the affected area. Cumulative impacts on land use and onshore resources from ongoing and future activities in the GOM could range from minor to major depending on the nature and location of demands. Most of these impacts are expected to be temporary.

The incremental contribution of routine operations under the Program to cumulative impacts in the GOM would be negligible to small because the existing infrastructure is considered sufficient to handle the small increases in demands for roads, utilities, and public services related to the Program. Activities within the GOM also may be affected by the post-DWH event conditions; BOEM continues to monitor the region to identify long-term impacts of concern. Land use–related impacts resulting from expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program include stresses of spill response on community infrastructure, increased traffic in the response area (both onshore and offshore), and temporary restricted access to affected lands (while cleanup is conducted). Such spills would result in a negligible to small incremental contribution to cumulative impacts on land use and existing infrastructure. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in minor to moderate impacts if they were to occur.

4.6.5.4.4 Commercial and Recreational Fisheries. Commercial fisheries are very important to the economies of the GOM coast States; in 2009, commercial fishery landings in the GOM reached almost 649,000 metric tons, worth more than $629 million. When related processor, wholesale, and retail businesses are included, the GOM seafood industry supports more than 200,000 jobs, with related income impacts of $5.5 billion. In 2009, Louisiana led the States in total landings and value, followed by Mississippi, Texas, and Florida. Recreational fishing is also important to the region. In 2010, more than 4.5 million people engaged in some form of recreational fishing. Most recreational fishing in the region is done on private/rental boats (about 60%), followed by fishing from shore, then fishing from charter vessels. Angling trips are also made in inland waters. The majority of recreational fish landings in 2010 were in Florida, followed by Louisiana, Alabama, and Mississippi. Cumulative impacts on commercial and recreational fishing result from changes in commercial fishing costs with the development of offshore oil and gas resources in the GOM coast region, and changes in accessibility of fisheries resources. Ongoing oil and gas development has affected commercial fishing costs both positively and negatively in the GOM coast through the effect offshore infrastructure placement has on the concentration of fisheries resources, and disused platforms have enhanced recreational fisheries. The cumulative effects of ongoing and future GOM activities on commercial and recreational fisheries are considered to be minor.

The incremental contribution of routine Program activities to cumulative impacts in the GOM would be small, since these activities would be unlikely to have population- or community-level effects on fishery resources because of the limited time frame over which most individual activities would occur and because a small proportion of habitat relative to similar available habitat would be affected during a given period. In addition, existing stipulations are in place to prevent or reduce impacts on sensitive habitats such as hard-bottom areas and topographic features. Construction of new platforms could represent a small increase in the availability of desirable recreational fishing locations for recreational anglers. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be medium, depending on the location, timing, and volumes of spills (among other environmental factors). Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be moderate if they were to occur. Large spills or a CDE could have significant localized effects on commercial fishing as a result of reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods, and on recreational fishing as a consequence of contamination of fish tissues, degradation of aesthetic values that attract fishers, or temporary closure of fishing areas. Large spills or a CDE have a greater potential to contact intertidal habitat and subsequently contaminate or reduce the abundance of commercial and recreational species that depend on nearshore habitat.

4.6.5.4.5 Tourism and Recreation. The GOM coastal zone is one of the major recreational regions of the United States, with marine fishing and beach-related recreation being particularly popular. The coasts in GOM States offer diverse natural and developed landscapes and seascapes, and the beaches, barrier islands, estuarine bays and sounds, river deltas, and tidal marshes are visited by residents and tourists throughout the year. In 2000, Florida was the most important destination for marine recreation, with more than 22 million people participating in the State. Cumulative impacts on tourism and recreation therefore result when there are changes in the accessibility of beach and offshore resources for recreational use, and from increases in marine vessel and aircraft traffic in the vicinity of recreational resources. Oil and gas development has had an important impact on tourism and recreation in the GOM coast through the effect of offshore infrastructure placement and the proximity of platform servicing traffic to recreational resources, as well as the visibility of offshore platforms from onshore recreational areas. Given the existence of offshore oil and gas developments and other ongoing activities in the GOM, however, cumulative impacts on tourism and recreation from ongoing and future OCS and non-OCS activities are expected to be minor.

The incremental contribution of routine operations under the Program to cumulative impacts in the GOM would be small, with potential adverse aesthetic impacts on beach recreation and sightseeing and potential positive impacts on diving and recreational fishing. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program would be small to medium, depending on the size, location, and timing of the spill (being greatest if it occurred during the peak recreational season). Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be minor to moderate if they were to occur. Short-term impacts would include beach and coastal access restrictions; restrictions on visitation, fishing, or hunting while cleanup is being conducted; and aesthetic impacts associated with the event itself and with cleanup activities. Longer-term impacts could be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event.

4.6.5.4.6 Sociocultural Systems. The counties along the GOM coast are home to a large and heterogeneous mix of cultures, subcultural groups, and populations. Within the coastal region, the effects of the offshore oil and gas industry are felt most directly by populations living within the coastal community commuting zone where industry support facilities and the people who work in them are located. Coastal estuaries provide a wealth of wild resources for subsistence harvesting. Although many of the subsistence activities in the GOM region are practiced recreationally, some Native American groups, such as the United Houma Nation and the federally-recognized Chittimacha Tribe in southern Louisiana, depend on fishing, hunting, and gathering for at least part of their domestic subsistence. Commercial Vietnamese fishers also retain a quarter of their catch for family use and barter. Cumulative impacts to sociocultural systems occur when ongoing and future actions (OCS and non-OCS program) cause changes in local populations and social institutions or when jobs are lost or created. Subsistence practices have already been stressed by natural trends associated with climate change (e.g., flood control along the Mississippi River). Cumulative impacts on sociocultural systems in the GOM as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be moderate over the next 40 to 50 years.

The incremental contribution of routine operations under the Program to cumulative impacts in the GOM would be small, since they are more likely to support the existing industry than to create industry growth. Any expansion of deepwater activities will result in jobs that require longer, unbroken periods of work offshore, specialized skills, and potential in-migration of part of the workforce. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program would be small to medium, especially on localized intertidal resources used by subsistence harvesters. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be moderate to major if they were to occur, especially if oil from a CDE were to reach the shore. Such spills could lead to long-term closure of fisheries, resulting in social and cultural stress. GOM subsistence harvesters make up a relatively small segment of the coastal population and replacement food resources are more available than for subsistence harvesters in Alaska, so while the impact of the loss of subsistence resources would be moderate for the coastal population as a whole, it would be locally major for populations that depended on subsistence harvesting for a significant proportion of their diet.

4.6.5.4.7 Environmental Justice. In general, environmental justice impacts occur when any activity or trend (OCS program- or non-OCS program-related) results in adverse health or environmental impacts that are significantly high and disproportionately affect minority and low-income populations. A large number of minority and low-income individuals are located in the LMA counties along the GOM coast. In this region, the adverse effects of several hurricanes over the past decade are still being felt; these events have had high and disproportionate effects on minority and low-income populations, especially in terms of property damage and loss of income. These effects are considered to be long-term, if not irreversible, and will likely persist into the foreseeable future. Cumulative impacts could result from changes in the proximity of onshore oil and gas infrastructure and to marine vessel and aircraft traffic, especially when these changes occur in counties where there are minority and low-income populations composing 50% or more of the total county population, or are more than 20 percentage points higher than the State average. Ongoing and future oil and gas development would continue to affect low-income and minority populations in some regions of the GOM coast by increasing the proximity to existing oil and gas infrastructure and associated health, environmental, and visibility impacts. It is likely that hurricanes in the region will increase in frequency and increase in the coming decades. Given all these factors, cumulative impacts on minority and low-income populations are considered to be moderate to major.

Because of the long-established and well-developed oil and gas industry present in the GOM and the fact that an estimated 75% of activity from the Program would occur in deep and ultra-deep waters, routine operations under the Program are not expected to cause additional environmental justice concerns; their contribution to cumulative impacts on low-income and minority populations therefore would be negligible. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be negligible to medium because of the movement of oil and gas activities farther away from coastal areas and the demographic pattern of more affluent groups (and fewer low-income and minority populations) living in coastal areas. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in moderate to major impacts, depending on the location, size, and timing of the event.

4.6.5.4.8 Archaeological and Historical Resources. Onshore cultural resources are highly varied in coastal areas of the GOM. Prehistoric cultural resources range from small, temporary-use sites to substantial permanent settlements, some from the earliest known human occupation of the areas, about 12,000 years ago. Based on current water levels, it is likely that sites older than 3,000 years could be located underwater in the region. Offshore cultural resources mainly consist of shipwrecks dating from as early as the sixteenth century; however, other structures, such as the Ship Shoal Lighthouse, can also be found offshore. Studies have indicated that two-thirds of all shipwrecks in the northern GOM are located within 1.5 km (0.9 mi) of the shore, with the highest concentration of ships occurring in areas that experienced high-volume marine traffic. Shipwrecks are also thought to be concentrated in the open sea of the eastern GOM. To date, shipwrecks have been found in water depths of up to 1,981 m (6,500 ft). Cumulative impacts to these resources occur when operations involving bottom-disturbing activities (e.g., channel dredging) come into physical contact with artifacts or their site context, or as a result of natural phenomena such as waves, currents, and tropical storms. The cumulative impacts of ongoing and future activities (OCS and non-OCS) are not currently known, but could range from minor to moderate, mainly because activities occurring on the OCS prior to USDOI's survey requirement, which went into effect in 1973, may already have affected (i.e., damaged or destroyed) significant sites.

Routine operations under the Program could affect significant archaeological and historic resources, especially offshore resources, with construction activities such as platform and pipeline construction, and dredging, potentially damaging or destroying affected resources. Onshore impacts include resource damage or loss, or visual effects and are possible from pipeline landfall, onshore pipeline, and road construction. Anchor drags could adversely affect shipwrecks. Impacts could range from negligible to major, depending on the presence of significant archaeological or historic resources in the area of potential effect. The incremental contribution of routine operations under the Program could be negligible to large, depending on the presence of significant archaeological or historic resources in the area of potential effect. Archaeological surveys that would identify significant cultural resources to be avoided could reduce these impacts.

The incremental contribution of expected accidental oil spills associated with the Program (most of which are less than 1,000 bbl) to cumulative impacts on archaeological and historical resources in the GOM would be negligible to large, depending on the presence of significant resources in the area of potential effect and the spill location, timing, duration, and size. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from minor to major if it were to occur.

4.6.5.5 Summary for Alaska – Cook Inlet

4.6.5.5.1 Areas of Special Concern. The Alaska National Interest Lands Conservation Act of 1980 designated certain public lands in Alaska as National Parks, Wildlife Refuges, Wild and Scenic Rivers, for the National Wilderness Preservation and National Forest Systems. Many of these occur in the Cook Inlet region. Other Areas of Special Concern include MPAs, National Estuarine Research Reserves, National Estuary Program Areas, MUAs, and NOAA-designated HCAs. In addition, there are several State parks and recreation areas bordering Cook Inlet. Cumulative impacts on these resources result from activities that could potentially cause damage to or degradation of fauna or habitats within these areas. Ongoing and future activities or trends that affect Areas of Special Concern in or near Cook Inlet include fishing, diving, dredging operations, marine vessel traffic (and wakes), tankering, trash and debris accumulation (from various sources), onshore infrastructure (e.g., roads and vehicle traffic), and oil and gas development and infrastructure (e.g., pipeline landfalls and onshore facilities). Cumulative impacts on Areas of Special Concern in the Cook Inlet would be negligible to moderate. The impacts of activities taking place within the Areas of Special Concern located onshore, such as National Parks and National Forests, are regulated through permitting processes. The cumulative level of impacts from spills would be minor to major, depending on spill frequency, location, and size; the type of product spilled; weather conditions; effectiveness of cleanup operations; and other environmental conditions at the time of the spill.

Routine operations under the Program could result in negligible to medium incremental increases in effects on National Sanctuaries, Parks, Refuges, and Estuarine Research Reserves. Expected oil spills (most of which are less than 1,000 bbl) that occur during the Program could result in a negligible to small incremental contribution to cumulative impacts on Areas of Special Concern, depending on spill frequency, location, and volume; the type of product spilled; weather conditions; effectiveness of cleanup operations; and other environmental conditions at the time of the spill. Large spills (1,000 bbl and greater) or an unexpected, low-probability CDE in areas adjacent to the National Parks, NWRs, or National Forests, whether from OCS or non-OCS sources, would also depend on these factors, and could result in moderate impacts if they were to occur. Such spills could negatively impact coastal habitats and fauna, and could also affect subsistence uses, commercial or recreational fisheries, and tourism.

4.6.5.5.2 Population, Employment, and Income. Between 2005 and 2009, the Municipality of Anchorage had a population of 280,389, about 45% of the total population in Alaska. Employment is concentrated in Anchorage, which provides about 83% of employment in the region. The largest employing sectors in 2008 were in services, wholesale and retail trade, and State and local government. Oil and gas employment is concentrated in Anchorage, with a total of 8,636 workers employed directly in oil and gas extraction activities, pipeline and refinery activities, and support activities in 2007. Cumulative economic impacts result from direct employment and income created through the development of offshore oil and gas resources and the indirect employment and income produced through the spending of wages and salaries and from the procurement of materials and services in the region. Oil and gas development has created large increases in employment and income in the economy of Alaska as a whole, and has led to rapid increases in population. In-migration of workers and their families into the region produces population impacts. Small incremental increases in employment, income, and population are expected with the development of offshore oil and gas resources in the Cook Inlet region under the Program.

The cumulative impacts of future OCS program and ongoing and future non-OCS program activities would be considered beneficial because these activities would increase employment and earnings in the region over the next 40 to 50 years. The Program would add to these beneficial impacts, especially on the Kenai Peninsula and in Anchorage. The incremental contribution of the Program is expected to be small, however, because the added employment demands are less than 5% of baseline levels in Alaska. In areas with a large proportion of impact-sensitive industry (such as commercial and recreational fishing), the cumulative impacts of accidental oils spills could be moderate to major, depending on the total volume of oil reaching land, the land area affected, and the sensitivity of local environmental conditions to oil impacts. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be negligible to small relative to those associated with future OCS program and ongoing and future non-OCS program activities. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in minor to moderate impacts if they were to occur. In the short-term, impacts of a CDE could be large as a result of loss of employment, income, and property value; increased traffic congestion; increased cost of service provision; and possible shortages of commodities or services.

4.6.5.5.3 Land Use and Infrastructure. Anchorage is the State center for scheduled aircraft and the regional center for chartered aircraft. It has a cargo facility served by a railroad connecting it to Alaska's interior and the port of Seward and two military bases (Joint Base Elmendorf-Richardon). It is also the center for the State's overall road network. Much of the on-land infrastructure around Cook Inlet supports offshore oil and gas development; facilities/complexes include the Trading Bay production facility, the Tesoro Refinery, the Drift River Terminal, and the Nikiski complex (Agrium and ConocoPhillips LNG). Cumulative impacts on land use and infrastructure result from demands on roads, utilities, and public services and the need to develop additional onshore facilities to accommodate ongoing and future activities in the inlet. Oil spill response also places stresses on community infrastructure and increases traffic in the affected area. Cumulative impacts on land use and onshore resources could range from minor to major, depending on the nature and location of demands. These impacts are generally considered temporary.

The incremental contribution of routine operations of the Program to cumulative impacts in Cook Inlet would be small to medium because land use changes would be needed for new onshore pipeline construction and transportation network. Land use–related impacts resulting from expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program include stresses of spill response on community infrastructure, increased traffic in the response area (both onshore and offshore), and temporary restricted access to affected lands (while cleanup is conducted). Such spills would result in a small incremental contribution to cumulative impacts on land use and existing infrastructure. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in moderate impacts if they were to occur.

4.6.5.5.4 Commercial and Recreational Fisheries. Commercial fisheries of Cook Inlet and the Gulf of Alaska target groundfish, Pacific halibut, Pacific salmon, herring, crab, shrimp, clams, scallops, sea urchins, and sea cucumbers. The groundfish fisheries accounted for the largest share ($640 million, or about 48%) of the ex-vessel value of all commercial fisheries in Alaska in 2009. Recreational fishing in the Cook Inlet region includes marine sport fishing, freshwater fishing, and shellfish gathering activities, which contribute substantially to the area's economy. On the western bank of upper Cook Inlet, there are recreational fisheries for razor clams, several species of hardshell clams, and crab. Cumulative impacts on commercial and recreational fishing result from changes in commercial fishing costs with offshore oil and gas development and changes in accessibility of fishery resources. The cumulative impacts on commercial and recreational fisheries in Cook Inlet are considered to be minor.

The incremental contribution of routine operations under the Program to cumulative impacts in Cook Inlet would be small since these would be unlikely to have population-level effects on fishery resources or result in long-term loss of fishery resources. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be negligible to medium, depending on the location, timing, and volumes of spills (among other environmental factors). Small spills are unlikely to affect a large number of fish or have a substantial effect on recreational fishing before dilution and weathering reduced concentrations of oil in the water. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be moderate if they were to occur. Large spills or a CDE could have significant localized effects on commercial fishing as a result of reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods, and on recreational fishing as a consequence of contamination of fish tissues, degradation of aesthetic values that attract fishers, or temporary closure of fishing areas. Large spills or a CDE have a greater potential to contact intertidal habitat and subsequently contaminate or reduce the abundance of commercial and recreational species that depend on nearshore habitat.

4.6.5.5.5 Tourism and Recreation. Opportunities for recreational activities such as hunting, hiking, boating, wildlife viewing, and sightseeing are abundant in the Cook Inlet region. Visitors reach the area via tour ships and ferries, as well as helicopters, small aircraft, and fishing charters. The Kenai Peninsula and Prince William Sound receive the heaviest recreational use by residents and nonresidents, and are in close proximity to Cook Inlet and Anchorage. The Chugach National Forest attracts hikers, campers, and other users. Cumulative impacts on tourism and recreation result from changes in accessibility of beach and offshore resources for recreational use, and from increases in marine vessel and aircraft traffic in the vicinity of recreational resources; these impacts are expected to be minor.

The incremental contribution of routine operations under the Program to cumulative impacts in Cook Inlet would be small, with potential adverse aesthetic impacts on sightseeing, boating, fishing, and hiking activities in the inlet. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program would be negligible to small, depending on the size, location, and timing of the spill (being greatest if it occurred during the peak recreational season). Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be minor to moderate if they were to occur. Short-term impacts would include beach and coastal access restrictions; restrictions on visitation, fishing, or hunting while cleanup is being conducted; and aesthetic impacts associated with the event itself and with cleanup activities. Longer-term impacts could be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event.

4.6.5.5.6 Sociocultural Systems. The region surrounding Cook Inlet includes economically complex cities such as Anchorage and its suburbs, the largest urban community in the State; towns such as Kenai, Soldotna, and Nikiski that are centers of the oil and gas industry; smaller towns such as Port Lions that depend on commercial fishing; and small predominantly Alaska Native communities. Subsistence harvesting plays some role in communities of all types. Cumulative impacts to sociocultural systems occur when ongoing and future actions (OCS and non-OCS programs) cause changes in local populations and social institutions or when jobs are lost or created. Subsistence harvesting could also be affected by activities that affect marine fauna, such as increases in airborne or subsea noise (e.g., aircraft or marine vessel traffic, seismic surveys, drilling) or degradation of water quality (e.g., fuel or oil spills, chemical releases, or dredging operations that increase turbidity), or that necessitate changes in subsistence fishing practices. Cumulative impacts on sociocultural systems in Cook Inlet as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be minor to moderate over the next 40 to 50 years.

The incremental contribution of routine Program activities to cumulative impacts would be small, since they would not introduce new kinds of activities that would alter existing socioeconomic systems. In addition, the relatively small number of new residents that would come into the area because of the Program should likewise not alter existing sociocultural systems. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be small to large, especially in intertidal and estuarine zones used by subsistence harvesters. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be major if they were to occur, especially if resources important to subsistence harvesters, including intertidal resources, migrating fishes, and fishes with strong ties to the shore, were affected.

4.6.5.5.7 Environmental Justice. In general, environmental justice impacts occur when any activity or trend (OCS program- or non-OCS program-related) results in adverse health or environmental impacts that are significantly high and disproportionately affect minority and low-income populations. A large number of minority and low-income individuals live in the south-central Alaska region; however, the number of minority individuals in each of the local boroughs does not exceed 50% of the population and does not exceed the State average by 20 percentage points or more in any of the boroughs. Thus, there is no minority population in south central Alaska. Likewise, there are no low-income populations in any of the boroughs around Cook Inlet. Subsistence hunting and fishing are an important part of the economies in rural communities. Although there are no environmental justice concerns here, cumulative impacts on local communities could result from changes in the proximity of onshore oil and gas infrastructure and to marine vessel and aircraft traffic. Ongoing and future oil and gas development would continue to affect populations in some regions of Cook Inlet by increasing the proximity to existing oil and gas infrastructure and associated health, environmental, and visibility impacts. Given these factors, cumulative impacts on local populations are considered to be moderate to major.

The incremental contribution of routine operations under the Program to cumulative impacts in Cook Inlet would be small, depending on the proximity of onshore pipelines and offshore infrastructure to communities and their subsistence harvest areas, but are not expected to cause additional environmental justice concerns; their contributions to cumulative impacts on low-income and minority populations therefore would be negligible. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be negligible to small. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in moderate to major impacts on the Alaska Native population, especially if subsistence resources were diminished or tainted as a result of the spill. Mitigation measures, cooperative agreements between Native and industry groups, and government-to-government consultations are designed to limit the effects from oil spills and routine operations.

4.6.5.5.8 Archaeological and Historic Resources. Onshore archaeological and historic resources occur along the shoreline surrounding Cook Inlet; the predominant types of prehistoric features are house pits containing household and subsistence artifacts like stone lamps, sinkers, and arrowheads. Historic sites onshore consist of early Russian houses, churches, roadway inns, fish camps, and mining camps. Little research has been done to characterize prehistoric resources in the offshore waters of Cook Inlet; however, it is likely that high-energy tidal movement has removed at least some resources from their original resting place. The best-preserved shipwrecks are likely to be found on the OCS, because wave action and ice are less likely to contribute to the breakup of ships in deeper waters. Cumulative impacts to these resources occur when operations involving bottom-disturbing activities (e.g., channel dredging) come into physical contact with artifacts or their site context, or as a result of natural phenomena such as high-energy waves and currents, ice gouging, and thermokarst collapse. The cumulative impacts of future OCS and ongoing and future non-OCS activities are not currently known, but could range from minor to moderate, mainly because activities occurring on the OCS prior to USDOI's survey requirement, which went into effect in 1973, may already have affected (i.e., damaged or destroyed) significant sites.

Routine operations could affect significant archaeological and historic resources, especially offshore resources, with construction activities such as platform and pipeline construction potentially damaging or destroying affected resources. Onshore impacts include resource damage or loss, or visual effects and are possible from pipeline landfall, onshore pipeline, and road construction. Anchor drags could adversely affect shipwrecks. The incremental contribution of routine operations under the Program is could be negligible to large, depending on the presence of significant resources in the area of potential effect. Archaeological surveys that would identify significant cultural resources to be avoided could reduce these impacts.

The incremental contribution of expected accidental oil spills associated with the Program (most of which are less than 1,000 bbl) to cumulative impacts on archaeological and historical resources in Cook Inlet would be negligible to large, depending on the presence of significant resources in the area of potential effect and the spill location, timing, duration, and size. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from minor to major if they were to occur.

4.6.5.6 Summary for Alaska – Arctic

4.6.5.6.1 Areas of Special Concern. The Alaska National Interest Lands Conservation Act of 1980 designated certain public lands in Alaska as National Parks, Wildlife Refuges, Wild and Scenic Rivers, and as designated for the National Wilderness Preservation and National Forest Systems. Some of these occur in the Arctic region. Other Areas of Special Concern include MPAs; there are no MUAs, National Estuarine Research Reserves, National Estuary Program Areas, or NOAA-designated HCAs in or adjacent to the Beaufort Sea or Chukchi Sea Planning Area. Cumulative impacts on these resources result from activities that could potentially cause damage to or degradation of fauna or habitats within these areas. Ongoing and future activities or trends that affect Areas of Special Concern in or near Arctic waters include fishing, diving, dredging operations, marine vessel traffic (and wakes), tankering, trash and debris accumulation (from various sources), onshore infrastructure (e.g., roads and vehicle traffic), and oil and gas development and infrastructure (e.g., pipeline landfalls and onshore facilities). Cumulative impacts on Areas of Special Concern in Arctic waters would be negligible to moderate. The impacts of activities taking place within the Areas of Special Concern located onshore, such as National Parks and National Forests, are regulated through permitting processes. The cumulative level of impacts from spills would be minor to major, depending on spill frequency, location, and size; the type of product spilled; weather conditions; effectiveness of cleanup operations; and other environmental conditions at the time of the spill.

Routine operations under the Program could result in negligible to medium incremental increases in effects on National Parks and Wildlife Refuges. Expected oil spills (most of which are less than 1,000 bbl) that occur during the Program could result in a negligible to small incremental contribution to cumulative impacts on Areas of Special Concern, depending on spill frequency, location, and volume; the type of product spilled; weather conditions; effectiveness of cleanup operations; and other environmental conditions at the time of the spill. Large spills (1,000 bbl and greater) or an unexpected, low-probability CDE in areas adjacent to the National Parks, NWRs, or National Forests, whether from OCS or non-OCS sources, would also depend on these factors, and could result in moderate impacts if they were to occur. Such spills could negatively impact coastal habitats and fauna, and could also affect subsistence uses.

4.6.5.6.2 Population, Employment, and Income. Population in the North Slope Borough is concentrated in Barrow, with a population of 4,078 between 2005 and 2009. Unemployment, especially in smaller villages, is high, especially during the winter when there is little alternate market-based activity; however, subsistence-related transactions play a key role in the economic well-being of those living in these communities. The largest employing sectors in 2008 were mining (including oil and gas), services, and State and local government. Oil and gas employment is relatively small, mainly because large numbers of oil and gas workers in the Arctic region reside in other parts of Alaska and the United States, relocating temporarily to work locations in the Arctic, as needed. The oil and gas industry employed about 7,540 workers who were employed directly in oil and gas extraction activities, pipeline and refinery activities, and support activities in 2007. Cumulative economic impacts result from direct employment and income created through the development of offshore oil and gas resources and the indirect employment and income produced through the spending of wages and salaries and from the procurement of materials and services in Alaska as a whole. In-migration of workers and their families into the region produces population impacts. Oil and gas development has created large increases in employment and income in the economy of Alaska as a whole, and has led to rapid increases in population. Small incremental increases in employment, income, and population in Alaska as a whole are expected with the development of offshore oil and gas resources in the Arctic region under the Program.

The cumulative impacts of future OCS program and ongoing and future non-OCS program activities would be considered beneficial because these activities would increase employment and earnings in the region over the next 40 to 50 years (although rural Alaskan employment in the petroleum industry, especially among Alaska Natives, would likely remain relatively low). The Program would add to these beneficial impacts. The incremental contribution of routine operations under the Program is expected to be small, however, because the added employment demands are less than 10% of total Alaska employment. The cumulative impacts of accidental oil spills could be minor to major, depending on the total volume of oil reaching land, the land area affected, and the sensitivity of local environmental conditions to oil impacts. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be negligible to small relative to those associated with ongoing and future OCS program and non-OCS program activities. Large spills (1,000 bbl or greater) or an unexpected CDE could result in minor to moderate impacts. In the short-term, impacts of a CDE could be large as a result of loss of employment, income, and possible shortages of commodities or services in both coastal and inland areas affected by the spill.

4.6.5.6.3 Land Use and Infrastructure. Land use in much of the Arctic region is not intense, with oil and gas-related development (onshore and offshore in State waters) and subsistence being the predominant uses. There are only a few small communities in the area, the largest of which is Barrow. Barrow is the economic, transportation, and administrative center for the North Slope Borough. Transportation-related infrastructure is minimal, but concentrated in the Prudhoe Bay oil field area. Marine shipping to North Slope communities is by barge and by lightering of cargo to shore because of the shallow coastal waters and the lack of dredging and heavy-lift equipment. Paved and unpaved roads are generally limited to the area within communities. During the winter, many residents travel by snowmobile. Airports and related service facilities are also limited. Most of the oil and gas-related infrastructure in the Arctic region is along the Beaufort Sea coastline. The Prudhoe Bay/Kuparuk oil field infrastructure is served by about 480 km (300 mi) of interconnected gravel roads, 640 km (400 mi) of pipeline routes, and related processing and distribution facilities. Cumulative impacts on land use and infrastructure result from demands on roads, utilities, and public services and the need to develop additional onshore facilities to accommodate ongoing and future activities in the region. Oil spill response also places stresses on community infrastructure and increases traffic in the affected area. Cumulative impacts on land use and onshore resources could range from minor to major, depending on the nature and location of demands. These impacts are generally considered temporary.

The incremental contribution of routine operations under the Program to cumulative impacts in the Arctic region would be small to medium because of land use changes needed for new onshore pipeline construction and transportation network. Land use–related impacts resulting from expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program include stresses of spill response on community infrastructure, increased traffic in the response area (both onshore and offshore), and temporary restricted access to affected lands (while cleanup is conducted). Such spills would result in a small incremental contribution to cumulative impacts on land use and existing infrastructure. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in moderate to major impacts.

4.6.5.6.4 Commercial and Recreational Fisheries. There currently is no commercial fishing and little data on recreational fishing in the Beaufort or Chukchi Seas (although the North Pacific Fishery Management Council has concluded that there are few recreational fisheries in these waters). Sport fishing likely occurs in coastal areas of larger population centers such as Barrow. Subsistence fishing is widespread in coastal areas of the Arctic; fisherman target Pacific herring, Dolly Varden char, whitefish, Arctic cod, and sculpin. Given the importance of fishing to local communities in the Arctic region, the most important cumulative impacts would result from any activities that cause a decline in fish availability for subsistence harvest. The cumulative impacts on recreational (and subsistence) fisheries in Arctic waters are considered to be moderate to major.

The incremental contribution of routine Program activities to cumulative impacts would be small, since routine operations under the Program would not occur in the immediate area where fisheries are located. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program would be medium, depending on the location, timing, and volumes of spills (among other environmental factors). Small spills are unlikely to affect a large number of fish or have a substantial effect on fishing before dilution and weathering reduced concentrations of oil in the water. Impacts associated with large spills (1,000 bbl or greater) and unexpected, low-probability CDEs could be moderate if they were to occur. Large spills or an unexpected, low-probability CDE could have significant localized effects on fishing as a result of reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods, and on recreational fishing as a consequence of contamination of fish tissues, degradation of aesthetic values that attract fishers, or temporary closure of fishing areas. Large spills or a CDE have a greater potential to contact intertidal habitat and subsequently contaminate or reduce the abundance of commercial and recreational species that depend on nearshore habitat.

4.6.5.6.5 Tourism and Recreation. Tour groups to the North Slope Borough make up most of the nonresidential recreational activity. Most visitors stay in Barrow or Deadhorse. Travel to these areas is primarily by air, although bus tours occasionally arrive via the Dalton Highway. Hikers and river rafters also visit the Arctic National Wildlife Refuge and other areas using scheduled or chartered airplanes for access. An increasing number of cruise ships are entering the Chukchi and Beaufort Seas. Cumulative impacts on tourism and recreation result from disruptions to land-based activities, increases in the trash and debris accumulation, and competition between workers and tourists for local services, such as air transport and hotel accommodations; these impacts are expected to be moderate to major.

The incremental contribution of routine operations under the Program to cumulative impacts would be small, with potential adverse aesthetic impacts on sightseeing, hiking, and rafting activities. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program would be negligible to small, depending on the size, location, and timing of the spill (being greatest if it occurred during the peak recreational season). Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be minor to moderate if they were to occur. Short-term impacts would include beach and coastal access restrictions; restrictions on visitation, fishing, or hunting while cleanup is being conducted; and aesthetic impacts associated with the event itself and with cleanup activities. Longer-term impacts could be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event.

4.6.5.6.6 Sociocultural Systems. Most of the sparsely populated rural lands in the Arctic region are inhabited by indigenous Alaskans. Barrow is the largest permanent community on the North Slope and serves as the administrative and commercial hub of the region. The Alaska Natives living in communities along the coast of the Beaufort and Chukchi Seas are primarily Iñupiaq Eskimo. Alaska Native communities along the Arctic coast are heavily dependent on subsistence harvesting of sea mammals, fish, and terrestrial fauna. Enclaves of workers at Prudhoe Bay and nearby oil fields are employed by the oil and gas industry. They commute from mostly south central Alaska, Fairbanks, and States outside of Alaska. For the most part, these two communities (Alaska Native communities and worker enclaves) have had little interaction because of the physical distance that separates them. Cumulative impacts to sociocultural systems occur when ongoing and future actions (OCS and non-OCS program) cause changes in local populations and social institutions or when jobs are lost or created. Subsistence harvesting could also be affected by activities that affect marine fauna, such as increases in airborne or subsea noise (e.g., aircraft or marine vessel traffic, seismic surveys, drilling) or degradation of water quality (e.g., fuel or oil spills, chemical releases, or dredging operations that increase turbidity), or that necessitate changes in subsistence fishing practices. Cumulative impacts on sociocultural systems in the Arctic Planning Areas as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be moderate over the next 40 to 50 years.

The incremental contribution of routine operations under the Program to cumulative impacts would range from small to medium, especially if subsistence-related activities, central to the well-being of Alaska Natives who inhabit the area, are affected. Many of these potential effects are mitigatable. Onshore linear features (e.g., pipelines and roads) affect the migration patterns of terrestrial mammals. Because of the high level of dependence on subsistence harvesting, the incremental contribution of the Program to cumulative impacts on subsistence activities near the Beaufort and Chukchi Seas would be expected to be small to medium. Effects would be major only if important resources were eliminated or made unavailable. Design stipulations and operational procedures could reduce the impact of onshore development.

The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be small to medium, depending on the location, volume, and timing (i.e., season) of the spill. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be major if they were to occur, especially if they disrupt sea mammal harvest or resulted in the IWC reducing or eliminating whale quotas in the Alaska Arctic. A CDE would prove challenging for existing response capacity and capability, especially if the spill were under ice or in broken ice. The cleanup process itself has the potential to cause displacement of subsistence resources and subsistence hunters, and would have major impacts in the short term depending on the timing and duration of the displacement. The associated influx of cleanup workers would likely overwhelm the resources of local communities and could result in cross-cultural conflicts.

4.6.5.6.7 Environmental Justice. In general, environmental justice impacts occur when any activity or trend (OCS program or non-OCS program related) results in adverse health or environmental impacts that are significantly high and disproportionately affect minority and low-income populations. A large number of minority and low-income individuals are located in the Arctic region, although the number of low-income individuals does not exceed 50% of the total population (thus there is no low-income population in the region). Subsistence hunting and fishing are an important part of the economies in Arctic communities. Cumulative impacts on local communities could result from changes in the proximity of onshore oil and gas infrastructure and to marine vessel and aircraft traffic. Ongoing and future oil and gas development would continue to affect populations in some regions along the Beaufort and Chukchi Seas by increasing the proximity to existing oil and gas infrastructure and associated health, environmental, and visibility impacts. Given these factors, cumulative impacts on local populations are considered to be moderate to major.

The incremental contribution of routine operations under the Program to cumulative impacts in the Arctic region would be negligible small, depending on the proximity of onshore pipelines and offshore infrastructure to communities and their subsistence harvest areas, but are not expected to cause additional environmental justice concerns; their contribution to cumulative impacts on low-income and minority populations therefore would be small. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be negligible to small. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in moderate to major impacts on the Alaska Native population, especially if subsistence resources were diminished or tainted as a result of the spill. Mitigation measures, cooperative agreements between Native and industry groups, and government-to-government consultations are designed to limit the effects from oil spills and routine operations.

4.6.5.6.8 Archaeological and Historic Resources. At the height of the late Wisconsinan glacial advance, about 19,000 years ago, the global sea level was much lower than at present, which created land bridges between the North American and Asian continents. During this time, large expanses of the OCS were exposed as dry land and shorelines shifted depending on the location of ice. These relict shorelines (and other relevant landforms) are currently inundated. Some studies indicate that ice gouging may have altered the seafloor in the Arctic region, removing all archaeological evidence of the first peoples; however, the extent of the disturbance is not known. To date, studies have been done in the Beaufort Sea, but more will be needed to fully understand the potential for significant artifacts to be present. Numerous shipwrecks have been documented in the Beaufort and Chukchi Seas. Most of these were associated with commercial whaling that occurred in the region between 1849 and 1921. Most of the shipwrecks are likely to be in State waters. There are significant onshore historic sites in the Arctic region; these include Cold War–era outposts, radar stations, and missile sites, and the Ipiutak Site National Historic Landmark at Point Hope, among others. Cumulative impacts to these resources occur when operations involving bottom-disturbing activities (e.g., channel dredging) come into physical contact with artifacts or their site context, or as a result of natural phenomena such as high-energy waves and currents, ice gouging, and thermokarst collapse. The cumulative impacts of future OCS and ongoing and future non-OCS activities are not currently known, but could range from minor to moderate, mainly because activities occurring on the OCS prior to USDOI's survey requirement, which went into effect in 1973, may already have affected (i.e., damaged or destroyed) significant sites.

Routine operations could affect significant archaeological and historic resources, especially offshore resources, with construction activities such as platform and pipeline construction potentially damaging or destroying affected resources. Onshore impacts include resource damage or loss, or visual effects, and are possible as a result of pipeline landfall, onshore pipeline, and road construction. Anchor drags could adversely affect shipwrecks. Impacts could range from negligible to major, depending on the presence of significant archaeological or historic resources in the area of potential effect. The incremental contribution of routine operations under the Program could be negligible to large, depending on the presence of resources in the area of potential effect. Archaeological surveys that would identify significant cultural resources to be avoided could reduce these impacts.

The incremental contribution of expected accidental oil spills associated with the Program (most of which are less than 1,000 bbl) to cumulative impacts on archaeological and historical resources in Arctic waters would be small to large, depending on the presence of significant resources in the area of potential effect and the spill location, timing, duration, and size. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from minor to major if they were to occur.

4.6.6 Cumulative Impacts Summary Tables

Anticipated trends and conclusions concerning cumulative impacts for the GOM, Cook Inlet, and Arctic regions, and the Program's incremental contribution to cumulative impacts in these regions, are summarized in Tables 4.6.6-1 (GOM), 4.6.6-2 (Cook Inlet), and 4.6.6-3 (Arctic region). Impact conclusions for potential cumulative impacts on each resource or system are provided in the second column of these tables using the same four-level classification scheme (negligible, minor, moderate or major) as was used for the direct/indirect impacts analyses (see Section 4.1.4). The incremental contribution of the 2012-2017 Program to cumulative impacts on a given resource or system, presented in the third column, is characterized in terms of small, medium, and large. The incremental contribution only takes into account effects from routine operations and expected accidental events and spills under the Program. A potential CDE that may occur in the future (an unexpected, low-probability event) from operations associated with past or future 5-year programs or other cumulative actions is described principally in terms of its direct and indirect impact (if it were to occur) in the body of analysis and is not incorporated into the overall effects or incremental contribution conclusions. In the case of the GOM, the 2010 DWH event has been accounted for in the cumulative impacts analysis as part of the existing baseline.

TABLE 4.6.6-1 Summary of Cumulative Impacts and Incremental Contributions of the Program – Gulf of Mexico

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Water Quality	There are many factors affecting the water quality in the GOM currently and all of these factors are expected to continue into the foreseeable future. In general, these include marine vessel traffic, wastewater discharge, dredging and marine disposal, oil and gas production (in State waters and on the OCS), military operations, LNG terminal operations, LOOP operations, and natural oil seepage along the continental slope. Coastal waters are also affected by numerous other factors, including river inflows, urbanization, agricultural practices, municipal waste discharges, and coastal industry. Climate change is also expected to affect water quality in the coming decades, especially in terms of surface temperature, salinity, vertical stratification, and pH. Another issue of importance to water quality in the GOM concerns an area known as the hypoxic zone, a zone of oxygen depletion (due to high nutrient loads) which is located at the bottom of the continental shelf of Louisiana and Texas. Cumulative impacts on water quality are attributed to a combination of all these factors and, overall, are considered to be **moderate**.	The incremental contribution of routine operations under the Program would be **small** to **medium**. Compliance with NPDES permits and USCG regulations would reduce the magnitude of most impacts. The effects of expected accidental oil spills (most of which are less than 1,000 bbl) would depend upon weather and sea conditions at the spill site, the type of oil spilled, the depth of the spill event, and the volume and rate of spillage; therefore, the incremental contribution of expected oil spills to cumulative water quality impacts could range from **small** to **large**. Water quality impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from **moderate** to **major** if it were to occur. Spill response and cleanup activities could also contribute to water quality impacts.
Air Quality	The ambient air quality in coastal counties along the GOM is relatively good. Coastal counties are in attainment for all criteria pollutants except 8-hr ozone (in some areas of Texas and Louisiana). Most of the human-caused visibility degradation is attributed to sulfate particles, but also to organic or elemental carbon particles, and nitrate particles. The effects of various USEPA regulations and standards are expected to result in a steady, downward trend in future air emissions in the coming decades. Cumulative impacts on air quality in the GOM region are attributed to both offshore and onshore activities. Offshore activities in the GOM are mainly associated with the oil and gas industry, but also include various marine vessel traffic (shipping, fishing, cruise ships), tanker lightering, and military operations. Onshore emission sources include power generation, industrial processing, manufacturing, refineries, commercial and home heating, on-road	The incremental contribution of routine operations under the Program would be **small**, because they would not cause exceedance of the NAAQS in public access areas or affect visibility. The effects of expected accidental oil spills (most of which are less than 1,000 bbl) would be localized and temporary due to dispersion; therefore, the incremental contribution of expected oil spills to cumulative air impacts could range from **small** to **medium**. Air quality impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could be **moderate** if it were to occur. Spill response and cleanup activities could also contribute to air quality impacts.

TABLE 4.6.6-1 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Air Quality (Cont.)	vehicles, and non-road engines (e.g., aircraft, locomotives, and construction equipment). Cumulative impacts on air quality in the GOM over the next 40 to 50 yr are expected to be **minor** to **moderate**.	
Acoustic Environment	Sources of ambient noise in the GOM include wind and wave activity, precipitation (rain and hail), lightening, biological noise, and distant marine vessel traffic. The main sources of anthropogenic noise in the GOM are numerous and include marine vessel traffic, dredging, construction, oil and gas activities (exploration, development, and production), marine mineral mining, geophysical survey, sonar, explosions, and ocean science studies. The quality of the acoustic environment in the GOM would continue to be adversely affected by ongoing and future OCS and non-OCS activities. The magnitude of cumulative impacts on the GOM acoustic environment is time- and location-specific and could range from **minor** to **major**, depending on the ambient acoustic conditions and the nature and combination of noise sources from all OCS and non-OCS activities in the GOM. See also Marine Mammals (this table).	The contribution of routine operations under the Program to cumulative impacts would vary with time and location could range from **small** to **medium** and would depend on the characteristics of the noise sources present. The incremental increase in adverse acoustic environmental impacts from expected accidental oil spills in GOM waters (mainly due to noise sources associated with response and cleanup) would be localized and temporary; therefore, the incremental contribution of expected oil spills (most of which are less than 1,000 bbl) to cumulative noise-related impacts would be **small**. Noise-related impacts associated with an unexpected, low-probability CDE could range from **minor** to **moderate** if it were to occur.
Coastal and Estuarine Habitats		
Barrier Beaches and Dunes	Cumulative impacts result from factors that reduce sediment input to downdrift areas and increase erosion of beaches and dunes. Past actions such as channelization and diversion of Mississippi River flows (through dams and reservoirs) and beach stabilization projects (using groins, jetties, and seawalls) have contributed to sediment deprivation and submergence of coastal lands, and these actions are expected to continue into the foreseeable future. Ongoing and future actions/trends that affect barrier beaches and dunes include those related to oil and gas development in State waters, coastal development (onshore industry and wastewater discharge), marine vessel traffic, recreation, and climate change. Cumulative impacts on barrier beaches and dunes are expected to be **moderate** to **major**.	Routine operations under the Program would result in minor localized impacts primarily due to facility construction, pipeline trenching and landfalls, channel dredging, and vessel traffic. The contribution of the Program to cumulative impacts on beaches and dunes therefore would generally be **small** to **medium**. The incremental impacts of expected accidental oil spills associated with the Program would be **negligible** to **large**, depending on the location, timing, duration, and size of the spill; the proximity of the spill to particular habitats; and the timing and nature of spill containment and cleanup activities. The majority of these spills would be small (less than 50 bbl) and most of them would not likely contact and affect coastal and estuarine habitats.

TABLE 4.6.6-1 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Barrier Beaches and Dunes (Cont.)		Large oil spills (1,000 bbl or greater) or an unexpected, low-probability CDE have the greatest potential to affect extensive areas of shoreline and coastal and estuarine habitats. Although these are rare events, the impacts of such releases on coastal and estuarine habitats could range from **moderate** to **major** if they were to occur.
Wetlands	Cumulative impacts result from direct elimination of wetland habitat by excavation or filling, reduction of sediment inputs, erosion of wetland substrates, and degradation of wetland communities (by reduced water quality or hydrologic changes). Losses of coastal wetlands have been occurring along the GOM coast for decades (especially in Louisiana) and are expected to continue into the foreseeable future. Ongoing and future actions/trends that affect wetlands include those related to oil and gas development in State waters, coastal development (onshore industry and wastewater discharge), marine vessel traffic, dredging/disposal operations, and climate change. Cumulative impacts on coastal wetlands are expected to be **moderate** to **major**.	Same as for barrier beaches and dunes.
Seagrass Beds	Most seagrass beds are in the Eastern GOM where there are no past or present OCS activities and none proposed as part of the Program. The distribution of seagrass beds in coastal waters of Western and Central GOM has diminished in recent decades, possibly due to increased turbidity caused by marine vessel traffic in shallow waters. Ongoing and future actions/trends that affect seagrass habitats include onshore development, commercial and recreational fishing (trawling and anchoring), marine vessel traffic (anchoring), recreation (diving), and climate change. Cumulative impacts on seagrass beds are expected to be **moderate** to **major**.	Same as for barrier beaches and dunes.

TABLE 4.6.6-1 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Benthic and Pelagic Habitats	Cumulative impacts on benthic and pelagic habitats result from activities that disturb ocean bottom or marine habitats, increase sediment suspension (turbidity), degrade water quality, or affect the food supply of biota depending on these resources. Ongoing and future actions/trends that affect these habitats include oil and gas activities in State waters, commercial shipping (including tankers), dredging/disposal operations, anchoring, and climate change. Cumulative impacts on benthic and pelagic habitats are considered to be **moderate** to **major**.	Routine operations under the Program in the GOM could result in mainly temporary and localized impacts from ground disturbance during drilling and pipeline and platform placement, as well as the discharge of drilling muds and cuttings and produced water (sensitive habitats could have long term affects depending on their proximity to these activities). The incremental contribution to cumulative impacts on marine benthic habitats would range from **negligible** to **medium** and would be limited by existing mitigation measures. The incremental impacts of expected accidental oil spills on benthic habitats (most of which are less than 1,000 bbl) would range from **negligible** to **small**, depending on the size, duration, timing, and location of the spill, and the nature (i.e., sensitivity) of the benthic habitat contacted by oil. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could range from **minor** to **moderate** if they were to occur. Major impacts to coral reef habitats could occur if the Flower Gardens Banks are heavily oiled and high mortality occurs.
Essential Fish Habitat	Cumulative impacts on EFH result from any activities that kill managed fish species, disturb ocean bottom habitats, increase sediment suspension (turbidity), degrade water quality, or affect the food supply for fishery resources. Ongoing and future actions/trends that affect EFH include commercial fishing, commercial shipping (and other marine vessel traffic), land development, water quality degradation, dredge/fill and disposal operations, the construction of channel stabilization structures, and climate change. Cumulative impacts on EFH are considered to be **moderate** to **major**.	Routine operations under the Program in the GOM could result in moderate short- and long-term impacts to EFH and managed species, mainly as a result of bottom disturbance during the placement of pipelines and production platforms. The incremental contribution to cumulative impacts on EFH would be **negligible** to **medium** and would be limited by specific lease stipulations. The incremental impacts of expected accidental oil spills on EFH (most of which are less than 1,000 bbl) would range from **negligible** to **medium** depending on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could result in **moderate** to **major** impacts if they were to occur.

TABLE 4.6.6-1 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Marine and Coastal Fauna		
Marine Mammals	All marine mammals in U.S. waters are protected under the *Marine Mammal Protection Act of 1972*. In the GOM, there are 21 species of cetaceans and one species of Sirenian. Their distribution and abundance is influenced by oceanographic circulation patterns (which is largely wind-driven, but with localized effects from freshwater discharge). Ongoing and future activities or phenomena that affect marine mammals include oil and gas development in State waters, natural phenomena (e.g., hurricanes and diseases), vessel traffic, commercial fishing, pollution, military operations, catastrophes, climate change, and invasive species. Cumulative impacts on marine mammals are considered to be **minor** to **moderate**.	Routine oil and gas-related activities (e.g., seismic surveys, facility construction, normal operations, and, eventually, decommissioning) would result in minor to moderate impacts on marine mammals. Impacts on marine mammals from these activities could include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. The contribution of Program activities to cumulative impacts on marine mammals would be **negligible** to **medium**. The incremental impacts of expected accidental oil spills (most of which are less than 1,000 bbl) would be **small** to **large**, depending on the location, timing, and volume of the spills; the environmental settings of the spills; and the species exposed to the spills. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from **moderate** to **major** if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.
Terrestrial Mammals	The terrestrial mammals considered here are federally endangered GOM coast beach mouse subspecies and the federally endangered Florida salt marsh vole. Present beach mice habitat is no longer of optimal quality because of historical beach erosion, habitat loss and fragmentation from beach front development, and tropical storm damage. Ongoing and future activities or phenomena that affect terrestrial mammals include oil and gas development in State waters, natural phenomena (e.g., hurricanes and tropical storms), industrial and residential development, vehicle traffic, recreation, trash and debris, artificial lighting, climate change (including sea-level rise), and invasive and feral species. Cumulative impacts on terrestrial mammals are considered to be minor to moderate. Cumulative impacts on terrestrial mammals are considered to be **minor** to **moderate**.	Routine oil and gas-related activities (e.g., facility construction, normal operations, and, eventually, decommissioning) are not expected to significantly affect the four federally endangered beach mouse subspecies and the federally endangered Florida salt marsh vole. Negligible to minor impacts may result from consumption of or entanglement in beach trash and debris originating from Program activities. The contribution of the Program activities to cumulative impacts therefore would be **negligible** to **medium**. The incremental impacts of expected accidental oil spills (most of which are less than 1,000 bbl) on these terrestrial mammals would be **small** to **large**, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding

TABLE 4.6.6-1 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Terrestrial Mammals (Cont.)		and other important habitats; the timing and nature of spill containment; and the status of the affected animals. An unexpected, low-probability CDE has a greater potential to affect the habitats of beach mice and the Florida salt marsh vole; therefore, impacts could range from **moderate** to **major** if it were to occur. Oil impacts on beach mice would be more likely if a storm surge transports the oil over foredunes.
Marine and Coastal Birds	The GOM is an important pathway for migratory birds. Most migrant birds either directly cross the GOM or move north or south by traversing the GOM or the Florida peninsula. There is a diverse range of habitats that support migratory and resident bird species along the northern GOM coast. Cumulative impacts result from direct injury or mortality of marine and coastal birds due to collisions with onshore and offshore structures, ingestion of trash or debris, or exposure to discharges or emissions; loss or degradation of habitat due to coastal development, climate change, or construction and operations activities; and behavioral disturbance due to commercial and recreational boating and small aircraft traffic. Many bird species are currently experiencing a loss or degradation of habitat due to land development and climate change and these impacts are expected to continue into the foreseeable future. Ongoing and future actions/trends that affect marine and coastal birds include those related to oil and gas development in State waters, coastal development, vessel traffic, dredging operations, and climate change. Cumulative impacts on marine and coastal birds are considered to be **moderate**.	Routine operations may result in localized short-term impacts due to infrastructure construction and marine vessel and aircraft traffic. The contribution of Program activities to cumulative impacts on marine and coastal birds therefore would be **negligible** to **medium**. The incremental contribution of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on marine and coastal birds would be **small** to **large**, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and nesting areas; the timing and nature of spill containment; and the status of the affected birds. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from **moderate** to **major** if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.

TABLE 4.6.6-1 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Fish	Fish in the northern GOM live in the water column (pelagic) and on the seafloor or near bottom waters (demersal) along the gradient from the continental shelf to the abyssal plain. Demersal species are much more abundant and diverse in the hard-bottom habitats found in the eastern GOM. Some fish migrate between saltwater and freshwater habitats. For example, anadromous species (such as the Gulf sturgeon and striped bass) spend most of their adulthood in saltwater but spawn in freshwater; catadromous species (such as the American eel) live primarily in freshwater and spawn in saltwater. Cumulative impacts result from OCS and non-OCS activities that generate lethal or sublethal impacts to individuals as well as habitat loss or degradation. Ongoing and future actions/trends that affect fish include oil and gas development in State and Federal waters, commercial and recreational fishing, noise, dredging and trawling operations, explosive platform removal, land loss, and coastal hypoxia. Climate change is also expected to affect fish habitat, productivity, and community structure. Cumulative impacts on fish are considered to be **moderate** to **major**.	The incremental contribution of routine Program activities to these impacts (primarily as a result of disturbance affecting demersal fishes) would be **negligible** to **small**, with the severity of impacts generally decreasing with distance from the disturbance (and a **negligible** contribution to impacts on threatened or endangered fish species). The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on fish would be **negligible** to **medium**, depending on the location, timing, duration, and volume of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range up to **moderate** if it were to occur.
Reptiles	Five species of sea turtles are known to inhabit the GOM. The federally protected American crocodile also lives in the eastern GOM, along Florida's southern coast (in mangrove swamps, brackish bays, and inshore freshwater habitats). Hurricanes in 2005 adversely affected sea turtle nesting sites; and the DWH event caused sea turtle mortality and fouling of habitats. Cumulative impacts on sea turtles result from OCS and non-OCS activities that generate lethal and sublethal impacts that alter or eliminate habitat required for reproduction, feeding, and early life stage development. Ongoing and future actions/trends that affect sea turtles and crocodiles in the GOM include climate change, OCS activities and non-OCS activities such oil and gas development in State and Federal waters, marine vessel traffic, coastal development, dredging, commercial fishing, and land loss. Cumulative impacts on sea turtles are considered to be **moderate** to **major**.	The incremental contribution of routine Program activities to these impacts would be **small** to **medium**, because population-level impacts are not expected. Expected accidental oil spills under the Program (most of which are less than 1,000 bbl) would result in a **negligible** to **medium** incremental increase in the overall impact of exposure to oil from other anthropogenic activities (such as spills from foreign tankers) because such spills are relatively easy to contain and would only affect small areas of habitat (and few individuals). However, large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could potentially result in population-level effects. Although such spills are rare events, impacts could be **major** and long-term if multiple individuals and their habitat (especially nesting habitat) are exposed to oil.

TABLE 4.6.6-1 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Lower Trophic Levels and Invertebrates	Invertebrates (animals without a backbone) occupy multiple habitat types from the intertidal zone to the deep sea. Benthic invertebrates burrow into bottom sediments or move along the sediment surface; pelagic invertebrates either drift with the current or actively swim. In the GOM, invertebrates and lower trophic level organisms include prokaryotes, viruses, protozoa, sponges, jellyfish, worms, mollusks (bivalves, squid, octopi), echinoderms (sea urchins and sea star), and crustaceans (barnacles, crabs, shrimp) among others. Cumulative impacts on invertebrates and lower trophic organisms result from activities that generate lethal or sublethal impacts on individuals as well as habitat loss or degradation. Cumulative impacts result from OCS and non-OCS activities that generate lethal or sublethal impacts to individuals as well as habitat loss or degradation. Ongoing and future actions/trends that affect invertebrates in the GOM include oil and gas development in State and Federal waters, dredging, trawling, land loss, coastal hypoxia, and climate change. Cumulative impacts on invertebrates in the GOM are considered to be **moderate** to **major**.	The contribution of the Program to cumulative impacts (mainly due to bottom-disturbing activities) would be **negligible** to **medium** (with **negligible** impacts to the ESA elkhorn coral), with the severity of the impacts generally decreasing with distance from bottom-disturbing activities. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on invertebrates would be **negligible** to **small**, depending on the location, timing, duration, and size of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could range up to **moderate** if they were to occur.
Areas of Special Concern	In the GOM, Areas of Special Concern are federally managed areas such as marine protected areas, National Marine Sanctuaries, National Parks, and National Wildlife Refuges. A number of other locations have been given special designations by Federal, State, and nongovernmental organizations; these include the National Estuarine Research Reserves, National Estuary Program Sites, and the Military and NASA Use Areas. Cumulative impacts on these resources result from activities that could potentially cause damage to or degradation of fauna or habitats within these areas. Ongoing and future activities or trends that affect these areas in/near the GOM include fishing, diving, dredging operations, marine vessel traffic (and wakes), tankering, trash and debris accumulation (from various sources), onshore infrastructure (e.g., roads and vehicle traffic), and oil and gas development and infrastructure (e.g., pipeline landfalls and onshore facilities). Extreme weather events such as hurricanes and tropical storms also occur regularly in the	Routine operations under the Program could result in a **negligible** to **medium** incremental increase in effects on Areas of Special Concern. Expected oil spills (most of which are less than 1,000 bbl) that may occur during the Program could result in a **negligible** to **small** incremental contribution to cumulative impacts on Areas of Special Concern, depending on spill frequency, location, and volume; the type of product spilled; weather conditions; effectiveness of cleanup operations; and other environmental conditions at the time of the spill. Large spills (1,000 bbl and greater) or an unexpected, low-probability CDE in areas adjacent to the National Parks, NWRs, or National Forests, whether from OCS or non-OCS sources, would also depend on these factors, and could result in **moderate** impacts if they were to occur. Such spills could negatively impact the FGBNMS and coastal habitats and fauna, and could also affect

TABLE 4.6.6-1 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Areas of Special Concern (Cont.)	GOM region and potentially cause damage by increasing shoreline erosion. Climate change has the potential to profoundly affect coral communities within these areas (e.g., in the FGBNMS, the only marine sanctuary in the GOM). Cumulative impacts on Areas of Special Concern in the GOM are considered to be **negligible** to **moderate**.	subsistence uses, commercial or recreational fisheries, and tourism.
Population, Employment, and Income	Population in the GOM coastal region has been steadily increasing since 1980, with the highest growth occurring in Texas. Most of the employment (and earnings) in the region is concentrated in Florida and Texas, with services, retail/wholesale trade, and State and local government being the highest employing sectors. Cumulative economic impacts in the region generally result from direct employment and income created through offshore oil and gas development and the indirect employment/income produced through spending of wages and salaries, and from the procurement of materials and services. Population is affected by the in-migration of workers and their families into the region. The cumulative impacts of ongoing and future OCS program and non-OCS program activities would be considered **beneficial** because these activities would increase employment and earnings in the region over the next 40 to 50 yr.	The Program would add to beneficial impacts, especially in Texas and Louisiana. The incremental contribution of the Program is expected to be **negligible**, however, because the added employment demands are less than 2% of the total GOM coast regional employment. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be **negligible** to **small** relative to those associated with ongoing and future OCS program and non-OCS program activities. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in **minor** to **moderate** impacts. However, short-term impacts of a CDE could be **major** as a result of lost employment and income, and possible shortages of commodities or services in both coastal and inland areas affected by the spill.
Land Use and Infrastructure	Most of the equipment and facilities supporting offshore oil and gas operations are located in the western and central GOM. Currently, there are hundreds of onshore facilities that support offshore industry. These include ports, refineries, and waste management facilities among others. Cumulative impacts on land use and infrastructure result from demands on roads, utilities, and public services and the need to develop additional onshore facilities to accommodate ongoing and future activities in the GOM. Oil spill response also places stresses on community infrastructure and increases traffic in the affected area. Cumulative impacts on land use and onshore resources could range from **minor** to **major** depending on the nature and location of demands.	The incremental contribution of routine operations under the Program to cumulative impacts would be **negligible** to **small** because the existing infrastructure is considered sufficient to handle the small increases in demands for roads, utilities, and public services related to the Program. Land use–related impacts resulting from expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program include stresses of spill response on community infrastructure, increased traffic in the response area (both onshore and offshore), and temporary restricted access to affected lands (while cleanup is conducted). Such spills would result in a

TABLE 4.6.6-1 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Land Use and Infrastructure (Cont.)		**negligible** to **small** incremental contribution to cumulative impacts on land use and existing infrastructure. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in **minor** to **moderate** impacts if they were to occur.
Commercial and Recreational Fisheries	Commercial fishers are very important to the economies of the GOM coast States. In 2009, commercial fishery landings reached almost 649,000 metric tons, worth more than $629 million. When considering related processor, wholesale, and retail businesses, the GOM seafood industry supports more than 200,000 jobs with related income impacts of $5.5 billion. In 2009, Louisiana led the States in total landings and values, followed by Mississippi, Texas, and Florida. Recreational fishing is also important to the region, with more than 4.5 million people engaged in the activity in 2010. Most of the recreational fish landings in 2010 were in Florida. Cumulative impacts on commercial and recreational fishing result from changes in commercial fishing coasts with offshore oil and gas development, and changes in accessibility of fisheries resources. Ongoing offshore oil and gas development has had both positive and negative effects in the region; the cumulative impacts are considered to be **minor**.	The incremental contribution of routine Program activities to cumulative impacts would be **small**, since these activities would be unlikely to have population- or community-level effects on fishery resources because of the limited timeframe over which most individual activities would occur and because a small proportion of habitat relative to similar available habitat would be affected during a given period. In addition, existing stipulations are in place to prevent or reduce impacts on sensitive habitats such as hard-bottom areas and topographic features. Construction of new platforms could represent a small increase in the availability of desirable recreational fishing locations for recreational anglers. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program would be **medium**, depending on the location, timing, and volumes of spills (among other environmental factors). Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be **moderate** if they were to occur.
Tourism and Recreation	The GOM coastal zone is one of the nation's major recreational regions, with marine fishing and beach-related recreation being top activities. The coast States offer diverse natural and developed landscapes and seascapes, and natural areas are visited by residents and tourists throughout the year. In 2000, Florida along had more than 22 million visitors. Cumulative impacts on tourism and recreation result from changes in accessibility of beach and offshore resources for recreational use and from increases in marine vessel and aircraft traffic in the vicinity of recreational resources. Given the existence of offshore oil and gas development and other ongoing activities in the GOM, cumulative impacts on tourism and recreation are expected to be **minor**.	The incremental contribution of routine operations under the Program to cumulative impacts would be **small**, with potential adverse aesthetic impacts on beach recreation and sightseeing and potential positive impacts on diving and recreational fishing. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be **negligible** to **small**, depending on the size, location, and timing of the spill (being greatest if it occurred during the peak recreational season). Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be **minor** to **moderate** if they were to occur.

TABLE 4.6.6-1 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Sociocultural Systems	The counties along the GOM coast are home to a large and heterogeneous population. Within the coastal region, the effects of the offshore oil and gas industry are felt most directly by populations living within the coastal community commuting zone where industry support facilities and the people who work in them are located. Coastal estuaries provide a wealth of wild resources for subsistence harvesting. Though much of the subsistence activities in the GOM region are practiced recreationally, some Native American groups in southern Louisiana depend on fishing, hunting, and gathering for at least part of their domestic subsistence. Commercial Vietnamese fishers also retain a quarter of their catch for family use and barter. Cumulative impacts to sociocultural systems occur when ongoing and future actions (OCS and non-OCS program) cause changes in local populations and social institutions or when jobs are lost or created. Subsistence practices have already been stressed by natural trends associated with climate change (e.g., flood control along the Mississippi River). Given all these factors, cumulative impacts on sociocultural systems are considered to be **moderate**.	The incremental contribution of routine operations under the Program to cumulative impacts would be **small**, since they are more likely to support the existing industry than to create industry growth. Any expansion of deepwater activities will result in jobs that require longer, unbroken periods of work offshore, specialized skills, and potential in-migration of part of the workforce. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program would be **small** to **medium**, especially on localized intertidal resources used by subsistence harvesters. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be **moderate** to **major** if they were to occur, especially if oil from a CDE were to reach the shore. Such spills could lead to long-term closure of fisheries, resulting in social and cultural stress.
Environmental Justice	Environmental justice impacts occur when any activity or trend results in adverse health or environmental impacts that are significantly high and disproportionately affect minority and low-income populations. A large number of minority and low-income individuals are located in the LMA counties along the GOM coast. In this region, the adverse effects of several hurricanes over the past decade are still being felt; these events have been high and disproportionate in their effects on minority and low-income populations, and will likely persist into the foreseeable future. Ongoing and future actions contributing to cumulative impacts in the region include proximity to existing oil and gas infrastructure and any associated health, environmental, and visibility impacts, and climate change (increase in hurricane frequency and intensity). Given all these factors, cumulative impacts on minority and low-income populations are considered to be **moderate** to **major**.	Because of the long-established and well-developed oil and gas industry present in the GOM and the fact that an estimated 75% of activity from the Program would occur in deep and ultra-deep waters, routine operations under the Program are not expected to cause additional environmental justice concerns; their contribution to cumulative impacts on low-income and minority populations therefore would be **negligible**. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be **negligible** to **medium** because of the movement of oil and gas activities farther away from coastal areas and the demographic pattern of more affluent groups (and fewer low-income and minority populations) living in coastal areas. An unexpected, low probability CDE could result in **moderate** to **major** impacts, depending on the location, size, and timing of the event.

TABLE 4.6.6-1 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Archaeological and Historical Resources	Onshore cultural resources are highly varied in coastal areas of the GOM. Prehistoric cultural resources range from small, temporary use sites to substantial permanent settlements, some from the earliest known human occupation of the areas. Offshore cultural resources mainly consist of shipwrecks dating from as early as the sixteenth century; however, other structures, such as the Ship Shoal Lighthouse, can also be found offshore. Studies indicate that most shipwrecks in the northern GOM are located within a mile of shore; with the highest concentration of ships occurring in areas that experienced high volume marine traffic. Shipwrecks are also thought to be concentrated in the open sea of the eastern GOM. To date, shipwrecks have been found in water depths of up to 1,981 m (6,500 ft). Cumulative impacts to these resources occur when operations involving bottom-disturbing activities come into physical contact with artifacts or their site context, or as a result of waves, currents, and tropical storms. The cumulative impacts of ongoing and future activities (OCS and non-OCS) are not currently known, but could range from **minor** to **moderate**, mainly because activities occurring on the OCS prior to the USDOI's survey requirement, which went into effect in 1973, may already have affected significant sites.	Routine operations could affect significant archaeological and historic resources, especially offshore resources, with construction activities such as platform and pipeline construction, and dredging, potentially damaging or destroying affected resources. Onshore impacts include resource damage or loss, or visual effects and are possible from pipeline landfall, onshore pipeline, and road construction. Anchor drags could adversely affect shipwrecks. The incremental contribution of routine operations under the Program would be **negligible** to **large**, depending on the presence of significant archaeological or historic resources in the area of potential effect. Archaeological surveys that would identify significant cultural resources to be avoided could reduce these impacts. The incremental contribution of oil spills, whether expected oil spills (most of which are less than 1,000 bbl) to cumulative impacts on archaeological and historical resources in Cook Inlet would be **small** to **large**, depending on the presence of significant resources in the area of potential effect and the spill location, timing, duration, and size. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from **minor** to **major** if it were to occur.

TABLE 4.6.6-2 Summary of Cumulative Impacts and Incremental Contributions of the Program – Alaska, Cook Inlet

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Water Quality	Factors affecting the water quality in Cook Inlet include marine vessel traffic, wastewater discharge, dredging and marine disposal, oil and gas production (currently only in State waters), military operations. Water quality is also affected by numerous other factors, including river inflows, urbanization, forest practices, mining, municipal waste discharges, and agriculture. Natural seepage of oil along the west part of the inlet may also be significant. Cumulative impacts on water quality are attributed to a combination of all these factors and, overall, are considered to be **minor** to **moderate**. These impacts may lessen with time since oil and gas production in Cook Inlet is currently in decline.	The incremental contribution of routine operations under the Program would be **small** to **medium**. Compliance with NPDES permits and USCG regulations would reduce the magnitude of most impacts. The effects of expected accidental oil spills (most of which are less than 1,000 bbl) would depend upon weather and sea conditions at the spill site, the type of oil spilled, the depth of the spill event, and the volume and rate of spillage; therefore, the incremental contribution of expected oil spills to cumulative water quality impacts could range from **small** to **large**. Water quality impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from **moderate** to **major** if it were to occur. Spill response and cleanup activities could also contribute to water quality impacts.
Air Quality	Except for a few population centers such as Anchorage, the existing air quality in Alaska is relatively pristine with pollutant levels that are well within the ambient standards. Cumulative impacts on air quality in Cook Inlet are attributed to both offshore and onshore activities. Offshore activities in the region are mainly associated with the oil and gas industry, but also include various marine vessel traffic (shipping, fishing, cruise ships). Onshore emission sources include power generation, industrial plants, mining, commercial and home heating, on-road vehicles, and non-road engines (e.g., aircraft, locomotives, and construction equipment). Overall, cumulative impacts on air quality in Cook Inlet over the next 40 to 50 yr are expected to be **minor** to **moderate**.	The incremental contribution of routine operations under the Program would be **small**, because they would not cause exceedance of the NAAQS in public access areas or affect visibility. The effects of expected accidental oil spills would be localized and temporary due to dispersion; therefore, the incremental contribution of expected oil spills (most of which are less than 1,000 bbl) to cumulative air impacts could range from **small** to **medium**. Air quality impacts associated with an unexpected, low-probability CDE would also be reduced by these factors, and could be **moderate** if it were to occur. Spill response and cleanup activities could also contribute to air quality impacts.

TABLE 4.6.6-2 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Acoustic Environment	Ice, strong tidal fluctuations, and currents all play an important role in the ambient noise levels in Cook Inlet. The main sources of anthropogenic noise are aircraft overflights, marine vessel traffic, oil and gas activities (including seismic surveys and production operations), and other operations such as dredging and pile driving (for new docks). The quality of the acoustic environment in Cook Inlet would continue to be adversely affected by ongoing and future non-OCS program activities and by future OCS program activities (currently there are no existing OCS activities, although seismic studies and exploratory drilling have been conducted in the past). The magnitude of cumulative impacts in the inlet is time- and location-specific and could range from **minor** to **major**, depending on the ambient acoustic conditions and the nature and combination of noise sources from all OCS and non-OCS activities. See also Marine Mammals (this table).	The contribution of routine operations under the Program to cumulative impacts could range from **small** to **medium** and would vary with time and location and would depend on the characteristics of the noise sources present. The incremental increase in adverse acoustic environmental impacts from expected accidental oil spills in Cook Inlet waters (mainly due to noise sources associated with response and cleanup) would be localized and temporary; therefore, the incremental contribution of expected oil spills (most of which are less than 1,000 bbl) to cumulative noise-related impacts would be **small**. Noise-related impacts associated with an unexpected, low-probability CDE could range from **minor** to **moderate** if it were to occur.
Coastal and Estuarine Habitats		
Barrier Beaches and Dunes	Coastal habitats along Cook Inlet are influenced by dynamic tidal currents. Sensitive shoreline habitats in the lower Cook Inlet include marshes, sheltered tidal flats, sheltered rocky shores, and exposed tidal flats. The affects of climate change on coastal habitats in Cook Inlet are also significant. These include sea level rise, which could inundate low-lying coastal habitats, and increase in the incidence of pests and diseases, which could result in increased forest tree mortality. Cumulative impacts on coastal beaches and dunes in Cook Inlet are considered to be **moderate**.	Routine operations under the Program would result in minor localized impacts primarily due to facility construction, pipeline trenching and landfalls, channel dredging, and vessel traffic. The contribution of the Program to cumulative impacts on beaches and dunes therefore would generally be **small** to **medium**. The incremental impacts of expected accidental oil spills associated with the Program would be **negligible** to **large**, depending on the location, timing, duration, and size of the spill; the proximity of the spill to particular habitats; and the timing and nature of spill containment and cleanup activities. The majority of these spills would be small (less than 50 bbl) and most of them would not likely contact and affect coastal and estuarine habitats. Large oil spills (1,000 bbl or greater) or an unexpected, low-probability CDE have the greatest potential to affect extensive areas of shoreline and coastal and estuarine habitats. Although these are rare events, the impacts of such releases on coastal habitats could range from **moderate** to **major** if they were to occur.

TABLE 4.6.6-2 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Wetlands	Cumulative impacts on coastal and estuarine habitats result from the loss of beach and wetland habitat in Cook Inlet. While there are no past or ongoing OCS activities in the Cook Inlet Planning Area, other ongoing and future actions/trends that affect these resources include those related to State oil and gas development, commercial shipping (and other marine vessel traffic), coastal development, discharge of municipal wastes and other effluents, domestic transportation of oil and gas, logging, and climate change. These activities can be reasonably expected to continue into the future. Cumulative impacts on coastal and estuarine habitats in Cook Inlet are considered to be **moderate**.	Same as for barrier beaches and dunes.
Benthic and Pelagic Habitats	Cumulative impacts on marine benthic and pelagic habitats in Cook Inlet result of from any activities that disturb ocean bottom or marine habitats, increase sediment suspension (turbidity), degrade water quality, or affect the food supply of biota depending on these resources. Ongoing and future actions/trends that affect these resources include oil and gas activities in State waters, commercial shipping (including tankers), dredging and disposal of dredging spoils in OCS waters, and anchoring. State oil and gas activities (in upper Cook Inlet) and future OCS activities could affect seafloor and pelagic habitats; these include the generation of noise, well drilling, pipeline placement, subsea production well and platform placement, and routine discharges. Accidental oil spills are also among these actions. Cumulative impacts on benthic and pelagic habitats in Cook Inlet are considered to be **moderate** to **major**.	Routine operations under the Program in Cook Inlet could result in negligible to moderate impacts from ground disturbance during drilling and pipeline and platform placement, as well as the discharge of drilling muds and cuttings and produced water. The incremental contribution to cumulative impacts on marine benthic habitats would range from **negligible** to **medium** and would be limited by existing mitigation measures. The incremental impacts of expected accidental oil spills on benthic habitats (most of which are less than 1,000 bbl) would range from **negligible** to **small**, depending on the size, duration, timing, and location of the spill, and the nature (i.e., sensitivity) of the benthic habitat contacted by oil. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could result in **minor** to **moderate** impacts if they were to occur.

TABLE 4.6.6-2 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Essential Fish Habitat	Cumulative impacts on EFH in Cook Inlet result of from any activities that kill of managed fish species, disturb ocean bottom habitats, increase sediment suspension (turbidity), degrade water quality, or affect the food supply for fishery resources. Ongoing and future actions/trends that affect these resources include land use practices (e.g., logging), point and non-point source pollution, dredging and disposal operations, anchoring, fishing (commercial, subsistence, personal use, and sportfishing), and commercial shipping (including imported oil). Subsistence fishing is subject to harvest limits that reduce the potential for overfishing; and much of Cook Inlet is defined as a nonsubsistence area where subsistence fishing is not authorized. For this reason, the impacts related to subsistence are considered minor. State oil and gas activities (in upper Cook Inlet) and future OCS activities could affect EFH (there are no ongoing OCS activities in the inlet); these include the generation of noise, well drilling, pipeline placement, subsea production well and platform placement, and routine discharges. Accidental oil spills are also among these actions. Cumulative impacts on EFH in the Cook Inlet are considered to be **minor** to **moderate**.	Routine operations under the Program in Cook Inlet could result in moderate short- and long-term impacts to EFH and managed species, mainly as a result of bottom disturbance during the placement of pipelines and production platforms. The incremental contribution to cumulative impacts on EFH would be **negligible** to **medium** and would be limited by specific lease stipulations. The incremental impacts of expected accidental oil spills on EFH (most of which are less than 1,000 bbl) would range from **negligible** to **medium** depending on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could result in **moderate** to **major** impacts if they were to occur.
Marine and Coastal Fauna		
Marine Mammals	All marine mammals in U.S. waters are protected under the Marine Mammal Protection Act of 1972. There are 17 marine mammal species that occur in Cook Inlet or nearby waters of the Gulf of Alaska; nine of these species are threatened or endangered. Ongoing and future activities or phenomena that affect marine mammals include oil and gas development in State waters, vessel traffic; commercial, recreational, and subsistence fishing; subsistence marine mammal harvests; pollution (and marine debris), military operations, development, climate change, and invasive	Routine oil and gas-related activities (e.g., seismic surveys, facility construction, normal operations, and, eventually, decommissioning) would result in minor to moderate impacts on marine mammals. Impacts on marine mammals from these activities could include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. The contribution of Program activities to cumulative impacts on marine mammals would be **negligible** to **small**.

TABLE 4.6.6-2 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Marine Mammals (Cont.)	species. Cumulative impacts on marine mammals in the Cook Inlet are considered to be **minor** to **moderate**.	The incremental impacts of expected accidental oil spills (most of which are less than 1,000 bbl) would be **negligible** to **small**, depending on the location, timing, and volume of the spills; the environmental settings of the spills; and the species exposed to the spills. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from **minor** to **major** if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.
Terrestrial Mammals	There are about 40 species of terrestrial mammals in south-central Alaska, including brown bears, moose, and river otters. Ongoing and future activities or phenomena that affect terrestrial mammals in the Cook Inlet region include State oil and gas development, aircrafts and vehicle traffic; coastal and community development, timber harvests, hunting; pollution, climate change, and natural catastrophes. Cumulative impacts on terrestrial mammals in the Cook Inlet are considered to be **minor** to **moderate**.	Routine oil and gas-related activities (e.g., facility construction including onshore pipelines, normal operations including aircraft and marine vessel traffic, and, eventually, decommissioning) would result in minor impacts on terrestrial mammals. Impacts on terrestrial mammals from these activities could include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. The contribution of Program activities to cumulative impacts would be **negligible** to **small**. The incremental impacts of expected accidental oil spills (most of which are less than 1,000 bbl) on terrestrial mammals would be **negligible** to **small**, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and other important habitats; the timing and nature of spill containment; and the status of the affected animals. An unexpected, low-probability CDE has a greater potential to affect the terrestrial habitats; therefore, impacts could range from **minor** to **major** if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.

TABLE 4.6.6-2 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Marine and Coastal Birds	There are more than 492 naturally occurring bird species in Alaska. Annual use patterns of Cook Inlet are characterized by the sudden and rapid occurrence of very large numbers of birds in early may followed by a sudden and rapid departure in mid- to late-May. Cumulative impacts result from direct injury or mortality of marine and coastal birds due to collisions with onshore and offshore structures, ingestion of trash or debris, or exposure to discharges or emissions; loss or degradation of habitat due to coastal development, climate change, or construction and operations activities; and behavioral disturbance due to commercial and recreational boating and small aircraft traffic. Many bird species are currently experiencing a loss or degradation of habitat due to land development and climate change and these impacts are expected to continue into the foreseeable future. Ongoing and future actions/trends that affect marine and coastal birds include those related to oil and gas development in State waters, coastal development, vessel traffic, dredging operations, and climate change. Cumulative impacts on marine and coastal birds are considered to be **minor** to **moderate**.	Routine operations may result in localized short-term impacts due to infrastructure construction and marine vessel and aircraft traffic. The contribution of the Program to cumulative impacts on marine and coastal birds therefore would be **negligible** to **medium**. The incremental contribution of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on marine and coastal birds would be **small** to **large**, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and nesting areas; the timing and nature of spill containment; and the status of the affected birds. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from **moderate** to **major** if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.
Fish	Cumulative impacts result from OCS and non-OCS activities that generate lethal or sublethal impacts to individuals as well as the loss or degradation of fish habitat. Ongoing and future actions/trends that affect fish in Cook Inlet include oil and gas development in State and Federal waters, commercial and recreational fishing, noise, dredging operations, and wastewater discharge. Climate change is also expected to affect fish habitat, productivity, and community structure. Cumulative impacts on fish in Cook Inlet are considered to be **moderate** to **major**.	The incremental contribution of routine Program activities to these impacts (primarily as a result of disturbance affecting demersal fishes) would be **negligible** to **small**, with the severity of impacts generally decreasing with distance from the disturbance (and a **negligible** contribution to impacts on threatened or endangered fish species). The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on fish would be **negligible** to **medium**, depending on the location, timing, duration, and volume of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range up to **moderate** if it were to occur. Impacts would be greatest if oil were to reach intertidal habitats.

TABLE 4.6.6-2 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Lower Trophic Levels and Invertebrates	Invertebrates (animals without a backbone) occupy the rocky and sandy substrates in the intertidal and subtidal zones. Water column invertebrates in Cook Inlet are composed of a mix of oceanic and coastal species. Several species of copepods (small crustaceans) dominate the macrozooplankton assemblage, peaking in late spring and summer. In lower Cook Inlet, benthic invertebrate communities vary spatially as a result of differences in ice formation, with Arctic species being more common on the western side of the inlet and temperate species being more common on the eastern side. Invertebrates and lower trophic level organisms in the rocky and sandy intertidal zone include echinoderms (sea urchins and sea stars), mollusks (bivalves, limpets, and snails), polychaetes (worms), and crustaceans (barnacles, crabs, and amphipods); clams and polychaetes are predominant in subtidal sandy and muddy sediments. Cumulative impacts result from OCS and non-OCS activities that generate lethal or sublethal impacts to individuals as well as habitat loss or degradation. Ongoing and future actions/trends that affect invertebrates in Cook Inlet include oil and gas development in State and Federal waters, dredging, trawling, and wastewater discharge. Climate change is also expected to affect fish habitat, productivity, and community structure. Cumulative impacts on invertebrates in Cook Inlet are considered to be **moderate** to **major**.	The contribution of the Program to cumulative impacts (mainly due to bottom-disturbing activities) would be **negligible** to **medium**, with the severity of the impacts generally decreasing with distance from bottom-disturbing activities. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on invertebrates would be **negligible** to **small**, depending on the location, timing, duration, and size of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could range up to **moderate** if they were to occur.

TABLE 4.6.6-2 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Areas of Special Concern	The Alaska National Interest Lands Conservation Act of 1980 designated certain public lands in Alaska as National Parks, Wildlife Refuges, Wild and Scenic Rivers, and for the National Wilderness Preservation and National Forest Systems. Many of these occur in the Cook Inlet region. Other Areas of Special Concern include MPAs, National Estuarine Research Reserves, National Estuary Program Areas, MUAs, and NOAA-designated HCAs. In addition, there are several State parks and recreation areas bordering Cook Inlet. Cumulative impacts on these resources result from activities that could potentially cause damage to or degradation of fauna or habitats within these areas. Ongoing and future activities or trends that affect Areas of Special Concern in or near Cook Inlet include fishing, diving, dredging operations, marine vessel traffic (and wakes), tankering, trash and debris accumulation (from various sources), onshore infrastructure (e.g., roads and vehicle traffic), and oil and gas development and infrastructure (e.g., pipeline landfalls and onshore facilities). Cumulative impacts on Areas of Special Concern in the Cook Inlet are considered to be **negligible** to **moderate**.	Routine operations under the Program could result in **negligible** to **medium** incremental increases in effects on national sanctuaries, parks, refuges, and estuarine research reserves. Expected oil spills (most of which are less than 1,000 bbl) that occur during the Program could result in a **negligible** to **small** incremental contribution to cumulative impacts on Areas of Special Concern, depending on spill frequency, location, and volume; the type of product spilled; weather conditions; effectiveness of cleanup operations; and other environmental conditions at the time of the spill. Large spills (1,000 bbl and greater) or an unexpected, low-probability CDE in areas adjacent to the national parks, NWRs, or national forests, whether from OCS or non-OCS sources, would also depend on these factors, and could result in **moderate** impacts if they were to occur. Such spills could negatively impact coastal habitats and fauna, and could also affect subsistence uses, commercial or recreational fisheries, and tourism.
Population, Employment, and Income	Between 2005 and 2009, the Municipality of Anchorage had a population of 280,389, about 45% of the total population in Alaska. Employment is concentrated in Anchorage, which provides about 83% of employment in the region. The largest employing sectors in 2008 were in services, wholesale and retail trade, and State and local government. Oil and gas employment is concentrated in Anchorage, with a total of 8,636 workers employed directly in oil and gas extraction activities, pipeline and refinery activities, and support activities in 2007. Cumulative economic impacts result from direct employment and income created through the development of offshore oil and gas resources and the indirect employment and income produced through the spending of wages and salaries and from the procurement of materials and services in the region. The cumulative impacts of future OCS program and ongoing and future non-OCS program activities would be considered **beneficial** because these activities would increase employment and earnings in the region over the next 40 to 50 yr.	The Program would add to beneficial impacts, especially on the Kenai Peninsula and in Anchorage. The incremental contribution of the Program is expected to be **small**, however, because the added employment demands are less than 5% of baseline levels in Alaska. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be **negligible** to **small** relative to those associated with future OCS program and ongoing and future non-OCS program activities. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in **minor** to **moderate** impacts. However, in the short-term, impacts of a CDE could be **major** as a result of lost employment, income, and property value; increased traffic congestion; increased cost of service provision; and possible shortages of commodities or services.

TABLE 4.6.6-2 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Land Use and Infrastructure	Anchorage is the State center for scheduled aircraft and the regional center for chartered aircraft. It has a cargo facility served by a railroad connecting it to Alaska's interior and the port of Seward and two military bases (Joint Base Elmendorf-Richards on). It is also the center for the State's overall road network. Much of the on-land infrastructure around Cook Inlet supports offshore oil and gas development; facilities/complexes include the Trading Bay production facility, the Tesoro Refinery, the Drift River Terminal, and the Nikiski complex (Agrium and ConocoPhillips LNG). Cumulative impacts on land use and infrastructure result from demands on roads, utilities, and public services and the need to develop additional onshore facilities to accommodate ongoing and future activities in the inlet. Oil spill response also places stresses on community infrastructure and increases traffic in the affected area. Cumulative impacts on land use and onshore resources could range from **minor** to **major**, depending on the nature and location of demands.	The incremental contribution of routine operations of the Program to cumulative impacts in the GOM would be **negligible** to **small** because the Program would not introduce new kinds of activities that would alter existing land uses. Land use–related impacts resulting from expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program include stresses of spill response on community infrastructure, increased traffic in the response area (both onshore and offshore), and temporary restricted access to affected lands (while cleanup is conducted). Such spills would result in a **small** incremental contribution to cumulative impacts on land use and existing infrastructure. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in **moderate** impacts if they were to occur.
Commercial and Recreational Fisheries	Commercial fisheries of Cook Inlet and the Gulf of Alaska target groundfish, Pacific halibut, Pacific salmon, herring, crab, shrimp, clams, scallops, sea urchins, and sea cucumbers. The groundfish fisheries accounted for the largest share ($640 million, or about 48%) of the ex-vessel value of all commercial fisheries in Alaska in 2009. Recreational fishing in the Cook Inlet region includes marine sport fishing, freshwater fishing, and shellfish gathering activities, which contribute substantially to the area's economy. On the western bank of upper Cook Inlet, there are recreational fisheries for razor clams, several species of hardshell clams, and crab. Cumulative impacts on commercial and recreational fishing result from changes in commercial fishing costs with offshore oil and gas development and changes in accessibility of fishery resources. The cumulative impacts on commercial and recreational fisheries in Cook Inlet are considered to be **minor**.	The incremental contribution of routine operations under the Program to cumulative impacts in Cook Inlet would be **small**, since these activities would be unlikely to have population-level effects on fishery resources or result in long-term loss of fishery resources. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be **negligible** to **medium**, depending on the location, timing, and volumes of spills (among other environmental factors). Small spills are unlikely to affect a large number of fish or have a substantial effect on recreational fishing before dilution and weathering reduced concentrations of oil in the water. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be **moderate** if they were to occur.

TABLE 4.6.6-2 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Tourism and Recreation	Opportunities for recreational activities such as hunting, hiking, boating, wildlife viewing, and sightseeing are abundant in the Cook Inlet region. Visitors reach the area via tour ships and ferries, as well as helicopters, small aircraft, and fishing charters. The Kenai Peninsula and Prince William Sound receive the heaviest recreational use by residents and nonresidents, and are in close proximity to Cook Inlet and Anchorage. The Chugach National Forest attracts hikers, campers, and other users. Cumulative impacts on tourism and recreation result from changes in accessibility of beach and offshore resources for recreational use, and from increases in marine vessel and aircraft traffic in the vicinity of recreational resources; these impacts are expected to be **minor**.	The incremental contribution of routine operations under the Program to cumulative impacts in Cook Inlet would be **small**, with potential adverse aesthetic impacts on sightseeing, boating, fishing, and hiking activities in the inlet. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program would be **negligible** to **small**, depending on the size, location, and timing of the spill (being greatest if it occurred during the peak recreational season). Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be **minor** to **moderate** if they were to occur.
Sociocultural Systems	The region surrounding Cook Inlet includes economically complex cities such as Anchorage and its suburbs, the largest urban community in the State; towns such as Kenai, Soldotna, and Nikiski that are centers of the oil and gas industry; smaller towns such as Port Lions that depend on commercial fishing; and small predominantly Alaska Native communities. Subsistence harvesting plays some role in communities of all types. Cumulative impacts to sociocultural systems occur when ongoing and future actions (OCS and non-OCS programs) cause changes in local populations and social institutions or when jobs are lost or created. Subsistence harvesting could also be affected by activities that affect marine fauna, such as increases in airborne or subsea noise (e.g., aircraft or marine vessel traffic, seismic surveys, drilling) or degradation of water quality (e.g., fuel or oil spills, chemical releases, or dredging operations that increase turbidity), or that necessitate changes in subsistence fishing practices. Cumulative impacts on sociocultural systems in Cook Inlet as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be **minor** to **moderate** over the next 40 to 50 yr.	The incremental contribution of routine operations under the Program to cumulative impacts would be **small**, since they would not introduce new kinds of activities that would alter existing socioeconomic systems. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be **small** to **large**, especially in intertidal and estuarine zones used by subsistence harvesters. Impacts associated with an unexpected, low-probability CDE could be **major** if it were to occur, especially if resources important to subsistence harvesters, including intertidal resources, migrating fishes, and fishes with strong ties to the shore, were affected.

TABLE 4.6.6-2 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Environmental Justice	Environmental justice impacts occur when any activity or trend (OCS program or non-OCS program related) results in adverse health or environmental impacts that are significantly high and disproportionately affect minority and low-income populations. A large number of minority and low-income individuals live in the south-central Alaska region; however, the number of minority individuals in each of the local boroughs does not exceed 50% of the population or the State average by 20 percentage points or more in any of the boroughs. Thus, there is no minority population in south-central Alaska. Likewise, there are no low-income populations in any of the local boroughs. Subsistence hunting and fishing are an important part of the economies in rural communities. Although there are no environmental justice concerns here, cumulative impacts on local communities could result from changes in the proximity of onshore oil and gas infrastructure and to marine vessel and aircraft traffic. Ongoing and future oil and gas development would continue to affect populations in some regions of Cook Inlet by increasing the proximity to existing oil and gas infrastructure and associated health, environmental, and visibility impacts. Given these factors, cumulative impacts on local populations are considered to be **moderate** to **major**.	The incremental contribution of routine operations under the Program would be small, depending on the proximity of onshore pipelines and offshore infrastructure to communities and their subsistence harvest areas, but are not expected to cause additional environmental justice concerns; their contribution to cumulative impacts on low-income and minority populations therefore would be **small**. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be **negligible** to **small**. Large spills (1,000 bbl or greater) or an unexpected CDE could result in **moderate** to **major** impacts on the Alaska Native population, especially if subsistence resources were diminished or tainted as a result of the spill. Mitigation measures, cooperative agreements between Native and industry groups, and government-to-government consultations are designed to limit the effects from oil spills and routine operations.
Archaeological and Historical Resources	Onshore archaeological and historic resources occur along the shoreline surrounding Cook Inlet; the predominant types of prehistoric features are house pits containing household and subsistence artifacts like stone lamps, sinkers, and arrowheads. Historic sites onshore consist of early Russian houses, churches, roadway inns, fish camps, and mining camps. Little research has been done to characterize prehistoric resources in the offshore waters of Cook Inlet; however, it is likely that high-energy tidal movement has removed at least some resources from their original resting place. The best preserved shipwrecks are likely to be found on the OCS, because wave action and ice are less likely to contribute to the breakup of ships in deeper waters. Cumulative impacts to these resources occur when operations involving	Routine operations could affect significant archaeological and historic resources, especially offshore resources, with construction activities such as platform and pipeline construction potentially damaging or destroying affected resources. Onshore impacts include resource damage or loss, or visual effects and are possible from pipeline landfall, onshore pipeline, and road construction. Anchor drags could adversely affect shipwrecks. The incremental contribution of routine operations under the Program is expected to be **negligible** to **large**, depending on the presence of significant archaeological or historic resources in the area of potential effect. Archaeological surveys that would identify significant cultural resources to be avoided could reduce these impacts.

TABLE 4.6.6-2 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Archaeological and Historical Resources (Cont.)	bottom-disturbing activities (e.g., channel dredging) come into physical contact with artifacts or their site context, or as a result of natural phenomena such as high-energy waves and currents, ice gouging, and thermokarst collapse. The cumulative impacts of future OCS and ongoing and future non-OCS activities are not currently known, but could range from **minor** to **moderate**, mainly because activities occurring on the OCS prior to the USDOI's survey requirement, which went into effect in 1973, may already have affected (i.e., damaged or destroyed) significant sites.	The incremental contribution of oil spills, whether expected oil spills (most of which are less than 1,000 bbl) to cumulative impacts on archaeological and historical resources in Cook Inlet would be **small** to **large**, depending on the presence of significant resources in the area of potential effect and the spill location, timing, duration, and size. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from **minor** to **major** if it were to occur.

TABLE 4.6.6-3 Summary of Cumulative Impacts and Incremental Contributions of the Program – Alaska, Arctic Region

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Water Quality	Factors affecting the water quality in the Beaufort and Chukchi Seas include marine vessel traffic, wastewater discharge, oil and gas production (currently only in State waters), military operations. Water quality is also affected by numerous other factors, including river inflows, mining, and municipal waste discharges. Cumulative impacts on water quality are attributed to a combination of all these factors and, overall, are considered to be **moderate**. Impacts related to marine vessel traffic in the Beaufort and Chukchi Seas (especially shipping and research vessels, icebreakers, and cruise ships) would likely increase in the coming decades as the open water season begins earlier and ends later (an effect of climate change).	The incremental contribution of routine operations under the Program would be **small** to **medium.** Compliance with NPDES permits and USCG regulations would reduce the magnitude of most impacts. The effects of expected accidental oil spills (most of which are less than 1,000 bbl) would depend upon weather and sea conditions at the spill site, the type of oil spilled, the depth of the spill event, and the volume and rate of spillage; therefore, the incremental contribution of expected oil spills to cumulative water quality impacts could range from **small** to **large**. Water quality impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from **moderate** to **major** if it were to occur. Spill response and cleanup activities could also contribute to water quality impacts.
Air Quality	The Arctic region has a low population. Barrow is the largest city in the North Slope Borough with a population (in 2010) of just 4,600. The primary industrial emissions in the region are associated with the oil and gas industry, power generation, small refineries, paper mills, and mining. Currently, the North Slope Borough is designated as an unclassified/attainment area for all criteria pollutants. The region does experience air pollution problems (e.g., Arctic haze), however, due to long-range transport of air pollutants from industrial parts of northern Eurasia and North America. Overall, cumulative impacts on air quality in the Arctic over the next 40 to 50 yr are expected to be **minor** to **moderate**.	The incremental contribution of routine operations under the Program would be **small** because they would not significantly increase onshore airborne pollutants or affect visibility. The effects of expected accidental oil spills (most of which are less than 1,000 bbl) would be localized and temporary due to dispersion; therefore, the incremental contribution of expected oil spills to cumulative air impacts could range from **small** to **medium**. Air quality impacts associated with an unexpected, low-probability CDE would also be reduced by these factors (depending on the season), and could be **moderate** if it were to occur. Spill response and cleanup activities could also contribute to air quality impacts.

TABLE 4.6.6-3 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Acoustic Environment	Arctic waters are a unique acoustic environment mainly because of the presence of ice, which can contribute significantly to ambient sound levels (e.g., ice cracking generates noise; ice deformation generates low-frequency noise). Ambient levels of natural sound can vary dramatically between and within seasons. During open water season, wind and waves are important sources of ambient sounds. The main sources of anthropogenic noise are aircraft overflights, marine vessel traffic, oil and gas activities (including seismic surveys and production operations), human settlements, and military activities. The quality of the acoustic environment in the Beaufort and Chukchi Seas would continue to be adversely affected by ongoing and future non-OCS program activities and by future OCS program activities (currently there are no existing OCS activities, although seismic studies and exploratory drilling have been conducted in the past). The magnitude of cumulative impacts in the Beaufort and Chukchi Seas is time- and location-specific and could range from **minor** to **major**, depending on the ambient acoustic conditions and the nature and combination of noise sources from all OCS and non-OCS activities.	The contribution of routine operations under the Program to cumulative impacts could range from **small** to **medium** and would vary with time and location and would depend on the characteristics of the noise sources present. The incremental increase in adverse acoustic environmental impacts from expected accidental oil spills in Arctic waters (mainly due to noise sources associated with response and cleanup) would be localized and temporary; therefore, the incremental contribution of expected oil spills (most of which are less than 1,000 bbl) to cumulative noise-related impacts would be **small**. Impacts associated with an unexpected, low-probability CDE could range from **minor** to **moderate** if it were to occur.
Coastal and Estuarine Habitats		
Barrier Beaches and Dunes	Arctic coastal habitats are greatly influenced by a short growing season and extremely cold winters; onshore sediments are underlain by permanently frozen soil (permafrost). They are also greatly affected by the dynamics of sea ice, which dominates coastal habitats during most of the year. The Arctic coastline is highly disturbed due to the movement of sea ice that frequently is pushed onshore, scouring and scraping the coastline. The affects of climate change on Arctic habitats are also significant. These include decreases in sea ice cover, warming of permafrost, a longer growing season, and changes in precipitation. Portions of the coast have experienced considerable erosive losses (up to 457 m [1,500 ft]) over the past few decades; the erosion rate in areas of the Beaufort Sea coast more than doubled between 1955 and 2005. Projections for future climate change indicate that these changes are expected to continue.	Routine operations under the Program would result in minor localized impacts primarily due to facility construction, pipeline trenching and landfalls, channel dredging, and marine vessel traffic. The contribution of the Program to cumulative impacts on beaches and dunes therefore would generally be **small** to **medium**. The incremental impacts of expected accidental oil spills associated with the Program would be **negligible** to **large**, depending on the location, timing, duration, and size of the spill; the proximity of the spill to particular habitats; and the timing and nature of spill containment and cleanup activities. The majority of these spills would be small (less than 50 bbl) and most of them would not likely contact and affect coastal and estuarine habitats. Large oil spills (1,000 bbl or greater) or an unexpected, low-probability CDE have

TABLE 4.6.6-3 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Barrier Beaches and Dunes (Cont.)	Cumulative impacts on barrier beaches and dunes result from factors that increase erosion of beach and dunes, such as disturbance of dune vegetation or beach and dune substrates. Increases in wave action also contribute to the erosion of beaches. Accidental oil spills may also affect these resources. While there are no past or ongoing OCS activities in the Beaufort Sea and Chukchi Sea Planning Areas (other than exploratory drilling), other ongoing and future actions/trends that affect beaches and sand dunes include those related to State oil and gas development, commercial shipping (and other marine vessel traffic), coastal development, and climate change. These activities can be reasonably expected to continue into the future. Cumulative impacts on coastal and estuarine habitats in the Arctic region are considered to be **moderate**.	the greatest potential to affect extensive areas of shoreline and coastal and estuarine habitats. Although these are rare events, the impacts of such releases on coastal habitats could range from **moderate** to **major** if they were to occur.
Benthic and Pelagic Habitats	Cumulative impacts on marine benthic and pelagic habitats in the Arctic region result of from any activities that disturb ocean bottom or marine habitats, increase sediment suspension (turbidity), degrade water quality, or affect the food supply of biota depending on these resources. Ongoing and future actions/trends that affect these resources include oil and gas activities in State waters, commercial shipping (including tankers), dredging and disposal of dredging spoils in OCS waters, and anchoring. State oil and gas activities (especially along the Beaufort Sea coastline) and future OCS activities could affect seafloor and pelagic habitats; these include the generation of noise, well drilling, pipeline placement, subsea production well and platform placement, and routine discharges. Accidental oil spills are also among these actions. Cumulative impacts on benthic and pelagic habitats in the Arctic region are considered to be **moderate** to **major**.	Routine operations under the Program in the Arctic region could result in impacts from ground disturbance during drilling and pipeline and platform placement, as well as the discharge of drilling muds and cuttings and produced water (sensitive habitats could have long term affects depending on their proximity to these activities). The incremental contribution to cumulative impacts on marine benthic habitats would range from **negligible** to **medium** and would be limited by existing mitigation measures. The incremental impacts of expected accidental oil spills on benthic habitats (most of which are less than 1,000 bbl) would range from **negligible** to **small**, depending on the size, duration, timing, and location of the spill, and the nature (i.e., sensitivity) of the benthic habitat contacted by oil. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could result in **minor** to **moderate** impacts if they were to occur.

TABLE 4.6.6-3 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Essential Fish Habitat	Cumulative impacts on EFH in the Arctic region result of from any activities that kill of managed fish species, disturb ocean bottom habitats, increase sediment suspension (turbidity), degrade water quality, or affect the food supply for fishery resources. Ongoing and future actions/trends that affect these resources include subsistence fishing, commercial shipping (including tankers and other marine vessels), coastal modifications, hardrock mining, dredging and disposal operations, anchoring, and climate change. Commercial fishing does not occur in the Beaufort Sea and Chukchi Sea Planning Areas. Sportfishing in the Arctic region is currently a minor activity, but could increase if regulations change and warming temperatures allow an increase in marine vessel traffic. State oil and gas activities (especially along the Beaufort Sea coastline) and future OCS activities could affect EFH; these include the generation of noise, well drilling, pipeline placement, subsea production well and platform placement, and routine discharges. Accidental oil spills are also among these actions. Cumulative impacts on EFH in the Arctic region are considered to be **moderate** to **major**.	Routine operations under the Program in the Arctic region could result in moderate short- and long-term impacts to EFH and managed species, mainly as a result of bottom disturbance during the placement of pipelines and production platforms. The incremental contribution to cumulative impacts on EFH would be **negligible** to **medium** and would be limited by specific lease stipulations. The incremental impacts of expected accidental oil spills on EFH (most of which are less than 1,000 bbl) would range from **negligible** to **medium** depending on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could result in **moderate** to **major** impacts if they were to occur.
Marine and Coastal Fauna		
Marine Mammals	There are 15 species of marine mammals in the Arctic Region, four of which are listed as threatened or endangered. Ongoing and future activities or phenomena that affect marine mammals include oil and gas development in State waters; vessel traffic; commercial, recreational, and subsistence fishing; marine mammal subsistence harvests; pollution (and marine debris); development; climate change (including temporal and spatial changes in sea ice); diseases; and natural catastrophes. The contribution of the Program activities to cumulative impacts would be small; however, the incremental impacts of accidental oil spills would be small to large, depending on spill location, timing, duration, and size. Cumulative impacts on marine mammals in the Arctic region are considered to be **minor** to **moderate**.	Routine oil and gas-related activities (e.g., seismic surveys, facility construction, normal operations, and, eventually, decommissioning) would result in minor to moderate impacts on marine mammals. Impacts on marine mammals from these activities could include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. The contribution of Program activities to cumulative impacts would be **negligible** to **small**. The incremental impacts of expected accidental oil spills (most of which are less than 1,000 bbl) would be **negligible** to **large**, depending on the location, timing, and volume of the spills; the environmental settings of the spills; and the species exposed to the

TABLE 4.6.6-3 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Marine Mammals (Cont.)		spills. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from **minor** to **major** if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.
Terrestrial Mammals	There are about 30 species of terrestrial mammals in the Arctic region. These include the brown bear, caribou, muskox, the Arctic fox, brown lemming, and wolverine, among others. Ongoing and future activities or phenomena that affect terrestrial mammals include State oil and gas development, aircrafts and vehicle traffic; coastal and community development, timber harvests, hunting; pollution, climate change, and natural catastrophes. Cumulative impacts on terrestrial mammals in the Arctic region are considered to be **minor** to **moderate**.	Routine oil and gas-related activities (e.g., facility construction including onshore pipelines, normal operations including vehicle and aircraft traffic, and, eventually, decommissioning) would result in minor impacts on terrestrial mammals. Impacts on terrestrial mammals from these activities could include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. The contribution of Program activities to cumulative impacts would be **negligible** to **small**. The incremental impacts of expected accidental oil spills (most of which are less than 1,000 bbl) on terrestrial mammals would be **negligible** to **large**, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and other important habitats; the timing and nature of spill containment; and the status of the affected animals. An unexpected, low-probability CDE has a greater potential to affect the terrestrial habitats; therefore, impacts could range from **minor** to **major** if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.
Marine and Coastal Birds	There are more than 492 naturally occurring bird species in Alaska. Because of the limited seasonal nature of open water and snow-free conditions, the Beaufort and Chukchi Seas support a much smaller number of birds than lower parts of Alaska. Most of the birds occurring in the Arctic region are migratory, being present for all or part of the period between May and early November. Cumulative impacts result from direct injury or mortality of marine and coastal birds due to collisions with onshore and offshore structures,	Routine operations may result in localized short-term impacts due to infrastructure construction and marine vessel and aircraft traffic. The contribution of the Program to cumulative impacts on marine and coastal birds therefore would be **negligible** to **medium**. The incremental contribution of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on marine and coastal birds would be **small** to **large**, depending on the

TABLE 4.6.6-3 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Marine and Coastal Birds (Cont.)	ingestion of trash or debris, or exposure to discharges or emissions; loss or degradation of habitat due to coastal development, climate change, or construction and operations activities; and behavioral disturbance due to commercial and recreational boating and small aircraft traffic. Many bird species are currently experiencing a loss or degradation of habitat due to land development and climate change and these impacts are expected to continue into the foreseeable future. Ongoing and future actions/trends that affect marine and coastal birds include those related to oil and gas development in State waters, coastal development, vessel traffic, and climate change. Cumulative impacts on marine and coastal birds are considered to be **minor** to **moderate**.	location, timing, duration, and size of the spill; the proximity of the spill to feeding and nesting areas; the timing and nature of spill containment; and the status of the affected birds. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from **moderate** to **major** if it were to occur. Spill response activities (e.g., vessel traffic, *in situ* burning, and the use of dispersants) could add to these impacts.
Fish	The Beaufort and Chukchi Seas support at least 98 fish species, with the greatest number found in Chukchi Sea. Fish in the Arctic region must survive extended seasonal periods of frigid and harsh conditions such as reduced light, seasonal darkness, prolonged low temperatures, and ice cover. Food resources tend to be scare during winter months, so most of a fish's yearly food supply must be acquired during the brief Arctic summer. Many species found in the Beaufort and Chukchi Seas are at the northern limits of their range. Subsistence fishing has a long history in the region (commercial fishing occurred infrequently in the past). Cumulative impacts result from activities that generate lethal or sublethal impacts to individuals as well as the loss or degradation of fish habitat. Cumulative impacts result from OCS and non-OCS activities that generate lethal or sublethal impacts to individuals as well as the loss or degradation of fish habitat. Ongoing and future actions/trends that affect fish include oil and gas development in State and Federal waters, noise, dredging operations, and the potential effects of climate change such as the loss of sea ice, habitat alteration, and changes in fish productivity and community structure. Cumulative impacts on fish in Arctic waters are considered to be **moderate** to **major**.	The incremental contribution of routine Program activities to these impacts (primarily as a result of disturbance affecting demersal fishes) would be **negligible** to **small**, with the severity of impacts generally decreasing with distance from the disturbance (and a **negligible** contribution to impacts on threatened or endangered fish species). The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on fish would be **negligible** to **medium**, depending on the location, timing, duration, and volume of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range up to **moderate** if it were to occur. Impacts would be greatest if oil were to reach intertidal habitats.

TABLE 4.6.6-3 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Lower Trophic Levels and Invertebrates	Invertebrates (animals without a backbone) occur in various intertidal and deepwater habitats in the Beaufort and Chukchi Seas. Benthic invertebrates are predominantly echinoderms, polychaetes, sponges, anemones, bivalves, gastropods, and bryozoans. The most common water column macroinvertebrates in the Arctic region are the copepods. Larger invertebrates tend to be sparse in much of the Beaufort Sea relative to the Chukchi Sea, where echinoderms, crabs, and shrimp are more abundant. Zooplankton productivity is highly seasonal. At the lowest trophic levels, microbes such as bacteria and protists are important in Arctic waters for breaking down and recycling nutrients and organic matter. Cumulative impacts on invertebrates and lower trophic organisms result from activities that generate lethal or sublethal impacts to individuals as well as habitat loss or degradation. Cumulative impacts result from OCS and non-OCS activities that generate lethal or sublethal impacts to individuals as well as habitat loss or degradation. Ongoing and future actions/trends that affect invertebrates include oil and gas development in State and Federal waters, dredging, trawling, and the potential effects of climate change such as the loss of sea ice, changes in invertebrate habitat and changes in invertebrate productivity and community structure. Cumulative impacts on invertebrates in Arctic waters are considered to be **moderate** to **major**.	The contribution of the Program to cumulative impacts (mainly due to bottom-disturbing activities) would be **negligible** to **medium**, with the severity of the impacts generally decreasing with distance from bottom-disturbing activities. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on invertebrates would be **negligible** to **small**, depending on the location of the spill and the season in which the spill occurred. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE would also depend on these factors, and could range up to **moderate** if they were to occur.

TABLE 4.6.6-3 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Areas of Special Concern	The Alaska National Interest Lands Conservation Act of 1980 designated certain public lands in Alaska as National Parks, Wildlife Refuges, Wild and Scenic Rivers, and as designated for the National Wilderness Preservation and National Forest Systems. Some of these occur in the Arctic region. Other Areas of Special Concern include MPAs; there are no MUAs, National Estuarine Research Reserves, National Estuary Program Areas, or NOAA-designated HCAs in or adjacent to the Beaufort Sea or Chukchi Sea Planning Area. Cumulative impacts on these resources result from activities that could potentially cause damage to or degradation of fauna or habitats within these areas. Ongoing and future activities or trends that affect Areas of Special Concern in or near Arctic waters include fishing, diving, dredging operations, marine vessel traffic (and wakes), tankering, trash and debris accumulation (from various sources), onshore infrastructure (e.g., roads and vehicle traffic), and oil and gas development and infrastructure (e.g., pipeline landfalls and onshore facilities). Cumulative impacts on Areas of Special Concern in Arctic waters are considered to be **negligible** to **moderate**. The impacts of activities taking place within the Areas of Special Concern located onshore, such as National Parks and National Forests, are regulated through permitting processes.	Routine operations Routine operations under the Program could result in **negligible** to **medium** incremental increases in effects on national parks and wildlife refuges. Expected oil spills (most of which are less than 1,000 bbl) that occur during the Program could result in a **negligible** to **small** incremental contribution to cumulative impacts on Areas of Special Concern, depending on spill frequency, location, and volume; the type of product spilled; weather conditions; effectiveness of cleanup operations; and other environmental conditions at the time of the spill. Large spills (1,000 bbl and greater) or an unexpected, low-probability CDE in areas adjacent to the National Parks and NWRs, whether from OCS or non-OCS sources, would also depend on these factors, and could result in **moderate** impacts if they were to occur. Such spills could negatively impact coastal habitats and fauna, and could also affect subsistence uses.
Population, Employment, and Income	The population in the Beaufort Sea and Chukchi Sea Planning Areas is concentrated in Barrow. It increased at an average annual rate of 3.6% between 1980 and 1990, and 2.1% between 1990 and 2000; it decreased by 1.0% between 2000 and 2009. The components of population increase include the natural increase due to births and net positive domestic migration; the population trend is uncertain over the next 50 yr and will likely depend on the availability of jobs. Most communities in the borough have a high percentage of American Indian or Alaska Natives. Cumulative impacts of future OCS program and ongoing and future non-OCS program activities	The Program would add to beneficial impacts. The incremental contribution of routine operations under the Program is expected to be **small**, however, because the added employment demands are less than 10% of total Alaska employment. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be **negligible** to **small** relative to those associated with future OCS program and ongoing and future non-OCS program activities. Large spills (1,000 bbl or greater) or an unexpected CDE could result in

TABLE 4.6.6-3 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Population, Employment, and Income (Cont.)	would be considered **beneficial** because these activities would increase employment and earnings in the region over the next 40 to 50 yr (although rural Alaskan employment in the petroleum industry, especially among Alaska Natives, would likely remain relatively low).	**minor** to **moderate** impacts. In the short-term, impacts of a CDE could be major as a result of lost employment, income, and property value; increased traffic congestion; increased cost of service provision; and possible shortages of commodities or services.
Land Use and Infrastructure	Land use in much of the Arctic region is not intense, with oil and gas-related development (onshore and offshore in State waters) and subsistence being the predominant uses. There are only a few small communities in the area, the largest of which is Barrow. Barrow is the economic, transportation, and administrative center for the North Slope Borough. Transportation-related infrastructure is minimal, but concentrated in the Prudhoe Bay oil field area. Marine shipping to North Slope communities is by barge and by lightering of cargo to shore because of the shallow coastal waters and the lack of dredging and heavy-lift equipment. Paved and unpaved roads are generally limited to the area within communities. During the winter, many residents travel by snowmobile. Airports and related service facilities are also limited. Most of the oil and gas-related infrastructure in the Arctic region is along the Beaufort Sea coastline. The Prudhoe Bay/Kuparuk oil field infrastructure is served by about 480 km (300 mi) of interconnected gravel roads, 640 km (400 mi) of pipeline routes, and related processing and distribution facilities. Cumulative impacts on land use and infrastructure result from demands on roads, utilities, and public services and the need to develop additional onshore facilities to accommodate ongoing and future activities in the region. Oil spill response also places stresses on community infrastructure and increases traffic in the affected area. Cumulative impacts on land use and onshore resources could range from **minor** to **major**, depending on the nature and location of demands.	The incremental contribution of routine operations under the Program to cumulative impacts in the Arctic region would be **small** to **medium** because of land use changes needed for new onshore pipeline construction and transportation network. Land use–related impacts resulting from expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program include stresses of spill response on community infrastructure, increased traffic in the response area (both onshore and offshore), and temporary restricted access to affected lands (while cleanup is conducted). Such spills would result in a **small** incremental contribution to cumulative impacts on land use and existing infrastructure. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in **moderate** to **major** impacts if they were to occur.

TABLE 4.6.6-3 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Commercial and Recreational Fisheries	There currently is no commercial fishing and little data on recreational fishing in the Beaufort or Chukchi Seas (although the North Pacific Fishery Management Council has concluded that there are few recreational fisheries in these waters). Sport fishing likely occurs in coastal areas of larger population centers such as Barrow. Subsistence fishing is widespread in coastal areas of the Arctic; fisherman target Pacific herring, Dolly Varden char, whitefish, Arctic cod, and sculpin. Given the importance of fishing to local communities in the Arctic region, the most important cumulative impacts would result from any activities that cause a decline in fish availability for subsistence harvest. The cumulative impacts on recreational (and subsistence) fisheries in Arctic waters are considered to be **moderate** to **major**.	The incremental contribution of routine Program activities to cumulative impacts would be **small**, since routine operations under the Program would not occur in the immediate area where fisheries are located. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be **medium**, depending on the location, timing, and volumes of spills (among other environmental factors). Small spills are unlikely to affect a large number of fish or have a substantial effect on fishing before dilution and weathering reduced concentrations of oil in the water. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be **moderate** if they were to occur.
Tourism and Recreation	Tour groups to the North Slope Borough make up most of the nonresidential recreational activity. Most visitors stay in Barrow or Deadhorse. Travel to these areas is primarily by air, although bus tours occasionally arrive via the Dalton Highway. Hikers and river rafters also visit the Arctic National Wildlife Refuge and other areas using scheduled or chartered airplanes for access. An increasing number of cruise ships are entering the Chukchi and Beaufort Seas. Cumulative impacts on tourism and recreation result from disruptions to land-based activities, increases in the trash and debris accumulation, and competition between workers and tourists for local services, such as air transport and hotel accommodations; these impacts are expected to be **moderate** to **major**.	The incremental contribution of routine operations under the Program to cumulative impacts would be **small**, with potential adverse aesthetic impacts on sightseeing, hiking, and rafting activities. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be **negligible** to **small**, depending on the size, location, and timing of the spill (being greatest if it occurred during the peak recreational season). Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could range from **minor** to **moderate** if they were to occur.

TABLE 4.6.6-3 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Sociocultural Systems	Most of the sparsely populated rural lands in the Arctic region are inhabited by indigenous Alaskans. Barrow is the largest permanent community on the North Slope and serves as the administrative and commercial hub of the region. The Alaska Natives living in communities along the coast of the Beaufort and Chukchi Seas are primarily Iñupiaq Eskimo. Alaska Native communities along the Arctic coast are heavily dependent on subsistence harvesting of sea mammals, fish, and terrestrial fauna. Enclaves of workers at Prudhoe Bay and nearby oil fields are employed by the oil and gas industry. They commute from mostly south central Alaska, Fairbanks, and States outside of Alaska. For the most part, these two communities (Alaska Native communities and worker enclaves) have had little interaction because of the physical distance that separates them. Cumulative impacts to sociocultural systems occur when ongoing and future actions (OCS and non-OCS program) cause changes in local populations and social institutions or when jobs are lost or created. Subsistence harvesting could also be affected by activities that affect marine fauna, such as increases in airborne or subsea noise (e.g., aircraft or marine vessel traffic, seismic surveys, drilling) or degradation of water quality (e.g., fuel or oil spills, chemical releases, or dredging operations that increase turbidity), or that necessitate changes in subsistence fishing practices. Cumulative impacts on sociocultural systems in the Arctic Planning Areas as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be **moderate** over the next 40 to 50 yr.	The incremental contribution of routine operations under the Program to cumulative impacts would range from small to medium, especially if subsistence-related activities, central to the well-being of Alaska Natives who inhabit the area, are affected. Many of these potential effects are mitigatable. Onshore linear features (e.g., pipelines and roads) affect the migration patterns of terrestrial mammals. Because of the high level of dependence on subsistence harvesting, the incremental contribution of the Program to cumulative impacts on subsistence activities near the Beaufort and Chukchi Seas would be expected to be **small** to **medium**. Design stipulations and operational procedures could reduce the impact of onshore development. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on would be **small** to **medium**, depending on the location, volume, and timing (i.e., season) of the spill. Impacts associated with large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could be **major** if they were to occur, especially if they disrupt sea mammal harvest or resulted in the IWC reducing or eliminating whale quotas in the Alaska Arctic.
Environmental Justice	Environmental justice impacts occur when any activity or trend (OCS program or non-OCS program related) results in adverse health or environmental impacts that are significantly high and disproportionately affect minority and low-income populations. A large number of minority and low-income individuals are located in the Arctic region, although the number of low-income individuals does not exceed 50% of the total population (thus there is no low-income population in the region). Subsistence hunting and fishing	The incremental contribution of routine operations under the Program would be small, depending on the proximity of onshore pipelines and offshore infrastructure to communities and their subsistence harvest areas, but are not expected to cause additional environmental justice concerns; their contribution to cumulative impacts on low-income and minority populations therefore would be **small**.

TABLE 4.6.6-3 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Environmental Justice (Cont.)	are an important part of the economies in Arctic communities. Cumulative impacts on local communities could result from changes in the proximity of onshore oil and gas infrastructure and to marine vessel and aircraft traffic. Ongoing and future oil and gas development would continue to affect populations in some regions along the Beaufort and Chukchi Seas by increasing the proximity to existing oil and gas infrastructure and associated health, environmental, and visibility impacts. Given these factors, cumulative impacts on local populations are considered to be **moderate** to **major**.	The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be **negligible** to **small**. Large spills (1,000 bbl or greater) or an unexpected, low-probability CDE could result in **moderate** to **major** impacts on the Alaska Native population, especially if subsistence resources were diminished or tainted as a result of the spill. Mitigation measures, cooperative agreements between Native and industry groups, and government-to-government consultations are designed to limit the effects from oil spills and routine operations.
Archaeological and Historical Resources	At the height of the late Wisconsinan glacial advance, about 19,000 years ago, the global sea level was much lower than at present and created land bridges between the North American and Asian continents. During this time, large expanses of the OCS were exposed as dry land and shorelines shifted depending on the location of ice. These relict shorelines (and other relevant landforms) are currently inundated. Some studies indicate that ice gouging may have altered the seafloor in the Arctic region, removing all archaeological evidence of the first peoples; however, the extent of the disturbance is not known. To date, more studies have been done in the Beaufort Sea, but more will be needed to fully understand the potential for significant artifacts to be present. Numerous shipwrecks have been documented in the Beaufort and Chukchi Seas. Most of these were associated with commercial whaling which occurred in the region between 1849 to 1921 and are likely to be in State waters. There are significant onshore historic sites in the Arctic region; these include Cold War era outposts, radar stations, and missile sites, and the Ipiutak Site National Historic Landmark at Point Hope among others. Cumulative impacts to these resources	Routine operations could affect significant archaeological and historic resources, especially offshore resources, with construction activities such as platform and pipeline construction potentially damaging or destroying affected resources. Onshore impacts include resource damage or loss, or visual effects and are possible from pipeline landfall, onshore pipeline, and road construction. Anchor drags could adversely affect shipwrecks. The incremental contribution of routine operations under the Program could be **negligible** to **large**, depending on the presence of significant archaeological or historic resources in the area of potential effect. Archaeological surveys that would identify significant cultural resources to be avoided could reduce these impacts. The incremental contribution of oil spills, whether expected oil spills (most of which are less than 1,000 bbl) to cumulative impacts on archaeological and historical resources in the Arctic region would be **small** to **large**, depending on the presence of significant resources in the area of potential effect and the spill location, timing, duration, and size. Impacts associated with an unexpected, low-probability CDE would also depend on these factors, and could range from **minor** to **major** if it were to occur.

TABLE 4.6.6-3 (Cont.)

	Anticipated Trends and Cumulative Impacts	Contributions of Program to Cumulative Impacts
Archaeological and Historical Resources (Cont.)	occur when operations involving bottom-disturbing activities (e.g., channel dredging) come into physical contact with artifacts or their site context, or as a result of natural phenomena such as high-energy waves and currents, ice gouging, and thermokarst collapse. The cumulative impacts of future OCS and ongoing and future non-OCS activities are not currently known, but could range from **minor** to **moderate**, mainly because activities occurring on the OCS prior to USDOI's survey requirement, which went into effect in 1973, may already have affected (i.e., damaged or destroyed) significant sites.	

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5 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

5.1 IMPACTS ON PHYSICAL RESOURCES

Some unavoidable adverse effects on water and sediment quality would be expected to occur as a result of routine operations under the proposed action. Operational discharges of drilling muds and cuttings, produced water, and small amounts of hydrocarbons into the water column during routine offshore oil and gas operations would lower local water and sediment quality. These discharges could temporarily raise the levels of some water quality and sediment parameters above normal within 100 to 2,000 m (328 to 6,562 ft) of the discharge point during drilling, and intermittently/continuously during the production period.

An increase in emissions of air pollutants would be expected to occur, particularly in areas that do not already have extensive oil and gas activities. Emissions of nitrogen oxides and reactive hydrocarbons would increase ozone concentrations in the immediate vicinity of the offshore operations for intermittent periods during the term of the proposal.

Seismic surveys, infrastructure construction and removal, and support vehicle traffic would result in unavoidable but short-term increases in ambient noise levels in the survey areas, project locations, and vessel and helicopter routes. More long-term increases in ambient noise levels would occur during normal operations; the duration of increased ambient noise levels would correspond directly to the duration of production operations.

5.2 IMPACTS ON ECOLOGICAL RESOURCES

Marine mammals would be adversely affected by noise and disturbances associated with routine offshore activities (seismic surveys, vessels, aircraft, drilling, and dredging) during relatively brief periods of time. Some marine mammals would exhibit short-term responses to noises and disturbance, such as confusion or avoidance. Bowhead whales, for example, will exhibit avoidance behavior to noise-producing activities. Should an oil spill contact marine mammals, some individuals would experience short-term effects, while a small number could die. An oil spill would also adversely affect local marine mammal prey resources in small areas affected by a spill.

Disturbances of terrestrial mammals by offshore related aircraft, vehicles, facilities, human presence, and habitat alteration from construction activities are unavoidable. Disturbance of caribou, bears, and other animals in Alaska would be temporary and would not affect their overall distribution and abundance.

Marine and coastal birds would be adversely affected by noise and disturbances associated with routine offshore and onshore activities. Habitat alteration from the construction of onshore facilities would affect a small portion of the available habitat. Should an oil spill contact marine and coastal bird habitat, some birds would experience short-term effects, while some birds that feed in or rest on the water could be coated with oil and die. An oil spill could also adversely affect local marine and coastal bird prey resources.

Wetland and estuarine habitat alteration resulting from pipeline and other related coastal construction could have an unavoidable adverse impact on fish nursery areas and terrestrial mammals; however, regulations are in place to minimize these impacts. An oil spill contacting fish habitat would have an adverse effect on local fishery stocks and food webs.

Although individual sea turtles may be injured or killed by support vessel collisions, population-level effects would be minimal. The most likely impacts from noise would be short-term behavioral changes such as diving and evasive swimming. If an oil spill were to contact sea turtles, some individuals might not recover from exposure, but sea turtle populations as a whole would not be threatened.

Unavoidable adverse effects on seafloor habitats and associated organisms could occur from anchoring, drilling discharges, structure emplacement and removal, and pipeline emplacement.

5.3 IMPACTS ON SOCIAL, CULTURAL, AND ECONOMIC RESOURCES

Commercial and, to a lesser extent, recreational fisheries will be adversely affected by loss of fishing areas occupied by offshore vessels, platforms, and exposed pipelines, particularly in areas where oil and gas activities have not previously occurred. Oil spills could contaminate, injure, or kill shellfish, finfish, eggs, and larvae in the vicinity.

Unavoidable adverse effects could be expected to occur to tourism and recreation areas from floating debris and oil spills that contact beach areas. Effects on scenic quality could also be expected to occur.

The proposed action with its ancillary activities will place increased demands on coastal communities, particularly in areas where oil and gas activities are not currently occurring. Offshore operations may result in the deposition of floating debris on beaches, precluding their use for recreation, and platform placement could also affect commercial fishing costs. Beaches may be affected temporarily by oil spills, which could also restrict commercial and recreational fishing. Impacts on beach recreation and on recreational and commercial fishing could disrupt coastal economies. Some unavoidable adverse effects on subsistence harvests in the Alaska region may result from routine offshore oil and gas activities. These offshore and onshore activities could cause localized displacement or loss of small numbers of subsistence resources. If oil spills were to contact bowhead and beluga whales and walruses, there could be a reduction of total annual harvests of these species. In such a case, short-term loss of some subsistence resources and potential repercussions on the culturally significant sharing system would be unavoidable.

Unavoidable adverse effects to archaeological resources could occur as a result of the proposed action. Construction and siting of offshore and onshore oil and natural gas facilities such as platforms, pipelines, or processing facilities could displace, damage, or destroy archaeological resources.

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6 RELATIONSHIP BETWEEN SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The short-term uses of man's environment in relation to the 2012-2017 Outer Continental Shelf (OCS) Leasing Program (the Program) are the offshore and onshore activities needed to develop oil and gas resources to meet the energy needs of the United States. The Bureau of Ocean Energy Management (BOEM) makes every attempt to minimize the environmental effects from these uses. By adopting mitigating measures for OCS operations, BOEM attempts to minimize long-term impacts and maintain or enhance the long-term productivity of areas in which oil and gas have been exploited. With proper removal of offshore oil and gas facilities, or their disposal in areas designed to enhance recreational fishing, offshore areas will continue to maintain fish resources and provide habitat for marine mammals, birds, and reptiles long after oil and gas operations have ceased. After the completion of oil and gas production, the marine environment that may be affected by routine operations under the Program is generally expected to remain at or return to its anticipated long-term productivity levels. The long-term productivity of the marine environment in GOM and Alaskan waters is affected by a wide variety of factors, many unrelated to OCS oil and gas activities, and it is speculative to suggest what productivity levels in these OCS waters may be in 40 to 50 years when the Program oil and gas activities would be completed. The onshore effects of the OCS program and the proposed action will contribute to the continuing alteration of nearby coastal areas from natural environments to urbanized and industrialized environments.

One confounding factor that may affect long-term productivity of the areas included in the Program is climate change. Even in the absence of the oil and gas activities that would occur under the Program and the proposed action, baseline environmental conditions (such as sea level and ocean acidification) are changing as a consequence of climate change; this is especially true in the Arctic (see Section 3.3 for a discussion of climate change and baseline conditions). As climate-driven changes occur, productivity may be expected to change as well, and any changes in long-term productivity that could occur as a result of the Program would be in addition to any climate-related changes.

Short-term use of the environment in the vicinity of OCS activities includes the exploration and development of OCS oil and gas resources during the period of activity needed for the completion of the proposed action. The overall life of the proposed action is estimated to be about 40–50 years, with about 10-15 years of oil and gas exploration and delineation activity and about 30–35 years of resource development and production activity. Many of the effects of routine operations discussed in Chapter 4 are the result of short-term uses and are greatest during the exploration, development, and early production phases. These effects may be reduced by mitigation measures required by BOEM, and are not expected to adversely affect long-term productivity of affected areas or resources.

Extraction and consumption of offshore oil and natural gas would be a long-term depletion of nonrenewable resources. Economic, political, and social benefits would accrue from the use of these natural resources. Most benefits would be short-term and would delay the increase in the dependency of the United States on oil imports. The production of offshore oil and natural gas from the proposed action would provide short-term energy sources and perhaps additional time for the development of long-term alternative energy sources or substitutes for these nonrenewable resources.

In the event of a catastrophic discharge event (CDE), such as the Deepwater Horizon (DWH) event or the *Exxon Valdez* spill in Alaska, some natural resources may incur long-term effects on productivity. Studies on the effects of the *Exxon Valdez* spill on biota and habitats in Prince William Sound show some resources to have recovered, others to still be showing possible spill effects, and yet for others that is no clear indication of the presence or absence of long-term effects (see discussions in Chapter 4). It is too early to ascertain whether the 2010 DWH event will cause long-term changes in productivity of affected resources. Long-term impacts of large oil spills to local economies and sociocultural systems may also be expected, especially in the Alaska planning areas.

Onshore facility construction (e.g., pipelines, processing facilities, service bases, etc.) causes definite short- and long-term changes, with localized long-term effects on coastal habitats along onshore pipeline corridors. Some biological resources, such as nesting birds, may have difficulty repopulating altered habitats and could be permanently displaced from the local construction area. Short-term biological productivity would be reduced or lost in the immediate onshore areas where construction takes place; however, areas where long-term effects may be incurred would be very limited in spatial extent and the long-term productivity in some of these areas could be mitigated with habitat reclamation. After the completion of oil and gas production, the marine environment is generally expected to remain at or return to its normal long-term productivity levels.

In the Alaska region, habitat disturbance associated with routine activities could cause local impacts to subsistence resources, which could threaten subsistence as a way of life. Road construction resulting from the proposed action would improve accessibility to primitive areas in the region. The wilderness values of the coast and along pipeline routes and associated access roads would decrease with increased human activity in these areas, particularly in areas that do not already have extensive oil and gas activities. Land use changes would be noticeable at onshore facility sites and along pipeline routes. Short-term changes may include a shift in land use from subsistence-based activities to industrial activities during the life of the proposed action. Areas adjacent to onshore facilities and pipeline corridors would probably be subject to hunting regulations and restrictions. Land use in some localized areas would change from conservation to resource development. Long-term effects on land use may result if the infrastructure or facilities continued to be used after the lifetime of the proposed action.

Increased population and minor gains in revenues have the potential for disrupting coastal communities in the short term. In Alaska, an added incentive to shift from a subsistence-based economy to a cash-based economy, a reduction in subsistence resources, a decrease in subsistence activities, and other changes brought about by the proposed action could be factors in long-term consequences for Native social and cultural systems. In the event of an oil spill, sociocultural systems and subsistence of local communities and populations may incur short-term consequences, while a large spill such as a CDE may have long-term consequences to affected communities and populations.

Archaeological and historic finds discovered during development would enhance long-term knowledge. Overall, finds may help to locate other sites, but destruction of artifacts or damage to sites would represent long-term losses.

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7 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Section 102(2)(c)(ii) of the National Environmental Policy Act (NEPA) requires that an environmental impact statement (EIS) include information on any adverse environmental effects that cannot be avoided, should the proposed action be implemented. A commitment of a resource is considered *irreversible* when the primary or secondary impacts from its use limit the future options for its use. An *irretrievable* commitment refers to the use or consumption of a resource that is neither renewable nor recoverable for use by future generations.

7.1 MINERAL RESOURCES

The development of oil and gas production facilities, as well as all exploration and project support activities, would result in the consumption of ship and aircraft fuel, structural steel, and other materials. Upon decommissioning, some of these materials would be available for reuse. The consumption of fuels during exploration, construction, production, and decommissioning would represent an irreversible and irretrievable commitment. The offshore oil and natural gas resources recovered as a result of the proposed action would be irretrievable once they are consumed.

7.2 BIOLOGICAL RESOURCES

In general, the impact of routine operations would not constitute an irreversible and irretrievable commitment of resources. During exploration, construction, production, and decommissioning, some biota would be affected, and for most species population-level effects (which could result in irreversible and irretrievable commitment of biological resources) would not be expected. Offshore and onshore oil and gas activities, such as facility construction; platform removal; and aircraft, vessel, and vehicle traffic could result in direct habitat loss in some limited areas and displace some fauna and flora species from favorable habitats to unfavorable habitats. Displacement and habitat loss may result in the reduction of some local populations and become irretrievable if alterations to the environment were permanently maintained. However, the degree of displacement and amount of irretrievable habitat loss should represent a transitory and negligible effect on the overall populations of most species.

An irreversible and irretrievable commitment of biological resources may occur where habitats (such as wetlands and corals) are impacted by dredging, construction activities, or oil spills. Dredging and construction activities can destroy coastal wetland vegetation, which results in soil erosion and wetland loss. Dredging and construction in offshore areas could similarly destroy marine benthic habitats and sessile biota inhabiting the disturbed areas. These types of losses would be greatest in areas where oil and gas activities are currently not occurring. However, implementation of habitat restoration measures may limit the amount of habitat that could be permanently lost.

An irretrievable and irreversible commitment of biological resources may also be incurred if one or more individuals of a species listed under the Endangered Species Act is injured or killed, or important habitats such as nesting sites are disturbed. However, consultation and coordination with the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) prior to initiation of any oil and gas development activities would identify mitigation measures to reduce or eliminate potential impacts to listed species, and implementation of such measures would act to reduce the potential for an irreversible and irretrievable commitment of these biotic resources.

7.3 LAND USE

In general, land used for support of oil and gas development and processing would not revert to its predevelopment characteristics; however, the land may become favorable to other urban or industrial uses. Some areas of land disturbance may be returned to predevelopment characteristics with active restoration.

7.4 ARCHAEOLOGICAL RESOURCES

Irretrievable prehistoric archaeological sites and cultural materials may be lost through indiscriminate or accidental activity on known and unknown sites such as placement of a pipeline across a shipwreck. Archaeological protection requirements should mitigate some losses.

8 CONSULTATION AND COORDINATION

8.1 PROCESS FOR THE PREPARATION OF THE 2012-2017 OCS OIL AND GAS LEASING PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

8.1.1 Draft Proposed Program and Draft PEIS

Preparation and review of the draft programmatic environmental impact statement (PEIS) closely paralleled that of the 2012-2017 Outer Continental Shelf (OCS) Oil and Gas Leasing Program (the Program) decision documents. Comments received on the program decision documents were also reviewed for consideration in the preparation of the PEIS.

In January 2009, the previous Administration published a Draft Proposed Program (DPP) and a Notice of Intent (NOI) to prepare a programmatic environmental impact statement (PEIS) that requested comments from States, local governments, Native groups, federally recognized tribes, the oil and gas industry, Federal agencies, and other interested individuals and groups and set out a schedule for scoping meetings in the areas of the DPP. In February 2009, the Secretary of the Interior extended the comment period on the DPP and postponed the scoping meetings to allow time to consider further public comment before determining which areas in the DPP should be scoped and analyzed for consideration in subsequent program proposals. A preliminary revised Program was proposed on March 31, 2010.

8.1.2 Scoping for the Draft PEIS

An NOI to prepare and scope the Program PEIS was published in the *Federal Register* (75 FR 16828) on April 2, 2010. That NOI invited the public to provide comments on the scope and content of the PEIS and identified as many as 14 locations where public scoping meetings might be held.

On June 30, 2010, Secretary of the Interior Salazar announced that the public scoping meetings would be postponed in response to the Deepwater Horizon (DWH) incident. The additional time would be used to evaluate safety and environmental requirements of offshore drilling. On December 1, 2010, Secretary Salazar announced an updated oil and gas strategy for the OCS. The new strategy continued a moratorium for areas in the Eastern Gulf of Mexico (GOM) and eliminated the Mid-Atlantic and South Atlantic Planning Areas from consideration for potential sales and development through the 2017 planning horizon. The Western GOM, Central GOM, Cook Inlet, Chukchi Sea, and Beaufort Sea OCS Planning Areas would continue to be considered in the PEIS. Subsequently, on January 4, 2011, a Notice of Scoping Meetings for the proposed 2012-2017 OCS oil and gas leasing program PEIS was published in the *Federal Register* (76 FR 376) and a second scoping period was conducted from January 6, 2011, through March 31, 2011. During this scoping period, public scoping meetings were scheduled for 12 locations in the GOM (three locations), Alaska (eight locations), and Washington, D.C. The scheduled Alaska meetings for Point Hope and Point Lay were not held because of inclement weather and subsequently could not be rescheduled because of ongoing schedule conflicts (e.g., whaling season). The public scoping meetings were held to garner significant issues and public concerns for inclusion in the PEIS. In addition, the Bureau of Ocean Energy Management (BOEM) received comments through the mail and maintained a public website to accept scoping comments electronically.

BOEM established cooperating agency status with the U.S. Department of Commerce National Oceanic and Atmospheric Administration (NOAA), the State of Alaska, and the Alaska North Slope Borough. They reviewed preliminary versions of the Draft and Final PEIS.

8.1.3 Commenting on the Proposed Program and Draft PEIS

Comments were requested during a 90-day period on the proposed Program and during a 60-day period on the associated Draft PEIS. The comments received were evaluated and considered in the preparation of the Proposed Final Program and Draft PEIS. The Proposed Final Program will be submitted to the President and to the Congress along with an explanation from the U.S. Department of the Interior (USDOI) concerning the reasons for the decision.

8.2 PUBLIC COMMENT ON THE DRAFT PEIS

A Notice of Availability (NOA) for the public release of the Draft PEIS was published in the *Federal Register* on November 10, 2011. The notice announced a 60-day public comment period from November 10, 2011 until January 9, 2012. All comments received during the public comment period were impartially considered and given equal weight by BOEM. Section 8.4.4 of this Final PEIS presents the responses to these comments prepared by BOEM. The stakeholders providing comments are listed in Tables 8.4-1 and 8.4-2.

During the public comment period, BOEM provided the public with three methods for delivering comments on the Draft PEIS:

- Electronically, using a Web-based form accessible on the Internet at http://www.boem.gov/5-year/2012-2017,
- Regular mail to BOEM Headquarters, and
- Public meetings.

Thirteen public hearings were held on the following dates and at the following locations:

- December 5, 2011 — Wainright, Alaska
- December 6, 2011 — Nuiqsut, Alaska
- December 6, 2011 — Washington, D.C.

- December 6, 2011 — Houston, Texas
- December 7, 2011 — Kaktovik, Alaska
- December 7, 2011 — Mobile, Alabama
- December 8, 2011 — New Orleans, Louisiana
- December 9, 2011 — Anchorage, Alaska
- December 12, 2011 — Kotzebue, Alaska
- December 13, 2011 — Point Hope, Alaska
- December 14, 2011 — Point Lay, Alaska
- December 16, 2011 — Barrow, Alaska

Two meetings to receive public comments were held on the same day in Houston, Mobile, and New Orleans, with single meetings at all other hearing locations. All meetings except the one held in Washington, D.C., were advertised in local newspapers and through local press releases.

Comments were received from State and local officials; Federal, State, and local agencies; environmental and nongovernmental organizations; the oil and gas energy sector; and individuals. Per CEQ NEPA Regulations, 40 CFR 1503.4, BOEM prepared responses to all substantive comments (see Section 8.4.4) and revised portions of the Final PEIS to incorporate some of the changes suggested by commenters.

8.3 DISTRIBUTION OF THE FINAL PEIS

The Final PEIS was distributed to Federal, State, and local agencies; to interested groups and individuals who had been involved in the preparation of the Program and the PEIS process; and to stakeholder and project area libraries.

FEDERAL AGENCIES: Copies of the PEIS were provided to the following Federal agencies:

- Federal Energy Regulatory Commission
- Marine Mammal Commission
- U.S. Department of Commerce
  - National Oceanic and Atmospheric Administration (NOAA)
  - NOAA National Marine Fisheries Service

- U.S. Department of Defense
  - U.S. Air Force
  - U.S. Army Corps of Engineers
  - U.S. Navy

- U.S. Department of Energy

- U.S. Department of the Interior (USDOI)
  - U.S. Fish and Wildlife Service
  - Bureau of Indian Affairs
  - Bureau of Mines
  - Bureau of Safety and Environmental Enforcement
  - National Park Service

- U.S. Department of Transportation

- U.S. Department of Homeland Security
  - U.S. Coast Guard

- U.S. Department of State

- U.S. Department of Justice

- U.S. Environmental Protection Agency (USEPA)

- U.S. Geological Survey

CONGRESS: Copies of the PEIS were provided to the following Congressional offices:

- House of Representatives Committee on Resources

- United States Senate Committee on Energy and Natural Resources

TRIBES/TRIBAL ORGANIZATIONS: Copies of the PEIS were provided to the following tribes and tribal organizations:

ALASKA

Afognak Native Corporation
Agdaagux Tribe of King Cove
Alaska Area Native Health Service
Alaska Eskimo Whaling Commission
Alaska Federation Of Natives
Alaska Intertribal Council
Alaska Inter-Tribal Council
Alaska Native Harbor Seal Commission
Aleut Corporation
Arctic Slope Native Association
Arctic Slope Regional Corporation
Bering Straits Native Corporation
Brevig Mission Native Corporation
Bristol Bay Native Association
Bristol Bay Native Corporation
Calista Corporation
Central Council of the Tlingit & Haida Indian Tribes of Alaska
Chenega IRA Council
Chickaloon Village Traditional Council
Chignik Lake Village Council
Chinik Eskimo Community
Chugach Alaska Corporation

Chuloonawick Native Village
Cook Inlet Regional Corporation
Cook Inlet Tribal Council
Council Native Corporation
Elim Native Corporation
Emmonak Native Corporation
English Bay Native Corp
Eskimo Walrus Commission
Inalik Native Corporation
Inupiat Community of The Arctic Slope
Ivanoff Bay Tribal Council
Kaktovik Inupiat Corporation
Kanatak Tribal Council
Karluk IRA Council
Kawerak Incorporated
Kenaitze Indian Tribe
Kikiktagruk Inupiat Corporation
King Island Native Corporation
King Salmon Village Council
Knik Tribe
Kodiak Area Native Association
Kongnikilnomuit Yuita Corporation
Koniag Incorporated
Kotlik Yupik Corporation
Kotzebue IRA
Koyuk Native Corporation
Larsen Bay Tribal Council
Maniilaq Association
Naknek Native Village Council
NANA Regional Corporation
NANA Regional Corporation IRA Council
Nanwalek Traditional Council
Native Village of Akutan
Native Village of Barrow
Inupiat Traditional Government
Native Village of Belkofski
Native Village of Chignik
Native Village of Ekuk
Native Village of False Pass
Native Village of Kaktovik
Native Village of Kanatak
Native Village of Kivalina
Native Village of Kotlik
Native Village of Kwigillingok
Native Village of Kwinhagak
Native Village of Nuiqsut
Native Village of Perryville
Native Village of Point Hope
Native Village of Point Lay
Native Village of Port Heiden
Native Village of Shaktoolik
Native Village of South Naknek
Nelson Lagoon Tribal Council
Newtok Corporation
Newtok Traditional Council
Nima Corporation
Ninilchik Traditional Council
Northwest Arctic Borough Planning Department
Nunakauiak Yupik Corporation
Old Harbor Native Corporation
Orutsararmuit Native Council
Ouzinkie Native Corp
Ouzinkie Tribal Council
Ouzinkie Tribal Media Center
Paimiut Corporation
Pauloff Harbor Tribe
Pilot Point Tribal Council
Platinum Traditional Village Council
Port Graham Corporation
Qagan Tayagungin Tribe
Qanirtuuq Corporation
Qawalangin Tribe of Unalaska
Qenritalek Coast Corporation
Quetekcak Native Tribe
Saguyak Incorporated
Savoonga Native Corporation
Seldovia Native Association Inc
Seldovia Village Tribe
Shaktoolik Native Corporation
Shishmaref Native Corporation
Shumagin Corporation
Sitnasauk Native Corporation
Sivuqaq Incorporated
Solomon Native Corporation
St Michael Native Corporation
Swan Lake Corporation
Teller Native Corporation
Tyonek Native Corporation
Ukpeagvik Inupiat Corporation
Unalakleet Native Corporation
Unga Corporation
Unga Tribal Council
Valdez Native Tribe
Village of Wales
Wales Native Corporation
White Mountain Native Corporation

STATE AGENCIES: Copies of the PEIS were provided to the governors and clearinghouses of the following States:

GOVERNORS
The Honorable Robert Bentley, Governor of Alabama
The Honorable Sean Parnell, Governor of Alaska
The Honorable Edmund G. Brown, Governor of California
The Honorable Dannel P. Malloy, Governor of Connecticut
The Honorable Jack Markell, Governor of Delaware
The Honorable Rick Scott, Governor of Florida
The Honorable Nathan Deal, Governor of Georgia
The Honorable Bobby Jindal, Governor of Louisiana
The Honorable Paul LePage, Governor of Maine
The Honorable Martin O'Malley, Governor of Maryland
The Honorable Deval Patrick, Governor of Massachusetts
The Honorable Haley Barbour, Governor of Mississippi
The Honorable John Lynch, Governor of New Hampshire
The Honorable Chris Christie, Governor of New Jersey
The Honorable Andrew M. Cuomo, Governor of New York
The Honorable Bev Perdue, Governor of North Carolina
The Honorable John Kitzhaber, Governor of Oregon
The Honorable Tom Corbett, Governor of Pennsylvania
The Honorable Lincoln D. Chafee, Governor of Rhode Island
The Honorable Nikki Haley, Governor of South Carolina
The Honorable Robert F. McDonnell, Governor of Virginia
The Honorable Chris Gregoire, Governor of Washington

ALASKA
Alaska Department of Environmental Conservation
Alaska Department of Natural Resources
Alaska Dept of Environmental Conservation
Alaska Oil and Gas Conservation Commission
Alaska Oil and Gas Conservation Commission
Bering Straits Coastal Resource Service Area (BSCRSA)
Department of Environmental Conservation
Department of Environmental Conservation
Department of Natural Resources
Department of Transporation & Public Facilities
Department of Community and Regional Affairs
Department of Fish and Game
Department of Labor
Division of Fisheries Rehabilitation
Division of Oil and Gas
Division of Parks & Outdoor Recreation
DNR Division of Oil and Gas
State of Alaska
State of Alaska Department of Natural Resources
State of Alaska Division of Habitat & Restoration
State of Alaska Division of Mining, Land and Water

ALABAMA
Alabama Department of Conservation
Alabama Department of Conservation & Natural Resources
Alabama Highway Department
Alabama Historical Commission
Alabama House District 99
Alabama Oil & Gas Board
Fairhope, Coastal Section
Geological Survey of Alabama
Natural Resources Committee
State Lands Division

CALIFORNIA
California Coastal Commission
California Department of Conservation
California Energy Commission
California State Lands Commission
Department of Fish & Game
Office of Spill Prevention and Response Resources Agency of California

DELAWARE
Delaware Department of Natural Resources and Environmental Control

FLORIDA
Apalachicola National Estuarine
Department of Environmental Protection
Department of Agriculture and Consumer Services
Department of Environmental Protection
Department of State
Department of Transportation

Department Office of Coastal and Aquatic Managed Areas
Fish and Wildlife Conservation Commission
Florida Chamber of Commerce
Florida Coastal Management Program
Florida DEP/ Mining & Minerals Regulation
Florida Department of Environmental Protection
Florida Department of State
Florida Fish & Wildlife Conservation
Florida Sea Grant College
Growth Management Administrator
Intergovernmental Program
National Marine Committee
Northwest Department District Office
Northwest Department of Environmental Protection District Office
Office of Policy & Stakeholder Coordination
Office of the Attorney General
State of Florida
Tampa Port Authority International Headquarters

LOUISIANA

Abbeville Harbor and Terminal District
Department of Culture/Recreation/Tourism
Department of Environmental Quality
Department of Natural Resources
Department of Transportation & Development
Department of Wildlife & Fisheries
Louisiana Department of Natural Resources
Louisiana Geological Survey
Louisiana Geological Survey/Lsu
Louisiana Sea Grant College Program
Marine Fisheries Division
State of Louisiana

MISSISSIPPI

Department of Environmental Quality
Mississippi Department of Archives and History
Mississippi Department of Wildlife Conservation
Mississippi State Port Authority

NORTH CAROLINA

North Carolina Department of Environment and Natural Resources

SOUTH CAROLINA

South Carolina Department of Health and Enviromental Control

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Texas Commission on Environmental Quality
Texas General Land Office
Texas Historical Commission
Texas Legislative Council
Texas Parks & Wildlife Department
Texas Water Development Board Department
Tracs Coordinator

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Northwest Arctic Borough
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Village of Goodnews Bay
Village of Salamatoff
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ALABAMA

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San Luis Obispo County Air Pollution Control District
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- Sarasota County Courthouse
- Sorasota County Government
- The City of Destin
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- Walton County Growth Management

LOUISIANA
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- City of New Orleans
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- Greater Lafourche Port Commission
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- Jefferson Parish Department of Environmental Affairs
- Jefferson Parish Port District
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- Lafourche Parish Coastal Zone Management
- Morgan City
- Parish President
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- Plaquemines Parish Port, Harbor and Terminal District
- Port of Iberia
- Saint Bernard Planning Commission
- South Lafourche Levee District
- St. Bernard Planning Commission
- St. Bernard Port, Harbor and Terminal District
- St. Charles Parish
- Terrebonne Parish
- Twin Parish Port Commission
- West Cameron Port Commission

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- City of Gulfport
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Florida Natural Areas Inventory
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Mote Marine Laboratory
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Northeast Florida Regional Planning Council
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International Window Film Association
Mangi Environmental Group, Inc.
National Wildlife Federation
Southern Environmental Law Center
The Nature Conservancy

INTERNATIONAL
CANADA

Joint Secretariat
Maurice-Lamontagne Institute Fisheries and Oceans

8.4 PUBLIC COMMENTS ON THE DRAFT PROGRAMMATIC EIS

8.4.1 Introduction

A Notice of Availability (NOA) for the public release of the Draft PEIS was published in the *Federal Register* on November 10, 2011. The notice announced a 60-day public comment period from November 10, 2011, until January 9, 2012. All comments received during the public comment period were impartially considered and given equal weight by BOEM. Comments were received from State and local officials; Federal, State, and local agencies; environmental and nongovernmental organizations; the oil and gas energy sector; and individuals.

A total of 342 comment documents[1] were received from Federal, State, and local governments and agencies, nongovernmental organizations, and individuals. Members of several of the nongovernmental organizations submitted comments using a ‘standard’ form letter for their constituents. For example, the Sierra Club submitted a compact disc with 24,000 form letters (or versions of the form letter) from organization members across the country. While this represents 24,000 submittals, the vast majority of these are identical to the form letter. Other groups submitting largely standardized form letters included the Institute for Energy Research (890 letters) and CREDO (71,626 letters).

As comment documents were received during the public comment period, they were assigned a 5-digit document number. Within each document, individual comments were further numbered. All comment documents received during the public comment period were cataloged in this manner and considered in the preparation of the Final PEIS. Evaluation of the 342 comment documents yielded a total of 1,992 unique comments.

8.4.2 Summary of Major Issues Raised by Commenters on the Draft PEIS

As comments documents were being evaluated and individual comments identified, comments with similar themes were grouped into categories based on the overall nature of the comment. Analysis of comments received on the Draft PEIS identified nine major topics of concern: (1) National Environmental Policy Act (NEPA) process and public involvement; (2) NEPA analysis; (3) alternatives; (4) environmental issues and concerns; (5) cumulative impacts; (6) oil spills; (7) mitigation; (8) regulations and safety; and (9) statutory compliance. These topics covered a wide range of issues, including, but not limited to, compliance and adequacy pertaining to NEPA and the Endangered Species Act (ESA), development of alternatives and selection of planning areas for program consideration, resource impact concerns, impacts on subsistence, oil spills and response, and public outreach.

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[1] A ‘comment document’ refers to the entire submittal provided by a commenter, whether in writing or verbally during one of the public hearings that was held on the Draft PEIS. Each comment document, in turn, may have one or more individual comments on one or more different topics. In some cases, the submitted document contained only a single substantive comment.

NEPA Process and Public Involvement. Some commenters called for BOEM to prepare site-specific EISs for each planning area and to not defer resource specific analyses and regulatory compliance activities to the leasing stage or later, but conduct those analyses as part of the 2012-2017 Program PEIS. Concerns related to public involvement included uncertainty over how the public comments received during scoping were used to prepare the PEIS, and displeasure with the overlap of the public comment period for the 2012-2017 Program PEIS with NEPA comment periods for other NEPA projects in the affected areas.

NEPA Analysis. Some commenters felt that BOEM underestimated risks and impacts of oil spills, did not identify spill responses plans or procedures, and overestimated the benefits of OCS oil and gas development. Several commenters called for the PEIS to include an evaluation of a 'worst case' oil spill scenario. Some commenters called for BOEM to adopt the recommendations of the Council on Environmental Quality (CEQ) and the National Commission on the Deepwater Horizon Oil Spill and Offshore Drilling (the National Commission) and reform its NEPA compliance procedures. Some commenters felt that BOEM did not take a hard look and adequately assess differences in impacts across alternatives, nor adequately consider important impacting factors, such as climate change, on the nature of those impacts. A number of commenters raised concerns regarding insufficient or incomplete information, calling for BOEM to conduct more studies before adopting any new leasing program.

Alternatives. Some commenters called for the addition of more planning areas, while others suggested limiting leasing to only certain areas within the planning areas. Several commenters felt that BOEM did not adequately evaluate the environmental impacts of the alternatives or the benefits of the No Action Alternative, while others felt there was insufficient consideration of alternate/renewable energy sources. Concerns were raised about including alternatives with Arctic leasing given the current industry and governmental capability to contain and clean up possible spills in the Arctic.

Environmental Issues and Concerns. A number of comments were received expressing concerns about how OCS oil and gas development would affect both natural and socioeconomic resources and conditions, including, but not limited to, impacts on air and water quality, biota, socioeconomics, public health, subsistence, and environmental justice. Many commenters were concerned about the impacts of both routine operations and accidental oil spills on one or more resources. Some comments expressed concern about how OCS oil and gas activities may affect human health and subsistence (especially in the Arctic).

Cumulative Impacts. Some commenters felt that the cumulative analyses did not sufficiently consider reasonably foreseeable future actions, climate change, and impacts on resources. Some commenters felt that the analyses did not adequately evaluate the Arctic and impacts on Arctic resources. Some commenters expressed concerns that the cumulative analyses did not adequately consider the full effects of oil spills, including the DWH event.

Oil Spills. Some commenters felt that the risk characterization of a catastrophic discharge event (CDE) presented in the Draft PEIS was insufficient, while others felt that the risks of deepwater drilling were overstated. A concern was also identified that the Draft PEIS did not sufficiently address the persistence of environmental impacts of oil spills on natural resources. Many commenters expressed concerns about the ability of industry and BOEM to respond to oil spills, especially if they occur under ice cover and in Arctic winter conditions. Some commenters requested a greater discussion of the use and impacts of dispersants, and more discussion of the reforms enacted by industry following the DWH event.

Mitigation. Some commenters felt that the Draft PEIS provided only minimal and generic information on required mitigation. Commenters felt that the PEIS should identify both planning area- and resource-specific mitigation measures and requirements.

Regulation and Safety. Some commenters requested that BOEM and the Bureau of Safety and Environment Enforcement (BSEE) reform their regulations and practices to reflect the findings and recommendations of the National Commission on the Deepwater Horizon Oil Spill and Offshore Drilling. Other commenters called for the PEIS to better identify safety changes implemented by industry since the DWH event. One commenter requested that the PEIS include a risk assessment of drilling. Several commenters identified a concern that BOEM, BSEE, the U.S. Coast Guard, and industry do not have adequate oil spill response measures in place to support OCS oil and gas leasing, especially in the Arctic.

Statutory Compliance. Some commenters noted that some major Federal laws and Executive Orders were missing from Appendix C (Federal Laws and Executive Orders), and that the Draft PEIS was not in compliance with, nor adequately explained, provisions of various environmental statutes. A number of commenters expressed concerns regarding BOEM's position with regard to the ESA, the Marine Mammal Protection Act (MMPA), and the Magnuson-Stevens Fishery Conservation and Management Act (FCMA). Commenters requested that the PEIS include U.S. Fish and Wildlife Service (USFWS) requirements for protecting polar bear dens, and identify industry practices for compliance with the USFWS requirements. Some commenters expressed concerns that the Executive Order instituting the National Ocean Policy and Coastal and Marine Spatial Planning directly conflicts with the Outer Continental Shelf Lands Act.

Other Comments. In addition to specific comments on the major issues summarized above, BOEM also received a variety of comments that were either not applicable to the PEIS, were general in nature, did not request or require changes to the Draft PEIS, or addressed topics other than the 2012-2017 OCS Leasing Program. These comments discussed topics such as general concerns about climate change, opposition to or support of oil and gas development and fossil fuel use, a need for basic services and human rights, the value of traditional knowledge, and displeasure with industry activities in the Arctic.

8.4.3 Summary of the Changes Made to the Draft PEIS

Following the closure of the public comment period on the Draft PEIS, BOEM reviewed and considered all of the comments received on the draft and made revisions to the PEIS as appropriate. Factual or editorial errors identified in the comments were corrected, and text was clarified or expanded to provide additional information on the proposed action and alternatives, the exploration and development scenarios, baseline environmental conditions, climate change, oil spills, potential environmental impacts, or other concerns. In addition, a cost-benefit analysis of the alternatives was added, and the discussion of issues of programmatic concern was expanded to provide a new discussion of programmatic deferrals and mitigation. Several of the figures were revised to clarify areas of confusion or correct errors identified by some commenters, and some new figures were developed.

8.4.4 Response to Comments

Presented below are the major issues that capture the substantive concerns raised in the comments received on the Draft PEIS. BOEM has prepared responses to the concerns associated with these issues, which are provided below. Table 8.4-1 identifies stakeholders providing comments on each issue.

8.4.4.1 Issue 1 NEPA Process and Public Involvement

1. Each planning area is unique. Combining the Gulf of Mexico, Cook Inlet, and Chukchi and Beaufort Seas in the PEIS is confusing and potentially problematic for the reader to understand the many distinctions between these areas. The regions are remarkably different with respect to location, climate, seasonal variations, as well as the level of activity anticipated from offshore energy exploration and development. Therefore, BOEM should create a separate site-specific, detailed EIS for each at the planning stage, especially in areas with complex geology, in deepwater, and in the Arctic and other frontier areas.

   Response: BOEM is cognizant of and sensitive to the unique environmental conditions that exist across the various OCS Planning Areas. The purpose of and need for preparing a schedule of potential OCS oil and gas lease sales is to “best meet national energy needs for the 5-year period following its approval” (43 USC 1344) by balancing the potential for adverse environmental and societal impacts with the beneficial impacts of the discovery and development of oil and gas. In developing the 5-year leasing schedule, BOEM considers regional and national energy needs; leasing interests as expressed by possible oil and gas producers; applicable laws, goals, and policies of affected States, local governments, and tribes; competing uses of the OCS; relative environmental sensitivity and marine productivity among OCS regions; public input; and the equitable sharing of benefits and risks among stakeholders. Therefore, to handle each OCS planning area separately, as the comment is suggesting, would be contrary to the purpose and need of the proposed action analyzed. The PEIS evaluates the potential effects to all planning areas that the Secretary of the Interior (Secretary) is considering in this PEIS, in order to adequately balance the factors described above. Including all of the OCS areas that the Secretary has already identified for consideration will ultimately lead to a more informed decision with regard to the program as a whole.

   In regard to the specific suggestion that BOEM create a separate site-specific analysis for each planning area, it is especially important to note here that BOEM uses a tiered analytical approach in its NEPA documents. When a broad NEPA document such as a PEIS has been prepared, any subsequent site-specific assessment or evaluation can summarize (and include by reference) the issues discussed in the broader document, and thus, the site-specific assessment can focus its analyses on project-specific issues of the particular proposed action (40 CFR 1502.20). Following selection of the Program, any subsequent lease sale-specific NEPA analyses and documentation may tier off the PEIS for the Program. This PEIS is the first of many NEPA analyses that will be done for the activities that occur as a result of the Program. The NEPA assessments, including EISs and environmental assessments (EAs) associated with various stages of OCS oil and gas development, are shown in Table 1-1 of the PEIS.

2. BOEM has exhibited a pattern of postponing its decisions on protected areas, mitigation measures, deferrals, health impact assessments, etc. until later stages in the tiered leasing program. After delaying these decisions, there is concern that BOEM fails to adequately address these issues in the subsequent stages. In particular, when these decisions are postponed until the exploration plan stage, there is concern that the timeframe of this phase prevents preparation of an adequately detailed site-specific analysis. To address these concerns, the impacts should be addressed at the programmatic phase. Barring that, EISs should be required for specific lease sales, especially for lease blocks in deep water, in areas with complicated geology, in the Arctic, and in frontier locations. At this programmatic stage, BOEM should conduct better science in order to more narrowly target lease sales.

   Response: The use of the tiering framework, from the 5-year Program through plan approval, allows BOEM to consider reasonable alternatives and integrate new environmental information during program implementation when the issues of concern are most ripe. BOEM does prepare NEPA documents for specific lease sales, but tiering encourages BOEM to first address a broad general program, such as the 2012-2017 OCS Oil and Gas Program, in an initial environmental impact statement, and then analyze narrower lease sale and project-specific proposals under the initial program in subsequent, more focused NEPA analyses. In fact, CEQ encourages the use of programmatic NEPA and tiering in these situations as evident in the NEPA Task Force report, Modernizing NEPA Implementation (CEQ 2003). This PEIS does not analyze additional deferrals and mitigations as alternatives.

   A useful approach for addressing the issues raised in comments is to strengthen the program's tiering process so that it is more effective and transparent, rather than attempting to develop specific mitigations and spatial/temporal deferrals at the preliminary planning stage of the program when information needed for an informed decision may not be available, needed consultation and coordination may not have occurred, and the analytic granularity is generally too coarse for site-specific or resource-specific decisions. BOEM has included a new section in the Issues of Programmatic Concern to facilitate the process of considering and evaluating different deferral and mitigation strategies that may need to be applied at appropriate program decision points. Consistent with the NEPA Task Force recommendation, the PEIS provides a roadmap, explaining where and when deferred issues raised by the public and/or regulatory agencies will be addressed. Chapters 1 and 2 of the PEIS explain how more detailed analyses should follow that will evaluate the need for specific mitigations in different program areas. Section 4.3.2 describes the process BOEM will follow during program implementation to foster focused leasing, deferral and mitigation strategies will be tracked and evaluated during the program, along with mechanisms for stakeholders to engage in and contribute to the lease sale alternative evaluation and development process.

With regard to conducting better science, BOEM has a robust research program in its Environmental Studies Program. Many of the studies funded and completed for the Environmental Studies Program directly support and inform the analyses presented in BOEM NEPA documents. In many instances, these studies assist BOEM in developing and improving upon mitigation strategies that ultimately may help identify and protect sensitive environmental areas. BOEM has found that leasing and plans can be tailored to protect resources, the details for which come most appropriately at those stages.

3. The PEIS acknowledged NOAA's concerns about sensitive hard-bottom habitat in the GOM, but deferred serious consideration of specific exclusion areas until later NEPA analyses for specific lease areas. NOAA would prefer to see the exclusion of these areas considered during the 5-year Program stage, rather than waiting for the lease sale phase. NOAA encourages BOEM to exclude these sensitive areas under the Outer Continental Shelf Lands Act Section 18 requirement to consider the ecological characteristics, environmental sensitivity, and other anticipated uses of the area in determining the timing and location of the leasing program.

   Response: Exclusion areas are generally determined at the lease sale stage. However, the Assumed Mitigation that is described in Appendix B does explain mitigation that BOEM assumes would be included. This includes mitigation relative to chemosynthetic communities, topographic features, Pinnacle Trend, and the Flower Gardens. Section 2.9.5 of the PEIS addresses the addition of areal and temporal exclusion areas, as well as the rationale for deferring the designation of new exclusions to lease sale and plan stages of the Program. In addition, a new section (Section 4.3.2) discussing programmatic deferrals and mitigation can be found in Section 4.3 Issues of Programmatic Concern.

4. BOEM should incorporate the "worst-case discharge" calculations from oil spill response plans into its NEPA documents.

   Response: Pursuant to BSEE OCS Regulations (30 CFR 254.47), operators are required to submit worst-case discharge (WCD) scenarios to BSEE for all OCS facilities. Furthermore, pursuant to 30 CFR 550.219 and 550.250, all plans must also be accompanied by information regarding oil spills, including calculations of the WCD scenario; this is further clarified by notices to lessee (NTL) No. 2010-N06. The WCD scenario is currently used to evaluate the adequacy of the assets in an oil spill response plan (OSRP), which is a required mitigation measure. Total calculation for the volume of oil that could be released in a WCD scenario is determined by the type of facility in question.

5. BSEE does take into consideration WCD calculations submitted by industry; however, the incorporation of WCD calculations for wells submitted by industry are not appropriate to incorporate at the programmatic level of NEPA analysis, as these numbers are submitted by industry and reviewed by BOEM and BSEE, where appropriate, at subsequent stages in the

leasing process, per relevant OCS regulations. By continuing to call events like the Macondo event phrases like “catastrophic oil spill”, the Federal Government is perpetuating a misunderstanding that is inherent to that phrase. A spill cannot be catastrophic. An eruption or a volcano of oil can be. It was recommended that any reference in the PEIS to such volumes of lost oil from operations not be called spill, but be called by a more accurate descriptive name.

Response: BOEM has used an appropriate term to describe this unprecedented oil spill and other low-probability events with catastrophic consequences. BOEM’s official term in the PEIS for this type of very large oil spill is a catastrophic discharge event (CDE). In the case of the April 2010 CDE, BOEM’s official term is the DWH event.

6. It is unclear how public comments from the scoping meetings have been incorporated into the PEIS. These important comments should be addressed in the PEIS so that the public can best understand the evolution of BOEM’s work on the leasing program.

   Response: On January 4, 2011, a Notice of Scoping Meetings for the proposed 2012-2017 OCS Oil and Gas Leasing Program PEIS was published in the *Federal Register* (76 FR 376) and a scoping period was conducted from January 6, 2011, through March 31, 2011. During this scoping period, public scoping meetings were held in 10 locations in Alaska, Texas, Louisiana, Alabama, and Washington, D.C. In addition, BOEM received comments through the mail and maintained a public website to accept scoping comments electronically.

   As evidenced in the scoping comments received, there was a wide range of interest in, and opinions expressed about, the 2012-2017 OCS Oil and Gas Leasing Program PEIS, and the comments summarized in Section 1.4.3 of the PEIS illustrate the varied and, at times, contradictory issues, concerns, and desired future conditions expressed by individuals, organizations, industry, and public agencies. This PEIS determined whether issues raised during the scoping period were relevant enough to be considered and analyzed further; any issues raised that were deemed irrelevant or beyond the scope of this PEIS were not further analyzed. Section 1.4.3 is intended to categorize and summarize the substance of the scoping comments, not reproduce the exact wording of individual comments. A number of analytical issues, many of which are addressed in this PEIS, were identified during scoping. These include the geographic scope of the PEIS, the analytical scope of the PEIS, the impacting factors to be considered in the analyses, and the resources that may be affected by the Program. These analytical issues are fully discussed in Section 1.5 of this PEIS. Also, issues that arose during the scoping process may be found addressed throughout the PEIS, as appropriate.

7. BOEM should take into account the burden on Alaska Native communities that are buried in overlapping public comment periods for very technical documents. To have different ending dates for the PEIS and the proposed Program served only to increase confusion and undermine the public process. BOEM should strive to release documents with sufficient time to review by communities and should coordinate internally with sister agencies to reduce confusion and simultaneous comment periods. Submitted comments were not made accessible during the comment period. BOEM should extend the comment period to allow

additional time for review. BOEM should ensure that it conveys the importance and purpose of their public hearings in advance. Public meetings held on Friday evenings during the holiday season are not convenient and have a low turnout. Meetings during the week from 3:00 p.m. to 7:00 p.m. are ideal.

Response: BOEM announced its intent to hold public hearings for the Draft PEIS for the Proposed 5-Year OCS Oil and Gas Leasing Program for 2012-2017 in a *Federal Register* Notice that was published on November 11, 2011 (https://www.federalregister.gov/articles/2011/11/10/2011-29152/draft-programmatic-environmental-impact-study-peis-for-proposed-5-year-outer-continental-shelf-ocs). The PEIS document was posted the same day of the Secretary's announcement of the proposed 2012-2017 Program on November 8, 2011. Hard copies of the PEIS were also sent to Alaska libraries (including universities, colleges, and public libraries) prior to filing the PEIS with the U.S. Environmental Protection Agency (USEPA). A complete distribution list can be found in Section 8.3.

The list of libraries that were sent a hard copy is presented in Section 8.3, and is posted here: http://www.boem.gov/uploadedFiles/BOEM/5-Year/2012-2017/PEIS/2012-2017_Draft_PEIS_library_list.pdf.

Public meetings were scheduled and held in full consideration of the Christmas holidays, with the first meeting beginning on December 5, 2011, in Wainright, Alaska. Eight more public meetings were held in Alaska, with the last one taking place on December 16 in Barrow, Alaska, at the Inupiat Heritage Center one week before the Christmas holidays. BOEM regrets that the 7-10 p.m. timeframe was inconvenient for some, although it was taken into consideration that meetings scheduled in the evenings are generally more convenient for most people because of other obligations during the day.

8. BOEM should develop and take public comment on a NEPA handbook designed to guide the agency's environmental analysis of OCS oil and gas issues. In a review of the Alaska Region office, the Government Accountability Office noted that "the lack of a comprehensive NEPA guidance handbook, combined with high staff turnover, leaves the process for meeting NEPA requirements ill-defined for the analysts charged with developing NEPA documents." The National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling recommended that BOEM, in consultation with the Council on Environmental Quality (CEQ), "develop and make public a formal NEPA handbook." The National Commission recommended that the handbook "provide guidelines for applying NEPA in a consistent, transparent, and appropriate manner to decisions affecting OCS oil and gas activities." Before BOEM undertakes any additional action in the Arctic that requires environmental analysis under NEPA, the agency should commit to developing and making available for public comment a NEPA handbook as recommended by the National Commission. The National Commission recommends that BOEM address the issue of tiering in the proposed NEPA handbook noted. (Ref: Government Accountability Office, GAO-10-276, *Offshore Oil and Gas Development: Additional Guidance Would Help Strengthen the Minerals Management Service's Assessment of Environmental Impacts in the North Aleutian Basin* (March 2010); National Commission on the BP Deepwater Horizon Oil

Spill and Offshore Drilling, *Deep Water: The Gulf Oil Disaster and The Future of Offshore Drilling* (Jan. 2011)).

Response: BOEM issued NEPA Guidance in September 2011 in response to a recommendation from the 2010 Government Accountability Office (GAO) report, in which it recommended that USDOI develop and set a deadline for issuing a comprehensive NEPA handbook providing guidance on how to implement NEPA and periodically update and revise this guidance as needed. BOEM regional offices are continuing to develop internal guidance that is more appropriately tailored to their specific geographical jurisdiction.

9. In July 2011, the President established the Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska ("Working Group") to, among other things, "engage in long-term planning," facilitate sharing of scientific and cultural knowledge and traditional information, and coordinate scheduling of regulatory and permitting activities in the Arctic. The Proposed Final Program should clarify how BOEM will engage with the Working Group. Good faith participation in the National Ocean Council (NOC) process would facilitate improved communication and coordination among different agencies with respect to decisions about oil and gas. BOEM should provide the public with more information about how BOEM will use the "Working Group" to coordinate with other Federal agencies, share information, and inform management decisions about leasing activities in the Arctic. BOEM is encouraged to use the "Working Group" process.

   Response: The Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska was established by Executive Order 13580 in 2011 and seeks to coordinate the efforts of Federal agencies responsible for overseeing the safe and responsible development of onshore and offshore energy resources and associated infrastructure in Alaska and to help reduce the Nation's dependence on foreign oil. An entirely separate Executive Order (E.O. 13547 — Stewardship of the Ocean, Our Coasts, and the Great Lakes) issued in 2010 establishes a national policy to ensure the protection, maintenance, and restoration of the health of ocean, coastal, and Great Lakes ecosystems and resources, enhance the sustainability of ocean and coastal economies, preserve the Nation's maritime heritage, support sustainable uses and access, provide for adaptive management to enhance understanding of and capacity to respond to climate change and ocean acidification, and coordinate with the Nation's national security and foreign policy interests.

   Executive Order 13547 also provides for the development of coastal and marine spatial plans that build upon and improve existing Federal, State, tribal, local, and regional decision-making and planning processes. These regional plans will enable a more integrated, comprehensive, ecosystem-based, flexible, and proactive approach to planning and managing sustainable multiple uses across sectors and improve the conservation of the ocean, coasts, and the Great Lakes. Please refer to Section 4.3.1 of the PEIS for further discussion of BOEM's compliance with Executive Order 13547.

   Therefore, these two initiatives are distinct and driven by separate directives, even though there are some overlaps in the issues that are being covered by each. Notwithstanding the foregoing, BOEM supports the implementation of E.O. 13580 by participating in the Alaska

"Working Group" as well as any future efforts on public outreach regarding this engagement, however, further discussion of this topic is outside the scope of this PEIS.

8.4.4.2 Issue 2 NEPA Analysis

1. The PEIS underestimates the risks and overstates the potential benefits of oil and gas OCS activity.

   Response: The purpose of this PEIS is to identify and document the potential impacts of the proposed action and alternatives to the proposed action. In Chapter 4 of this PEIS, the effects of routine activities and cumulative effects associated with the proposed action are analyzed. BOEM also analyzes the potential impacts of a CDE.

   The discussion of the potential benefits of oil and gas activity has been clarified in this PEIS. As a complement to the impact analysis and conclusions in this PEIS, Section 2.12 summarizes the conclusions of the cost-benefit analysis of the Program. The cost-benefit analysis compares the net economic value with the net social value, the latter of which includes environmental costs. The full cost-benefit analysis discussion can be found in the Proposed Final Program document. In addition, Section 4.5, Other Alternatives, has been expanded to include a more robust tradeoff discussion, including possibly foregone socioeconomic benefits.

2. BOEM should adopt the recommendations of CEQ and the National Commission on the Deepwater Horizon (DWH) event, including: reforming its NEPA compliance procedures and incorporating 'worst-case scenario' calculations from oil spill response plans into its NEPA documents. BOEM has not addressed NEPA actions with regard to lessons learned.

   Response: BOEM prepares EISs when deemed appropriate, such as with this PEIS and multi-sale EISs. CEQ regulations require low-probability, catastrophic events to be analyzed if reasonably foreseeable. BOEM follows the CEQ regulations at 40 CFR 1502.22 in this regard. BOEM has made changes to its NEPA procedures and provides for wider use of EAs with opportunity for public comment on post-lease activities than prior to the DWH event. The PEIS has an expanded Section 4.3.3 to include not only past, but also current and likely future reforms by BOEM and BSEE that have come frequently from various independent investigations such as the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. See Section 4.3.3.3.4 and response to Comment 3 in NEPA Process and Comment 1 in NEPA Analysis above.

3. BOEM should ensure that the 2012-2017 Program is part of a planning effort that acknowledges connections between marine, coastal, and terrestrial areas in the Arctic and balances energy extraction with conservation.

   Response: BOEM agrees that the 2012-2017 Program should be integrated with connections between marine, coastal, and terrestrial areas in the Arctic and all of its planning areas; therefore, BOEM coordinates with other Federal, State, local, and tribal governments and other groups and individuals that utilize various resources and geographic areas. See Section 4.3.3 for recent regulatory reforms implemented to reduce risk. BOEM must implement its programs in concert with USDOI leadership, which seeks to minimize environmental impact and maintain a robust research program with its Environmental Studies Program.

4. What if there are drastic changes within five years?

   Response: The Secretary of the Interior is empowered to cancel or postpone a lease sale, each of which was done in the GOM after the DWH event. The Secretary can also defer a lease sale area. The Secretary must also undertake annual reviews of the program per Section 18(e) of the Outer Continental Shelf Lands Act (OCSLA). That could be a mechanism to revise the program (i.e., delay or cancel sale) or reapprove a program. Enhanced Section 18(e) reviews will be done as a way to increase clarity. See Section 4.3.2 and the Proposed Final Program document for additional information.

5. While the PEIS indicates potential intensity of environmental harm from oil and gas exploration and drilling activities, it avoids concluding whether an impact will be "significant," which is the main purpose of an EIS under NEPA. Instead, the PEIS provides over-simplified charts noting whether population-level impacts for biological and physical resources are expected to be "negligible, minor, moderate, or major" and whether the incremental contribution is expected to be "small, medium, or large." Some explanation as to what these terms mean are found in the PEIS, but it is unclear how the terms are to be interpreted in relation to whether there will be a "significant impact," which is the threshold requirement for preparation of a subsequent EIS. This is troubling given the history of using tiered analysis for offshore oil and gas to achieve categorical exclusions, which circumvent adequate safety and mitigation measures to protect against oil spills and other impacts. Further, the absence of a determination at the programmatic level as to whether activities could have a "significant impact" carries the potential for DWH event, the General Accounting Office "found considerable variation among MMS's OCS regions in how they determine what constitutes a 'significant' environmental impact" (Ref: 177 See 40 CFR 1502.1 ("The primary purpose of an environmental impact statement is to serve as an action-forcing device…it shall provide a full and fair discussion of significant environmental impacts…").

   Response: NEPA's significance threshold is of most importance when deciding how to analyze a proposed action. In the case of the 5-year Program, it was determined that significant impacts could occur to various resource areas. Therefore, an environmental impact statement was prepared instead of an environmental assessment. See Section 1.3.1 for a general discussion on the scope of this PEIS. The PEIS identifies the nature, extent, and magnitude of impacts that may be incurred by natural, physical, socioeconomic, and cultural resources and systems from routine OCS Program activities as well as from accidental oil spills. The assessment approach used for the analyses presented in the PEIS, as well as definitions of impact levels, are presented in Section 4.1.3, and the impact levels are identified on a resource-by-resource basis in the Chapter 4 of the PEIS. The assessment approach as well as the impact levels used in this PEIS are fully consistent with the NEPA-required considerations of both context and intensity for determining significance (40 CFR 1508.27). There are many impacts that could be significant depending on many factors, including a possible unexpected CDE for which the impacts could be quite variable. BOEM has always recognized that a CDE has impacts that could be significant in any of its planning areas. A CDE is not part of the proposed action, but it is recognized and analyzed as a low probability catastrophic discharge event. BOEM regions have very different environments and types and levels of activities so it should be expected that there would be variation in how significant impacts are determined and why subsequent EIS's are prepared at later stages such as the lease sale stage. The fact that this PEIS was prepared is recognition of the fact that impacts from the proposed action could be "significant," but exactly when and where the impacts rising to the level of "significant" will occur cannot be determined until a later stage of OCS development.

6. The PEIS fails to meet NEPA requirements for the analysis of alternatives. BOEM failed to rigorously explore and objectively evaluate all reasonable alternatives to the Proposed Action, failed to do a thorough, comparative analysis of potential impacts at the programmatic level, and failed to include temporal or spatial deferral alternatives within a given planning area. The Department can and should do a more thorough and robust analysis of potential impacts and alternatives at the programmatic level. NEPA requires the Department to consider whether the agency can carry out proposed actions in a manner less environmentally damaging, and whether alternatives exist that make the action unnecessary.

   Response: BOEM believes that analysis presented in the PEIS meets the standards of analysis prescribed by the CEQ and that the alternatives analyzed in this PEIS represent a range of reasonable alternatives; the activities corresponding to each alternative are analyzed in view of current environmental standards, and the alternatives meet the purpose and need identified at the beginning of Chapter 1. Chapter 2 discusses the range of alternatives considered in this PEIS and includes those alternatives which are fully analyzed in this PEIS as well as those considered but eliminated from further analysis at this programmatic stage for various reasons. Alternatives not analyzed at this stage may be appropriate for re-consideration at the lease sale stage.

   Considering alternatives suggesting specific spatial or temporal deferrals, it should be emphasized that portions of planning areas (subareas) can be deferred either at the outset of, or later during, a 5-year leasing program, at the Secretary's discretion. The Secretary may "carve out" deferral areas that are based on specific, established need and supported by adequate information, such as deferral areas selected in previous 5-year program alternatives and needed to continue protection of bowhead whale migration in the Beaufort Sea and coastal subsistence uses in the Chukchi Sea.

   Detailed analyses of the large number of proposed exclusions in different planning areas, which vary widely in spatial definition and the completeness of supporting scientific information, can be more meaningfully accomplished at the lease sale stage. The determination of other areal and temporal exclusions and restrictions will depend on the location of specific lease sale areas and whether exploration and further analysis of resource potential, environmental concerns, and potential effects on other uses such as subsistence and fishing. New scientific information may become available or public input may be provided later in the Program in advance of actual lease sales that help inform such exclusion decision-making. The exclusion of specific areas or blocks within a planning area is generally considered at the lease sale stage of the Program or when specific OCS projects are being evaluated.

During scoping and the public comment period on the PEIS BOEM also received numerous comments about including an alternative that would delay both Arctic and Gulf proposed lease sales to the later years of an approved 5-year Program. Based on the Secretary's balancing decision of OCSLA factors, BOEM has already delayed Arctic sales and proposes to conduct those sales late in the Proposed Program; however, BOEM has not delayed sales in the GOM. The Secretary maintains the discretion to delay and/or cancel any lease sales in any OCS Planning Areas that are part of an approved program if he deems it prudent. Therefore, the concept and possibility of delaying lease sales is implicit in the alternatives presented in this PEIS.

Before a lease sale can occur, an additional NEPA document would need to be prepared for each of the OCS lease sale areas included in the proposed 5-year Program. These subsequent NEPA documents would focus in greater detail on local conditions in the lease sale area. During Program implementation, decisions on additional deferrals specific to that particular sale would be made. But it is generally premature to make those decisions now, particularly because if conditions described and evaluated in a 5-year PEIS changed during the Program as a result of new information, technologies, or other developments that mitigated the issues responsible for the deferral of a subarea, it would not be possible to restore the subarea for leasing during the existing Program if it were not included in the Program at the outset.

7. The PEIS should not assume that Alaskan oil and natural gas will only be transported via onshore pipelines. Tanker transport and a subsea pipeline should be considered and evaluated. The PEIS should include a discussion of the existing natural gas infrastructure and marketplace in North America.

Response: Section 1.2 has information on demand for oil and gas. Discussing all possible infrastructure and marketplace conditions is beyond the scope of this PEIS.

Onshore pipelines are the preferred transportation system for both oil and gas for engineering, economic and safety reasons. The analyses in the PEIS focus on the most likely and reasonably foreseeable activities. Additional discussions of all possible development strategies are beyond the scope of this general PEIS analysis. After leasing and exploration has resulted in the discovery of commercial size oil or gas pools, all aspects of development proposals would be analyzed before these plans are approved. At this time, BOEM does not know the location or characteristics of future commercial projects, so although the Bureau cannot categorically exclude any alternatives for development, it also must focus on the most reasonably foreseeable alternatives.

Several possible marine transportation scenarios were considered, including oil and liquid natural gas (LNG) tankering, but pipeline systems are clearly the most feasible for logistical, regulatory and economic reasons. Logistically, in the Arctic, sea ice conditions will continue to inhibit marine traffic for the majority of the year — regardless of recent trends in summer open-water conditions. Shallow water areas near shore will restrict the size of tankers, so dozens of ships would be required to carry the same volume as a large diameter overland pipeline. Therefore, pipelines are anticipated to be used for Alaska operations instead of other marine transportation options. Economically, pipelines are a more efficient delivery system for both oil and gas, and marine transport is only used when conditions preclude pipelines. Our pipeline scenario represents the most reasonably foreseeable scenario for purposes of analysis. Many other scenarios are possible, although less likely, and it is not practical to analyze less-likely alternatives for transporting oil and gas from Arctic Alaska.

Either natural gas will remain stranded or it will be delivered to market through a future transportation system. To cover the range of possibilities, BOEM included three scenarios related to a range in oil and gas prices. Under current conditions (low gas prices and no transportation system), the more likely scenario is that gas remains stranded in northern Alaska. Assuming a transportation system is built, BOEM includes natural gas production for the mid- and high-price scenarios. Of the possible systems to transport gas, a large-capacity pipeline is the most feasible for logistical, regulatory, and economic reasons. LNG transport is a possible, but less likely, alternative than a large overland pipeline system.

In 2003, a new 40-year right-of-way was approved for the Trans-Alaska Pipeline System (TAPS). Shortly thereafter, an upgrade of the system's pump stations was completed. In 2009, a study was completed to analyze problems and possible solutions associated with low flow rates. The goal of these projects is to extend the economic life of TAPS while maintaining operational efficiencies and safety. This means that there is no fixed life expectancy, and a properly configured and maintained TAPS could continue to transport oil for many decades into the future. A detailed engineering review of the corrosion status and maintenance program for the entire pipeline infrastructure on the North Slope is far beyond the scope of this general PEIS, and BOEM believes the current analytical assumptions are reasonable.

Concerning references about elevated onshore pipelines to connect to TAPS, these general assumptions are part of the reasonably foreseeable scenario and are not taken from a published engineering feasibility study. Therefore, no reference can be supplied. However, before any new pipeline systems are built, detailed studies will be done to define optimum locations and designs to minimize environmental impacts. At this time, before commercial discoveries have occurred, it is premature to speculate on the site specific details or impacts of future pipeline systems across the North Slope.

8. There should not be numerical limits or pre-determined restrictions on the number of pipeline landfalls or the potential development of oil and gas resources in Alaska.

   Response: BOEM determines the scenario based on past use and best available projections. The scenario is specifically designed in the PEIS to give the subject matter experts enough information to evaluate the general impacts from the proposed action. The Alaska-Arctic scenario described in Chapter 4.4.1.3 explains why no new pipeline landfalls or support bases are expected to occur in the Chukchi region. It is assumed that the required infrastructure would have already been constructed as a result of Lease Sale 193 activities.

9. The PEIS does not adequately take into account the effects of climate change and incorrectly claims that missing information pertaining to climate change impacts is not essential to a reasoned choice among alternatives. The PEIS wrongly claims that missing information pertaining to the impacts of climate change on marine and coastal birds is not essential to a reasoned choice among alternatives. BOEM's rationale for reaching this conclusion is that, because the information is missing for all alternatives, it is irrelevant in choosing among them (4-594). That suggestion is flawed for one simple reason: the Proposed Action and alternatives would affect climate change differently and so lead to different impacts on resources.

   The effects of climate change may not be entirely clear, but the impacts of climate change would be different under the different alternatives considered in the PEIS. Better information on the effects of climate change on resource areas, which does exist in the literature, would allow for a more accurate understanding of the differential impacts of the alternatives, and thus allow for a more reasoned choice among alternatives. BOEM should correct its erroneous statement that missing information pertaining to the impacts of climate change is not essential to a reasoned choice among alternatives, and modify its PEIS to reflect this correction accordingly.

   Response: The PEIS includes analyses of climate change as part of the baseline condition for several resource areas. Climate change is also analyzed and highlighted as an impacting factor in the cumulative impacts section for several resource areas. Scientifically credible information available at the time the PEIS was written was used, including updates between the Draft and Final PEIS. BOEM follows the CEQ regulations at 40 CFR 1502.22 regarding incomplete and unavailable information. BOEM disagrees that a clear distinction could be made among the alternatives for their impact on climate change. Instead, it is BOEM's finding that the alternatives, including the No Action Alternative, would not have a substantially different impact on climate change. Oil and gas are worldwide commodities controlled by complex economic markets and the lack of a lease sale or sales would not noticeably affect the global demand for or production of oil and gas. Climate change is a global issue that must be globally managed.

   The PEIS considers how climate change, based on the observed changes that have been occurring during the past several decades, may affect baseline conditions of resources over the 40- to 50-year period during which oil and gas production could occur following lease sales under the Program. The effects of climate change on ecosystems are complex and non-uniform across the globe and vary among atmospheric, terrestrial, and oceanic systems. Considerations of climate change effects in OCS Planning Areas focus on marine and coastal system impacts, where environmental sensitivities are typically associated with increasing atmospheric and ocean temperatures, sea-level rise, and ocean acidification. These general categories of climate change responses are occurring in addition to human-induced pressures related to coastal population densities (e.g., land use changes, pollution, overfishing) and trends of increasing human use of coastal areas. The PEIS presents resource-specific discussions of the affected environment with discussions of the effects of ongoing, observable climate changes on those resources. In addition, the impacts of the continuing trend in climate change during the life of the Program are evaluated as well. Section 3.3 of the PEIS contains a discussion of climate-change effects and baseline conditions, as do each of the resource sections.

10. Comments suggested that inadequate baseline science or information was currently available for some resources on the OCS, and moreover, without that information, potential impacts to those resources were difficult to evaluate. The PEIS does not properly deal with the fact that baseline information is missing and incomplete. BOEM has a duty to gather research when information is lacking.

    Response: BOEM uses scientifically credible information that is available at the time the PEIS is written, including updates between the Draft and Final PEIS. BOEM follows the CEQ regulations at 40 CFR 1502.22 regarding incomplete and unavailable information. There is often uncertainty with respect to the context and intensity of impacts at the programmatic level of analysis. In instances of missing information related to resource impacts and mitigation for this PEIS, it was determined that the information was not essential to the Secretary's reasoned choice among alternatives at this broad, programmatic stage. If missing or unavailable information were to be arguably necessary to a reasoned choice among alternatives, the Secretary would treat this information as directed by the CEQ regulations implementing NEPA. Even in the face of unavailable information, the Secretary must maintain an oil and gas leasing program, but, at the lease sale stage, the Secretary does have the discretion to delay and cancel lease sales that are part of an approved 5-year Program. For example, if missing information is identified and it is deemed essential to a lease sale decision, the Secretary can cancel or delay the sale.

    BOEM asserts that there is adequate scientific baseline knowledge of the OCS for the decision at hand, which is establishing a schedule of potential lease sales and framing the geographic scope for which OCS development can occur. If exploration and development occur as a result of the lease sale, each ensuing project would undergo additional environmental review and analysis that focuses on a smaller area, as mentioned above. Should the proposed 5-year Program be approved, subsequent NEPA documents would focus in greater detail on local conditions and identify additional mitigation measures relevant to the lease sale area. Therefore, in view of the increasing focus and specificity of NEPA documents that would occur if an approved 5-year program progresses to further stages, BOEM believes that the analysis in this PEIS is appropriate at this preliminary planning stage of the proposed 2012-2017 Program.

11. It would be helpful for the PEIS to provide more information on how BOEM will determine the appropriate level of NEPA documentation for actions "tiered" from this PEIS.

    Response: Table 1-1 in the PEIS shows the various tiering stages. BOEM has clarified its commitments and procedures in the PEIS with regard to deferrals (see Section 4.3.2). The regional offices determine what level of NEPA documentation is needed based on many factors (e.g., see 40 CFR 1502.9(c)). BOEM follows CEQ regulations and guidance in determining the appropriate level of NEPA documentation for all Bureau actions. Generally, in the BOEM GOM Regional Office, the NEPA document would be an environmental impact statement (EIS) at the lease sale stage and an environmental assessment (EA) or categorical exclusion review (CER) at the plan stage. Generally, in the BOEM Alaska Regional Office, the NEPA document would be an EIS for at the lease sale and EIS or EA at the plan stages due to the frontier nature of oil and gas activity in the Alaska region.

12. Section 1.3.1.1, Incomplete and Unavailable Information: The PEIS states that "CEQ regulations require an agency to obtain, or explain why it cannot obtain, relevant information about reasonably foreseeable significant adverse impacts that is essential to a reasoned choice among the alternatives presented in an EIS (40 CFR 1502.22)." However, the actual instructions concerning how to analyze incomplete or unavailable information in regulation 1502.22 have more detail than the quoted sentence suggests. We recommend revising this statement to better reflect the CEQ regulations.

    Response: The discussion of incomplete and unavailable information, now found in Section 1.4.2 of the PEIS, presents a salient excerpt and points the reader to the full regulatory citation.

13. BOEM claims that deferring deepwater leasing would not be reasonable because allowing deepwater leasing strikes the right balance between potential benefits (specifically, helping to meet the Nation's need for oil and gas) and adverse impacts, such as environmental damage to the ocean and coastal zone. How the PEIS arrives at this conclusion is not at all clear. Indeed, no analysis in support of this statement is conducted; it is simply stated as a self-evident truth. That approach is exactly backward. The purpose of an EIS is to evaluate the "comparative merits" of the Proposed Action and reasonable alternatives (40 CFR 1502.14) and then determine which action is most appropriate in light of the environmental impacts of each. In the PEIS, however, BOEM simply presumes that maximum oil and gas production — including deepwater leases — is more appropriate than an option that excludes deepwater leases. BOEM's approach ignores the purpose of NEPA review by rejecting out of hand a reasonable alternative that would "avoid or minimize" the adverse environmental impacts of the 5-year Program (40 CFR 1502.1).

    Response: Without new deepwater activity in the GOM for the Program, 93% of the expected oil production from the Program would become unavailable, essentially removing GOM oil production from the 2012-2017 Program (see Table 4.4.1-2 for depth-related scenario information). As discussed in Section 4.3.3, water depth is only one of many factors that control oil-spill risk (see Table 4.3.3-2 for a listing of these complex risk factors). While there may be greater logistical difficulties associated with containing a catastrophic discharge event in deepwater, the risk to environmental resources from shallow-water drilling in some circumstances could be greater because of the proximity to and greater likelihood of oil contact with many of those resources. Therefore, excluding deepwater from the Program does not necessarily equate to avoiding or minimizing adverse environmental impacts. In addition, excluding deepwater activity in the GOM for this Program does not stop any associated adverse environmental impacts that could occur from currently leased oil and gas activity in deepwater areas of GOM. BOEM's rationale for not fully analyzing a GOM deepwater deferral has been expanded (see Section 2.9.7).

14. With the exception of the Central and Western GOM Planning Areas, all OCS Planning Areas would benefit from the addition of new geophysical seismic data. Doing so would help us understand what resources are subject to administrative withdrawals or moratoria, would better inform the decision making process for administrative withdrawals or moratoria during the length of the program, and would encourage interest in those areas if and when they are opened.

    Response: The collection of geophysical data in OCS areas outside Program areas is beyond the scope of this PEIS. The PEIS considers the environmental effects of geophysical operations in the six planning areas under consideration.

15. A comprehensive, stakeholder-driven scientific research and monitoring program should be in place before BOEM decides whether and where leases should be offered on the OCS.

    Response: BOEM has a robust research program with its Environmental Studies Program (ESP), which was initiated in 1973. BOEM's ESP in the Alaska Region alone has funded over 400 biological, physical oceanographic, contaminants, and socioeconomic studies for a total of over $300 million and currently has 50 studies underway, 90% having to do with the Arctic offshore.

    BOEM implements a concerted effort to find and fund relevant research in all of the regions where it is involved. The research is comprehensive, covering physical oceanography, atmospheric sciences, biology, protected species, social sciences and economics, submerged cultural resources and environmental fates and effects. The Environmental Studies Program Information System (ESPIS) is a searchable database of all completed ESP reports (http://www.boem.gov/Environmental-Stewardship/Environmental-Studies-Program-Information-System.aspx). It includes technical summaries of more than 700 BOEM-sponsored environmental research projects, and more than 2,000 full research reports. BSEE's Technology Assessment and Research (TAR) Program and Environmental Studies Program work in concert by conducting interdisciplinary cooperative research projects. These joint efforts allow for a broader research scope and help to maximize the efficient use of the funds available for studies. The TAR Program supports research associated with operational safety and pollution prevention as well as oil-spill response and cleanup capabilities. The TAR program was established in the 1970s to ensure that industry operations on the OCS incorporated the use of the best available and safest technologies.

    See also comment responses in Issues 4 (Environmental Concerns), 5 (Cumulative Impacts), and 6 (Oil Spills) for more information on how the PEIS has been further expanded to address these concerns.

16. The PEIS does not contain a sufficient analysis of the impacts of the DWH event in the GOM in order to make a decision. The full impacts of the DWH event on the GOM are not yet understood. The ecological baseline in the Gulf has changed and the PEIS should be updated to include this information as well as lessons learned from the event.

Response: The purpose of the PEIS is to look at environmental impacts associated with a decision on a schedule of potential OCS oil and gas lease sales from 2012–2017. The full impact of the DWH event on the GOM probably will not be understood for many years to come and may never be understood. However, BOEM used the best available, scientifically credible information to update the Final PEIS. Chapters 3 and 4 of the PEIS have been updated with numerous references to peer-reviewed scientific information about the status of the GOM environmental baseline and the nature of the effects from the DWH event. In addition, the PEIS includes a much expanded Section 4.3.3 on risk that did not appear in the EIS for the 2007-2012 Program and within that Section, 4.3.3.3.4 discusses BOEM regulatory reforms as a result of the DWH event. Lessons learned and regulatory reforms will be an ongoing process.

BOEM implements a concerted effort to find and fund relevant research in all the regions where it is involved. Research covers physical oceanography, atmospheric sciences, biology, protected species, social sciences and economics, submerged cultural resources, and environmental fates and effects. The ESPIS is a searchable database of all completed ESP reports. It includes technical summaries of more than 700 BOEM-sponsored environmental research projects, and more than 2,000 full research reports. BSEE's TAR Program and ESP work in concert by conducting interdisciplinary cooperative research projects. These joint efforts allow for a broader research scope and help to maximize the efficient use of the funds available for studies. The TAR Program supports research associated with operational safety and pollution prevention as well as oil spill response and cleanup capabilities. The TAR program was established in the 1970s to ensure that industry operations on the OCS incorporated the use of the best available and safest technologies.

There is often uncertainty with respect to the context and intensity of impacts at the programmatic level of analysis. In instances of missing information related to resource impacts and mitigation for this PEIS, it was determined that the information was not essential to the Secretary's reasoned choice among alternatives at this broad, programmatic stage. If missing or unavailable information were to be arguably necessary to a reasoned choice among alternatives, the Secretary would treat this information as directed by the CEQ regulations implementing NEPA. Per OCSLA, the Secretary is not at liberty to delay the issuance of the entire 5-year Program due to the unavailability of the information, but at the lease sale stage the Secretary does have the discretion to delay and cancel lease sales that are part of an approved 5-year Program. For example, if missing information is identified and it is deemed essential to a lease sale decision, the Secretary can cancel or delay the sale.

At this stage, the Secretary is only establishing a schedule of potential lease sales and framing the geographic scope for which OCS development can occur. If exploration and development occur as a result of the lease sale, each ensuing project would undergo additional environmental review and analysis that focuses on a smaller area, as mentioned above. Should the proposed 5-year Program be approved, subsequent NEPA documents would focus in greater detail on local conditions and identify additional mitigation measures relevant to the lease sale area. Therefore, in view of the increasing focus and specificity of NEPA documents that would occur if an approved 5-year Program progresses to further stages, the Bureau believes that the analysis in this PEIS is appropriate at this preliminary planning stage of the proposed 2012-2017 Program.

17. Ecosystem-based models are needed to predict how expanded offshore oil and gas drilling in the GOM would impact the marine environment and resources. Fulton et al. (2011) demonstrates an ecosystem-based model called the Atlantis modeling framework, which has been used for decades for marine management decision making. This modeling framework is being coupled to climate, biophysical and economic models to help consider climate change impacts, monitoring schemes and multiple use management. This model could be utilized in the PEIS to give a comprehensive view of the impacts of oil and gas activities on water quality, air quality, greenhouse gas emissions, oil spill risk, affected habitats, subsistence communities and other resources. Using this model would greatly improve the PEIS by giving it a more encompassing view of oil and gas activities weighed against affected environments and the multiple long-term uses that have been described within the lease sale areas in the 5-year Program.

    Another good example of an applied environmental sensitivity index is Grilli et al. (2011), which was used for offshore wind site assessment in the Rhode Island Special Area Management Plan. This model incorporates fisheries, recreation, and biodiversity to weigh the impacts of siting offshore wind in certain locations off Rhode Island. This model could be further scaled up to give an impact index for the 5-year Program's proposed oil and gas activities in the GOM Large Marine Ecosystem by incorporating multiple uses and biodiversity. These modeling studies will require consultation from NOAA and FWS about endangered species and commercially important species. In light of such a large stressor like the DWH event, it is even more imperative that the PEIS adequately model how the GOM has changed and how it could be further impacted by offshore oil and gas activities in the 5-year Program in order to make a reasoned decision amongst the alternatives.

    Response: An ecosystem model is an abstract representation of an ecosystem which is developed to help understand how the actual ecosystem functions. It integrates known biological and physical data to help make predictions about how the ecosystem may react under different conditions. Ecosystems themselves are complex, with many interacting variables. Ecosystem models have to simplify these interactions using a limited number of variables that are well-understood. Ecosystem models are, by their nature, limited by the quality and completeness of the data used to develop them and by the scope of the objectives of the model design. Ecosystem models developed for a specific geographic area (such as Atlantis) may not easily transfer to other areas, because of the lack of comparable data inputs or differences in the importance of various ecosystem components to ecosystem structure and function. Specifically, the Atlantis model and methodologies like the Rhode Island Special Area Management Plan (SAMP) have only been implemented in a few small areas to address specific non-energy management concerns. The effort involved to scale these methodologies to the entire U.S.OCS would be a substantial, multi-year process limited by the intense data requirements noted above. BOEM is currently evaluating multiple potential methodologies to address the potential impacts of OCS energy development (including Atlantis and the Rhode Island SAMP) as the agency strengthens its analysis of relative environmental sensitivity, but it disagrees that a large-scale ecosystem model is essential to making a reasoned choice among the alternatives presented in the PEIS.

BOEM recognizes models can be useful tools to help understand what outcomes are expected under various conditions and uses models in the analysis of impacts for the 5-year Program and subsequent lease sales and plans. BOEM includes conceptual models for a wide range of individual resources in the 5-year PEIS (see Figures 4.4.7.1- 4.4.10.3) and incorporated NOAA's Environmental Sensitivity Index and coastal vulnerability indexes into its analyses. BOEM did not develop large-scale ecosystem models as part of the 5-year EIS process; such models might have value, but they would also have limitations, particularly at such a broad scale. The PEIS does, however, thoroughly evaluate the potential for impacts on individual resources within a broader ecosystem context.

18. Due to the extent of potential adverse impacts from offshore facility lighting with regards to protected birds and other species, and the options for reducing these impacts, we believe that a supplemental Draft PEIS must be prepared to ensure these issues are adequate to meet NEPA requirements for the Draft PEIS. While we recognize this can delay completion of the PEIS, the impacts that are not adequately addressed are significant as are BOEM's relevant legal obligations under Federal law.

    Response: BOEM asserts that the PEIS currently addresses facility lighting issues sufficiently in the PEIS for the programmatic stage of the oil and gas leasing process. At this stage, the Secretary is only establishing a schedule of potential lease sales and framing the geographic scope for which OCS development can occur. If exploration and development occur as a result of the lease sale, each ensuing project would undergo additional environmental review and analysis that focuses on a smaller area. Should the proposed Program be approved, subsequent NEPA documents would focus in greater detail on local conditions and identify additional mitigation measures relevant to the lease sale area. Therefore, in view of the increasing focus and specificity of NEPA documents that would occur if an approved 5-year Program progresses to further stages, BOEM asserts that the analysis in this PEIS is appropriate at this preliminary planning stage of the Program.

19. The effects of hydrocarbon consumption that would be produced or not produced in the Proposed Alternative should have a direct bearing on the decisions regarding the proposed leasing program. This would assess the full footprint of the Proposed Alternative and must be included. The PEIS violates NEPA by failing to quantify greenhouse gas emissions within the scope of the 5-year Program.

    Response: Consistent with judicial guidance, the USDOI does not analyze the global environmental impact of oil and gas consumption in its NEPA documents as analyzing the entire gamut of activities that entail the use of the byproducts derived from OCS extraction would be considered too remote and speculative to permit any meaningful analysis.

20. It was suggested that the PEIS clarify that, in addition to re-gasifying LNG for import, an emerging trend in GOM LNG development is to liquefy the gas for export.

    Response: The trend in exporting domestically produced LNG has been clarified in the PEIS in Section 4.6.1.2. Most natural gas is exported to Mexico or Canada; however, as an overall trend, relatively more natural gas is imported. Authorization to export LNG is provided by the U.S. Department of Energy Office of Oil and Gas Global Security and Supply, Office of Natural Gas Regulatory Activities.

21. A national energy strategy should stress conservation, efficiency, alternative transit, and the development of diverse energy supplies due to concerns about climate change and other environmental impacts from fossil fuels. Alternatively, there were suggestions that a national energy strategy should incorporate responsible oil and gas development in addition to energy conservation and renewable energy. Instead of oil and gas development, BOEM should consider a national energy strategy that shifts away from fossil fuels and promotes investments in various renewable energies and conservation strategies. This strategy would mitigate climate change and promote green jobs and energy security/independence.

    Response: The purpose of the proposed action is to prepare a schedule of potential OCS oil and gas lease sales to best meet national energy needs for the 5-year period following its approval. While we may agree that a national energy strategy is important, BOEM works within statutory and policy bounds and is not in a position to start developing a new national energy strategy.

    BOEM believes that the alternatives analyzed in this PEIS present a range of reasonable alternatives to meet the purpose and need identified at the beginning of Chapter 1, and the activities corresponding to each alternative are analyzed in view of current environmental standards.

    The role of energy conservation and renewable energy sources in meeting the energy demands of this country continues to grow. Such sources, however, could not replace the energy supplied by oil and gas from OCS sources in the near term. A more detailed discussion of alternative forms of energy and other energy substitutes for oil and gas appears in Section 4.5.7, which considers the environmental effects of the No Action Alternative. BOEM has an offshore renewable energy program committed to orderly, safe, and environmentally responsible renewable energy development activities, such as the siting and construction of offshore wind farms on the OCS, as well as other forms of renewable energy, such as wave, current, and solar. For more information about this Program, BOEM recommends that you visit the following bureau Web page: http://www.boem.gov/Renewable-Energy-Program/index.aspx.

    While the Bureau's offshore renewable energy program seeks to expand and diversify the national energy portfolio, OCLSA mandates that the management of the OCS be conducted in a manner which considers economic, social, and environmental values of both the renewable and nonrenewable resources contained in the outer Continental Shelf. Notwithstanding the valuable contributions of renewable energy sources, OCSLA specifically mandates the development of an OCS oil and gas program every five years and renewable energy development is not yet a substitute for oil and gas development.

8.4.4.3 Issue 3 Alternatives

1. The inclusion of additional areas in the leasing program would encourage new investment in offshore exploration and eventually development - an investment that would create new jobs, generate billions of dollars in economic activity, and allow for the delivery of much-needed energy to American consumers, while continuing to reduce U.S. dependence on foreign energy resources. We encourage BOEM to continue to look for opportunities to bring potentially promising areas into the leasing program.

   Response: There are 26 planning areas on the OCS, and 6 of these have been identified for leasing consideration as part of the Program (Figure 1-1). Twenty planning areas located along the Atlantic, Pacific, Florida, and Alaska coasts are neither part of the proposed action nor analyzed in any alternative considered in this PEIS. There is no requirement to include all OCS planning areas in the PEIS. On December 1, 2010, Secretary Salazar announced an updated oil and gas strategy for the OCS that recognizes a continuing Congressional moratorium in place for most of the Eastern GOM (Figure 1-2) and eliminates the Mid-Atlantic and South Atlantic Planning Areas from consideration for potential sales and development through the 2017 planning horizon. The Western GOM, Central GOM, Eastern GOM (only a very small portion thereof), Cook Inlet, Chukchi Sea, and Beaufort Sea OCS Planning Areas (Figure 1-1) are considered in the proposed Program and consequently analyzed in this PEIS. Although additional OCS areas were included in the Draft Proposed Program, the Secretary decided to exclude them from the proposed 2012-2017 Program after giving further consideration to the potential for environmental damage, the potential for the discovery of oil and gas, and the potential for adverse impact on the coastal zone in all OCS areas. The Secretary also decided to focus, in the Program, on areas with already-established leasing programs, although this could change in future 5-year programs.

2. Alternative 1 should be modified to delay GOM lease sales for 2012 or 2013 to allow time to analyze impacts of the DWH event. The PEIS violates NEPA and OCSLA by failing to consider an alternative that would forego any lease sales in the GOM Planning Areas during 2012 and 2013 so that additional data on the impacts of the DWH event can be gathered. The alternatives analysis is integral to an EIS and should ensure that decision-makers can consider "all possible approaches to a particular project (including total abandonment of the project) which would alter the environmental impact and the cost-benefit balance." BOEM's ability to cancel scheduled lease sales does not preclude its duty to conduct this environmental analysis. And while BOEM could analyze the impacts of canceling individual lease sales in subsequent EISs at the lease sale stage, that in no way negates BOEM's duty to analyze, in this EIS, the environmental impacts of a programmatic alternative in which GOM lease sales are not scheduled at all in 2012 and 2013. This alternative would be reasonable and crucial to a reasoned choice among alternatives. In fact, by not considering the alternative, the PEIS is less able to achieve one of its stated purposes. If lease sales in the GOM were canceled for 2012 and 2013, oil and gas companies could still explore for oil and gas on thousands of preexisting leases; oil and gas companies currently hold 4,251 leases in the GOM that are inactive, meaning they have no approved exploration or development plan, roughly double the number of active leases in the Gulf (*U.S. Department of the Interior Oil and Gas Lease Utilization – Onshore and Offshore*, Report to the President, Mar. 2011,

pg. 4). These inactive leases, according to the Department of the Interior, contain approximately 70% of the Undiscovered Technically Recoverable Resources in the GOM, totaling 11.6 billion barrels of oil and 59.2 tcf of natural gas. The Secretary also decided to focus, in the 2012-2017 Program, on areas with already-established leasing programs, although this could change in future 5-year programs.

Response: The OCSLA mandates that the Secretary prepare a schedule of proposed lease sales every five years. OCSLA also mandates that the Secretary select the timing and location of leasing in consideration of a proper balance among the potential for environmental damage, potential for the discovery of oil and gas, and the potential for adverse impact on the coastal zone. The Secretary must see that lease sales are conducted in an expeditious manner. These tenets clearly define the purpose and need of the proposed action. This PEIS was prepared to meet that obligation and help inform the Secretary's decision as to where and when those lease sales may be held. The consequences of approving the proposed program would be to establish a schedule for one or more lease sales within the areas included in the program, but that does not guarantee that any particular sale will occur; a scheduled lease sale can be canceled if deemed necessary in the future. Before any lease sale can occur, additional NEPA documents would be prepared for the OCS lease sale areas included in the 5-year Program, as is currently being prepared in the GOM for potential Western and Central Planning Area lease sales.

The PEIS does not include a specific alternative to delay lease sales in the GOM to allow for more time to analyze the impacts of the DWH event or allow the Gulf ecosystem to recover from oil spill effects. A different but practical equivalent of this alternative (i.e., delaying sales until oil spill response and drilling safety reform is complete), was considered, but eliminated from further evaluation as an alternative. Section 2.9.3 has been revised to address the recommendation to delay lease sales until more information is gathered regarding the DWH event.

BOEM does not analyze the suggested alternative to delay leases in the GOM until more information about the post-spill baseline condition is available because this is a decision that can best be made at the lease sale phase and is largely already embodied in the No Action Alternative considered for each individual lease sale. In previous 5-year EISs, BOEM's predecessor, the Minerals Management Service, evaluated alternatives to slow the pace of leasing with the stated objective of giving affected governments and communities more time to plan for and address sale-related impacts. However, an option to hold fewer or delay lease sales was limited to areas where leasing was not already occurring.

In the GOM, where annual lease sales are anticipated, holding relatively fewer or delaying a few lease sales does not necessarily equate to significantly less cumulative OCS activity in the present or next few years. Under a fewer or delayed Gulf lease sales scenario, BOEM still expects that most of the OCS activity that could occur over the next few years will occur under leases issued pursuant to previously approved 5-year Programs, already approved or imminently approval plans, new geophysical and geological permit applications, etc. These activities can even occur in the absence of a new 2012-2017 Program with or without another lease sale, that corresponding level of activity may influence the recovery of the GOM ecosystem. However, deferring an entire 5-year Program of lease sales in the GOM, or in either the Central or Western Planning Areas, could have an important effect in reducing the level of OCS activity at some point in the future; therefore, those alternatives are considered in the PEIS.

Holding fewer Gulf lease sales later in the 2012-2017 Program may result in a relatively minor incremental decrease or delay in the number of seismic surveys occurring in support of a new lease sale and, potentially, fewer exploration operations may proceed through the Exploration Plan, OSRP, and Application for Permit to Drill (APD) approval process following the first lease sales in the Western and Central Planning Areas. The context is fundamentally different from the Arctic, where a delay is proposed because of lack of ongoing activity and that delay will allow BOEM and BSEE to collect new data related to proposed exploration activities under previous lease sales. Even in the absence of new lease sales in 2012 and 2013 in the GOM, it is possible that industry would elect to develop existing leases, resulting in no net change in the level of overall activity. Similarly, in the longer-term reasonably foreseeable future, it is possible that holding fewer lease sales in this 5-year Program may or may not affect the overall cumulative activity in the GOM over the 40–50 year life of the program. If OCS activities remain confined to acreage currently under active lease at the start of the program, OCS operators would likely proceed on leased acreage while exploration, delineation, and development strategies would be re-evaluated in consideration of restricted access to acreage that, if acquired, could have served to improve the delineation of their oil and gas prospects. New lease terms were put into place for Lease Sale 218 and combined Lease Sales 216/222 during the last sales under the 2007-2012 Program to in part incentivize industry to re-evaluate its portfolios of leases and develop leases more quickly. Industry may perceive these policy changes as a signal of future access restrictions and may react by increasing its bidding activity on tracts in available areas under later 2012-2017 lease sales in order to improve its acreage position. Restricting access to acreage available for lease in space or time will challenge industry to reallocate and re-prioritize assets; however, the nature of this re-distribution is somewhat speculative and will not be carried out only within the confines of the U.S. OCS.

If the 1989 Valdez incident in Prince William Sound is a corollary, a definitive scientific understanding of the environmental impacts of the DWH event may take a very long time to achieve through the pre-assessment and injury-assessment phases of the Natural Resources Damage Assessment (NRDA) process (i.e., well beyond a 2-year horizon). Under the provisions of the Oil Pollution Act, the NRDA Trustees are collecting valuable scientific data to help define the extent of impacts and loss of public resources realized during and following the DWH event. This also necessitates consideration of the extent to which the Gulf ecosystem is resilient and has inherent capacity to recover. BOEM is a cooperating agency on the NRDA Programmatic EIS currently being developed to evaluate a range of restoration alternatives to compensate the public and the environment for loss of natural resources and services due to the DWH event.

This PEIS was prepared to provide the Secretary of the Interior with best-available environmental information to consider when developing a national schedule of OCS oil and gas lease sales for the 2012–2017 timeframe. Again, the Secretary maintains the discretion to postpone or cancel lease sales at any time, or suspend operations if scientific evidence indicates it is prudent to do so.

To make sure that this issue is memorialized in the PEIS, BOEM has included a new section (Section 4.3.2) in the Issues of Programmatic Concern in order to facilitate the process of considering and evaluating different alternatives and mitigation strategies that may need to be applied at appropriate program decision points. Consistent with the NEPA Task Force recommendation, the PEIS provides a roadmap, explaining where and when deferred issues raised by the public and/or regulatory agencies will be addressed. Chapters 1 and 2 of the PEIS explain how more detailed analyses in subsequent lease sale NEPA documents will evaluate the need for specific mitigation in different program areas. Section 4.3.2 also describes the process BOEM will follow during program implementation to ensure focused leasing alternatives will be tracked and evaluated during the program, along with mechanisms for stakeholders to engage in and contribute to the lease sale alternative evaluation and development process.

3. BOEM should have made allowances for partial leasing of each of the OCS planning areas.

   Response: Portions of planning areas (subareas) can be deferred either at the outset of, or later during, a 5-year leasing program, at the Secretary's discretion. The Secretary may "carve out" deferral areas that are based on specific, established need and supported by adequate information, such as deferral areas analyzed and selected in previous 5-year program alternatives and needed to continue protection of bowhead whale migration in the Beaufort Sea and coastal subsistence uses in the Chukchi Sea. Detailed analyses of the large number of proposed exclusions in different planning areas, which vary widely in spatial definition and the completeness of supporting scientific information, can be more meaningfully accomplished at the lease sale stage. The determination of other areal and temporal exclusions and restrictions will depend on the location of specific lease sale areas and whether exploration and further analysis of resource potential, environmental concerns, and potential effects on other uses such as subsistence and fishing. New scientific information may become available or public input may be provided later in the Program in advance of actual lease sales that help inform such exclusion decision-making. The exclusion of specific areas or blocks within a planning area is generally considered at the lease sale stage of the Program or when specific OCS projects are being evaluated. Please refer to Section 4.3.2 for a description of the process BOEM has committed to during program implementation to ensure focused leasing alternatives will be tracked and evaluated during the Program, along with mechanisms for stakeholders to engage in and contribute to the lease sale alternative evaluation and development process.

4. The PEIS includes minimal discussion of Alternative 5 to exclude the Beaufort Sea Planning Area and Alternative 6 to exclude the Chukchi Sea Planning area for the duration of the program. The discussion is limited to one short paragraph for each alternative, concluding only that "the potentially available resources" that would "not be made available" under these alternatives include: "as much as 0.4 Bbbl of oil and as much as 2.2 Tcf of natural gas" for the Beaufort Sea Planning Area and "as much as 2.1 Bbbl of oil and as much as 8.0 Tcf of natural gas." The PEIS lacks a discussion of the advantages of excluding these regions from lease sales — such as avoiding the numerous potential significant impacts to the ecological and economic health of the region that could result from oil and gas drilling. Without this

evaluation, it is impossible for the PEIS to provide "a clear basis for making a reasoned choice among the alternatives by the decision-maker."

Response: Section 4.5 of the PEIS describes the potential effects associated with each of the action alternatives considered. Sections 4.5.4 and 4.5.5 generally considered adverse effects avoided by not pursuing oil and gas exploration and development activities in the Beaufort Sea and Chukchi Sea Planning Areas, respectively. The PEIS has been revised to better characterize the possible beneficial effects of pursuing those alternatives, which are inherently related to avoided adverse effects. The potential for different economic effects under those exclusion alternatives is also presented in Section 4.5 and Section 2.12.

5. BOEM must revisit its analysis of the "No Action Alternative" in order to more fully depict the potential benefits of no action, ensuring that costs are depicted appropriately for the Arctic region, appropriately incorporate conservation and efficiency, and include a discussion of an option value. Once it corrects those failings, BOEM must use this information in the PEIS to more accurately reflect the costs and benefits of alternatives relevant to the Arctic Ocean.

Response: BOEM has revised the effects analysis of the "No Action" Alternative (Alternative 8; see Section 4.5.7). BOEM has incorporated by reference the Energy Alternatives and the Environment Report (OCS Study BOEM 2011-051), which provides the underlying energy substitution scenario, including estimates of substitutions across energy sectors that may be reasonably expected under that alternative. A redacted, preliminary version of the draft report formed the basis of the discussion of the No Action Alternative in the PEIS. BOEM has revised the Energy Alternatives and the Environment Report to address relevant comments received on the PEIS and Proposed Program. In turn, the No Action Alternative content has been revised in the PEIS. In addition, the PEIS incorporates by reference and summarizes the cost-benefit analysis prepared under the Section 18 requirements of the OCSLA. The cost-benefit summary can be found in Section 2.12.12 of the PEIS. The underlying methodologies for economic analysis are described in a series of related reports (e.g., Economic Analysis Methodology for the 5-year OCS Oil and Gas Leasing Program 2012-2017 (OCS Study BOEM-2011-050) and Description of the Cost and Benefit Calculations in the Offshore Environmental Cost Model (no publication number is available).

The PEIS discloses potential adverse and beneficial impacts associated with the No Action Alternative, such as the potential for increased spill impacts from tankering in non-Arctic U.S. waters and avoided adverse impacts from no OCS oil and gas development and tankering in the Arctic. The Proposed Final Program depicts the monetized cost of pursuing the No Action Alternative in the Arctic Planning Areas. The PEIS and Proposed Final Program documents treat the potential for conservation and efficiency substitution, which were estimated as a 6% reduction in demand over the life of the program. The PEIS and supporting analytical documents have been revised to further clarify the nature of impacts under the No Action Alternative, incorporate the cost-benefit analysis per the CEQ requirements in 30 CFR 1502.23, and more fully discuss adverse and beneficial effects of the No Action Alternative, including potential economic ramifications. Note that the CEQ requirement does not provide any instruction about the methodology and/or content of the cost-benefit analysis, but rather, simply states that if a cost-benefit analysis, in whatever form, is prepared, that analysis should be used to help aid in evaluating the environmental consequences of alternatives.

Option value is the sum of individuals' willingness to pay for maintaining or preserving a public good now for later or different use, even if there is little or no likelihood of actually ever using it, which has not historically been considered in BOEM's Section 18 cost-benefit analyses. It is discussed within the framework of the Fair Market Value analysis in the context of hurdle prices (p. 70-72 of Proposed Program). In the Proposed Final Program, BOEM has clarified that discussion addressing option value, which in turn has been incorporated by reference into Chapter 2 of this PEIS.

6. By not considering the potential for increased research and development and deployment of alternate/renewable energy sources, spurred by a reduced emphasis on oil and gas production, the PEIS fails to adequately characterize the potential for those alternatives to displace the oil and gas that would be produced under the Proposed Action. For example, the PEIS does not include assumptions about additional government investment in potential of electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs). This shortcoming does not apply only to the PEIS's discussion of EVs, but to its discussion of oil and gas action alternatives as a whole. Thus, the PEIS fails to properly substantiate its claim that alternate/renewable energy sources could not replace some or all oil and gas that would be produced under the Proposed Action. The Energy Information Agency's (EIA) energy projection is only one of many trusted sources that provide energy projections. The PEIS seems to ignore other trusted sources for energy consumption projections.

   Response: The substitution effects anticipated by pursuing the No Action Alternative can be found in BOEM's Energy Alternatives and Environment report. The report has been incorporated into the discussion of the impacts of the No Action Alternative presented in the PEIS (Section 4.5.7) to provide BOEM's most current evaluations of energy substitutions for oil and gas and their near- and long-term market outlooks. As explained in another associated report, Economic Analysis Methodology for the 5-year OCS Oil and Gas Leasing Program 2012-2017 (OCS Study BOEM 2012-022, BOEM uses the MarketSim model to estimate the substitutions for offshore oil and gas production in the absence of lease sales in each of the areas. MarketSim calculates the energy market substitutions of additional imports, onshore production, and fuel switching, as well as reduced demand and consumption of oil and gas that could potentially replace OCS production. MarketSim models oil, gas, coal, and electricity markets under a special energy projection baseline run by the EIA's National Energy Modeling System (NEMS). The exploration and development scenarios from each Planning Area, summarized in Section 4.4 of the PEIS, are then introduced into the model as a shock to this special baseline, triggering a series of simulated price changes until each fuel market reaches equilibrium or supply equals demand. The MarketSim uses elasticities derived from the special EIA NEMS runs and elasticities from other credible elasticity studies to estimate the changes that would occur to prices and energy production and consumption through 2064.

BOEM maintains that the EIA information is an authoritative source where the underlying assumptions regarding each energy sector are clearly specified in source documentation. In this specific analysis, MarketSim incorporates a modified NEMS version of the EIA's 2009 Annual Energy Outlook (AEO) reference case (updated to reflect the American Recovery and Reinvestment Act). The AEO reference case is normally based on baseline assumptions for future OCS oil and gas leasing, but has been modified to assume no OCS leasing. The modified version is prepared by EIA at BOEM's request. Each energy sector is modeled separately for residential, commercial, industrial, and transportation demand with the own-price and cross-price elasticity specific to each submarket and fuel. NEMS also includes macroeconomic and international modules to address concerns like those raised in this comment about policy decisions that potentially affect energy demand and consumption. Each module incorporates the potential impact of government policies combined with the most likely trajectories for primary energy prices, technology adoption, and global economic growth. In order to produce a policy-neutral forecast, the AEO reference case used in NEMS incorporates only existing laws, rules, and regulations, taking into account the effective start and end date of each. The discussion of energy alternatives in this paper demonstrates the potential — independent of OCS leasing decisions — for reduction in oil and gas demand, both from increased efficiency and the transition to alternative fuels. To explore the impact of these factors, the EIA's AEO Outlook analyses also include a number of "side cases" that look at the impact of deviations from the baseline assumptions used in the reference case. The Energy Alternatives and Environment report has been revised to more clearly address side cases: policies and standards cases, technology cases, and greenhouse gas cases.

In general, the side cases illustrate the potential variability in future energy market conditions and examine many of the substitution opportunities already discussed in the No Action Alternative. The changes under these cases generally include reductions in overall energy consumption and may also accelerate the shift away from oil and gas; however, the alternative energy substitutes do not alter the fundamental dependence of the U.S. economy on oil and gas, or at least, reduce oil demand to the point that the United States would become a net exporter. Furthermore, the impact of any of these NEMS side cases would likely affect all alternatives, not just the no action alternatives. Therefore, the relative percentage changes of substitutions under the No Action Alternative are unlikely to change significantly under alternate NEMS cases. For this reason, BOEM does not conduct detailed MarketSim analyses for each side case and different set of policy assumptions. Finally, it is important to note that the Secretary's authority is generally confined to a decision on the oil and gas leasing program options, not the national energy policy decisions that are embodied in the NEMS side cases. As a result, information based on the policy-neutral forecast in the AEO reference case (reflecting only current laws, rules, and regulations) is the most useful for the Secretary in making his decision. BOEM acknowledges that there are other factors beyond the Secretary's authority that could lead to innovations in energy efficiency and renewable energy technologies, major changes in consumer attitudes towards "green" energy, and unforeseen changes in global energy markets.

In summary, the MarketSim analysis indicates that increases in imports and domestic onshore production as well as fuel switching would be necessary to meet continuing domestic demand for oil and gas resources. Although the model provides estimates specific to the anticipated production from each Planning Area, on average it indicates overall that most of the anticipated production would be replaced by increased oil imports, but with the remainder replaced by increased onshore gas production, gas imports, domestic coal production, electricity, onshore oil production, and other energy sources. As summarized in the PEIS in Section 4.6, the production reduction without new leasing would lead to slightly higher prices, which would lead to only a small change in the quantity of oil and gas demanded. Additional domestic production, increased imports, or fuel switching would be necessary to meet the continuing demand for oil and gas resources. Renewable energy contributions will account for less than around 2% of the substitution market, despite ongoing Administration initiatives to expand renewable energy sources on Federal lands and on the OCS.

7. Alternate/Renewable energy and energy efficiency need not replace all of the energy supplied by OCS oil and gas in order to be considered a viable alternative. Alternate/Renewable energy and energy efficiency would minimize significant impacts to the environment and create jobs, so an alternative that renewable energy can serve as a partial substitute for oil and gas leasing should be considered.

   Response: Section 2.9.4 presents the rationale why BOEM has eliminated from detailed analysis the alternative of partial substitution of renewable energy sources. As summarized in Section 4.5.7, the reduction in production provided no new OCS oil and gas leasing in the next five years would lead to slightly higher prices which in turn would lead to only a small reduction in oil and gas demand and substitution towards renewable energy sources (~4% in biofuels, solar, wind, hydropower, etc.). Additional domestic production, increased imports, or fuel switching would be absolutely necessary to meet the continuing demand for oil and gas resources as the United States will continue to be a net importer of oil. Although BOEM recognizes recent advances in renewable energy technology, renewable energy-friendly Federal and State energy policy changes (e.g., Department of Energy and tax subsidies, State renewable energy portfolio standards), and increases in U.S. market demand and supply, renewable energy, under the present set of policy assumptions, is not a major partial substitute over the window of consideration. Although CEQ's Forty Questions indicates that BOEM should consider alternatives outside of the Secretary's jurisdiction, in certain circumstances, the investments and policy changes required to achieve such a significant policy shift are not reasonable or economically practical within the 2012–2017 framework. This fact supports a less searching treatment of partial alternative energy as a reasonable alternative to some oil and gas OCS development.

   Consistent with judicial guidance on the 5-year Program, BOEM has incorporated by reference the Energy Alternatives and Environment report within the framework of the No Action Alternative to address the potential for substitution towards renewable energy sources. Within the constraints of the relevant authorities, the Secretary is already leading several initiatives to expand wind and solar energy development on Federal lands and on the OCS, such as Smart from the Start along the Mid-Atlantic coast. The Secretary has streamlined the regulatory burdens to facilitate renewable energy development and at the present time, there is no indication that, within market conditions, more can be done. If major policy changes were implemented over the 40–50 year life of the program, reduced consumption and/or increases in supply of renewable energy may affect the energy alternatives/substitutions. The Energy Alternatives and Energy report discloses that potential. However, as long as the United States is a net importer of oil and oil prices are determined on a world market, the alternative energy substitutes would likely affect all alternatives.

8. BOEM's rationale for not considering a 'Develop Alternate/Renewable Energy Sources' Alternative is flawed and the Final EIS should include an alternative to develop alternative energy and energy efficiency in lieu of OCS leasing.

   Response: Section 2.9.4 presents the rationale why BOEM has eliminated from detailed analysis the alternative of full or partial substitution of renewable energy sources. The role of renewable energy sources in meeting the energy demands of this country continues to grow. Such sources, however, could not replace the energy supplied by oil and gas from OCS sources in the near term. A more detailed discussion of alternative and other energy substitutes for oil and gas appears in Section 4.5.7, which considers the environmental effects of the No Action Alternative. BOEM has an offshore renewable energy program committed to orderly, safe, and environmentally responsible renewable energy development activities, such as the siting and construction of offshore wind farms on the OCS, as well as other forms of renewable energy, such as wave, current, and solar. For more information about this Program, we recommend that you visit the following bureau Web page: http://www.boem.gov/Renewable-Energy-Program/index.aspx.

   While BOEM's offshore renewable energy program seeks to expand and diversify the national energy portfolio, OCLSA mandates that the management of the OCS be conducted in a manner that considers economic, social, and environmental values of both the renewable and nonrenewable resources contained in the OCS. Notwithstanding the valuable contributions of renewable energy sources, OCSLA specifically mandates the development of an OCS oil and gas program every five years and, renewable energy development is neither a whole substitute nor a reasonable partial substitute for oil and gas development at this time. See also the response to Comment 7 in Alternatives.

9. The PEIS should thoroughly analyze an alternative to postpone the lease sales until the recommendations from the National Commission and the National Academy of Engineering are fully implemented.

   Response: As described in the PEIS, BOEM has considered but dismissed the alternative to postpone leases until the recommendations of the National Commission, the National Academy of Engineering, and other review bodies, including the Department's own Inspector General, are fully implemented. As described in Section 4.3.3, the Secretary of the Interior has pursued and continues to pursue an aggressive reform with respect to the regulatory oversight of OCS oil and gas. Many of these reforms address the underlying criticisms that resulted in recommendations for reform. The assumption that postponing leases will ultimately result in reduced activity levels on the OCS in the same timeframe is flawed, as was previously explained in context of the recommendation to delay lease sales for two years to allow the GOM ecosystem to recover from oil spill effects. In the PEIS, BOEM has further clarified its rationale for dismissal from further consideration in the PEIS of postponement of some or all sales. It also clarifies and explains that the Secretary maintains the discretion to consider the practical equivalent of the alternative suggestion at each lease sale and does so in the No Action Alternative considered at the lease sale stage. Moreover, consistent with BOEM's commitment to do so, Section 4.3 (Issues of Programmatic Concern) of the PEIS memorializes this alternative suggestion and will track its consideration through subsequent lease sales in the GOM, when it may be considered and analyzed if determined appropriate at the lease sale phase.

8.4.4.4 Issue 4 Environmental Issues and Concerns

8.4.4.4.1 Issue 4.1 General Concerns.

1. The Arctic is a fragile ecosystem that should receive special consideration; the PEIS should consider wide ecosystem impacts of a spill, and use an ecosystem approach when analyzing cumulative impacts. The PEIS should also consider climate change impacts at the ecosystem-level, and evaluate the cumulative effects of small oil spills on ecosystems.

   Response: BOEM recognizes that oil and gas development may affect natural, physical, and socioeconomic resources in the Arctic. Each resource section presented in Chapter 3 of the PEIS includes a subsection that specifically identifies the Arctic resources that may be affected by normal operations and/or accidental oil spills. Similarly, Chapter 4 of the PEIS identifies and discusses potential impacts on the Arctic environment and its resources. Specific mitigation measures for minimizing or avoiding impacts during normal operations, as well as spill response plans, will be developed at the lease sale stage and in subsequent development activities. Cumulative impacts on the Arctic environment and its resources are presented in Sections 4.6.2.3, 4.6.3.3, 4.6.4.3, and 4.6.5.3.

2. The PEIS should include discussions of how climate change, and especially changes in ocean acidification, sea ice loss, water temperatures, and freshwater inflows could affect primary and secondary productivity and nutrient cycling, and the range extension of sub-Arctic species and thus affect coastal and marine food webs and biotic communities in the Arctic.

   Response: The potential effects of climate change on coastal and marine environments and resources are discussed throughout the PEIS. Additional text discussing the potential effects of climate change (as associated with sea ice loss, increased ocean acidification, altered freshwater inflows, and increasing water temperatures) on primary and secondary productivity and food webs and associated effects on higher trophic levels, and range expansions of sub-Arctic species, has been added to several of the resource-specific discussions found in Chapter 3 of the PEIS.

3. The Draft PEIS fails to adequately analyze potential harm to the marine environment from noise impacts, including impacts to fisheries and marine mammals.

Response: The PEIS evaluates noise impacts on a variety of resources (see Chapter 4). Section 4.4.5 Potential Impacts on the Acoustic Environment examines the potential impacts of noise generated during routine oil and gas activities (such as vessel traffic, helicopter overflights, and seismic surveys) on ambient noise levels in the planning areas. BOEM does recognize the potential effects of operational noise (including that from seismic surveys), and noise-related impacts on marine mammals, marine and coastal birds, sea turtles, and invertebrates; these are addressed in the ecological resource-specific discussions of impacts found in Section 4.4.7 of Chapter 4. Those impact discussions have been revised to provide additional information regarding impacts. More detailed location- and resource-specific evaluations of noise impacts on resources will be conducted for lease sale activities and later NEPA documents. Compliance with ESA and MMPA will require consultations with NMFS and USFWS and will identify specific measures that will reduce the likelihood and magnitude of adverse impacts from routine operations to marine mammals (and other ESA-listed biota).

4. Biological hot spots and areas important for subsistence should be excluded from leasing plans. The USGS named a few of the known biological hot spots in its Arctic science review: Chukchi ice lead system, Barrow Canyon, Hannah Shoal, Point Barrow, Boulder Patch, and Camden Bay.

   Response: BOEM recognizes the presence and importance of biological hot spots in the Arctic. Camden Bay and the Boulder patch are specifically discussed in Section 3.7.2.3 of the PEIS, and the importance of ice leads is discussed in Section 3.8.1.3. Section 3.9 of the PEIS also identifies other areas of concern such as marine protected areas. Potential impacts on these various areas are discussed throughout Chapter 4 of the PEIS. The potential for impacting important biological areas will be addressed in more specific detail at the lease sale stage, as will the identification of mitigation measures to avoid or minimize impacting important areas.

5. Oil spills have impacts that can adversely affect biota and ecosystems and must be accounted for, including the effects of long-term exposure.

   Response: Chapter 4 of the PEIS discusses the impacts of oil spills, ranging in size from expected small accidental spills to unexpected catastrophic discharge events, on a resource-by-resource basis. The cumulative effects from long-term exposures are discussed in Section 4.6.4 Marine and Coastal Fauna.

6. Many sections of the Draft PEIS appear to utilize a single species approach when it comes to analyzing and describing impacts. Consider using an ecosystem approach for the cumulative impacts analysis. Suggest including a discussion on the food web and resulting ecosystem impacts.

   Response: The discussion of cumulative impacts to biota, as presented in the PEIS in Section 4.6.4, does not focus on individual species, but rather, discusses impacts on entire categories (e.g., marine mammals, coastal birds, etc.). When individual species are discussed, this is primarily in the context of providing examples of impacts. The text has been revised to present more of an ecosystem perspective, and text regarding the role of food webs in the movement of spill-related contaminants in affected ecosystems has been added to several of the fauna-specific impact sections in Chapter 4, as well as to the discussion of cumulative impacts on marine and coastal fauna in Section 4.6.4.

7. The Draft PEIS often broadly discusses biologic and physical aspects of Cook Inlet without regard for the specific area of the Inlet at issue, and there are important differences between these areas. The lower Inlet, in which the Federal lease sale may occur, is much different from the upper Inlet. Provide greater detail about the biological and physical aspects of Cook Inlet.

   Response: The affected environment discussion of the Cook Inlet Planning Area focuses on the area itself, which encompasses the lower half of the inlet. Section 4.2.3 also discusses the physical oceanography in the Cook Inlet. The level of detail provided in the PEIS is appropriate and does include resource status throughout the inlet. For example, the discussion regarding water quality (Section 3.4.2) identifies flushing times, riverine and marine inputs, and longitudinal gradients of suspended sediments within the inlet, and the discussion of marine and coastal birds identifies important avian areas throughout the inlet (see Figure 3.8.2-8 in Section 3.8.2.2). Many of the impact sections also discuss potential effects on resources in the upper portion of the inlet. Should a lease sale occur, greater detail regarding the inlet would be provided as part of the lease sale stage activities and NEPA analyses.

8. BOEM should incorporate information about the effects of the DWH event and conduct studies to examine the decomposition and weathering of spilled oil and on the effects of dispersants on water quality and ecological resources.

   Response: The programmatic-level NEPA analyses presented in the PEIS are appropriate for decision makers to make a general planning decision. The PEIS uses scientifically credible information and accepted scientific methods to make reasoned judgments and arrive at reasoned conclusions regarding the impacts and consequences of oil and gas development that could occur under the 2012-2017 Program. The PEIS discusses the effects of the DWH event on GOM resources throughout Chapter 3. Section 4.3.3 of the PEIS discusses the risk of spills (including large spills such as the DWH event), and includes a discussion of the breakdown and weathering of oil. In addition, the resource-specific impact discussions (beginning with Section 4.4.3) address the impacts of oil spills (including unexpected CDEs), as well as the impacts of cleanup activities, including the use of dispersants. These discussions have been updated to include more recent information. More detailed analyses would be conducted at later stages in the OCS leasing process. These analyses would incorporate the results of new studies that are currently underway regarding the effects of the DWH incident and the use of dispersants. There are currently numerous studies being conducted to support a Natural Resource Damage Assessment (NRDA) being prepared on the DWH spill. While much of the data and results of those investigations is currently unavailable, information from the NRDA studies will be included (as it becomes available) in lease sale and subsequent NEPA assessments. In addition, BOEM has a very robust research program through its Environmental Studies and Technology Assessment Research Programs, and the results of applicable studies coming from those programs would also be incorporated into later lease sale studies.

9. There is no proven technology to clean up an oil spill in Arctic conditions with cold temperatures, limited ability, broken sea ice, and high winds. Oil and gas development can impact bowhead, walrus, fish, and other subsistence resources. There is little baseline science that exists to measure the effects of the spill on the Arctic ecosystem.

   Response: BOEM has always recognized that a large spill could have significant environmental impacts, and also recognizes that spills occurring under winter Arctic conditions would be especially challenging to control and cleanup. In addition, the schedule for the proposed 2012-2017 Program provides that the first Arctic lease sale would not take place until 2015; leasing decisions made at that time would take into account any advances in spill response and cleanup technologies and comply with any new regulations and NTL's that may be issued by that time.

10. The Draft PEIS does not adequately account for the impacts of the Deepwater Horizon event or show the comprehensive impacts of the 5-year Program on GOM marine resources.

   Response: The purpose of the PEIS is to evaluate the potential effects of oil and gas development (from routine operations, expected accidental spills, and unexpected CDEs) on the natural, physical, and socioeconomic environment, and not to evaluate the DWH event. The PEIS does discuss the impacts of the DWH event on the current conditions of physical, natural, and socioeconomic resources of the GOM. These impacts are discussed on a resource-by-resource basis throughout Chapter 3. BOEM addresses the relevance of incomplete and unavailable information as it relates to impacts in Section 1.4.2. The PEIS has been revised to incorporate new information that has become available since the publication of the Draft PEIS. In addition, Section 4.3.3 of the PEIS discusses in depth the risk of CDEs. More detailed analyses will be conducted at the lease sale stage of the Program.

11. Chapter 6 of the Draft PEIS fails to discuss the effects of climate change, ocean acidification, and the impacts of oil spills on short-term use and long-term productivity; there is no analysis cited to support the suggestion that the pre-2010 impacts of oil and gas production in the GOM have not had an impact on biological productivity.

   Response: Chapter 6 has been revised to acknowledge the potential effects of climate change (including ocean acidification), and additional text has been added to Chapter 6 of the PEIS regarding the possible effects of oil spills (including CDE-level spills) on long-term productivity. Section 3.3 of the PEIS discusses the potential effects of climate change on baseline environmental conditions in the GOM and Alaska, including potential effects of sea level rise, ocean acidification, and other climate-related factors. While the DWH event clearly had short-term impacts on ecological resources in some portions of the GOM, it is too soon after the spill to draw any conclusions regarding the nature and magnitude of any long-term effects of the spill. As results of current, ongoing, and likely future studies evaluating long-term impacts of the spill become available, BOEM will incorporate those results in its future assessments and future decision making regarding oil and gas activities on the OCS.

8.4.4.4.2 Issue 4.2 Climate. A number of comments discussed concerns related to climate change, usually in regards to effects to specific resources. These comments are addressed in other issue comment categories and responses.

8.4.4.4.3 Issue 4.3 Water.

1. USEPA recommended the insertion of the following language in Section 4.4.3.1.

   "Permits issued under Section 402 of the Clean Water Act for offshore activities must comply with any applicable water quality standards and/or Federal water quality criteria as well as Section 403 of the Clean Water Act. Water Quality Standards consist of the water body's designated uses, water quality criteria to protect those uses and determine they are being attained, and anti-degradation policies to help protect high quality water bodies. Discharges from offshore activities near State water boundaries must comply with all applicable State Water Quality standards."

   In addition, USEPA recommended that BOEM consider incorporating the water quality effects information contained in the USEPA Region 10 Ocean Discharge Criteria Evaluations (ODCEs) previously developed for the 2006 Arctic Oil and Gas Exploration National Pollutant Discharge Elimination System (NPDES) General Permit (http://yosemite.epa.gov/rl0/water.nsf/npdes+permits/arctic-gp), as well as those that are currently being finalized for new Chukchi Sea and Beaufort Sea Exploration NPDES General Permits. USEPA Region 10 can provide copies of the latter documents when complete if they become available prior to the publication of the Final PEIS.

   Additional information should be provided about the expired USEPA Region 10 Arctic Oil and Gas Exploration NPDES General Permit and the two separate permits that will be issued for exploration for the Beaufort and Chukchi Seas that will replace the Arctic General Permit.

   Lastly, the entry for dredging and marine disposal in Table 4.6.2-1 (Section 4.6.2) should be clarified. USEPA is responsible for identifying recommended ocean disposal sites. USEPA and USACE are jointly responsible for management and monitoring of ocean disposal sites. USACE issues permits for ocean dumping of dredged material under the Marine Protection, Research, and Sanctuaries Act (MPRSA), subject to USEPA review and concurrence.

   Response: The suggested language on Sections 402 and 403 of the Clean Water Act has been added into Section 4.4.3.1 of the PEIS. The water quality effects information contained in the USEPA Region 10 NPDES permit for oil and gas exploration have been incorporated into Section 4.4.3.3 of the PEIS. Information about the USEPA Region 10 NPDES permit for has been added to Section 4.4.3.3 in the PEIS. Table 4.6.2-1 has been updated to clarify the entry for dredging and marine disposal.

2. What is the status of the DWH event? Is there oil still leaking through seeps?

   Response: The DWH event was capped on July 15, 2010. Text related to the DWH event has been updated throughout the PEIS to incorporate recent information (see Section 3.4.1.4). Naturally occurring oil seeps can be found on the sea floor of the Gulf of Mexico, and the contribution of such natural seeps to petroleum hydrocarbons in Gulf of Mexico waters is discussed in Section 3.4.1.2.2.

3. Section 4.4.3.2 of the PEIS should mention that on October 31, 2008 the United States Environmental Protection Agency (USEPA) formally approved the State of Alaska's National Pollutant Discharge Elimination System (NPDES) General Permit program application. Authority is being transferred in phases. Phase IV, which includes the discharges associated with the oil and gas industry, will be transferred to the State on October 31, 2012. The Alaska Department of Conservation (ADEC) will authorize discharges after that date.

   Response: Information on the NPDES authority transfer process has been updated in Section 4.4.3.2.

4. Section 4.4.3.2.1 of the Draft PEIS states: "The majority of wastes generated during construction and developmental drilling would consist of drill cuttings and spent muds (MMS 2002a). Drilling muds and cuttings generated when installing exploration and delineation wells would be discharged at the well site." Drilling muds are mentioned in many sections throughout the document. It would be helpful in all of these sections (not just in this one) if the reader was informed whether the muds associated with drilling in a particular geographic area were oil-based, synthetic-based, or water-based.

   Response: Additional information about drilling muds has been added to the water-quality text of the PEIS. Discussion of specific drilling muds used at a regional level is beyond the scope of the 5-year PEIS and would be presented in a lease sale or project-specific EIS.

5. Section 4.4.3.2.1 of the Draft PEIS states: "Fill deposited during artificial island construction also increases turbidity." NOAA does not have any disagreement with this statement. However, NOAA is not aware of artificial islands being used in Cook Inlet for drilling.

   Response: The reference to artificial islands in Cook Inlet has been omitted in the PEIS.

6. Section 4.4.3.3.2, Accidents: NOAA recommends clarifying the statement "A hydrocarbon plume in the water underneath the ice could persist with concentrations that are above ambient standards and background levels for a distance that would be five times greater than that in the open sea (MMS 2008b)." What is meant by "ambient standards"?

Response: Background conditions in the arctic are discussed in Section 3.4.3 of the PEIS. Text in Section 4.4.3.3 has been updated to reference the background conditions that are discussed in the Affected Environment section of the PEIS, Section 3.4.3.

7. Should the reference to "dispersant release" in Section 3.7.3.1.1 of the PEIS be changed to "dispersant application"?

   Response: The text in Section 3.7 has been revised as suggested.

8. Clarify the studies and information presented in the Draft PEIS about the fate of the oil that was released during the DWH event.

   Response: Further information and clarification about the fate of the oil that was released during the DWH event has been provided in Section 3.4, but many studies are ongoing, and may be for many years to come. Information from these and future studies will be evaluated and incorporated, when available, into future USEPA analyses conducted under the 2012-2017 OCS Leasing Program.

9. Section 3.4.1.4 of the Draft PEIS states, "The composition of the oil from the DWH event varies with the state of weathering of the oil; as the lighter-end components are removed from weathering process, only the heavier-end components remain (Core and Technical Working Groups 2010)." Should not this statement be revised to state that "only a portion of the heavier-end components remain" to clarify that heavier-end components are also partially weathered?

   Response: Section 3.4.1.4 has been revised to clarify the meaning of this statement, and additional references have been added.

10. Section 3.4.1.4 of the Draft PEIS states, "Some of the constituents released during the DWH event evaporated at the surface or rapidly dissolved into the GOM waters before the oil reached the surface." Should this statement include the fact that some constituents also underwent photo-oxidation at the surface?

    Response: The text in Section 3.4.1.4 has been revised to include photo-oxidation in the list of processes and to include additional references.

11. Section 3.4.1.4 of the Draft PEIS states, "Evidence from the DWH event indicates that methane gas released from the well was rapidly broken down by bacterial action with little oxygen drawdown (Camilli et al. 2010; Kessler et al. 2011." Should this statement refer to "natural gas" instead of "methane gas" because Kessler found that ethane and propane were also rapidly degraded, potentially even more quickly than methane?

    Response: The text in Section 3.4.1.4 has been revised to reflect that in addition to methane gas, ethane and propane gases were also present in the DWH event release, and were consumed by bacterial action.

12. Should the discussion of the fate of the oil released during the DWH event in Section 3.4.1.4 of the Draft PEIS be expanded to include a discussion of biodegradation of other oil components in the water column and along the shoreline, as discussed in work done by Operational Science Advisory Team of the Unified Area Command (OSAT) and studies by Gong and others presented at IOSC and SETAC?

    Response: The scope of this discussion is more appropriate for lease sale or project specific EISs. No changes were made to the PEIS as a result of this comment.

13. Section 3.4.1.4 of the Draft PEIS refers to the "four major constituents" of the chemical dispersant used during the DWH event. Should this phrase be changed to "four dispersant constituents" because the four items listed by BOEMRE are not the largest constituents of dispersants by volume?

    Response: The text in Section 3.4.1.4 has been revised as suggested.

14 Section 3.4.1.4.1 of the Draft PEIS discusses "a large amount of data" collected during the NRDA process regarding the scope of oil contamination. Should this discussion note that the last observation of surface oil by trained aerial observers occurred August 3, 2010, as discussed in OSAT-1?

    Response: This addition is not necessary for clarity. No changes were made to the PEIS as a result of this comment.

15. Section 3.4.1.4.1 of the PEIS states, "Within 3 km (2 mi) of the wellhead, however, concentrations of oil related chemicals in the deepwater sediments were still found to be elevated above benchmark concentrations for aquatic life (OSAT 2010)." Should this statement be qualified because not all samples in the region were above the benchmarks? Should this statement indicate that only "some samples" were above the benchmarks?

    Response: The text in Section 3.4.1.4.1 has been revised to indicate that only some samples were above the benchmarks.

16. Section 3.4.3 of the Draft PEIS states, "Hydrocarbon concentrations in sediments of the Beaufort Sea are relatively high compared with other undeveloped marine areas (Steinhauer and Boehm 1992)." Should this statement be revised to reflect the fact that the Steinhauer study uses the terms "elevated" (not "relatively high") and "non-polluted" (not "undeveloped")?

    Response: Page 249 of the Steinhauer and Boehm, 1992, report states that, "The relatively high concentrations of both saturated and aromatic hydrocarbons that constitute the sediment background in the Beaufort Sea may present difficulties in detecting low-level petrogenic inputs due to oil and gas-related activities." The PEIS text in Section 3.4.3 has been revised to reflect that Steinhauer and Boehm, 1992, presented the Beaufort Sea sediments as "non-polluted."

17. Section 3.4.3 of the Draft PEIS states, "Total hydrocarbon concentrations in sediments range from 2 to 85 milligrams per kilogram (mg/kg) (Steinhauer and Boehm 1992; Naidu et al. 2001; Brown 2003)." This statement is not included in any of the three references cited.

    Response: The text in Section 3.4.3 has been revised to reflect the hydrocarbon concentrations presented in the studies cited.

18. Section 3.4.3 of the Draft PEIS refers to "concentrations of hydrocarbons at a sampling site near West Dock in Prudhoe Bay…" Should this statement specify that these were "PAH concentrations of hydrocarbons…"?

    Response: The text in Section 3.4.3 has been changed to reflect that there were elevated concentrations of PAHs at the sampling site near West Dock in Prudhoe Bay.

19. Section 3.4.1.4 of the Draft PEIS states, "To evaluate the impacts of the DWH event on the environment, the USEPA has set benchmark concentrations of 41 compounds found in the oil from the DWH event for human health, aquatic health, and sediment (OSAT 2010). This statement could be clarified to better reflect USEPA's selection of the benchmarks. Should the phrase "USEPA has set" be changed to "USEPA selected" and should the phrase "compounds found in the oil form the DWH event" be changed to "compounds typically found in oil"? Additionally, should "41 compounds" be changed to "43 compounds" because benchmarks were also developed for nickel and vanadium?

    Response: Text was changed in Section 3.4.1.4 to reflect that the benchmarks were "USEPA selected." No change was made to the text with regard to the composition of the oil that was released during the DWH event. The text has been updated to reflect that the human health benchmarks included those for nickel and vanadium.

20. Sections 3.4.1.4.1, 3.4.1.4.2, and 3.4.1.4.3 of the Draft PEIS state that "oil leaks from boats" could have been alternate sources of oil detected after the DWH event. Should this text also note that natural seeps are a common source of oil in the GOM?

    Response: Reference to natural seeps has been added to the list of examples presented in Sections 3.4.1.4.2 and 3.4.1.4.3.

21. Section 3.4.1.4.3 of the Draft PEIS states that "seven sediment samples taken within 3 km (2 mi) of the wellhead exceeded the aquatic life sediment quality benchmark…" Should this statement indicate the total number of samples taken within the vicinity to clarify that not all samples exceeded benchmarks?

    Response: The text in Section 3.4.1.4.3 has been modified to include the total number of sediment samples (17).

22. Section 3.4.1.4.3 of the Draft PEIS states that Camilli et al. "conducted a subsurface hydrocarbon study two months after the DWH event…" Should this statement clarify that Camilli et al.'s sampling occurred while oil was still being released from the wellhead?

    Response: The statement in Section 3.4.1.4.3 has been clarified as requested.

23. Section 3.4.1.4.3 of the Draft PEIS states that Camilli et al. "found a continuous oil plume…" Should this statement be revised to refer to "dispersed oil" or "clouds of dispersed oil" to clarify that oil concentrations even in the so-called "plume" were in the low ppm to ppb range and that oil was not present in a continuous subsea "slick"? See Atlas & Hazen (2011).

    Response: The statement in Section 3.4.1.4.3has been clarified as requested.

24. In citing Camilli and Diercks, Section 3.4.1.4.3 of the Draft PEIS states that the "plume persisted for many months at this depth with no substantial biodegradation." The Camilli and Diercks studies cited here were based on conditions during the spill and are not representative of the current state of the GOM, or biodegradation once the release was stopped. Should this discussion also reference Reddy et al. (2011)? This study notes that petroleum hydrocarbons had a degradation half-life of approximately one month, while the gas and n-alkanes had a half-life on the order of two days, which suggests that biodegradation likely rapidly depleted the subsurface dispersed oil once the release was stopped.

    Response: Additional information and references have been included in the discussion of the DWH event that is presented in Section 3.4.1.4 of the PEIS. A reference to the study by Reddy et al. (2011) was added in Section 3.4.1.4, where the general fate of the released petroleum hydrocarbons is discussed. Additional discussion was added to Section 3.4.1.4.3 and clarification was provided that some of the studies cited, including the one by Camilli et al. (2010), were conducted while oil was still being released from the wellhead.

25. Section 3.4.1.4 of the Draft PEIS states that Camilli et al. (2010) "measured concentrations throughout the water column and found similarly high concentrations of aromatic hydrocarbons in the upper 100 m (328 ft)." Does this study in fact support this conclusion?

    Response: Yes, the study supports the conclusion stated in the PEIS. The attenuation at 10-m depth that Camilli et al. 2010 are referring to is hypothesized by the authors to be due to ventilation to the atmosphere that occurred near the surface. No change has been made to the PEIS as a result of this comment.

26. Should the discussion of Joye et al. (2011) in Section 3.4.1.4 of the Draft PEIS mention the sampling period (May/June 2010)?

    Response: The discussion in Section 3.4.1.4 has been updated to include sampling periods used by Joye et al. 2011.

27. Should the discussion of Joye et al. (2011) and Yvon-Lewis et al. (2011) in Section 3.4.1.4 of the Draft PEIS discusses Ryerson et al. (2011), which found "No CH4 enhancements correlated with the spill were detected on either of the two P-3 survey flights; rather CH_4 variability is attributed to larger-scale atmospheric transport and mixing of air masses affected by sinks and sources unrelated to the spill. …" Ryerson et al. (2011)?

    Response: Information from the study by Ryerson et al. 2011 has been included in the updated discussion of the DWH event presented in Section 3.4.1.4.

28. Section 3.4.1.4 of the Draft PEIS states, "The fate of 771,000 gallons of chemical dispersants injected at the DWH wellhead near the seafloor (1,500 m [4,921 ft]) was studied by Kujawinski et al. (2011)." Should this statement be revised to indicate that the quantity of chemical dispersants was approximate? Should it also be noted that Kujawinski et al.'s results were for DOSS (dioctyl sodium sulfosuccinate), only one of the dispersant ingredients? Should it be clarified that Kujawinski found DOSS concentrations to be extremely low, and below aquatic toxicity levels?

    Response: The text in Section 3.4.1.4 has been updated to clarify results of Kujawinski et al. (2011).

29. Section 3.7.2.1 of the Draft PEIS stated that impacts of a large spill "could be increased if they occurred in areas with degraded water quality, such as areas continuing to be affected by the DWH." Should this statement reference the extent of the "area" still affected, which is relatively limited?

    Response: BOEM has used the best available information at the time of publication of the FEIS to describe the area affected by the DWH event. NOAA, through the NRDA process, is still working to identify areas and resources affected by the DWH event. It should be noted that the area affected by the DWH event could expand or shrink over the years due to the influence of multiple factors.

30. Ocean discharge of a wide variety of waste streams also threatens to introduce toxins that can bioaccumulate in our food chain and disrupt the sensitive Arctic ecosystem.

    Response: Sections 4.4.7.1.3, 4.4.7.3.3, and 4.6.4.3.1 of the PEIS discuss bioaccumulation related to the OCS program in the Arctic.

31. The approach stated in Section 1.5.4 of the Draft PEIS for evaluating water quality impacts focuses on effects on biological resources: "Water quality issues relate primarily to marine water quality and how changes in water quality could affect biological resources". This statement should be expanded to clearly include human resources including public health, and traditional and customary uses.

Response: The PEIS discusses public health in Sections 3.15 and 4.4.14; water quality in Sections 3.4 and 4.4.3; and subsistence uses of resources in Sections 3.14, 3.15, 4.4.13, and 4.4.14.

32. Aquatic Life Benchmarks to estimate environmental toxicity do not reflect best available science. The Draft PEIS appears to rely heavily on the recommendations of the Aquatic Life Benchmarks developed during the BP/Deepwater Horizon incident in 2010. The PAH Benchmarks are useful because they are a measure of some of the most toxic compounds in crude oil, but they are not inclusive enough because they do not accurately measure the total toxicity of all substances in crude oil. Therefore, the toxicity of PAH Aquatic Life Benchmarks relied upon in this Draft PEIS are limited and not fully characterized. Nor does USEPA, the source of the Benchmarks, appear to currently have the resources to more fully evaluate toxicity of oil spills. The PEIS should recognize the limits of the Benchmarks and adjust assumptions to reflect those limits. Furthermore, recognizing limits in USEPA's ability to evaluate routes of exposure and mechanisms of toxicity of oil and oil-derived substances, BOEM should consider filling this gap through its environmental studies program.

    Response: The USEPA is the principal source for toxicity information. It should be noted that the USEPA states on its website (http://www.epa.gov/bpspill/health-benchmarks.html#gen2) that "benchmarks are meant to be used for screening purposes only; they are not regulatory standards, site-specific cleanup levels, or remediation goals." In Section 3.4.1.4 of the PEIS, the OSAT report is cited and the evaluation approach of the OSAT is discussed in the context of providing information about the DWH event and how that event has shaped the baseline condition of the water quality in the GOM. Much data was collected in the wake of the DWH event, and studies continue to be published discussing and evaluating that data. The OSAT study is only one of many studies cited in the PEIS to characterize the baseline condition of the water quality in the GOM, and the PEIS does not rely solely on this source in its analysis. Observed impacts on the ecological environment as a result of the DWH event are discussed in Sections 3.7 and 3.8. No changes were made to the PEIS as a result of this comment.

33. Section 4.4.11.2 of the Draft PEIS should restate the predicted amount of turbidity and drilling wastes so that there is a reference point to compare it with river discharge. In addition, it should specify the time frame in which the discharge will occur. Claiming that the turbidity and discharge by exploration and development is less than naturally occurring river discharge is misleading. River discharge carries nutrients to the ocean, and the turbidity occurs near shore extending only a few miles offshore. Furthermore, river discharge is a seasonal and predictable event to which organisms in the near shore community have adapted to. The drilling sites may occur far away from any river discharge. Increased turbidity and discharge resulting from exploration and development may impact the phytoplankton community by changing its species composition to organisms that are adapted to low light levels and have lower levels of primary production.

    Response: The text in Section 4.4.11.2 has been revised to address this comment.

34. Provide updated data concerning shoreline and nearshore impacts related to the Deepwater Horizon Event.

    Response: The text in Section 3.4.1.4 has been updated to reflect new information on shoreline and nearshore impacts of the DWH event available at the time of publication of the Final PEIS.

35. Should the Draft PEIS be revised to incorporate references to studies showing that natural seeps are common in the GOM, as well as the 2009 MMS study finding that background levels of PAHs in sediments on the Outer Continental Shelf can be as high as 1000 ppb?

    Response: The PEIS contains a discussion of natural seeps in the GOM (See Section 3.4 of the PEIS). A discussion of background levels of PAHs in sediments of the Outer Continental Shelf has been added to Section 3.4.

36. The Proposed Program notes that oil spills are unavoidable yet states that compliance with NPDES permits would reduce or prevent most impacts from normal operations. However, given the remoteness of the Arctic and the limited amount of development that currently exists, it is unclear whether sufficient government capacity is in place to ensure frequent monitoring and enforcement of NPDES permit terms. The Draft PEIS goes on to state that "in the presence of cold temperatures and ice, cleanup activities could be more difficult than in more temperate environments" (Section 4.4.3.4). Yet it goes on to conclude that a "large spill in coastal waters could result in longer term impacts on water quality, but cleanup efforts would reduce the likelihood of permanent impairment. A large spill in marine waters would be expected to have temporary impacts on water quality; however, cleanup efforts and evaporation, dilution, and dispersion would minimize the long-term impacts" (Section 4.4.3.4). This is an extraordinary and seemingly unsupportable conclusion, given the nation's past experience with oil spills, especially in colder waters; the anticipated difficulties of response and clean-up efforts in the Arctic; and the known lack of significant response infrastructure.

    Response: The USEPA is responsible for enforcement of NPDES permits. The information presented in Section 4.4.3.3 about oil spills in the Arctic has been updated.

37. The Draft PEIS estimates discharges of up to 12,000 barrels of drilling fluids and 12,000 tons of drill cuttings disposed in the Chukchi Sea (Section 4.3.3.3). Section 5.1 describes these discharges as having "unavoidable adverse environmental effects" and Section 4.4.3.4 states that "overall coastal and marine water quality impacts due to routine operations and operational discharges under the proposed action would be unavoidable." These intentional discharges, however, are clearly avoidable. We request the final EIS include a discussion of the feasibility of zero discharges during exploration activities. If zero discharges are required for production, they surely could be avoided during exploration.

    Response: The Alaska-Arctic scenario described in Section 4.4.1 includes a conservative estimate of the drilling fluids potentially discharged during exploration and development drilling in order to ensure that all potential impacting factors and water quality effects are disclosed. It should be noted that all potential discharges, either from exploration or development operations, will require USEPA NPDES permits. In the past, a limited number of widely scattered offshore exploration wells in Alaska have been allowed to discharge the drilling wastes onsite. USEPA Region 10 is in the process of reissuing the expired Arctic NPDES General Permit for exploration drilling as two general permits (Beaufort and Chukchi GP). Information about the USEPA Region 10 NPDES permit for has been added to Section 4.4.3.3 in the PEIS. The areas of coverage include potential discharges from existing lease locations and future leases that might be sold during the 2012-2017 OCS Oil and Gas Leasing Program. USEPA has signaled its intent to eliminate the authorization to discharge non-aqueous drilling fluids and associated drill cuttings, allowing only water-based drilling fluids and cuttings to be discharged, and even the latter would not be permitted to be discharged during active bowhead whaling activities in the Beaufort Sea, unless the USEPA authorizes the discharge after review of the operator's evaluation of the feasibility of drilling facility storage capacity and land-based disposal alternatives. The discharge standard may change during the 50-year activity profile associated with the program. Individual operations may provide for zero discharge as recently proposed by Shell for exploration drilling operations in Camden Bay at the Sivulliq and Torpedo prospects. Onshore exploration wells are typically required to haul all wastes back to an offsite disposal facility. For offshore production operations (many wells drilled from a platform), the PEIS assumes that drilling wastes will have to be hauled offsite for disposal. In comparison, in the GOM the USEPA allows onsite disposal.

38. The statements in Section 4.4.6.3.3 of the Draft PEIS regarding discharge of drill cutting practices should be verified against current BOEM requirements and industry practices currently being allowed. Re-injection of produced waters should not be assumed. The PEIS should describe the discharge of produced waters in more detail, including the potential volume, possible petroleum content, and potential impacts to the environment.

    Response: The Section 4.4.6.3 text states that "it is assumed that drilling muds and cuttings would be discharged in the Beaufort and Chukchi Sea Planning Areas for exploration wells only. Drilling wastes from development and production wells would be reinjected into the wells." This description is consistent with the scenario described in Table 4.4.1-4. For further information, see the response to Issue 4.3 Water, comment number 37.

8.4.4.4.4 Issue 4.4 Air.

1. The Draft PEIS should be revised to reflect the transfer in air permitting in the Arctic OCS from USEPA to BOEM.

    Response: Section 4.4.4.3 has been revised to indicate that jurisdiction for air permitting lies with BOEM and not USEPA, and a callout has been added to Appendix C, which discusses air-permitting authorities. The transfer of jurisdiction will not affect the conclusions regarding air quality presented in the Final PEIS.

2. Several comments noted the need to discuss icebreakers as important source of air emissions in the Arctic that is not present in the GOM.

   Response: The discussion in Section 3.5.2.3 of icebreaker emissions was expanded based on the information in the referenced website, as applicable.

3. Several comments noted that the air quality data presented in the Draft PEIS needs to be updated.

   Response: Air quality data were updated in Sections 3.5 and 4.4.4 with available recent data from the Alaska Department of Conservation.

4. USEPA recommends that the air quality analysis for future, project-specific EISs include the following, as appropriate, an evaluation of how the actions will comply with the new short-term 1-hr NO_2/SO_2 NAAQS and $PM_{2.5}$ standards, and an updated Class I increment analysis for the Breton National Wilderness area.

   Response: No text change required. In this PEIS, BOEM is only establishing a schedule of potential lease sales and framing the geographic scope for which OCS development can occur. If exploration and development occur following an actual lease sale, each ensuing project would undergo additional environmental review and analysis. These site-specific reviews would address impacts for all ambient standards in effect at that time and updated increment studies of affected Class I areas.

5. Section 3 — Affected Environment: Florida's State air quality standards and the nonattainment status of Hillsborough, Florida, which is a coastal GOM county, need to be updated.

   Response: Text was revised in Section 3 to update the Florida standards and nonattainment status of Hillsborough, Florida.

6. USEPA questions the validity of the analysis in Section 4.4.4 of the Draft PEIS. Based on USEPA's review of the analyses provided, it is not clear that these conclusions are supported with respect to the new short-term NO_2 and SO_2 standards and the $PM_{2.5}$ standards by ignoring the fact that SO_2 and NO_2 are precursors of $PM_{2.5}$, the time variation of NOx emissions, and USEPA source-specific modeling indicating that near-shore drilling activities may have significant NO_x impacts. The studies used in the PEIS do not address $PM_{2.5}$ impacts. USEPA is also concerned that future NEPA analyses required for the Lease Sales and Project Plan approvals may, as has occurred in the past, rely upon the more generalized analysis conducted in the PEIS, rather than provide the more detailed analysis that is needed to ensure protection of the NAAQS and coastal consistency.

   Likewise, the conclusion that the Program will be well within the PSD increments does not appear to be supported for Class I areas. Given the year of the study used in the PEIS, it does not incorporate recently permitted sources, nor include emissions from sources located within the lease blocks covered in this PEIS. The study also is reported to include only platforms and not exploratory operations. Hence, it is unclear whether it can be determined at this stage that impacts are "well within PSD increments" without more detailed analysis. USEPA recommends that the PEIS identify how the subsequent NEPA analyses for the Lease Sales for locations that may impact Breton will ensure protection of these sensitive Class I areas.

Response: No text change is required. There is often uncertainty with respect to the air impacts at the programmatic level of analysis. The PEIS used the information and studies available at the time it was written at that time, OCS activities had not been modeled to assess their potential impacts on the short-term NO_2 and SO_2 standards and the $PM_{2.5}$ standards. Since that time, additional Prevention of Significant Deterioration (PSD) modeling has been done, and the text in Section 4.4.4 was updated to include results of this modeling for the Frontier Discoverer and Noble Discoverer drillships. BOEM recognizes the need to address these issues and standards and the PEIS used available data to make reasonable estimates of the likely impacts. It was not felt that detailed assessments of impacts with respect these standards were essential to making a reasoned choice between alternatives at the programmatic level. BOEM plans to use the most detailed information available at each step in its NEPA analyses from the programmatic down to the individual lease sale level. At this programmatic stage, BOEM is only defining the geographic scope within which OCS development can occur. If exploration and development occur following an actual lease sale, each individual project would undergo additional air review and analysis focusing on the specific project area and addressing all applicable ambient standards.

7. In Section 3.5.2.2 of the Draft PEIS, the statement that ambient air concentrations in Alaska, outside of the metropolitan areas, are below the NAAQS is not correct. Elevated levels of PM_{10} and $PM_{2.5}$ have been measured at various locations throughout the State. Ambient air outside may not always be in compliance with the PM_{10} and $PM_{2.5}$ NAAQS. We recommend revising this statement to reflect actual conditions.

   Response: Text in Section 3.5.2.2 was updated based on the Alaska data referenced in the comment, as applicable.

8. The Draft PEIS discusses VOC (volatile organic compound) releases in Section 3.5.2.1 ("Evaporation from the oil spill itself would result in VOCs in the atmosphere."). This discussion should include a discussion of the dissolution of lighter and more volatile oil components.

   Response: There is no disagreement that atmospheric emissions could be affected by dissolution of certain fractions in the water. There is also no disagreement that VOCs would enter the atmosphere, regardless of the partitioning. Text was updated in Section 3.5.2.1 based on the reference to indicate, if supported by the reference, that lighter components dissolve preferentially in water.

9. The discussion in Section 3.5.2.1 of the Draft PEIS of SOA (secondary organic aerosols) should note that similar concentrations of SOA have been observed in urban data and note where that the measurements were not taken where the public has access.

Response: No text change was made. The concentration of SOAs in urban areas is not relevant. The text is limited to reported observations without attempting to account for them.

10. The Draft PEIS does not note that monitoring during the DWH response included more than BTEX (benzene, toluene, ethylbenzene and xylene) and the term “unmeasured” should be removed.

    Response: Text was added to Section 3.5.2.1 to note that additional compounds were measured. “Unmeasured” was not removed, as it accurately reflects the reference cited in the PEIS.

11. The discussion of in situ burning in Section 4.4.4.1.2 of the Draft PEIS should include a discussion of the Nova Scotia Offshore Burn Experiments.

    Response: The suggested reference for the Nova Scotia Burn Experiments was included and discussed in Section 4.4.4.1.

12. The discussion in Section 3.5.2.1 of the Draft PEIS of potential public health effects as a result of DWH event needs to account for evidence that the benzene measurements were unlikely to be attributable to evaporation from a surface slick, as measurement indicated that benzene was completely dissolved in the water column prior to surfacing. This discussion should note that short-term Louisiana benzene standard may have been exceeded as the result of numerous onshore sources. Should it also note that maximum onshore benzene concentrations measured by USEPA were higher than maximum offshore concentrations reported by BP, the National Institute for Occupational Safety and Health (NIOSH), and others, suggesting an onshore contribution?

    Response: The discussion in Section 3.5.2.1 was supplemented with information from Ryerson, T.B., et al., 2011 (Atmospheric Emissions from the Deepwater Horizon Spill Constrain Air-Water Partitioning, Hydrocarbon Fate, and Leak Rate, *Geophysical Research Letters* 38:L07803), noting that most benzene dissolved in the water column based on the referenced study. The statement about levels being above the standard was modified to indicate that the standard was met even though individual samples may have exceeded the standard level. Text was added to Section 3.5.2.1 to include the information regarding onshore sources presented in the comment.

13. In Section 3.5.2.1, the Draft PEIS appears to compare short-term monitoring results taken during the DWH event response to Louisiana’s annual ambient air quality standard for benzene.

    Response: The PEIS does not compare short term measurements to a long-term standard. It notes that even though some individual measurements exceed the long term value, the long term standard is still met (as invariably is the case for an average). However, the text in Section 3.5.2.1 was clarified to avoid confusion.

14. Section 4.4.4.1.1: The sentence about using low-sulfur fuel as a mitigation measure should be revised to indicate that low sulfur fuel and likely ultra-low sulfur fuel would only be available in the future.

    Response: The comment incorrectly states that low- and ultra-low-sulfur fuel would only be available in the future. Refineries began producing ultra-low-sulfur diesel (ULSD) in 2006, and the use of low-sulfur fuels is specified in the USEPA Clean Air Highway Diesel final rule (see http://www.epa.gov/oms/highway-diesel/regs/420f06064.htm). The PEIS text was updated in Section 4.4.4.1 to indicate that low-sulfur fuel is not a mitigating measure, but a requirement.

15. Section 4.4.4.4: The first sentence in this section should end with the additional phrase "in onshore areas".

    Response: The text in Section 4.4.4 was revised as suggested.

16. For a single operator with a single exploration plan, proposed activities can result in consumption of almost the entire National Ambient Air Quality Standards (NAAQS). Therefore, BOEM cannot conclude that additional leasing will not impact compliance air quality standards or human health in the Arctic.

    Response: No change was required. There is often uncertainty with respect to the air impacts at the programmatic level of analysis. Specific projects have not been proposed and the detailed data needed to accurately predict the potential impacts of OCS activities on NAAQS are unavailable. As discussed in Section 4.4.4, the PEIS assessed the potential impacts of OCS operations on the NAAQS using the information and studies available at the time it was written. At that time, it was felt that, in view of the unavailability of specific supporting data, detailed assessments of impacts with respect to these standards were not essential to making a reasoned choice between alternatives at the programmatic level. BOEM plans to use the most detailed information available at each step in its NEPA analyses from the programmatic level down to the individual lease sale level. At this programmatic stage, BOEM is only defining the geographic scope for which additional OCS leasing can occur. If exploration and development occur following an actual lease sale, each individual project would undergo additional air review and analysis based on detailed site-specific data. These reviews would include air quality modeling to address potential impacts of the specific proposal on all the NAAQS.

17. The discussion of ozone and ozone formation in Section 4.4.4.3 of the Draft PEIS is inaccurate and inadequate. The EIS concludes that "conditions in Alaska are seldom favorable for significant O_3 formation." This conclusion is contrary to air quality monitoring data collected by ConocoPhillips and Shell on the North Slope. Moreover, the Draft PEIS says nothing about USEPA's proposal to revise the standard. In light of the amount of background Ozone in the Arctic already, BOEM cannot ignore Ozone as a significant concern in the offering of additional leases in the Beaufort or Chukchi Seas.

Response: The text was updated where required in Section 4.4.4.3 using available data referred to in the comment. No changes were made based on what USEPA might do, what its opinion of USEPA's own standards is, or on proposed standards. An analysis based on proposed standards is inappropriate, as standards can change between proposal and promulgation.

18. BOEM cannot rely on the PSD increments to substitute for an analysis of air emissions impacts in the Arctic and the increments used are outdated. Section 4.4.4.3 of the Draft PEIS concludes that no modeling is required to analyze SO_2 and PM_{10} emissions relying upon data from a 1991 MMS document on NO_2 emissions. The Draft PEIS also concludes that if NO_2 emissions are so low (1.29 $\mu g/m^3$), no further analysis is necessary. However, this is factually incorrect. For example, Shell's air permits for the Discoverer showed modeling results far above the NO_2 concentration noted in the PEIS. Please ensure that you update the PEIS with current and real projections about the actual impacts that Arctic offshore operations will have on air quality.

    Response: The text was updated in Section 4.4.4.3 to include the PSD increments that were promulgated after the publication of the Draft PEIS and to clarify the use of PSD increments in the air impact analysis as discussed in the next paragraph.

    The analysis in the PEIS does not rely solely on PSD increments. It notes that, "The combined facility concentrations for Liberty plus background were well within NAAQS (between 2 and 30% of the standards)." Additionally, PSD increments are less than the corresponding NAAQS and, if a source meets an increment, that source alone will not cause a violation of the NAAQS. However a NAAQS analysis must also consider the contribution of other sources, often estimated by adding the source contribution to a background level as noted in the quote above. At the low impact levels provided in the references available for the PEIS, an analysis using PSD increments is reasonable. Even at the impact levels noted by the comment, which are about 10 times as large as those in the Draft PEIS, comparison with the PSD limits remains a valid indicator. The Discoverer permit was used as a source for $PM_{2.5}$ impact estimates and the text in Section 4.4.4.3 was revised accordingly.

    The $PM_{2.5}$ PSD increments were included in the discussion in Section 4.4.4.3, and in Section 3.5.2.

    BOEM plans to use the most detailed information available at each step in its NEPA analyses from the programmatic down to the individual lease sale level. At this programmatic stage, BOEM is only defining the geographic scope for which new OCS leasing can occur. If exploration and development occur as a result of an actual lease sale, each individual project would undergo additional air review and analysis based on detailed site-specific data. These reviews would include air quality modeling to address potential impacts of the specific proposal on all the NAAQS.

19. Section 4.4.4.2.2: The sections describing the air quality effects from oil spills, in situ burning and a catastrophic discharge event present different types of emissions for each region. Please identify if these emissions affect all areas or are specific to individual regions.

Section 4.4.4, Table 4.4.4-5: Because much of the activity in the Beaufort Sea and Chukchi Sea may be confined to ice-free portions of the year, it should be noted that the emissions will not be spread evenly over the year, but be condensed into approximately four months.

Response: The text was clarified in Section 4.4.4 to note whether there are expected differences in the emissions from in-situ burning in different regions. The discussions of CDE emissions in the two Alaska areas (Sections 4.4.4.2 and 4.4.4.3) refer to the GOM discussion and need no change. The discussions of spill emissions are essentially identical and need no change.

Text was added to Table 4.4.4-5 to note that emissions in Beaufort and Chukchi Seas will occur only during ice-free months.

20. In Section 4.4.4.1.2, the PEIS should specify where the measurements were taken and the relationship to the location of the public and workers; the discussion should also cite studies other than Schaum with significantly different measurements; the PEIS should clarify the term "small" by comparing it with standard reference values; and the use of Kuwaiti oil field fires should be supplemented with results from additional studies.

    Response: The reference is a source characterization and emission factor development study, not an exposure study. To avoid misinterpretation, text was added to Section 4.4.4.1 to note where the measurements were taken and that the general public does not normally have access to these locations.

    No change was required. The text fairly represents the results of the Schaum study and the reference to Schaum was not deleted. No additional studies were cited, as Schaum is an authoritative USEPA/NOAA study. The estimates from Schaum were included with the statement that the estimates "were below USEPA's level of concern" of 10^{-6}.

    Text was amended in Section 4.4.4.1 to note that there may be differences between burns in the desert and GOM environments. The PEIS text was expanded to include findings of other studies of health impacts of the Kuwaiti oil field fires.

21. The discussion of BTEX concentrations should be expanded to include comments beyond BTEX because significant sampling data is available to address the observed concentrations of other hydrocarbons.

    Response: No text change was required. The context of the paragraph is the concern over benzene levels, not the broader issue.

22. The rationale for not calculating the GHG (greenhouse gas) emissions resulting from the combustion of oil and gas produced under the Proposed 5-year Program is flawed. BOEM claims that the scope of the PEIS is too limited to account for such emissions, stating that "consumption of oil and gas is considered at a broader level when decisions are made regarding the role of oil and gas generally, including domestic production and imports, in the overall energy policy of the United States" (1-18). However, under the No Action Alternative, reduced demand would substitute for 6% of the lost OCS oil and gas (4-496,

Table 4.5.7-1). Clearly, then, the Proposed 5-year Program does have a direct bearing on the general decision of how much oil and gas the nation will consume, and where that oil and gas will come from. Although BOEM cannot predict where OCS oil and gas will be combusted, BOEM can predict and quantify in what sector OCS oil and gas will be combusted and the consequent GHG emissions. Data are available from the EIA and USEPA giving projected levels of consumption of oil and gas by sector to 2035 and GHG emissions factors for oil and gas. These data could be used to estimate GHG emissions from oil and gas produced under the 5-year Program.

Response: No text change was required. At this programmatic stage, BOEM is only defining the geographic scope for which new OCS leasing can occur. This PEIS is only examining the emissions caused by oil and gas operations on the Outer Continental Shelf (see Section 1.5.5.5). Regulation of the use of these products onshore is the responsibility of other government agencies and should be analyzed in their NEPA documents. Information on when and how the produced oil and gas will ultimately be consumed is speculative and would not inform a decision as to where OCS leasing should occur. Also, see the response to Comment 20, Section 8.4.4.1 Issue 1 as well as Section 1.5.5.5.

23. Please add greenhouse gases or CO_{2e} to the discussion of thresholds for BACT

    Response: The text was changed in Section 4.4.4 to acknowledge the 100,000/75,000 thresholds for CO_{2e}.

24. Section 4.4.4, Table 4.4.4-6: It would be useful to provide the total greenhouse gas emissions for the program in addition to the emissions by planning area.

    Response: The program totals (three planning areas) for all three planning areas were added to the tables for each planning area.

8.4.4.4.5 Issue 4.5 Acoustics.

1. Several comments noted that the discussion of sound impacts to marine mammals and birds in the GOM should receive a similar detailed level of treatment as the sound impact discussion for the Arctic region.

   Response: Text was updated in Sections 3.6 and 4.4.5 based on additional available studies that deal with the effects of noise on marine wildlife in the GOM. The discussions of sound impacts in each potential lease area reflect the availability of data, which varies between areas.

2. Several comments suggested using information from recent reports regarding background noise in the Arctic.

Response: Text was updated in Sections 3.6 and 4.4.5 to reflect the monitoring at Northstar Island and other relevant references as appropriate.

3. Several comments suggested that the Draft PEIS be updated to reflect the extensive references on marine mammals and listed species currently available.

   Response: No text change was required. The discussions of the acoustic environment presented in Sections 3.6 and 4.4.5 address only the potential changes to the acoustic baseline conditions that could result with oil and gas development under the 2012-2017 Program. Impacts of noise on marine mammals, birds, fish, and other biota are discussed separately in Section 4.4.7. At this programmatic stage, BOEM is only establishing a schedule of potential lease sales and framing the geographic scope within which additional OCS leasing can occur. The National Marine Fisheries Service (NMFS) and/or BOEM are currently preparing EISs and other environmental analyses that characterize sound sources used in oil/gas activities and potential impact of these sounds on marine mammals and other marine resources. It is at this activity-specific level that a more detailed analysis as requested in this comment should be conducted. For more information, please see http://www.nmfs.noaa.gov/pr/permits/eis/arctic.htm (Arctic), and http://www.nmfs.noaa.gov/pr/permits/incidental.htm (for the GOM).

4. Noise from oil and gas activities is an important concern because of the potential to disrupt the migration of species used for subsistence in the Northwest Arctic Borough. There is no detailed discussion of the cumulative effects of noise on animals from oil and gas activities combined with other activities such as increased shipping. In addition, the discussion of natural background noise in Section 3.6.3.1 does not recognize the lack of information about the level of background noise. The 2011 report of the U.S. Geological Survey (USGS) contains a good discussion on this topic.

   Response: The PEIS text was updated in Section 3.6.3.1 to reflect the information in the USGS report. In addition, NMFS is currently preparing an EIS addressing the effects of seismic surveys and exploratory drilling on marine mammals in the Arctic. BOEM and the North Slope Borough are cooperating agencies. BOEM anticipates that this document will contain the requested level of detail and discussion on noise effects and their impact to cumulative effects necessary for activity-level decisions (see http://www.nmfs.noaa.gov/pr/permits/eis/arctic.htm). Also see responses to related cumulative impact comments in Section 8.4.4.5 (Comments 3 and 5).

5. Section 4.4.7.1.3: This discussion contains several statements which appear to confuse frequency with sound pressure or intensity.

   Response: The text in Section 4.4.7.1 was clarified.

6. Section 2.10, Table 2.10-1, Impact-Producing Factors Associated with OCS Oil and Gas Development: Offshore construction noise should be included in the table under Noise.

Response: The table was updated as suggested.

7. Section 3.6.2.2: Regarding the statement about noise data for Cook Inlet oil platforms, Blackwell and Greene (2002) included inwater noise measurements; the highest level recorded was 119 dB re 1 µPa at a distance of 1.2 km.

   Response: The text in Section 3.6.2.2 was updated to incorporate the results of the referenced study as appropriate.

8. It is far more accurate to say that routine operations will affect the acoustic environment in the Beaufort Sea, (and in the Chuckchi Sea). Suggest changing the first sentence of Section 4.4.5.4.1 to "Routine operations will affect ambient noise conditions".

   Response: The text in Section 4.4.5.3 (previously Section 4.4.5.4.1) was revised as suggested.

9. Table 4.1.1-1, and Table 4.1.3-1: Offshore construction should be included as an impact producing factor.

   Response: The referenced tables in Section 4.1 were revised as suggested.

10. Section 4.4.5: Ambient noise levels should be stated, if known. If unknown, NOAA recommends that BOEM should conduct a study to quantify the amount of noise in the GOM.

    Response: No text change was required. BOEM has included a study profile in its new Study Development Plan to do this for the GOM. For a discussion of incomplete and unavailable information, see Section 1.4.2 and the response to Comment 10 in Section 8.4.4.2.

11. Tables 2.10-1 and 4.1.1-1 in Sections 2.10 and 4.1.1. BOEM should note that exploration drilling is accompanied by seismic noise.

    Response: The referenced tables in Sections 2.10 and 4.1.1 were revised as suggested.

12. In Section 3.6.1.4, BOEM has listed seismic technologies that, except for marine vibroseis, are outdated, are not in commercial use, and are not expected to be used during the life of this 5-year plan. Accordingly, IAGC believes that BOEM should remove these technologies from Subsection 3.6.1.4.4 and Table 3.6.1-1 or BOEM should include a comment that these technologies are not used.

    Response: BOEM concurs that the use of sleeve exploders and gas guns represents outdated seismic technology and references to their use were removed from Section 3.6.1.4.4 of the PEIS and the corresponding Table 3.6.1-1. BOEM does, however, believe that there may be potential (to what degree is yet unknown) for marine vibroseis to be used in some level of seismic surveying over the time period considered in this document. In order to cover that possibility, the references to marine vibroseis were retained in this section and the table. The use of smaller sleeve guns was added to the text and the table.

8.4.4.4.6 Issue 4.6 Coastal Habitats.

1. Decommissioned Pipelines: NOAA recommends that in Section 4.4.6.1.1 the PEIS address the potential loss of suitable sediment sources for renourishment/restoration activities that might result from pipeline construction or decommissioning.

   Response: BOEM agrees that loss of sediment sources should be included as a potential impact. BOEM has a significant sand resources policy that is memorialized in NTL No. 2009-G04 (Significant OCS Sediment Resources in the Gulf of Mexico) and is a standardized condition of all lease sales. Text has been added to Section 4.4.6.1 that discusses impacts of construction and decommissioning.

2. Section 3.5.2.1 of the Draft PEIS refers to various statistics regarding the fate of oil released during the Deepwater Horizon Event. Should this discussion note that the statistics given were accurate for the fall of 2010, and that residual oil amounts have decreased significantly as a result of biodegradation and continued weathering?

   Response: BOEM agrees that residual oil has decreased since 2010. A statement has been added and referenced in Section 3.5.2.1 regarding the dated nature of the statistics and the continued biodegradation and weathering.

3. Section 3.5.2.1 of the Draft PEIS states, "In summary, a third (33%) of the total leaked oil in the BP spill was captured or mitigated by the unified command recovery operations, including burning, skimming, direct recovery from the wellhead, and chemical dispersion." What source can be cited to support this number? Does this number reflect the amount of oil collected from the shoreline? If not, does it underestimate the effectiveness of the response?

   Response: BOEM agrees that a source should be cited and the sentence clarified. In Section 3.5.2.1, a citation has been added to the text and the discussion clarified regarding shoreline collection.

4. Section 3.5.2.1 of the Draft PEIS states, "Half of the total leaked oil (naturally and chemically dispersed and residual) is currently being degraded naturally." Why is dissolved oil not included in this estimate, as it is highly biodegradable? Much of dispersed, dissolved, and residual oil has been degraded since 2010. Should this statement also be modified to note that the oil "is continuing to be" degraded naturally?

   Response: BOEM agrees that dissolved oil and continual degradation should be discussed. The statement has been clarified in Section 3.5.2.1.

5. Section 3.7.3.1.1 of the Draft PEIS refers to a DWH oil "plume" that was "as thick as 200 m." Is use of the term "thick" misleading because it implies that the so-called "plume" was a solid mass? Additionally, rather than the term "plume," would it not be more accurate if this discussion referred to "dispersed oil" or "clouds of dispersed oil" to clarify that oil concentrations even in the so-called "plume" were in the low ppm range and that oil was not present in a continuous subsea "slick"? See Atlas & Hazen (2011).

   Response: BOEM agrees that the phrase should be clarified. The reference says the plume was "as high as 200 m, and in certain areas more than 2 km in width." Atlas and Hazen use the term cloud and plume. The text in Section 3.7.3.1.1 has been changed to "clouds of oil" to reflect the more recent reference. The hydrocarbon concentrations in the plume have also been added.

6. Section 3.7.3.1.1 of the Draft PEIS states, "The spill released both oil and methane gas into the water column. Some of it rose to the surface above the well." Should this statement be clarified to apply to the oil, not the methane? In the DWH event, effectively all the methane dissolved in the water column, with little or no methane reaching the atmosphere. Data collected by Yvon-Lewis et al. (2011) in June 2010, while the spill was still active, indicated the methane release was not significantly contributing to methane concentrations in the surface water or atmosphere. NOAA overflight measurements in June 2010 also found no methane at the surface (Ryerson et al. 2011).

   Response: BOEM agrees that the statement needs clarification. The text in Section 3.7.3.1.1 has been modified to clarify that methane was not released into the atmosphere. Additional references have also been cited.

7. Section 3.7.3.1.1 of the Draft PEIS states, "Surveys in late June 2010 indicated that there was a subsurface methane plume in 800 to 1,200 m (2,625 to 3,937 ft) of water that extended from the DWH." Should this statement clarify that the so-called "plume" was found in approximately 800 to 1,200 m of water?

   Response: BOEM disagrees. The comment is confusing — the PEIS already states that the plume is in 800–1200 m of water.

8. Section 3.7.3.1.1 of the Draft PEIS states, "However, by September 2010, the plume had not been found, despite extensive areal [*sic*] sampling coverage (Kessler et al. 2011)." Should this statement be clarified to reflect the fact that surveys conducted from August to October 2010 did not find methane concentrations elevated above background levels for the GOM? See Kessler et al. (2011).

   Response: BOEM agrees that the statement should be clarified. The text in Section 3.7.3.1.1 has been modified to clarify the sampling dates and add information on methane concentrations.

9. NOAA recommends adding “temperature” to the list of factors in the last sentence of paragraph 2 of Section 4.4.6.1.4 (impact conclusions).

   Response: BOEM agrees to the change. “Temperature” has been added to the list of factors in each of the CDE impact conclusions presented in Section 4.4.6.1.

10. Section 3.7.2.1.7 of the Draft PEIS states, “Some researchers have reported seeing dead and dying benthic animals as well as what appear to be thick deposits of oil or flocculants of oil and organic matter on the seafloor (BOEMRE 2010b).” Does the cited source support this proposition? Does this source state that further testing must be completed to determine if the substance observed was DWH oil?

    Response: BOEM agrees that the statement in Section 3.7.2.1.7 needs further explanation. The text has been modified to clarify the statement.

11. Section 3.7.4.1 of the Draft PEIS states, “Some researchers have reported seeing what appear to be thick deposits of oil or flocculants of oil and organic matter on the seafloor (BOEMRE 2010b).” The source cited uses the wording “brown substance” instead of “deposits of oil” and states that further tests will be done to identify the source of the brown substance. Should an updated source be used to explain the actual source of the substance? Alternatively, the statement could be revised to say “Some researchers have reported seeing what appears to be a brown substance on the sea floor, but have not yet confirmed the source of these deposits.”

    Response: BOEM agrees that the text should be revised. The text in Section 3.7.4.1 has been modified to remove the word oil.

12. Section 3.7.2.1.7 of the Draft PEIS states, “It is likely that the sediment hydrocarbon concentrations decreased significantly with distance from the well.” Rather than phrasing this conclusion in speculative terms, should not this statement discuss sediment data from OSAT?

    Response: BOEM agrees that sediment data should be used. The text has been modified in Section 3.7.2.1.7 to incorporate OSAT findings.

13. Section 3.7.2.1.7 of the Draft PEIS states, “In heavily oiled areas, the recovery time is unknown, but sediments in deeper waters may take longer to recover because of colder temperatures.” While microbial activity is generally greater in warmer waters, should this statement note that deep sea cold waters contain microbial populations evolved to consume oil at ambient, low temperatures? Hazen et al. (2010) have identified species responsible for rapid biodegradation observed after DWH. Laboratory studies by Ken Lee reported at the International Oil Spill Conference(IOSC) confirmed that biodegradation may be rapid and efficient at temperatures as low as 0.5°C.

Response: BOEM agrees that the text should be modified. Section 3.7.3.1.1 describes microbial degradation and states "These studies suggest the GOM has a tremendous natural capacity to assimilate accidental oil spills." The text has been modified in Section 3.7.2.1.7 to read: "However, studies of deepwater plumes following the DWH event suggest bacterial communities rapidly respond to the presence of oil and microbial reduction in oil concentrations occurred more rapidly than expected given the low temperatures and high pressure (Hazen et al. 2010). Whether the same rapid breakdown would occur along the seafloor is unknown."

14. Section 3.7.2.1.7 of the Draft PEIS states, "Overall, natural processes should break down the oil, and it is likely that no permanent changes in soft sediment habitat affected by the DWH event would occur." Should this statement be reworded to clarify that natural processes "will break down the oil"? Should this statement identify examples of natural process, such as biodegradation, dissipation, evaporation, etc.?

    Response: BOEM agrees that the sentence should be clarified. The text has been modified in Section 3.7.2.1.7 to read "Overall, natural physical and bioremedial processes will break down the oil…"

15. Section 4.4.6.1.1 of the Draft PEIS states, "In some locations, the potential exists for dredging to result in the resuspension and transport of oil spilled during the DWH event." Given the limited impact of the DWH event on sediments outside of the area immediately surrounding the wellhead (not a dredging area) and isolated areas with tar mats, would not such an event be a low probability event? Moreover, would it not be more accurate to say, "In some locations, the potential exists for dredging to result in the resuspension and transport of sediments that may contain residual oil from the DWH event…"?

    Response: BOEM agrees that the text should be clarified. The text in Section 4.4.6.1.1 has been revised to indicate low probability and the resuspension of sediments.

16. The Texas Parks and Wildlife Department (TPWD) agrees with the conclusions presented in Section 4.4.3.1.1 that construction of onshore support facilities (e.g., pipeline landfalls, pipe yards, processing facilities) could affect the quality of near shore and fresh waters in the GOM Planning areas. Impacted resources could also include jurisdictional and nonjurisdictional wetlands. Section 4.6.2 of the Draft PEIS does discuss Section 404 of the Clean Water Act as it pertains to cumulative impacts associated with dredging and marine disposal. However, it does not address potential impacts to wetlands (jurisdictional and non-jurisdictional) that may occur as result of infrastructure development associated with the oil and gas industry. TPWD recommends the PEIS include a discussion of Section 404 of the Clean Water Act (regulating the discharge of dredged and fill material into waters of the United States, including wetlands) as it may pertain to impacts to coastal resources associated with the proposed project. TPWD also recommends that Executive Order (EO) 11990 — Wetlands, be included in the PEIS. Activities associated with the proposed project should include measures per EO 11990 that would minimize the destruction, loss or degradation of wetlands regardless of jurisdictional determination.

Response: The text in Section 4.4.6.1.1, which discusses wetland impacts, has been revised to include a discussion of Clean Water Act (CWA) Section 404 and EO 11990 (the latter was also added to Appendix C).

8.4.4.4.7 Issue 4.7 Marine Habitats.

1. The following statement that appears in Section 4.4.6.3.2 of the Draft PEIS should be quantified: "Eventually, the oil would be broken down by natural processes, and pelagic habitat would recover." What is the expected time to recovery?

   Response: Recovery time is a function of the specific spill, environmental conditions, and resource of interest. Therefore, recovery time cannot be quantified in a general way. The text in Section 4.4.6.3 has been modified to remove 'eventually' and to instead state that "habitat recovery increases as oil breaks down."

2. The discussion presented in Section 4.4.6.4.1needs to consider meteorological and bacterial degradation at depth, not only at the water surface.

   Response: The Camilli et al. (2010) and Kessler et al. (2011) studies cited in the text are all investigations of microbial breakdown of oil in deepwater plumes. The text in Section 4.4.6.4.1 has been changed to "…quickly by bacteria both at the surface and at depth."

3. Section 4.6.3.2.2 states "Warmer temperatures may also increase phytoplankton productivity, potentially resulting in greater food inputs to benthic habitats and subsequent increases in the productivity of benthic biota." Warmer temperatures may increase productivity; however, in many cases the phytoplankton community shifts to dominance by small cell phytoplankton. Consequently, most of the production is consumed in the water column by microzooplankton, resulting in less input to food reaching the bottom. NOAA recommends quantifying the statement "Although pelagic habitat is likely to recover quickly following an oil spill…" What is meant by "quickly"?

   Response: Shifts from benthic to pelagic based food webs are discussed in the Arctic fish (Section 3.8.4.3) and benthic habitat (Section 3.7.2.3) sections. Additional text on the potential changes in primary and secondary productivity was added. The text was also modified to say, "Alternatively, the greater expected river discharge could increase stratification and reduce light available for primary productivity resulting in a reduction in algal inputs to the benthos." The impacts of climate change on phytoplankton are highly speculative because of the numerous controlling factors (Strom et al. 2010). Therefore, the text in Section 4.6.3.2.2 was modified to read "Climate change could increase or decrease phytoplankton productivity, potentially resulting in greater or lesser food inputs to benthic habitats and subsequent increases or decreases in the productivity of benthic biota." Also, the word "quickly" was removed.

4. The Marine and Coastal Habitats summary states that "Protective measures, currently required at the lease sale phase through lease stipulations, exist for seafloor habitats such as live bottom and pinnacle trend areas in the GOM." It is unclear what these protective measures are. These stipulation measures may be especially important in regions where seafloor habitat is not well studied such as in the Arctic. NOAA recommends that BOEM provide a citation to where these measures can be located.

   Response: Stipulations are lengthy and therefore inappropriate for the Summary of the PEIS. References to, and descriptions of, stipulations are provided in Section 4.4.6.2.1 and Appendix B Assumed Mitigation and Other Protective Measures. In the case of the Arctic, which is a frontier area, specific mitigation to protect habitat would be developed through the lease sale process.

5. The summary of Potential Impacts on Essential Fish Habitat presented in Table 2.10-2 for Alternative 1 – Proposed Action only mentions coral as a type of EFH (essential fish habitat). This summary should be similar to the Potential Impacts described for Coastal and Estuarine Habitats and Marine Pelagic Habitats in Table 2.10-2.

   Response: Text was added to Table 2.10-2 to include other EFH for which mitigation measures exist.

6. NOAA recommends that BOEM consider consulting pages 5-7 to 5-10 of the NOAA report "Impacts to Essential Fish Habitat from Non-fishing Activities in Alaska" to add to the discussion of impacts and mitigation options in Section 3.7.4.2 of the PEIS.

   Response: NOAA's mitigation recommendations from its report have been added to the impact discussions in Sections 4.4.6.4.2 and 4.4.6.4.3 of the PEIS.

7. Section 4.4.6.2.1 of the Draft PEIS states, "Modeling indicates that oil spilled at the surface could mix to a depth of 20 m (66 ft) at highly diluted concentrations (MMS 2008a)." Does this modeling include the surface application of dispersants, or are the results based on natural dispersion? This section also states, "However, if dispersants are used in the subsurface or if the released oil has a significant fraction of gas, a subsurface plume may form that would increase the potential for contact with a HDDC habitat." See also PEIS Section 4.4.6.3.1 ("A subsurface plume capable of traveling long distances could form if dispersants are used or if the well releases a mixture of oil and gas."). These statements imply that subsea dispersant use and a significant fraction of gas are the only means for a subsurface "plume" to occur, but any condition that produces very small dispersed oil droplets may result in such a plume.

   Response: 'Natural dispersion' was added to Section 4.4.6.3.1 and the commented sentence in Section 4.4.6.3.1 was modified to say "...or if the oil is released at high velocity."

8. What source was used to support the statement that natural gas would tend to rise in the water column and could degrade habitat quality in a large portion of the water column, and particularly the conclusion regarding the "degradation of habitat quality"?

   Response: Although not well studied, natural gas can be toxic to marine life, and therefore, its release into the water would represent a degradation of habitat quality within the area affected by the gas release. A large methane release in the Sea of Azov resulted in cell damage, biochemical alteration, impaired movement, blood disorders, and alteration of biochemical processes in fish collected around the platform and in fish held in water near the platform (Patin 1999). The blowout also reduced mollusk abundance in the benthos. The Patin 1999 reference was added to Section 4.4.6.3.1 of the PEIS.

9. Does the Camilli et al. (2010) study report that hydrocarbons were detected more than 35 km from the source, as suggested in Section 4.4.6.1 of the Draft PEIS?

   Response: Section 4.4.6.2.1 has been corrected to say 35 km, and not 56 km. This statement is correct elsewhere in the text.

10. There are many shallow and deepwater hard-bottom features that support an array of biological diversity. The commenter is supportive of BOEM's willingness to provide a buffer around biologically sensitive areas and recommends that BOEM should ensure that adequate information exists to confirm that biologically sensitive areas are not within the proposed area before permitting activities and that BOEM should consider oil and gas activities that have the potential to impact deepwater habitats outside the buffer zone.

    Response: NOAA is consulted before BOEM permits activities that could affect sensitive benthic habitat. BOEM has several lease stipulations protecting corals, deepwater corals, and live hard-bottom, as described in Section 4.4.6.2.1. The stipulations are NTL-2009-G39 and NTL-2009-G40. Descriptions of stipulations to protect sensitive coral habitats are provided in Section 4.4.6.2.1. Oil and gas activities do have a potential to affect these habitats located outside the buffer zone. Section 4.4.6.2.1 has a discussion of the potential impacts of drilling muds on corals located away from the drilling site.

11. A commenter requested more information be provided on oil spill impacts on EFH for Arctic cod (*Boreogadus saida*) because of the importance of this species to the Chukchi Sea and the Beaufort Sea Large Marine Ecosystems. They also request that it be stated that a CDE could have moderate effects on EFH.

    Response: The susceptibility of Arctic cod to spills is discussed in Section 4.4.7.3.3, and a discussion was added to Section 4.4.6.4.3. In addition, information regarding the spawning period of the Arctic cod was added to the Arctic Cod EFH description in Section 3.7.4.3. Species specific impacts will be considered in more detail in individual lease sale EISs.

12. The following statement was presented in Section 4.4.6.3.4 of the Draft PEIS: "Pelagic habitats would eventually recover their habitat value as hydrocarbons broke down and were

diluted." Statement needs to be quantified. How long would it take? Will the digestion be 100% effective? Suggest including findings of past and ongoing studies of natural degradation of hydrocarbons by indigenous bacteria (i.e., McFarlin, Leigh, 2011, indigenous microorganisms degrade dispersed oil in Arctic seawater).

Response: Discussions of additional studies were added to Section 4.4.6.3.3 to support the statement that the hydrocarbons would be broken down and indigenous oil-consuming bacteria are present. However, a specific time to recovery cannot be provided because each spill is different. All data from the Valdez spill suggests breakdown and dilution in the water column is rapid (Neff and Stubbenfield 1995; Boehm et al. 2007), while localized benthic contamination can persist for >10 years (Short et al. 2007; Taylor and Reimer 2008; Exxon Valdez Oil Spill Trustee Council 2010c).

13 Increased river discharge may intensify the strength of the Alaska Coastal Current making advection much more important than local production processes. Warming would prolong the period that phytoplankton is nitrate limited and production is dominated by small phytoplankton cells. This would lengthen the food chain with less production going into fish and other higher trophic levels.

Response: Any predicted changes in productivity resulting from climate change are highly speculative because of the numerous controlling factors (Strom et al. 2010). Text in Section 4.4.7.3 of the PEIS was modified to state that increases or decreases in primary productivity are possible, and additional discussion of potential changes in productivity was provided to this section.

14. Commenter requests two conference presentations be cited in Section 3.8.5.1 that describe benthic invertebrate communities near the Macondo well before and after the DWH event.

Response: Results of the OSAT sediment sampling data have been incorporated into Section 3.7.2. The results given in Putt et al. (2010) and Benfield et al. (2010) have been incorporated into the discussion of invertebrates (Section 3.8.5.1), although these are presentations, not peer-reviewed papers.

15. A commenter requested more information be added to Section 3.7.3.3.2 on the impacts of ocean acidification on the commercial shellfish (king and Tanner crab and snow crab) populations in the Cook Inlet Planning Area.

Response: This comment refers to the pelagic habitat section (Section 3.7.3), so benthic invertebrates were not discussed. The potential impact of climate change on snow crabs is discussed in the invertebrates climate change section (Section 3.8.5).

16. The commenter states that BOEM must analyze the effects of its leasing program in contributing to climate change, and analyze potential oil and gas activities in the context of climate change and provides several references that could provide information on this topic.

Response: The PEIS discusses the potential impacts of climate change on Arctic habitats and biota. Information from the cited reports was added to Section 3.3, as well as to Sections 3.7 and 3.8.

8.4.4.4.8 Issue 4.8 Mammals.

1. When describing potential oil spill clean-up impacts to endangered beach mice or the endangered Florida salt marsh vole in Section 4.4.7.1.1, it would be more appropriate to use more relevant citations rather than documents developed for Alaska.

   Response: The discussion in Section 4.4.7.1.1 of potential oil spill and oil spill clean-up impacts on beach mice and the Florida salt marsh vole has been modified to include more relevant and/or recent information on the GOM.

2. What is the cause of the recent ringed seal deaths in the Arctic Region? Can it be related to climate change?

   Response: A discussion of the Unusual Mortality Event (UME) that involves ringed seals and other pinniped species in the Arctic has been added to Section 3.8.1.3.1 and is also mentioned in Section 4.6.4.3.1. As of the drafting of this response, the NMFS has not yet determined the cause of this UME, but continues to post UME updates at http://www.alaskafisheries.noaa.gov/protectedresources/seals/ice/diseased/.

3. The endangered manatee should be included in the list of marine mammals identified as receiving detailed analyses in the PEIS since manatees are discussed in some detail further in the document.

   Response: The West Indian manatee has been added to the list of mammals in Section 1.5.4 that are receiving detailed analyses in the PEIS.

4. The cited reference, NMFS 2011f, is absent in the references section for Chapter 3. Please provide a detailed citation for that reference.

   Response: The citation for NMFS (2011f) found in Section 3.8.1.1 of the PEIS has been added to the Chapter 3 references (Section 3.17 of the PEIS).

5. The depicted range map for endangered beach mice (Figure 3.8.1-1) is inaccurate.

   Response: Figure 3.8.1-1 has been revised to include the historic range of the endangered beach mice subspecies, and the text of Section 3.8.1.1.2 has been updated to list the counties where each endangered beach mouse subspecies is known or believed to occur.

6. When referring to beluga whales in Cook Inlet, replace ‘stock’ with ‘distinct population segment.’

Response: As suggested, "stock" has been replaced with "distinct population segment" in Sections 3.8.1.2 and 4.4.7.1.2 where Cook Inlet beluga whales are discussed.

7. The UME that was declared in the northern GOM is still ongoing as the stranded bottlenose dolphins found with *Brucella* have been combined with the animals that stranded post-DWH.

   Response: The discussion in Section 3.8.1.1.1 of the UME in the northern GOM has been updated to include the information on the stranded bottlenose dolphins mentioned in the comment. The discussion also includes the web link to the NMFS website on this UME at http://www.nmfs.noaa.gov/pr/health/mmume/cetacean_gulfofmexico2010.htm.

8. When mentioning oil spills in the Cook Inlet Planning Area in Section 4.4.7.1.2, there is no mention of the Beluga whales although other whale species are mentioned.

   Response: The Section 4.4.7.1.2 discussion referred to in the comment has been amended to include mention of the beluga whale.

9 The PEIS should address the effects of climate change on sea ice and how this can impact marine mammals.

   Response: A discussion of climate change impacts on sea ice, as it may affect marine mammals, can be found in Sections 3.8.1.3.1 and 4.6.4.3.1.

10 An appropriate level of analysis on the effects of noise on bowhead whales in the Arctic Region was not included in the Draft PEIS.

   Response: The level of analysis presented is appropriate for a programmatic EIS. More thorough assessments of noise impacts on bowhead whales will be included in Arctic region-, lease-, or activity-specific NEPA documents prepared by BOEM during the 2012-2017 OCS Leasing Program. In addition, BOEM and the NMFS are preparing an EIS for geophysical (seismic) and exploratory drilling in the Arctic (http://www.nmfs.noaa.gov/pr/permits/eis/arctic.htm).

11. The Draft PEIS fails to include a discussion of bowhead whale use of the Beaufort and Chukchi Seas in regards to feeding habitat and migration routes.

    Response: Additional information on bowhead whale-feeding habitat and migration routes in the Beaufort and Chukchi Seas has been added to the PEIS. Region-, lease-, and activity-specific NEPA analyses will address potential impacts on bowhead whales in more detail. Lease-specific activities and permits will also be required to comply with the requirements of the Endangered Species Act and the Marine Mammal Protection Act.

12. The PEIS does not reflect the most current and accurate information on the movement patterns of bowhead whales.

Response: Sections 3.8.1.3.1 and 4.4.7.1.3 of the PEIS have been updated to include current information on the movement patterns of bowhead whales.

13. The PEIS needs to address the impacts of drilling muds on the walrus and its prey.

    Response: Information on potential impacts of drilling muds on Arctic resources are provided throughout Chapter 4. With regard to the walrus and its prey, please see Sections 4.4.6.2.3 (Arctic marine benthic habitats), 4.4.6.3.3 (Arctic marine pelagic habitats), 4.4.7.1.3 (Arctic marine mammals), and 4.4.7.5.3 (Arctic invertebrates and lower trophic levels).

14. The receding sea ice is impacting walrus.

    Response: BOEM recognizes the concern that climate change is having an adverse effect on sea ice, and that this may impact the Pacific walrus as well as several other marine mammals. Information about the Pacific walrus is provided in Subsection 3.8.1.3.1 of the PEIS; while information on climate change impacts on sea ice, as it affects marine mammals, can be found in Sections 3.8.1.3.1 and 4.6.4.3.1.

15. Manatees could be impacted by vessel strikes and oil spills.

    Response: Section 4.4.7.1.1 of the PEIS acknowledges the potential for vessels to strike manatees. While incidents cannot be discounted, the potential for an OCS vessel to hit a manatee is unlikely. Marine mammal observers and adherence to vessel speed requirements in shallow waters contribute to the protection of manatees from vessel strikes. The Draft Multisale EIS (available on BOEM's website: http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/NEPA/nepaprocess.aspx) provides an analysis of potential oil spill impacts on manatees. Site-specific mitigation measures, including those pertaining to oil spills, will be in lease-specific NEPA analyses.

16. The PEIS should include additional support (as cited in the comment) for the conclusion that seismic does not adversely affect marine mammals under current BOEM seismic survey requirements.

    Response: BOEM is aware of the information cited in the comment, but disagrees with the broad-scale recommendation that BOEM determine in this document that seismic does not "adversely affect marine mammals under current BOEM regulation." BOEM will undertake a more detailed discussion of seismic activities and impacts on marine mammals in lease sale and activity specific NEPA documents, especially the draft PEISs for geological and geophysical activities in the GOM, mid/south Atlantic, and Arctic (in preparation).

17. Marine mammals can also inhale oil when they surface to breathe which causes damage to mucous membranes and airways and can be fatal.

Response: Potential impacts on marine mammal mucous membranes and airway passages from an oil spill have been added to the accident discussions in Section 4.4.7.1.

18. Section 4.4.5.3.1of the Draft PEIS states: "However, most exploration activity takes place during the open-water season, minimizing the effects on polar bears (MMS 2008b)." NOAA notes that there are no polar bears in Cook Inlet.

    Response: The mention of polar bears in the Cook Inlet area has been deleted from Section 4.4.5.2 (previously Section 4.4.5.3.1).

19. Section 4.4.7, Table 4.4.7-1: NOAA recommends that the table be put into an MMPA context for marine mammals. Mortality and serious injury may also result from vessel collisions. Injury (Level A harassment) should be included in the decommissioning analysis as it was authorized in the Explosive Removal of Offshore Structures (EROS) rule. Dolphins have also been previously killed in EROS-related activities.

    Response: Table 4.4.7-1 has been amended, as suggested.

20. Section 4.4.7.1.1: Bryde's whales reliably occur in the DeSoto Canyon area.

    Response: Information on the Bryde's whale occurring in the DeSoto Canyon area has been added to Section 4.4.7.1.1.

21. Section 4.4.7.1.1: Sperm whales also commonly occur in the DeSoto Canyon area and west of the Florida Keys and Tortugas.

    Response: Information on sperm whales occurring in the DeSoto Canyon area and west of the Florida Keys and Tortugas has been added to Section 4.4.7.1.1.

22. Section 4.4.7.1.2, Alaska — Cook Inlet: The designated no-entry zone for Steller sea lion major haul outs and rookeries in and near the Cook Inlet OCS Planning Area is 3 nautical miles (5.5 kilometers) rather than 3,000 feet as indicated here (50CFR 223.202).

    Response: The distance of the designated no-entry zone near the Cook Inlet OCS Planning Area has been corrected in Section 4.4.7.1.2.

23. Section 4.4.7.1.2: The described prohibitions on helicopter approaches to humpback whales are not applicable to Alaskan waters, where no such prohibitions exist. NMFS has established regulations for vessels operating near humpback whales (66FR29502, May 31, 2001).

    Response: The sentence pertaining to restrictions on helicopter approaches to humpback whales in Hawaiian waters has been deleted.

24. Section 4.4.7.1.4, Conclusion: It is difficult to reconcile BOEM's conclusion that impacts to marine mammals in the Arctic could range from negligible to moderate against many of the statements and conclusions presented in this section. Examples of this include the following statements: "Any increased mortality in a pinniped population could impact the population as a whole, especially for sensitive or declining populations (e.g., Pacific walruses)"; and "a catastrophic discharge event contaminating ice leads or polynyas in the spring could have devastating effects, trapping bowhead whales."

    Response: The negligible-to-moderate impacts on marine mammals presented in Section 4.4.7.1 apply to routine operations. BOEM acknowledges that a catastrophic discharge event could potentially cause a major impact on marine mammals. All lease sales will require separate NEPA analyses on marine mammals and Endangered Species Act consultations.

25. Section 4.6.4.3.1, Marine Mammals. It would be helpful to have a quantitative estimate of cumulative effects on marine mammals. Tables earlier in the document indicate a range of possible number of drill sites, and likely locations of drilling. This kind of information could be combined with marine mammal density information and known "takes" of marine mammals to provide a quantitative estimate of the expected cumulative effects, at least for some species.

    Response: Quantitative estimates of cumulative impacts are not needed, or even reliable, at the programmatic level. Such assessments can be included in more region-, lease sale-, or activity-specific NEPA analyses.

26. There is often a 2–3-year lag between new research results and the inclusion in the marine mammal stock assessment reports. NOAA Fisheries (NMFS) recommends referring to more recent Alaska Marine Mammal Stock Assessments (Allen and Angliss 2011, and Allen and Angliss 2010) instead of the now-outdated Angliss and Allen 2009.

    Response: The marine mammal sections have been updated to incorporate information from NOAA's most recent Stock Assessment Reports.

27. In the Summary, Marine and Coastal Fauna: NOAA suggests deleting the example for "temporary abandonment of young".

    Response: The example dealing with temporary abandonment of young has been deleted from the Summary section of the PEIS location indicated in the comment.

28. In the Summary, the question is not whether vessel collisions may occur, but how frequently relative to a species' population size. Some populations (e.g., North Pacific right whales) are so imperiled that even infrequent collisions will have a population-level effect. NOAA recommends that BOEM modify the sentence (and any later parts of the document) to make it clear that what are important to analyze are the effects of collisions on the impacted population, not just the number of collisions.

Response: The Summary identifies the overall types of impacts possible. Text revisions have been made in Section 4.4.7.1 to indicate that the potential effect of vessel collisions on marine mammals depends on both the number of collisions and the population size of the species.

29. Section 3.7.2.3: Bowhead whales are also known to feed in this nearshore area and should be included in the list of species utilizing this habitat.

    Response: The bowhead whale has been added to the list of biota that feed in nearshore benthic areas in Section 3.7.2.3.

30. In Section 3.8.1, the original literature should be referenced whenever possible.

    Response: In the marine mammal sections of the PEIS, the original literature has been utilized whenever practicable and/or available. However, in a number of situations, NOAA's Stock Assessment Reports or other similar reports were referenced as they are more readily available to members of the public that may want to see a source document.

31. The Gervais' beaked whale (*Mesoplodon europaeus*) is also endemic to the deep waters across the tropical and temperate Atlantic Ocean.

    Response: The text has been modified to state that the Gervais' beaked whale is also endemic to deep waters across the tropical and temperate Atlantic Ocean.

32. Section 3.8.1, Table 3.8.1-1: The scientific name for sei whale is *Balaenoptera borealis,* not *Balaenoptera edeni*.

    Response: The scientific name for the sei whale has been corrected in the PEIS.

33. Section 3.8.1, Table 3.8.1-1: Spelling error. The scientific name for pygmy killer whale is *Feresa attenuate*, not *Feresa attentuata*.

    Response: The spelling of the scientific name for the pygmy killer whale has been corrected in Table 3.8.1-1.

34. Section 3.8.1.1.1: Gervais' beaked whale is not distributed worldwide, but is in deep waters across the tropical and temperate Atlantic Ocean, both north and south of the equator (Jefferson et al. 2008).

    Response: The distribution of the Gervais' beaked whale has been corrected, as indicated in the comment, in Section 3.8.1.1.1 of the PEIS.

35. Section 3.8.1.2.1: The NMFS Alaska Regional Office uses 340 as the population estimate, which is based on the 2010 aerial surveys.

Response: The population estimate for the population of Cook Inlet beluga whales in Section 3.8.1.2.1 has been updated using the 2011 aerial survey information.

36. Section 3.8.1.2.2, Terrestrial Mammals: BOEM should specify that the abundance estimates are based on old data, and provide the years of the surveys.

    Response: Statements have been added to Section 3.8.1.2.2 in the PEIS to mention the year of the surveys for which the older abundance estimates apply.

37. Summary, Marine Mammals: In other paragraphs, there have been statements about the magnitude of expected impacts, and this information should also be summarized here. For instance, "Disturbance from noise sources is the most likely impact and is expected to (insert expected magnitude of outcome here)." This same pattern should be followed for the expected effects of an oil spill (as is done for the expected impact of an oil spill on birds in the subsequent paragraph) and for related sections on the Chukchi Sea.

    Response: The marine mammal text in the Summary has been modified as suggested in the comment to make statements on expected impacts, to be consistent with those presented for other species groups such as birds.

38. Terrestrial Mammals. If the lease sale results in a discovery, there is likely to be additional development of onshore facilities, and subsequent impacts on terrestrial mammals. Although this document may not be required to consider possible long-term outcomes, it is suggested mentioning this possibility. The program document estimates net benefits from exploration and development beyond the lease sale period (e.g., page 100); it seems logical then that some assessment of impacts beyond the lease sale period should also be considered.

    Response: The impact analyses presented in Section 4.4.7.1 consider impacts over the life of the projects developed under the proposed action (40+ years). Region-, lease-, or activity-specific NEPA documents would address terrestrial mammals in more detail, including impacts from onshore facilities. The cumulative impact analyses in these documents would include an assessment of impacts on terrestrial mammals that would extend beyond the lease sale period.

39. The Draft PEIS discusses the consequences of a CDE in Section 4.4.7.1.1. The discussion assumes that several outcomes "would" happen as a result of a CDE. For example, the Draft PEIS states, "Additional effects on marine mammals would occur from water and air quality degradation associated with response and cleanup vessels…" PEIS in Section 4.4.7.1.1: Should these statements be revised to indicate that such consequences could happen, particularly given that the possible effects of PAHs (polyaromatic hydrocarbons) on marine mammals are not well understood? Should it also be noted that response measures to such an event will take into account the locations and potential impact on marine mammals and their habitat? On Scene Coordinator Report (Sept. 2011).

Response: The potential outcomes of a CDE on marine mammals in Section 4.4.7.1 have been changed from "would" to "may." A sentence has also been added that water and air quality degradation associated with response and cleanup vessels may also affect marine mammals. More detailed analyses of a CDE's impacts on marine mammals can be found in the Draft GOM Multisale EIS (available on BOEM's website: http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/NEPA/nepaprocess.aspx).

40. Section 3.8.1: Reference to Section 3.5.5 is incorrect. There is no Section 3.5.5. Further, Section 3.5 does not refer to subsistence resources or local knowledge (of marine mammals). Section 3.8.1.2.1: This paragraph has no mention of Humpback whales in Cook Inlet or near Kodiak Island. This paragraph would be more valuable with information specific to the Cook Inlet Planning Area and the stock(s) frequenting this area instead of a general summary of humpbacks in Alaska. Sentences regarding Chukchi Sea and Beaufort Sea humpbacks should be moved to 3.8.1.3.1 on the Arctic area.

    Response: Sections 3.8.1.2.1 and 3.8.1.3.1 of the PEIS have been amended as suggested in the comment.

41. Section 3.8.1.2.1: Are these stocks the one most likely to be present in Cook Inlet? If not, why are the population sizes only for these provided? Section 3.8.1.2.1: A reference and/or explanation regarding the effect of climate change on beluga whales is needed to support this statement. Section 3.8.1.2.2: American bison — the only wild population is located near Delta Junction, AK. This is not generally considered part of south central Alaska, but rather Interior Alaska and is over 200 miles from Upper Cook Inlet. Correct the sentence to reflect the proper geographic area. Section 3.8.1.2.2: Roosevelt Elk — This is an introduced species in Alaska, present on only two islands in south central Alaska and some islands in southeast Alaska. Recommend re-examining the species to be included in this list of select terrestrial mammals.

    Response: Sections 3.8.1.2.1 and 3.8.1.2.2 of the PEIS have been amended as suggested in the comment.

42. Section 3.8.1.2.2: Is the intent of providing population size for Kenai and Game Management Unit 16B to show the variation in population size in different areas or is it to try to represent the Planning Area population? If the former, a density estimate would be more informative. If the latter, these areas exclude bear population numbers for the southern half of the planning area. Section 3.8.1.2.2: Clarify the two population numbers. Is this a range? Are these estimates from two distinct years in the early 1990s? Section 3.8.1.2.2: Regarding the use of population estimates from Game Management Unit 16/16B. It should be noted that this unit includes the entire watershed for the upper western Cook Inlet, encompassing areas as distant as Denali National Park.

    Response: Section 3.8.1.2.2 of the PEIS has been amended as suggested in the comment.

43. Section 3.8.1.2.2: South Alaska has limited application. Is the intention to refer to south central and southeast Alaska? These areas are two very distinct and distant geographic areas that have been commonly recognized in public documents discussing both ecological and economic resources. It would be clearer to rephrase "throughout south central Alaska…" Further, are these food sources only in Southeast Alaska? Recommend removing information not applicable to the south central river otter population.

    Section 3.8.1.3.1: The text would be more clear and informative if it was more specific to the Arctic region and stocks that occur in this region. Much of this information is a repeat of information provided in the Section 3.8.1.2.1

    Section 3.8.1.3.1: The text expresses conflict concerning whether there are population estimates available or not. Is the concern that the NMFS estimate is not reliable or recent? Either remove statement that estimates are not available, or provide explanation on the discrepancy or doubt regarding NMFS estimate.

    Section 3.8.1.3.1: Recommend moving Pacific Walrus to this subsection since they are presently an ESA Candidate species, but within the lease period, they may be further listed as endangered or threatened. In 3.8.2 Candidate species are listed within the subsections on T&E Species.

    Section 3.8.1.3.1: Is there any information available on the decline of the Southern Beaufort Sea stock? When did the decline begin? Any causes attributed to the decline? As a species listed as threatened, with current litigation regarding its ESA Critical Habitat, it will be beneficial to provide additional information on this statement.

    Section 3.8.1.3.1: The killer whale text is a great example of a concise, region-specific description. Recommend using this as an example for revising paragraphs on Humpback whales and other species descriptions that include information on stocks elsewhere in Alaska or its range.

    Section 3.8.1.3.1: Move Pacific walrus paragraph to the subsection that discusses pinnipeds, as recommended in previous comment. Insert information on identification of species as a Candidate for listing by USFWS, including listing priority.

    Section 3.8.1.3.1: Include an explanation of possible cause to >36% population decline in 16 years between 1990 and 2006. This is particularly useful considering Candidate status of the Pacific walrus.

    Section 3.8.1.3.1: It may be beneficial to include information regarding the recent court decision on Center for Biological Diversity v. Lubchenco, 758 F. Supp. 2d 945 (N.D. Cal. 2010). The court found that Service did not violate the ESA in failing to list the ribbon seal as threatened or endangered. The court decision is stayed; however, pending Ninth Court mediation, with a report on mediation expected early 2012. Additionally, API (American Petroleum Institute) and AOGA (Alaska Oil and Gas Association) had filed comments with NMFS on March 25, 2011 that could be used in addressing the ribbon seal situation.

Section 3.8.1.3.2: Species list is randomly ordered, with species of same family not grouped together. We suggest listing the species taxonomically.

Response: Sections 3.8.1.2.2, 3.8.1.3.1, and 3.8.1.3.2 of the PEIS have been amended as suggested by commenters.

44. There is an incomplete sentence in Section 4.4.7.1.2 of the Draft PEIS.

    Response: The incomplete sentence in Section 4.4.7.1.2 has been amended.

45. Section 4.4.7.1.2: This information, and similar, regarding rookeries, haul-outs or other important use areas or population concentration areas would be beneficial in Section 3. This comment is intended globally for Section 3.8, but is particularly applicable to 3.8.1.

    Response: Information provided in Chapter 4 pertaining to haulouts, rookeries, and other important use areas or population concentration areas for several marine mammal species has been moved or duplicated in Chapter 3, Section 3.8.1.

46. "Accidents" Section 4.4.7.1.2: Consistent structure between the Planning Areas would assist the reader to review potential consequences. The description in the Arctic area is more specific with the discussion of the modes of exposure (inhalation, ingestion, and direct contact) compared to the more general statements of exposure in the Cook Inlet area. The Arctic section's format of "X action/behavior resulting in Y exposure with Z consequence" is straightforward and easy to access. Please review and update as appropriate.

    Response: The marine mammal accident assessment discussions have been modified to make them more consistent across the document (e.g., the Cook Inlet discussion has been changed to be similar to that provided for the Arctic region).

47. Section 4.4.7.1.2: Sentence is confusing and needs to be rewritten: "Since there are reports of oiled marine mammal's exposure."

    Response: The Section 4.4.7.1.2 sentence referred to in the comment has been amended.

48. Section 4.4.7.1.2: A discussion of the risk of oil spills to Beluga Whale is needed. The only mention of the species, whose Cook Inlet population is endangered, is the last sentence of the Catastrophic Discharge Event subsection.

    Response: A discussion of the risk of an oil spill on beluga whales has been added to Section 4.4.7.1.2.

49. Section 4.4.7.1.3: Resolve the conflict in the number of cetaceans present in different locations of this section.

Response: The conflict between the sentences in Section 4.4.7.1 (previously Section 4.4.7.1.4) mentioned in the comment has been resolved.

50. Section 4.4.7.1.4: Sentence regarding beluga whales is misleading. While belugas do primarily occur in the area north of the Planning Area, the ESA Critical Habitat includes, in addition to Upper Cook Inlet, the entire west coast of Cook Inlet south to Kamishak Bay and Kachemak Bay. Please review and update as appropriate.

    Response: The sentence regarding beluga whales in the Cook Inlet in Section 4.4.7.1.4 has been amended in response to the comment.

51. Section 4.4.7.1.4: The organizational variability between BOEM's approach for presenting marine mammal impacts vs. terrestrial mammal impacts is confusing. Why are all areas combined for marine mammals, but segregated for terrestrial mammals? With the high variability between GOM and Alaskan habitats and species under consideration, it does not make sense to assume all impacts for all areas would be the same. This is critical under the heading =Accidents' (page 4-293), but again, there is no differentiation between GOM and Alaska.

    Response: Section 4.4.7.1 has been revised to make the conclusions presented for marine mammals consistent with the format used for terrestrial mammals (i.e., improved differentiation in the impacts between the GOM region and the Alaska regions).

52. In the GOM, there are many areas in which information about sensitive resources and the impact of oil activities on them and their habitats are unknown. For instance, while noise impacts on cetaceans can be great, the impact of anthropogenic noise on endangered sperm whales in the GOM is unknown.

    Response: Where appropriate, the discussion in the PEIS of impacts on marine mammals in the GOM indicates where information may be incomplete. The potential impacts of anthropogenic noise on sperm whales and other marine mammals will be addressed in more detail in GOM-specific NEPA analyses, particularly in the *Programmatic EIS for the Geological and Geophysical Exploration of Mineral and Energy Resources in the GOM* currently being prepared by the NMFS and BOEM.

53. Section 4.4.13.3.1: The discussion of the impacts of noise from oil and gas operations (including seismic) only references traditional knowledge of the impacts of noise and none of the considerable body of western science that reaches similar conclusions. As an example, the attachment to these comments shows deflection areas for bowhead whales in the Beaufort Sea as documented by western science. BOEM needs to provide a Summary of both traditional knowledge and western science on the impacts of noise on bowhead whales and then analyze these impacts and discuss mitigation measures for them.

    Response: Impacts of noise on bowhead whales (and other marine mammals) based on "western science" are presented in Section 4.4.7.1.3 of the PEIS. A thorough assessment of noise impacts on bowhead whales will be included in Arctic region-, lease-, or activity-specific NEPA documents (i.e., the EIS currently in preparation by the NMFS and BOEM for geophysical (seismic) and exploratory drilling in the Arctic (http://www.nmfs.noaa.gov/pr/permits/eis/arctic.htm) and related authorizations under the Marine Mammal Protection Act and Endangered Species Act. For examples, see: (1) FWS — http://alaska.fws.gov/fisheries/mmm/Beaufort_Sea/76FR47010.pdf, http://alaska.fws.gov/fisheries/mmm/Chukchi_Sea/pdf/73FR33212.pdf and http://alaska.fws.gov/fisheries/mmm/itr.htm; (2) NMFS — http://www.nmfs.noaa.gov/pr/permits/incidental.htm; and (3) BOEM — http://www.alaska.boemre.gov/ref/Biological_opinions_evaluations.htm and http://www.alaska.boemre.gov/ref/eis_ea.htm.

54. ICAS (Inupiat Community of the Arctic Slope) joins in the comments of the AEWC (Alaska Eskimo Whaling Commission) in critiquing the consideration of impacts to bowhead whales, their habitat, and Inupiat subsistence practices in the Draft PEIS. The discussion of these topics is minimal and fails to analyze all the impacts to our communities from additional offshore oil and gas leasing.

    Response: The concerns raised in the comment will be addressed in detail in region-, lease-, or activity-specific NEPA documents.

55. Section 4.4.7.1.1: This "well documented aggregation" could also be because this was an area that experienced significant survey effort (see Jochens et al. 2008). Newer data indicates they are spread throughout the GOM. Additional study would be required to substantiate these statements, therefore we request that they be deleted.

    Response: Telemetry data from Jochens et al. (2008) suggests a core use area in the Mississippi Canyon, though tagged animals did use the entire northern GOM. The highest use area of the GOM was between the Mississippi Canyon and the DeSoto Canyons.

56. OCS oil and gas development in the Arctic should occur during the summer or after the whaling season to minimize disturbance from seismic surveys.

    Response: The potential effects of seismic surveys on marine mammals are reviewed in Section 4.4.7.1.3 of the PEIS. More detailed analysis of seismic surveys will be provided in lease- and activity-specific NEPA documents (i.e., the EIS currently in preparation by NMFS and BOEM for geophysical (seismic) and exploratory drilling in the Arctic (http://www.nmfs.noaa.gov/pr/permits/eis/arctic.htm)).

57. Section 4.6.4.3: Which whale species is the discussion referencing? Please review and update as appropriate.

    Section 4.6.4.3: Is this supposed to state "no known harvest"? Please review and update as appropriate.

Section 4.6.4.3: The annual subsistence harvest for Pacific Walrus seems very high. Garlich-Miller et al. (2006), states the following: "Since 1992, the harvest of Pacific walruses has been limited to the subsistence catch of coastal communities in Alaska and Chukotka. Harvest levels through the 1990s ranged from approximately 2,400 to 4,700 animals per year"). Please review and update as appropriate.

Response: Section 4.6.4.3 of the PEIS has been amended in response to the items mentioned in the comment.

58. In the past, our whaling captains have experienced firsthand how underwater noise associated with drilling, seismic studies, and icebreaking have interfered with the bowhead whale hunt at Cross Island. When whales are deflected from their normal migration route, our whaling captains are forced to travel great distances in dangerous conditions to obtain the food that feeds our people. Our traditional knowledge tells us that bowhead whales are very sensitive to underwater noise, and yet western science is still unable to tell us what the cumulative impacts are to the whales from multiple exposures to seismic, drilling, and icebreaking activities over a wide portion of the whale's range over a period of many years. We are also concerned about the potential impacts to other subsistence resources, including beluga whales, seals, fish, and caribou.

    Response: Section 4.4.7.1.3 of the PEIS discusses noise impacts on bowhead whales. Both Section 3.8.1.3.1 and 4.4.7.1.3 of the PEIS have been updated to include additional information on movement patterns of bowhead whales and the potential impact of noise on their movements. Section 4.4.7.1.3 also discusses potential impacts on belugas, seals, and caribou; while Section 4.4.7.3.3 discusses potential impacts on fish. Lease- and activity-specific NEPA documents will analyze potential impacts on these subsistence resources in more detail (i.e., the EIS currently in preparation by the NMFS and BOEM for geophysical (seismic) and exploratory drilling in the Arctic (http://www.nmfs.noaa.gov/pr/permits/eis/arctic.htm)).

59. The impacts of airgun surveys are felt on an extraordinarily wide geographic scale — especially on endangered baleen whales, whose vocalizations and acoustic sensitivities overlap with the enormous low- frequency energy that airguns put in the water (numerous citations provided).

    Response: The PEIS has been amended in Section 4.4.7.1.3 to include additional information (including that from several of the references listed in the comment) regarding noise impacts on marine mammals. Also, lease- and activity-specific NEPA, ESA, and MMPA documents will address noise impacts in more detail (i.e., the EISs currently in preparation for geophysical (seismic) surveying in the GOM, mid/south Atlantic and Arctic-see http://www.nmfs.noaa.gov/pr/pdfs/fr/fr69-67535.pdf, http://www.gomr.boemre.gov/homepg/offshore/atlocs/gandg.html, and http://www.nmfs.noaa.gov/pr/permits/eis/arctic.htm.

60. The amount of disruptive activity under consideration in the Draft PEIS is enormous. Potential impacts of seismic surveys should be discussed.

Response: Section 4.4.7.1.1 discusses the potential impacts of seismic surveys on marine mammals in the GOM. Lease- and activity-specific NEPA, ESA and MMPA documents will address noise impacts in more detail (i.e., the EIS currently in preparation for geophysical (seismic) surveying in the GOM (http://www.nmfs.noaa.gov/pr/pdfs/fr/fr69-67535.pdf). The cumulative impact sections of these documents will also address other sources of noise that marine mammals are exposed to in the GOM.

61. The Draft PEIS lacks any serious analysis of the potential impacts of program-related noise on marine wildlife, and offers in its place a number of specious claims in an apparent effort to diminish their serious effects. The Draft PEIS does not address the true elephants in the room: behavioral impacts, which have been demonstrated to occur at very large distances from seismic arrays, and masking effects, for which empirically-based, quantitative models are available. BOEM's dismissive treatment of acoustic impacts simply does not reflect the best available science. For all of the foregoing reasons, the PEIS must analyze and acknowledge that the activities under review – particularly the airgun surveys that presently represent the dominant means of offshore exploration – are likely to significantly impact marine mammals; affect vital rates in endangered species and populations, including the North Atlantic right whale.

    Response: Potential impacts of noise on marine mammals are provided in Sections 4.4.7.1.1 through 4.4.7.1.3. The PEIS has been amended to include additional information regarding noise impacts on marine mammals. Also, lease- and activity-specific NEPA, ESA, and MMPA documents will address noise impacts in more detail (i.e., the EISs currently in preparation for geophysical (seismic) surveying in the GOM, mid/south Atlantic and Arctic — see http://www.nmfs.noaa.gov/pr/pdfs/fr/fr69-67535.pdf, http://www.gomr.boemre.gov/homepg/offshore/atlocs/gandg.html, and http://www.nmfs.noaa.gov/pr/permits/eis/arctic.htm. The cumulative impact sections of these documents will also address other sources of noise to which marine mammals are exposed.

62. Section 4.4.7.1.1: This section summarizing the effects of seismic surveys on marine mammals should include effects to prey (e.g., fish and squid). Studies suggest that squid, the primary prey item of endangered sperm whales, may experience statocyst damage that may result in injury or death resulting from exposure to low frequency sound.

    Response: Potential impacts of seismic surveys on fish and invertebrates (which includes marine mammal prey) are provided in Sections 4.4.7.3 and 4.4.7.5, respectively.

63. Section 4.4.7.1.1: The seismic pulse is under 10 ms every 12 sec. or more, therefore the 10% duty cycle is much lower than cited, and thus any potential masking would be much smaller than suggested. This should be corrected.

    Response: Additional information on duty cycles of seismic pulses have been added to Section 4.4.7.1.1 of the PEIS to demonstrate that the duty cycle of seismic surveys can be much lower than 10%.

64. Section 4.4.7.1.3: Industry practices as mandated by the USFWS and NMFS include maintaining 1-mile exclusion zones around known polar bear dens, use of aerial Forward Looking InfraRed Radar (FLIR) surveys to identify polar bear dens, and Incidental Harassment Authorization and Polar Bear& Wildlife Interaction Plans which specify the means by which industry minimizes contact, conflict, or stress upon the Polar Bears. These industry and regulatory practices should be specified to demonstrate protection of the polar bears. This section should also note a prior USFWS finding that "documented impacts on polar bears by the oil and gas industry during the past 30 years are minimal" and "historically, oil and gas activities have resulted in little direct mortality to polar bears." Line 12: Statements similar to those presented in this paragraph on sensitive and listed species need to be provided more extensively throughout the document so that the reader understands the significance and regulatory authorization of the discussed impact, along with the mitigation measure(s) to be employed to reduce the impact to levels consistent with ESA directives.

    Response: The USFWS (2008b, 2011) has developed regulations that authorize the nonlethal, incidental take of small numbers of polar bears (and Pacific walruses) from oil and gas industry activities in the Chukchi Sea and Beaufort Sea areas, respectively. These documents include the requirement for maintaining 1-mile exclusion zones around known polar bear dens. A text addition has been made to Section 4.4.7.1.3 that refers to these documents. The FWS also has a website (http://alaska.fws.gov/fisheries/mmm/itr.htm) that addresses incidental take regulations on marine mammals under its jurisdiction (including polar bears, walruses, and sea otters). Section 4.4.7.1 defines level A and B harassment takes of marine mammals. As appropriate, statements similar to that presented in the paragraph referred to in the comment have been added to the PEIS.

65. "BOEM showed a slide earlier and it showed a red buffer zone of 25 miles up from Point Lay to Wainwright. It is really not enough. Walruses and other marine mammals are hauling out because there isn't any more ice nearby that they can rest on, where they can leave their juveniles and go forage for food. They find themselves making their way to land and spending one month, and it's working towards two months now, of every year looking for a place to rest. These animals, when they beach themselves, they're so tired they can't even get out of the surf. They're sick. We're finding sores all over these walruses, all over the seals, along with the belugas. Point Lay is a lagoon system that is about 100 miles long and is pretty unique. It's got more water fowl and sea mammals than anywhere else in the world. They spend their summers there. These areas are very sensitive, along with thousands of other sensitive areas along the Chukchi Sea and up towards Barrow and all the way to Kaktovik. All these shorelines are used. We were finding hundreds of dead walruses, mostly juveniles. These animals were getting sick, there were sores. Scores of them were dead. And I want to mention something about the belugas, too. Point Lay hunters have been harvesting belugas for as long as I've been there, and I have only been there since 1973. Point Lay's history goes way back, and belugas was one of the mainstays there. This year, the animals seem to be a different group. And that's kind of strange and unusual because the belugas that they were normally seeing were much larger. This is a group of — a pod of belugas that were mature but smaller. So we're not sure where this group actually came from."

Response: A discussion of the UME that involves predominately ringed seals, but also some walrus, in the Arctic has been added to Sections 3.8.1.3.1 and 4.6.4.3.1 of the PEIS. A discussion of climate change impacts on sea ice can also be found in those sections of the PEIS, as well other subsections throughout Sections 3.8.1.3 and 4.6.4.3. As of the drafting of this response, NMFS has not yet determined the cause of this UME but will continue to post updates at http://www.alaskafisheries.noaa.gov/protectedresources/seals/ice/diseased/. The Marine Mammal Stranding Network, as well as the North Slope Borough and others, are involved in the investigation of the UME. BOEM is aware that walrus are coming ashore in large numbers when the sea ice retreats northward of the continental shelf, leaving calves particularly vulnerable to deaths during disturbance events and energetically depleted from long swims between foraging areas and the shore. The U.S. Geological Survey (USGS) and USFWS have been studying this phenomenon since about 2007. Recent genetic samples taken from a pod of beluga in Kotzebue Sound seem to indicate that it is genetically distinct from the group that used to show up there. Both the Alaska Department of Fish and Game and the North Slope Borough take samples from the beluga hunts and have an ongoing research program that studies different beluga stocks. There are some changes in habitat use by at least some pods of beluga, though why and where they are going is not completely understood. It is possible that these changes may relate to climate change or changes in prey distribution. In past lease sales, BOEM has looked at both a 25-mile and 50-mile buffer along the coastline. While a 50-mile buffer offers more protection, a 25-mile buffer was selected for Lease Sale 193. There have been discussions about deferring important walrus foraging habitat, primarily the Hanna Shoal area. BOEM is aware of the changing distribution of some marine mammal species, which seems to be driven by factors related to loss of sea ice and climate change. This information will be considered along with other factors in determining the lease sale areas and possible deferrals in future sales in the Chukchi Sea.

66. Section 4.4.7.1.1: NMFS uses different thresholds for Level B harassment, depending on the sound source (impulse, continuous, sonar, etc.), not just 160 dB. For exploratory and production drilling in the Arctic, 120 dB is used as the threshold for Level B harassment as it is a continuous noise source.

    Response: Text has been added to Section 4.4.7.1.1 to include the NMFS thresholds.

8.4.4.4.9 Issue 4.9 Birds.

1. The PEIS should better address the attraction of migrating birds to offshore platform lighting.

   Response: Injury or mortality to birds from collisions with platforms is discussed in Section 4.6.4.1.2 of the PEIS. The text has been revised to include additional text regarding the attraction of birds to platform lighting.

2. The Draft PEIS should be revised to update distribution and habitat information (including figures) for the red knot, wood stork, Audubon’s crested caracara, piping plover, and the experimental eastern population of the whooping crane.

Response: Text and figures have been updated in Sections 3.8.2 and 4.4.7.2 to reflect current information and distribution of threatened, endangered, and candidate bird species, to update the numbers of bird species that could occur in each of the planning areas, and to clarify locations of important bird habitats that could be affected by oil and gas activities and accidental spills.

3. The Draft PEIS should be revised to provide information regarding the Migratory Bird Treaty Act, the ESA, and BOEM compliance with Executive Order 13186 Responsibilities of Federal Agencies to Protect Migratory Birds.

   Response: The Migratory Bird Treaty Act of 1918 (MBTA) is a strict liability law that contains no provision authorizing a permitting system for "incidental take" such as is contained in the Endangered Species Act. The Memorandum of Understanding (MOU) between the Minerals Management Service (MMS, now BOEM) and USFWS regarding implementation of Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds, is carefully worded such that BOEM is not obligated to any specific action or actions, but is obligated "to the extent allowed by law, subject to the availability of appropriations and within budgetary limits, and in harmony with the Department's and the BOEM's missions and capabilities," to take bird conservation practices into consideration when taking any actions. BOEM includes an effects analysis to migratory birds, thereby taking bird conservation into consideration.

   Discussions of the Migratory Bird Treaty Act were added to Sections 3.8.2.1.1 and 4.4.7.2.1.

4. The accuracy of the presented DWH event bird impact data should be reviewed and updated if appropriate; additional information on affected species and oil toxicity may be warranted; the discussion of oil impacts on birds should be updated.

   Response: Table 3.8.2-6 was checked for accuracy and the provided source is correct. Water quality impacts resulting from the DWH event are discussed in Section 3.4.1.4 of the PEIS. "Seabirds" is a meaningful ornithological designation (as seen in Peterson field guides). Section 3.8.2.1.5 was updated to mention laughing gulls as the dominant bird species reported as affected by the DWH event. Section 3.8.2.1.5 was updated to include more specific information about the potential effects of crude oil and weathered oil on bird species.

5. Additional language should be added to expand on the attraction of birds to platform lighting. To mitigate collision impacts to birds, BOEM should require new lighting technologies (such as red lights) on offshore platforms.

   Response: BOEM recognizes recent advances in lighting technology as a potential bird collision mitigation strategy. Mitigation measures must comply with FAA and Coast Guard regulations (which currently do not allow for red lighting), and will be determined at the lease sale phase when more detailed analyses occur. Additional text has been added to Sections 3.8.2 and 4.4.7.2 regarding platform lighting and bird attraction. The identification of potential mitigation measures takes place at the lease sale EIS or EA level (see Table 1-1, Chapter 1). Please see Section 8.4.4.8, Issue 8, Mitigation, for additional responses concerning requests for specific mitigation measures.

6. The Draft PEIS discusses bird habitat disturbance by spill containment and cleanup activities in Section 4.4.7.2.1. Should this discussion take into account the involvement of wildlife experts in response activities for the purpose of minimizing response impacts to wildlife and habitat?

   Response: Section 4.4.7.2.1 was updated to explain that spill response plans will include consultations with wildlife experts to minimize potential impacts.

7. Table 4.4.7-2 indicates that potentially minor impacts on juvenile and adult birds may result from seismic noise. Seismic noise is not implicated in injury or mortality of these life stages of birds and the table should be corrected to indicate no or negligible effect anticipated.

   Response: Table 4.4.7-2 was updated to show no or negligible effects are anticipated for juvenile or adult birds from seismic noise.

8. The Draft PEIS incorrectly claims that missing information pertaining to the impacts of climate change on marine and coastal birds is not essential to a reasoned choice among alternatives. Better information on the effects of climate change on birds would allow for a more accurate understanding of the differential impacts of the alternatives, and thus allow for a more reasoned choice among alternatives.

   Response: BOEM disagrees. Programmatic-level analyses and decisions do not require the same detailed analyses that may be necessary at later stages of OCS leasing (see Section 1.4.2 for additional discussion of incomplete and unavailable information). Resolving the uncertainty regarding the effects of climate change on birds is not essential at this programmatic stage. BOEM acknowledges the potential effects of climate change on not only birds but all natural resources. The PEIS discusses the potential consequences of climate change on Arctic birds (Section 3.8.2.3.5). Additional text has been added to Section 3.8.2 of the PEIS to discuss climate change consequences for birds in the GOM and Cook Inlet planning areas. Also, see the response to Comment 9 in Section 8.4.4.2, Issue 2, NEPA Analysis.

9. The text should be modified to indicate that moderate impacts would be anticipated to marine and coastal birds in the case of a CDE.

   Response: Depending on the location, timing, and species and habitats affected, a CDE could have a moderate-to-major impact on marine and coastal birds. This impact range is identified for CDEs occurring in the GOM (Section 4.4.7.2.1), Cook Inlet (Section 4.4.7.2.2), and Arctic (Section 4.4.7.2.3) planning areas.

8.4.4.4.10 Issue 4.10 Reptiles.

1. The USFWS requests the inclusion of the Alabama red-belly turtle (*Pseudemys alabamensis*) and gopher tortoise (*Gopherus polyphemus*) in the Affected Environment and Impact Sections (Sections 3.8.3 and 4.4.7.4). Both of these species are reptiles listed under the Endangered Species Act.

   Response: Discussion of these species has been added to the Affected Environment Section (Section 3.8.3) and Impact Section (Section 4.4.7.4).

2. Table 4.1.3-1 in Section 4.1.3 should be revised to omit duplication of impacting factors and revise some of the impacts to sea turtle habitats and life stages.

   Response: This table in Section 4.1.3 has been revised to omit duplication and update impacting factors.

3. The stranding numbers of sea turtles during the Deepwater Horizon event have been revised. Revise sea turtle stranding numbers in the PEIS accordingly (Section 4.4.7.4.2).

   Response: Turtle stranding numbers have been revised in Section 4.4.7.4 to reflect the most up-to-date information at this time.

4. Additional discussion on the role of *Sargassum* to sea turtle life history is needed. The effects to *Sargassum* should be considered in the potential effects to sea turtle habitat resulting from a catastrophic discharge event. *Sargassum* is also a vitally important developmental habitat for sea turtles. *Sargassum* can be found throughout the GOM and can reproduces both sexual and through vegetative regeneration and can be affected in all planning areas. Although *Sargassum* may recover from such events in the long-term, the short-term effects to the ecosystem resulting from a catastrophic discharge event can be of high magnitude.

   Response: Additional discussion on the role of *Sargassum* in the sea turtle life history and impacts to *Sargassum* from OCS O&G activities has been added to Sections 3.7.3.1.2 and 3.8.3.

5. The habitat listed for Kemp's ridley sea turtles (Table 3.8.3-1 in Section 3.8.3) is missing the juvenile and oceanic habitat. Both oceanic and neritic habitats are important for different life history stages of Kemp's ridleys.

   Response: Text has been revised in Section 3.8.3 to discuss juvenile and adult habitats for Kemp's ridley sea turtles.

6. The Affected Environment section could benefit from a more rigorous description of both the neritic and oceanic developmental stages of sea turtles that could be affected by oil and gas activities. Sea turtle life history patterns and the developmental habitat shifts have been

categorized as Type 1, Type 2, and Type 3, depending on the species. Oceanic stage Kemp's ridleys, as well as neritic stage animals, were directly impacted during the Deepwater Horizon Oil spill and could be impacted by other OCS activities in the GOM.

Response: Reptile section (Section 3.8.3) has been updated to include additional discussion of habitat preferences of all turtle life stages.

7. Request discussion of other reptile species listed as sensitive species or species of concern by the USFWS or the States in the GOM Planning regions. Non-federally listed reptile species were not discussed in the Draft PEIS.

   Response: Only reptile species that are federally listed as threatened or endangered under the Endangered Species Act are discussed in this PEIS. The discussion of other sensitive or rare reptile species is more appropriate at the more detailed lease sale or activity-specific stages.

8. Figure 3.8.3-1 in Section 3.8.3 does not accurately represent the occurrence of sea turtles or the nesting of sea turtles along the Texas coast. The inclusion of this figure may lead one to draw inaccurate conclusions regarding the potential impact of oil and gas development in the Western GOM Planning Area.

   Recommendation: Either omit this figure from the PEIS or revise it to more accurately reflect the occurrence of sea turtles and nesting sea turtles in the GOM and particularly along the Texas coast.

   Response: Additional data sources will be reviewed and the figure will include the best available data. However, new information that could be used to revise the figure is not essential in order to make a reasoned choice among alternatives.

9. The Draft PEIS states, "Following the DWH event, a total of 1,146 sea turtles were recovered from the GOM that had come in contact with or were in the vicinity of spilled oil" (Section 3.8.3.1). Does this statement account for the fact that some of these turtles were collected well after the DWH well had been capped? As a result, it is unlikely that those turtles were ever in the vicinity of the spilled oil. Additionally, some were collected in Florida, which also reduces the likelihood that they were in the vicinity of oil. Is there any data indicating that sea turtle nests were in fact oiled, or is this speculation?

   Response: Text has been revised in Section 3.8.3.1 to clarify the interpretation of the data regarding turtle and nest fouling following the DWH event.

10. The BOEM is legally obligated to prevent the deaths of protected species under the Migratory Bird Treaty Act and the Endangered Species Act. Similar concerns could be expressed about the Draft PEIS treatment of issues relating to endangered and threatened marine turtles.

Response: The PEIS identifies sea turtles as being listed as threatened or endangered under the ESA. Any discussion on impacts to these species will be conducted at the lease sale or activity-specific level in compliance with ESA and MBTA requirements. The PEIS describes the ESA and MBTA requirements in Sections C.1.8 and C.1.10, respectively, in Appendix C.

11. BOEM has admitted that the "range of toxicity, the degree of sensitivity to oil hydrocarbons, and the effects of cleanup activities on sea turtles are unknown . . ." (Supplemental EIS for Lease Sale 218 at 4-139). Id. at 4-160.

    Response: It is unclear whether the comment refers to this 5-year OCS PEIS or to the GOM Lease Sale 218 EIS. Regardless, more detailed analysis on these issues will occur at the lease sale or activity-specific level following the PEIS.

8.4.4.4.11 Issue 4.11 Invertebrates.

1. Section 3.8.5.3, Alaska — Arctic — More detailed information on crab stocks in this region can be found in Rand and Logerwell (2011) and in the Arctic FMP. See Rand, K. M., and E. A. Logerwell 2011. The first demersal trawl survey of benthic fish and invertebrates in the Beaufort Sea since the late 1970s. *Polar Biol.* 34:475–488.

    Response: Additional information on the snow crab was added to Section 3.8.5.3.

2. The commenter states that in Sections 3.7.2.1.7 and 3.7.4.1 of the Draft PEIS, the statements regarding the brown substance coating deepwater corals are incorrect because the source does not attribute the "brown substance" to the DWH event and states that laboratory analysis is still needed to determine the source.

    Response: The statement modified to say brown substance. Text modified in Sections 3.7.2.1.7 and 3.7.4.1 to state "covered in brown flocculent (http://www.boemre.gov/ooc/press/2010/press1104a.htm), and recent analyses (White et al. in press) provide evidence that the flocculent contained oil from the DWH event located approximately 11 km (7 mi) to the northeast."

3. Section 4.4.6.2.1 of the Draft PEIS states, "There is evidence that oil released from the DWH event was mixed with dispersant … and may have killed deepwater corals…" Should this statement be clarified to note that testing is still underway to determine if the substance was DWH oil or dispersants? Can the results be provided? In addition, should this passage note that while the effects of dispersant on deepwater corals are poorly understood, dispersant chemicals contain constituents that are considered to have low levels of toxicity when compared to toxic constituents of spilled oil (Wells 1989)?

    Response: The text in Section 4.4.6.2.1 has been modified to say "There is evidence that oil released from the DWH event was mixed with dispersant (Kujawinski et al. 2011), and there is some evidence that oil from the DWH event killed habitat-forming deepwater corals (http://www.boemre.gov/ooc/press/2010/press1104a.htm; White et al., in press; Section 3.7.2.1.7)." The effect of chemically dispersed oil on corals is equivocal, with some studies finding large effects of oil and dispersant mixtures on corals and others finding only minor effects (Dodge et al. 1984; Wyers et al. 1986; Epstein 12 et al. 2000; Haapkvla et al. 2007; Shafir et al. 2007).

4. Sections 4.6.4.1.5 and 4.6.4.3.4 of the Draft PEIS discuss the magnitude and severity of potential effects to invertebrate resources from oil spills. Should these discussions note that the distribution and densities of invertebrate communities in waters potentially affected by the Deepwater Horizon event are under investigation? See NOAA, NRDA Workplans and Data, available at http://www.gulfspillrestoration.noaa.gov/oil-spill/gulf-spill-data/ (linking over a dozen studies of oysters, benthic invertebrates, nekton, and zooplankton). In addition, LDWF has conducted, and continues to conduct, sampling and analysis of crab, shrimp, and oysters.

   Response: Ongoing studies were noted in Section 4.6.4.1.5, the section that discusses invertebrates in the GOM. However, very little data from these studies has been synthesized and peer reviewed. Therefore, it is too soon to do a comprehensive evaluation of the impacts of the DWH event. However, as more information becomes available, BOEM will include the results in subsequent environmental analyses. The purpose of this PEIS is to identify and document the potential impacts of the proposed action and alternatives to the proposed action. To support planning decisions for establishing a 5-year schedule for lease sales, detailed analyses of highly variable, region-specific and/or well-specific risk is neither feasible nor appropriate. See Section 1.4.2 for a discussion of incomplete and unavailable information.

5. The commenter states that Section 3.8.5.1 of the Draft PEIS should note that the yearly hypoxic zone occurs on the Louisiana and Texas continental shelf, away from the deepwater zone where the DWH event occurred.

   Response: This was a general statement about bacteria contributing to the GOM hypoxic zone and was not in reference to the DWH event. It was noted in the text in Section 3.8.5.1 that the hypoxic zone is on the continental shelf not in deepwater. Hypoxia in the GOM is discussed in detail in the water quality section (Section 3.4.1).

6. Sections 3.8.5.1 and 4.4.6.3.1 of the Draft PEIS state that studies following the DWH event demonstrated that the amount of methantropic and oil-eating bacteria increased greatly after the DWH event (Camilli et al. 2010; Kessler et al. 2011). Should these statements also cite Hazen et al. (2010)?

   Response: Reference added as requested to Sections 3.8.5.1 and 4.4.6.3.1.

7. Tables 4.4.7-8 and 4.4.7-9 in Section 4.4.7: The table shows the impact level from noise from seismic surveys potentially affecting invertebrates as blue = minor. Yet the language in

Sections 4.4.7.5.1 and 4.4.7.5.3 suggest that the effects would be "negligible." This table should be changed to reflect an impact level from seismic noise to white = negligible.

In addition, in Table 4.4.7-10, the colors are not consistent with Footnote A. If this table is incorrect, and seismic noise was intended to be classified as a higher impact level, please immediately advise the writer as to the correct classification. In such a circumstance, we reserve and request the right to comment on the corrected table.

Response: The PEIS defines negligible as "no measurable impacts" and minor as "most impacts on the affected resource could be avoided with proper mitigation." If impacts occur, the affected resource will recover completely without mitigation once the impacting stressor is eliminated." Noise can affect invertebrates and, therefore, the definition of Minor better fits with the impacts on invertebrates as described in the literature. Negligible has been changed to minor in the text in Sections 4.4.7.5.1 and 4.4.7.5.3 to match the tables.

8. Commenter requests that a discussion of the impacts of oil spills on pelagic marine invertebrates be added to Section 4.4.7.5.3 and Section 4.4.6.3.3 and notes that if dense aggregations of spawning zooplankton contact oil, reproduction and recruitment may be halted for a year or more depending on how long it would take to clean up the oil spill.

   Response: Invertebrates (including zooplankton) are discussed throughout Section 4.4.7.5. In order to avoid text duplication, Section 4.4.7.5.3 directs the reader to Section 4.4.7.5.2 for a complete discussion of the effects of exploration and site development activities on invertebrates. The existing text has been expanded to discuss impacts on zooplankton from oil spills.

8.4.4.4.12 Issue 4.12 Threatened and Endangered Species.

1. There should be full ESA Section 7 consultation, including the preparation of a Biological Assessment and Biological Opinion. BOEM must avoid conflating the ESA take prohibition with critical habitat designation.

   Response: The Program broadly defines the portion of each planning area that is proposed for subsequent leasing consideration, and decision options for the leasing program are preserved for the Secretary at the time the decision is made for each sale. It is at the lease sale stage or activity-specific stage (i.e., regional seismic EISs) that BOEM begins Section 7 consultations (see Section 1.5.5.4 of the PEIS). BOEM agrees that critical habitat and species listings are separate under the ESA and that designation of critical habitat does not directly prohibit take of the species. BOEM fully complies with all requirements of the ESA, and impacts to ESA-listed species and designated habitats are discussed in various section of Chapter 4 of the PEIS. Also see responses to ESA-related comments presented in Issue 9 of this section of the PEIS.

2. The impact levels used in the Draft PEIS are directed at populations not individuals. However, per ESA, BOEM should direct that evaluation of impacts to individuals that are

much more critical and justified for listed threatened and endangered species. Text should be provided to clarify this issue and subsequent evaluations should consider the uniqueness and vulnerability of listed species when assessing and/or designating a particular impact level.

Response: The impact level definitions provided in Section 4.1.4.1 have been revised to indicate that for evaluations of ESA-listed species, the impact levels consider impacts on individuals as well as populations. In addition, the PEIS has been revised to provide a more uniform and consistent discussion of impacts on ESA-listed species at both the individual and population level. As discussed in Section 1.5.5.4 of the PEIS, ESA Section 7 consultations (whether informal or formal) are premature at the 5-year programmatic stage, and ESA Section 7 consultations would begin at the lease sale stage. It is at this stage that more species-specific impact evaluations would occur, including identification for adversely affecting individuals. BOEM recognizes the uniqueness and vulnerability of listed species. The PEIS identifies these species in Section 3.8, and discusses possible impacts in Section 4.4.7, of the PEIS.

3. The sections on ESA (and other) birds associated with Cook Inlet and Arctic areas are treated much more extensively than any other discussions on ESA species. Revise the document to provide a consistent treatment of the important sensitive biological receptors within each proposed lease area.

   Response: Section 3.8 of the PEIS has been revised to present a more equal treatment of impacts on ESA species and other non-listed species.

8.4.4.4.13 Issue 4.13 Land Use and Infrastructure.

1. The commenter suggested a modification to the text to indicate that the Trans-Alaska Pipeline System (TAPS) could not transport gas. Gas from the Beaufort and Chukchi, therefore, would not be transported via the TAPS, but instead would be transported via a new gas line to the lower 48 States or a port in south central Alaska or directly from future North Slope infrastructure.

   Response: A typographical error was made in the PEIS that indicated that TAPS would transport both oil and gas in Sections 2.1 and 4.4.1.3. The text was amended to show that TAPS will only transport oil. The text revision in these two sections did not result in changes to potential impacts discussed as part of individual resource sections and conclusions.

2. The commenter was concerned about the future viability and operations of the TAPS (including the economic implications for the owners) being connected to the actions described in the Draft PEIS. The comment text indicated that while substantial interest in resources along the North Slope is present, as evidenced by recent lease sales of State lands, the actions undertaken as part of this PEIS are not essential to the future of TAPS.

   Response: While BOEM recognizes the economic and infrastructural importance of TAPS, the concerns for maintenance, improvements, and future viability for this pipeline are out of scope for the evaluation conducted as part of this PEIS, and for BOEM and its compliance with OCSLA. It should be noted that a new 40-year right-of-way was approved in 2003 for TAPS, which was followed shortly afterward by an upgrade of the system's pump stations. Additional activities have been conducted with the goal of extending the economic life of TAPS, while maintaining operational efficiencies and safety. See the response to Comment 7 in Section 8.4.4.2.

3. This commenter described a concern for potential impacts on onshore and offshore resources associated with the use of helicopters, planes, and other vessel traffic.

   Response: The expected levels of helicopter and vessel traffic that could occur under the proposed action are presented in Table 4.4.1-1 for the GOM planning areas, Table 4.4.1-3 for the Cook Inlet planning area, and Table 4.4.1-4 for the Beaufort and Chukchi Seas planning areas. The potential impacts resulting from use of various transport modes (e.g., helicopters and airplanes) are analyzed on a resource-by-resource basis in Chapter 4.

4. The commenter suggested that oil and gas exploration companies should locate support facilities and infrastructure onshore in order to create a tax base and training opportunities for locals, while at the same time reducing the cost of health care, schools, transportation, utilities, and housing in the Northwest Arctic Borough.

   Response: Support facilities and onshore infrastructure for Chukchi oil and gas activity are unlikely to be located within the borders of the Northwest Arctic Borough. However, workers in the Northwest Arctic Borough could be involved in work generated by OCS activities. The Northwest Arctic Borough might consider partnering with the oil and gas industry, the North Slope Borough, and/or other entities for work training programs, which would be applicable to work on the OCS.

   Job training and other reductions in cost (e.g., health care, schools, and utilities) as described in this comment are not, per se, a part of BOEM's responsibilities.

5. The commenter suggested that the TAPS is only used for crude oil, rather than gas as described in the PEIS. The commenter further suggested that the use of a natural gas pipeline to the mid-continent and the tanker concepts are not viable for transporting resources from the Chukchi and Beaufort Seas. The commenter, therefore, suggested two scenarios, one in which resources remain stranded, and another in which the natural gas is exported outside the country.

   Response: The Draft PEIS incorrectly stated that the TAPS would be used to transport both oil and natural gas from the Arctic to Valdez. This error has been corrected in Sections 2.1 and 4.4.1.3 of the PEIS. As discussed in Section 4.4.1.3, a natural gas pipeline from near Prudhoe Bay is assumed to be in place and operational by 2020. The construction of a pipeline for natural gas transport to the lower 48 States has been under serious consideration by industry since 2011, and more recently, industry and the State of Alaska are examining the potential for a pipeline to the southern Alaska coast to support liquefied natural gas (LNG) export outside of the country. Examination of LNG export is outside the scope of the

PEIS. Authorization to export LNG is provided by the U.S. Department of Energy, Office of Oil and Gas Global Security. See the response to Comment 21 regarding LNG export in Section 8.4.4.2.

6. The commenter suggested that the text showing Kivalina as the third largest port in the State of Alaska should be changed to Ketchikan, since Kivalina only has a barge landing.

   Response: The listing of ports was provided by port tonnage based on figures from the United States Army Corp of Engineers (USACE) for the year 2009 (http://www.ndc.iwr.usace.army.mil//wcsc/portname09.htm). According to this data source (which lists the top 100 ports, by tonnage), Valdez was listed as the 18th-largest port in the United States; Nikiski (formerly Nikishka) was listed as 76th; Kivalina was listed as 89th; and Anchorage was listed as 96th. Ketchikan is not included in this listing by the USACE.

   Kivalina is a port for a large mine at Red Dog. The actual port is located outside the immediate community.

   The text in Section 3.11.2 was amended to clarify this information and therefore lists the port as Kivalina (Red Dog).

7. The commenter was unaware of any applications for a gas line that would connect the Beaufort and Chukchi Seas to the lower 48 States.

   Response: Applications for the development of natural gas pipelines are being processed. The BLM, for instance, is processing right-of-way (ROW) applications for the Denali-Alaska Gas Pipeline, the Alaska Pipeline Project, and the Alaska Gasoline Development Corporation Stand Alone Pipeline.

   Among these projects, the initial open season for the Alaska Pipeline Project was conducted from May to July 2010. Project proponents intend to file to the Federal Energy Regulatory Commission (FERC) in October 2012.

8. The commenter stated that the Arctic has very limited coastal infrastructure outside of the Prudhoe/Kuparuk development. The commenter suggested that the opportunity should be used to carefully plan where needed coastal development should be located, including infrastructure to support coastal communities, exploration, production, transportation, safety, and pollution response.

   Response: Existing infrastructure in the Arctic is described in Section 3.11.3. Additional information is also provided in the exploration and development scenario, which is presented in Section 4.4.1.3. While the scenario indicates what types of infrastructure would be needed as part of the overall program, the location, construction, and operation would be determined by an individual applicant and in consideration of other permitting/regulatory requirements. To plan for coastal development at this level (as described in this comment) is outside the scope of this PEIS as well as outside the authority of BOEM.

9. The commenter suggested that the Draft PEIS lacked a discussion of the use of jack-up rigs or platforms in the Chukchi Sea, drill ships, specific drilling techniques (e.g., the extended reach and directional drilling), and gravel islands, thereby ignoring current oil and gas technologies and strategies for protecting critical marine resources and potentially conflicting uses.

   Response: The PEIS includes a discussion of the types of drilling approaches and technologies that would be used in the Arctic, including the Chukchi Sea. Section 4.4.1.3 of the PEIS discusses the uses of gravel islands, mobile platforms, and drill ships under various depth and weather conditions.

10. The commenter requested that the PEIS clarify why the Beaufort Sea required a pipeline, and how oil and gas would be transported from the Chukchi Sea, referencing the text in Section 4.4.7.2.3, the construction of onshore pipelines section.

    Response: The exploration and development scenario for the Arctic is described in further detail in Section 4.4.1.3. The section referenced in the comment summary above is a summary statement that references the exploration and development scenario. As stated in Section 4.4.1.3, oil produced in the Beaufort Sea Planning Area would be delivered via trenched subsea pipeline to existing onshore facilities. In the Chukchi Sea Planning Area, production operations would use gravity-base structures with trenched subsea pipelines to transport oil to landfalls. In both areas, onshore pipelines would convey the oil and gas from the landfall facilities to production facilities at Prudhoe Bay.

8.4.4.4.14 Issue 4.14 Fish and Fisheries.

1. Commenter requests the PEIS note that the U.S. Fish and Wildlife Service issued a substantial 90-day finding (50 CFR Part 17: 60431-60444) on September 29, 2011, for the American eel and is currently conducting a status review of the species to determine if it warrants protection under the Endangered Species Act of 1973.

   Response: The text has been updated in Section 3.8.4.1.12 to reflect new information about the status of the American eel.

2. Commenter states that lakes used for ice roads contain fish and that small fish are pumped out of these lakes when the ice roads are being made and the fish are visible along the road. These impacts should be addressed.

   Response: A discussion of impacts to fish from ice roads has been added to Sections 4.4.7.3.3 (Fish) and 4.4.6.4.3 (EFH).

3. Commenters state that they were horrified by the BP oil disaster and that impacts to oysters and menhaden are unknown because the studies are ongoing. They have also heard stories that oil is coming up from around the Macondo well and that Corexit is still being sprayed. Commenter also noted that more fish have sores on their bodies that never used to be there.

Response: The spill at the Macondo well was capped on July 15, 2010, and Corexit is no longer being sprayed. BOEM concurs that some effects from the oil spill may take years to determine. BOEM also concurs that all effects are not know at this time, and we will continue to follow research on this issue. However, it can be difficult from anecdotal information to determine causality.

4. The commenter states that airgun surveys have important consequences for the health of fisheries and provides several citations to support the claim.

   Response: Section 4.4.7.3 acknowledges that fish hearing is potentially damaged by air guns and the literature cited in the comment has been discussed in the text when applicable to fish. Potential impacts on commercial fisheries were noted in the commercial fisheries section.

5. Section 4.4.7.3, Fish: BOEM acknowledges that trace metal and hydrocarbon constituents in drilling fluids can be toxic to fish at all life stages if they are exposed to high enough concentrations. NOAA recommends that BOEM either include a reference, or a brief description of what constituents might be present in these fluids.

   Response: Section 4.4.3.1 (Potential Impacts on Water Quality-GOM) describes the various categories of drilling fluids and their primary constituents. A reference to this section and the papers it cites has been added to Section 4.4.7.3.

6. Sections 4.4.11.1.2 and 4.4.11.2.1, Commercial Fisheries: NOAA has previously commented that negative values in tables describing the estimates of increased costs to fishing vessels need explanation. Based on how positive values are treated in the text, a negative value implies operational costs will decrease as a result of the placement of new oil/gas structures. These negative values require explanation; absent explanation, the underlying model becomes suspect, raising questions on the estimated increased costs as well. Further, it is unclear how the results in Section 4.4.7.5.2 are derived. For example, the PEIS states that for the Western Planning Area 0-60m depth, the cost impact for one structure is estimated to be $41.24 (Table 4.4.11.1-1). If 44–80 platforms are to be built, the respective range of cost is $1,815 ($41.24 × 44) − $3,299 ($41.24 × 80) and not the $1,993−$3,819 reported. Similar math "disconnects" result from examining the estimates for the Central Planning Area.

   Response: The commenter is correct is assuming that negative values in Tables 4.4.11.1 and 4.4.11.2 indicate that costs would decrease as a result of the placement of offshore oil and gas structures. Specifically, in Table 4.4.11.1, coefficients for platforms in the 0–60 m (0–197 ft) depth range are negative in the Central and Eastern Planning Area, which implies that additional platforms in this depth range will dampen the negative impacts of platforms in other depth ranges in the Planning Area. The text in Section 4.4.11 of the PEIS has been changed to clarify the nature of impacts, and provide more information on the calculation procedures.

7. Section 4.6.3.2.3, Essential Fish Habitat: "Egg and larval stages would be at greater risk of exposure to oil spills because spawning aggregations of many groundfish species (e.g., walleye pollock) produce pelagic eggs that could come into contact with surface oil slicks. Herring are also potentially susceptible to oil spills because they spawn in nearshore waters for protracted periods of time." In Shelikof Strait pollock eggs are spawned at depth 250-300m and rise to the surface. Larvae are found 30–40m depth. Pollock eggs are found at the surface in the eastern Bering Sea so there could be other areas in the Gulf of Alaska where the eggs would be right at the surface. Note that Sablefish larvae are neustonic. They would be at risk in an oil spill that left Cook Inlet proper and contaminated the Gulf. Please check the AFSC (Alaska Fisheries Science Center) Icthyoplankton Information System http://access.afsc.noaa.gov/ichthyo/index.cfm for a complete listing of the habitats for the target species.

   Response: Additional information on pollock was added to Section 4.6.3.2.3. Detailed fisheries impact analysis would occur at the individual lease sale.

8. In the assessment of potential impacts on fish resources and EFH, the conclusion was that no permanent impacts on fish populations are expected although some fish populations may be measurably depressed for several years in the event of a spill. This conclusion fails to recognize the relative importance of a single year class to overall population health, such as is found with some gadid and herring species.

   Response: The size of a particular year class is affected by a variety of physical, chemical, and biological factors. Most impacts are unlikely to affect a whole year class unless the species is concentrated in one location. The text in Sections 3.7.4 and 4.4.6.4 was modified to add information on gadids and herring as appropriate to addressing permanent impacts on fish populations.

9. Commenter requests that the effects of platform removals be added to the summary section on fish and EFH impacts.

   Response: Added effects of platform removals to Section 4.4.6.4 on fish and EFH impacts.

10. The NMFS is in the process of rulemaking, which will remove the species identified below (Section 3.7.4.1) from their respective fishery management units in the GOM. Although final action has not occurred at this time, BOEM should verify their status prior to publishing the Final PEIS. (Contact: David Dale, Southeast Region Essential Fish Habitat Coordinator david.dale@noaa.gov). Reef Fish: dog snapper, mahogany snapper, schoolmaster, misty grouper, red hind, rock hind, blackline tilefish, anchor tilefish, sand perch, and dwarf sand perch. Coastal Migratory Pelagics: bluefish, cero, dolphin, and little tunny.

    Response: David Dale has been contacted, and the text in Section 3.7.4.1 was revised to reflect species updates provided by Mr. Dale.

11. Section 3.7.4.2: This section has an incomplete reference pointing only to NMFS (2005).

Response: It is uncertain as to what the commenter means by saying the reference is incomplete. However, the referenced link www.fakr.noaa.gov/npfmc/fmp/fmp.htm is no longer functional and has been replaced with www.fakr.noaa.gov/npfmc/index.html.

12. Section 3.8.4.2.3, Demersal Fishes: "Groundfish typically use Cook Inlet as a seasonal feeding area, while spawning occurs offshore, often on the continental shelf edge of the GOA." This is accurate for most but not all groundfish. Pollock, for example, use Shelikof Strait and the Shumagin Islands as their primary spawning areas, which are located above the continental shelf. NOAA recommends BOEM revise this text.

    Response: Areas used by Pollock have been clarified in Section 3.8.4.2.3.

13. Section 3.8.5.2, Alaska — Cook Inlet. Climate-change effects on commercially important crustacean species such as king and Tanner crab should be specifically mentioned here.

    Response: Text on ocean acidification and commercial crabs has been added to Section 3.8.5.2.

14. Section 3.8.5.3, Alaska — Arctic: More detailed information on crab stocks in this region can be found in Rand and Logerwell (2011) and in the Arctic FMP. See Rand, K. M., and E. A. Logerwell (2011). The first demersal trawl survey of benthic fish and invertebrates in the Beaufort Sea since the late 1970s. *Polar Biol.* 34:475–488.]

    Response: Snow crab information from Rand and Logerwell (2011) has been added to Section 3.8.5.3.

15. Commenter states that the DWH event resulted in potential long-term impacts to fish and impacts to commercial fisheries and cites literature support. Such revenue losses and long-term effects of spill- induced fishery closures on fishing communities must be recognized in Chapter 6 of the PEIS.

    Response: It is premature to say what the long-term effects of the DWH event may or may not be on fisheries in the GOM. Throughout the implementation of the 2012-2017 Program, BOEM will continue to review and incorporate research findings into our understanding of effects and our OCS oil and gas activities. The Whitehead study referenced in the comment was added to Section 3.8.4.1. The impacts of the DWH event on commercial fisheries are addressed in Section 3.12.1.1. Text has been added to Chapter 6 that discusses the effects of an unexpected CDE on long-term productivity.

16. The commenter wants more acknowledgement that the DWH event could produce long-term impacts to fish and provides citations for additional information.

    Response: The text in Section 4.4.7.3 states "...although there remains the potential for long-term population impacts from sublethal and chronic exposure." Discussion of impacts on the bluefin tuna was expanded in this section. Population dynamics are difficult to predict.

Productivity can be density-dependent. It is hard to determine the limiting factors for populations. Sublethal effects are possible, although they may be less pronounced in far-ranging species since they may not be exposed to geographically concentrated contamination. BOEM would concur that the true impact will take years to determine.

17. The commenter does not like the data cited in the text as sourced from a Mississippi State University website, feeling that the information is too limited, and provides his own analysis of fisheries impacts.

    Response: BOEM agrees that the information provided on the cited website is very limited in scope, and the text in Section 3.8.4.1 has been revised to remove the citation and associated reference. Information provided by the commenter was not peer-reviewed in nature, consisting of newspaper articles, and thus was not used to revise the PEIS. The PEIS does not claim there were no impacts on shrimp populations or shrimp fisheries from the DWH event. It is too early to assess the impacts of the DWH event on fish populations and fisheries catch and it will take time and rigorous scientific inquiry to determine the extent and severity of impacts from the DWH event.

18. Section 3.7.4.1 of the Draft PEIS states, "Oil released as a result of the DWH event affected more than 1,046 km (650 mi) of the GOM coastal EFH," citing OSAT-2 (2011) and National Commission (2011). Do these authorities refer to "EFH," or instead to "Gulf Coast habitats"? The commenter also states the PEIS should include the results from Atlantic Bluefin Tuna Status Review Team, 2011. Status Review Report of Atlantic Bluefin tuna (*Thunnus thynnus*), Report to National Marine Fisheries Service, and that there are many studies of the DWH event on marine life.

    Response: Gulf Coast habitats are considered EFH for reef and other species under the Gulf of Mexico Fishery Management Plan (Section 3.7.4.1). The Status Review 2011 report results were incorporated into the PEIS, and other text was modified to indicate there are many ongoing studies of the DWH event but little of the data is synthesized, peer-reviewed, and available.

19. Commenter asks whether the "long-term, population-level impacts" described in the Draft PEIS are adequately supported or, instead, largely conjectural? At a minimum, should not these statements be qualified by referring to current research suggesting that, while certain fish species may have experienced biological impacts in the short-term as a result of the DWH event, there is little evidence of a significant decrease in fish populations after the DWH event? See Fodrie et al. (2011); Atlantic Bluefin Tuna Status Review (2011).

    Response: This statement was not referring to the effects of the DWH event, but rather, the potential effects of catastrophic spills in general. The effects of the *Exxon Valdez* spill may have had population effects (see the *Exxon Valdez* Oil Spill Trustee Council site http://www.evostc.state.ak.us/), although it can be difficult to differentiate what was spill-caused and what was due to other factors.

20. Section 3.7.4.1 of the Draft PEIS states, "Although much of the oil remaining after cleanup is highly weathered, several constituents have the potential to cause toxicological effects (OSAT-2 2011)." Should this statement clarify that oil weathering depleted a large portion of the more toxic PAHs in oil? Should this statement reference Boehm SETAC (Society for Environmental Toxicology and Chemistry) and IOSC (International Oil Spill Conference) presentations on high rates of biodegradation for DWH oil?

    Response: The text has been clarified in Section 3.7.4.1 as suggested, but also includes a discussion of the OSAT-2 finding that the residual oil evaluated contained high-molecular-weight hydrocarbons, including the more toxic PAHs that are resistant to weathering and microbial biodegradation.

21. Section 3.7.4.1 of the Draft PEIS states, "The methane plume appeared to be relatively short-lived (Kessler et al. 2011), but dispersant was still detectable at low, nontoxic levels up to 300 km (186 mi) away from the wellhead 64 days after the dispersant release ended (Kujawinski et al. 2011).". The cited Kessler article reviews methane concentrations in August and September 2010, one to two months after the wellhead was closed. The timeframe of the Kessler article is similar to the 64-day timeframe of the dispersant study. Should the quoted PEIS statement be rewritten to note that methane was effectively consumed within one to two months, and that dispersant concentrations, while still detectable, were very low (at the ng/L level) — well below toxic concentrations - in the same time period?

    Response: Text in Section 3.7.4.1 modified to: "The methane plume appeared to be relatively short-lived with most of the methane being consumed by bacteria within 120 days from the onset of release (Kessler et al. 2011). Dispersant was detectable at low, nontoxic levels up to 300 km (186 mi) away from the wellhead 64 days after the dispersant release ended (Kujawinski et al. 2011). Sediment and water quality contaminant data from OSAT also added.

22. Section 3.12.2.2: The 1987 sourced information appears dated. Suggest including a statement that no more recent data are available in place of the implicit statement. Suggest investigating the availability of more recent information on recreational fishing than 1987 studies.

    Section 3.12.2.3: There is quantitative data presented for most types of the fishing or statements to indicate the lack of such data. Provide similar statements for the subsistence fishing as other fisheries if available.

    Response: The text in the PEIS has been changed in Sections 3.12.2.2 and 3.12.2.3 to reflect the data noted in the comment.

23. Section 4.4.7.3.1, Protected Species: Gulf Sturgeon: Although accidents are addressed to some degree for this species, why have impacts from a CDE not been discussed more extensively, or at least within the "Accidents" section? Data obtained during the DWH event

studies (i.e., OSAT 1) would aid in understanding the vulnerability and/or potential effects (or not) from such a unique event.

Response: Section 4.4.7.3.1 has been modified. Although there are many ongoing studies, there is very little actual data and even less consensus on the effects of the DWH event on future fish populations. The Fodrie paper is one of the few peer-reviewed papers currently available and it is cited in the PEIS as is the population model for bluefin tuna. The OSAT studies were of sediment and water column PAH concentrations and are discussed in the habitat discussions presented in this PEIS (see Section 4.4.6). Also, the DWH event should not be taken as being necessarily similar to future spills, although the PEIS includes an analysis of the potential effects to fish and fish habitats in an unexpected CDE were to occur in the GOM.

24. Section 4.4.11.1.1: This section is extremely limited considering the biological, economical and sociological attributes associated with commercial and recreational fishing in the GOM.

Response: The biological, economic, and sociological aspects of commercial fishing in the GOM are covered in detail in Sections 3.12 and 3.14 of the PEIS. The intention of Section 4.4.11.1 is to provide a description of expected cost impacts on commercial fisheries, and the various regulatory limits on activity. Additional information was added as appropriate. Detailed evaluation of fisheries will be considered in specific lease sales.

25. The Draft PEIS fails to appropriately consider information from the Deepwater Horizon event in analyzing the environmental impacts of future spills. Chapter 6 asserts that there has been "no discernible decrease in [biological] productivity in U.S. offshore areas where oil and gas have been produced for many years." Yet, early data from the Deepwater Horizon event strongly suggests that this is not the case. At the height of the Deepwater Horizon event, 36% of Federal waters in the GOM were closed to commercial and recreational fishing, suggesting there were, in fact, significant biological impacts. We understand that the timeframe for completing the PEIS makes it impossible to incorporate all the lessons learned from the Gulf spill. However, this does not absolve BOEM from considering existing information and analyzing the potential for environmental impact, especially given the numerous assurances of Federal leaders and agencies that the same mistakes will not be made twice.

Response: Reasons for fishery closure are not tightly linked to biological productivity. The closures were to protect human health and the perception of the quality of the seafood not from spill areas. This way the public is reassured that fish being sold could not be from spill-affected areas. Studies of the DWH event are ongoing and conclusions cannot be drawn at this time concerning effects on overall productivity.

26. Commenter requests clarification and consistency on impact tables in Section 4.4.7.

Response: Definitions of the impact levels used in the PEIS are provided in Section 4.1.4. Minor is defined as: "If impacts occur, the affected resource will recover completely without mitigation once the impacting stressor is eliminated." There is literature describing how noise can affect fish, and therefore, the definition of "minor" better fits with the impacts on fish as described in the literature. Text has been modified in Section 4.4.7 to match the table when they are not consistent.

27. Section 4.4.7.3: The sentence "However, fish larvae may suffer greater mortality because of their small size and relative lack of mobility" is speculation, and should be referenced or removed.

    Response: A reference has been added in Section 4.4.7.3 to support the original statement.

28. Summary, Fish Resources and Essential Fish Habitat: This language incorrectly singles out seismic potential impact for displacement of fish in the vicinity of the activity. The implication made that seismic surveys such as those that will be conducted under the Program will injure or kill fish in the vicinity of the seismic survey activity is not correct, and is not supported by the scientific literature. Therefore, these references/statements should be corrected or removed.

    Response: The text in the Fish Resources and Essential Fish Habitat section of the Summary was modified to include other noise sources. There is some uncertainty as to the impact magnitude of seismic surveys on fish, but impacts are possible. Complete discussion of noise effects on fish can be found in Section 4.4.7.3.1 (Fish Resources-GOM), which can include mortality.

29. Section 4.4.7.3.3: It should be stated that moderate impacts are expected in the case of a CDE.

    Response: The text in Section 4.4.7.3.3 was modified as requested.

30. Section 4.4.7.3.1, Protected Species: Gulf Sturgeon, Accidents: The essential features of Gulf sturgeon critical habitat could be affected by accidental discharges of oil and other chemicals. NOAA recommends that the essential features of critical habitat be discussed for their potential to be adversely affected.

    Response: The potential for impacts on Gulf sturgeon critical habitat are noted in the existing text in Section 4.4.7.3.1. The potential impacts of oil spills on coastal habitats that comprise the critical habitat of the Gulf sturgeon are described in Section 4.4.6.1, and a reference to this section has been added to Section 4.4.7.3.1, where the Gulf sturgeon is discussed. More detailed treatment of Gulf sturgeon Critical Habitat would be provided in future specific lease sale EISs.

31. Section 3.8.4.1.4: The units that may be affected by the lease plan should be listed and described. Maps should also be provided. The essential features of Gulf Sturgeon critical habitat that are provided in the final rule should be described as well. Southeast U.S. critical habitat metadata can be found on NMFS GIS page at http://www.nmfs.noaa.gov/gis/

data/critical.htm#se. An image of all the critical habitats units is available at http://www.nmfs.noaa.gov/pr/pdfs/criticalhabitat/gulfsturgeon.pdf.

Response: An expanded listing of Gulf sturgeon critical habitat and supporting citations have been added to Section 3.8.4.1.4. The coastal habitats used by Gulf sturgeon are described in Section 3.8.4.1.4 and a figure depicting critical habitat has been added to this section.

32. Section 3.12.2.3, Alaska — Arctic. NOAA recommends that the paragraph on subsistence fisheries be expanded considerably. There is abundant literature documenting the locations, levels, and importance of subsistence fishing to Arctic communities.

    Response: Section 3.12.2.3 discusses only recreational fisheries, so subsistence fishing is not discussed. The paragraph was removed because it is not appropriate for the section. Subsistence fishing is discussed in detail in Section 3.14.3.2

33. Section 4.4.7.3: The text in this section is erroneous and misleading, as the circumstances created by the study (i.e., repeated, close exposure to an airgun over an extended period of time) would almost certainly not take place in association with actual seismic surveys conducted under the Program. The sentence should be removed or corrected.

    Response: Section 4.4.7.3 states that the study refers to continuous long-term exposure. Later in the paragraph, the text states that “For adult fishes, continuous exposures are unlikely under natural circumstances as fish could move from the area.” The text in Section 4.4.7.3 was modified to make this clearer.

34. Section 2.10, Table 2.10-2, Essential Fish Habitat: The summary of Potential Impacts on Essential Fish Habitat for Alternative 1 – Proposed Action only mentions coral as a type of EFH. This summary should be similar to the Potential Impacts described for Coastal and Estuarine Habitats (Section 4.4.6.1) and Marine Pelagic Habitats (Section 4.4.6.3).

    Response: The text in Section 2.10 was modified to include other EFH and relevant mitigation measures.

8.4.4.4.15 Issue 4.15 Oceanography.

1. Commenters requested a more detailed description of ice conditions and dynamics in Cook Inlet be provided in the PEIS, as ice and scour are important impact-producing factors, and sea ice conditions differ between the upper and lower portions of Cook Inlet.

    Response: Section 4.2.2 of the PEIS was revised to describe differences in sea ice conditions in the lower and upper reaches of Cook Inlet.

2. The State of Alaska requested that BOEM contrast in Chapter 2 the Alaska OCS planning areas to deepwater environments in the GOM, differentiating physiography and physical oceanography.

   Response: The principal purpose of Chapter 2 is to present the alternatives considered and analyzed in the PEIS, rather than differentiating between planning areas evaluated under the Program alternatives. Section 2.9 describes the alternatives that were considered but eliminated from further consideration. Section 4.2 provides a detailed description regarding the physiography and physical oceanography of the Arctic and Cook Inlet in comparison to the GOM.

8.4.4.4.16 Issue 4.16 Areas of Special Concern.

1. Several sections of the Draft PEIS discuss "areas of special concern." These discussions focus on designated areas such as marine protected areas. Since there are few marine protected areas designated for the Alaska Arctic, we (the Northwest Arctic Borough) recommend these sections be expanded to include important ecological areas. The 2010 Arctic Marine Synthesis Atlas of the Chukchi and Beaufort Seas provides a good source for areas of ecological importance.

   Response: The different types of Areas of Concern (AOCs) are given at the beginning of Section 3.9. Ecologically important areas of the Arctic are described in the PEIS in detail under separate resource categories presented in Sections 3.7 and 3.8. More detailed habitat descriptions are most appropriate for a specific lease sale EIS.

2. Discussion should be included as to whether or not consideration was given to the exclusion of areas designated as national marine sanctuaries and monuments, essential fish habitat, or habitat areas of particular concern from leasing. Additionally, some consideration should be given at the program planning stage to alternatives other than sales of all unleased acreage. In particular, recognition of sensitive and protected marine habitats (e.g., Hanna Shoal) should be considered at this stage, rather than waiting until the lease sale stage.

   Response: Exclusion areas are generally determined at the lease sale stage. Section 2.9.5 of the PEIS addresses alternatives recommending the addition of new areal and temporal exclusion areas, as well as the rationale for generally deferring the designation of exclusion areas to the lease sale phase. In addition, a new section (Section 4.3.2) discussing programmatic deferrals and mitigation can be found in Section 4.3, Issues of Programmatic Concern. Also, see responses to Comments 2 and 3 in Section 8.4.4.1, NEPA Process and Public Involvement, for further discussion of exclusion areas and alternatives.

3. The Natural Diversity Database maintained by Texas Parks and Wildlife Department (TPWD) indicates that more than 200 rookeries and migratory bird fallout sites, more than 50 rare or special terrestrial communities, 40 rare plant populations, and over 170 records of State and/or federally listed endangered, threatened, or rare vertebrates have been documented within 10 miles of the Texas coastline.

Response: The different types of AOCs are given at the beginning of Section 3.9. The important ecological areas of the Arctic do not have the legal definitions typical of AOCs. However, the ecologically important areas of the Texas coastline are described in the PEIS in detail under separate resource categories. These include Section 3.8.2.1, Marine and Coastal Birds, and Section 3.7.1.1, GOM Coastal and Estuarine Habitats. Endangered species are discussed under individual sections on birds, reptiles, and fish. Specific mention of the importance of the large coastline of Texas for biota has been added to the text in these sections. More detailed habitat descriptions would be provided in lease sale-specific EISs.

4. The Draft PEIS states, "These habitats were also affected by prevention and cleanup efforts (NOAA 2010)." PEIS at Section 3.7.4.1. To which NOAA source does this statement cite?

   Response: The text in Section 3.7.4.1 has been revised to cite OSAT-2 (2011) rather than NOAA 2010.

8.4.4.4.17 Issue 4.17 Archeological and Historical Resources.

1. The proposed 5-year leasing program includes two sales in 2014 and 2016 in the Eastern GOM Planning Area. We do have concerns about potential adverse impacts to cultural resources. Requirements for cultural resource surveys in areas that have potential to encounter historic sites and properties should be implemented. Adequate buffer areas for site protection of significant resources and the avoidance of adverse impacts should be required. Both coastal and submerged sites and properties must be considered prior to any undertaking.

   Response: The required Section 106 consultations set forth in the National Historic Preservation Act (NHPA) and its implementing regulations will be carried out during the lease sales proposed under the oil and gas program and during subsequent undertakings that require approval subsequent to lease issuance. As required in the *Identification of Historic Properties* part (36 CFR 800.4), BOEM will determine the scope of identification efforts, review existing information, and seek information on existing and potential historic properties from consulting parties and the public. BOEM may require cultural resource surveys as part of its reasonable and good faith effort in carrying out appropriate identification efforts based on current research, the magnitude and nature of the undertaking, and the nature and extent of potential effects on historic properties. Any adverse effects on cultural resources may require mitigation.

2. There is a concentration of the wrecks of historically important whaling ships off of Cape Lisburne.

   Response: Section 3.16.3.2 acknowledges that numerous shipwrecks are found in the Cape Lisburne area. In the event that exploration or development operations are proposed for that area, BOEM is required to comply with the Section 106 process of the NHPA. As required in the *Identification of Historic Properties* part (36 CFR 800.4), BOEM will determine the scope of identification efforts, review existing information, and seek information on existing and potential historic properties from consulting parties and the public. BOEM may require cultural resource surveys as part of its reasonable and good faith effort in carrying out appropriate identification efforts based on current research, the magnitude and nature of the undertaking, and the nature and extent of potential effects on historic properties. Any adverse effects on cultural resources may require mitigation.

8.4.4.4.18 Issue 4.18 Human Health Assessment.

1. Commenters from both the GOM and the Arctic expressed concern regarding a variety of health issues such as the incidence of diabetes, heart disease, cancer, and respiratory ailments, and concern that these health issues could be caused or exacerbated by oil and gas development activities and oil spills. Commenters from the Arctic cited that their concerns were based on traditional knowledge and personal observations.

   Response: BOEM recognizes the concern for human health and the potential impacts of oil and gas development on human health. BOEM has identified human health impacts as an issue of programmatic concern and expanded the discussion presented in the PEIS (see Section 4.3.4). Health effects will be further considered at the later stages of the oil and gas development process (e.g., with NEPA documents prepared during the lease sale stage).

2. Commenters requested that human health assessments be conducted as soon as possible, including before a decision is made on the 2012-2017 OCS O&G program; commenters also question BOEM’s decision for deferring the conduct of health assessments to later stages of oil and gas development (lease sale or later).

   Response: This PEIS is a broad-level document discussing impacts over entire planning regions, which address a different spatial scale than would the examination of health issues of specific human populations at specific locations. The conduct of human health assessments to evaluate potential impacts to populations at specific locations is more appropriate at the lease sale or plan stage, when there will be a better understanding of where development may actually occur and who may be affected.

3. There is concern of mercury poisoning that is occurring throughout the Arctic (including Canada) needs to be addressed. The commenter also expressed concern regarding flaring.

   Response: The PEIS evaluates potential impacts at a broad, planning area scale. The analysis of cumulative impacts presented in Sections 4.6.1.2.2, 4.6.1.2.3, and 4.6.1.2.4 of the PEIS discuss the cumulative impacts of persistent contaminants, including mercury. The evaluation of mercury releases and flaring will be further addressed at the lease sale level, where the evaluations can focus on specific locations and populations.

4. BOEM should review the Operational Science Advisory Team report (OSAT-2) on the fate and effects of remnant oil and revise the Draft PEIS to better address the potential for human contact with tar balls, oil weathering and human contact, reoiling potential, and the fate of oil-related volatile organic compounds.

Response: The OSAT-2 report was reviewed and is cited in Section 4.3.4.4 of the PEIS. This section has been revised in the PEIS to better discuss human contact with tar balls, human contact with oil and oil weathering products, reoiling potential, and the fate and transport of VOCs.

5. Was the Goldstein et al. 2011 study on the mental and physical health effects of the DWH event, cited in Section 4.3.4.4 of the Draft PEIS, done using an appropriate baseline? Should this statement be revised or deleted because it pertains to surveys of first responders to Hurricane Katrina?

   Response: The Goldstein et al. 2011 report is a summary article that reports the finding of multiple other peer-reviewed publications that specifically investigated the impacts of oil spills on mental and physical health. Some studies did note that some of the mental health effects observed following the DWH event may have been compounded, as some of the spill responders were also Hurricane Katrina responders who suffered some of the same mental health effects. Section 4.3.4.4 has been revised to include the findings of a recent study (Osofsky et al. 2011) that specifically examined mental health impacts following the DWH event and considered effects from Hurricane Katarina.

6. Section 4.4.4.1 of the Draft PEIS states, "The effects of a catastrophic discharge event on public health and the environment can be classified as short-term and long-term effects. The short-term effects include watery and irritated eyes, skin itching and redness, coughing, and shortness of breath or wheezing." Should this statement be revised to state that short-term effects may include the aforementioned issues?

   Response: BOEM agrees that the aforementioned effects 'may' occur, and the referenced text in Section 4.4.4.1 has been revised to state that the short-term effects 'may' include the aforementioned effects.

7. Section 4.3.2.4.1 of the Draft PEIS states, "After an accidental release of oil into the environment, the more volatile, water-soluble, and degradable compounds will be weathered and degraded, leaving behind the heavier, less degradable elements." Should this statement be clarified to reflect the fact that hydrocarbons with higher molecular weights will ultimately undergo weathering, but at slower rates? Additionally, the heavier, less-degradable elements have lower toxicity.

   Response: BOEM agrees with the comment, and the text in Section 4.3.4.4.1 (previously Section 4.3.2.4.1) has been revised as suggested.

8.4.4.4.19 Issue 4.19 Socioeconomics.

1. Concerns about oil and gas development, and especially oil spills, will affect tourism and the restaurant, fishing, and service industries in the GOM.

Response: BOEM acknowledges that socioeconomic impacts are possible, especially in the event of large oil spills. The role of the food service, fishing, and tourism sectors in the economic baseline of the GOM, and the potential impacts of OCS oil and gas activities (and spills) on these sectors are discussed in Sections 3.10, 4.4.9, 4.4.11, and 4.4.12 of the PEIS.

2. The resources of the OCS are a vital source of jobs, revenue, energy, reliability, security, and economic growth, the importance of which is reported in an independent study in the GOM.

   Response: The PEIS has been revised in Section 3.10 to include information referenced in the comment.

   The economic impact of the oil and gas industry on employment in the GOM is presented in Section 3.10.5 of the PEIS. Although no projections of direct oil and gas employment are provided, current baseline conditions and projections to 2030 provided for population, employment, and earnings for the region, assuming current levels of leasing activity. These projections include long-term projections of oil and gas industry activity, spending, and employment, and implicitly assume levels of activity in the industry based on existing lease sales before the DWH event and the drilling moratorium.

   Although BOEM agrees that the oil and gas sector has significant impacts on the remainder of the United States, both in terms of capital and labor expenditures, the PEIS assessed the impact of existing oil and gas activity and of proposed OCS activity in the counties adjacent to the GOM, rather than the entire United States, as this would be the region most affected by the proposed OCS activity.

3. Section 4.4.9.3 demonstrates that most of the estimated employment benefits from oil and gas activities in the Arctic will go to Alaska's largest population centers. While the North Slope Borough may tax infrastructure within its boundaries associated with offshore development, the Northwest Arctic Borough would receive increased risks to its socioeconomic structure without commensurate economic impacts/benefits. Recommend the PEIS include a discussion of how revenue sharing could increase local economic benefits, and how environmental justice issues are involved with the leasing of the area, particularly with low-income minority communities being placed at risk.

   Response: Under current fiscal circumstances, the Northwest Arctic Borough would not receive direct revenue from OCS activities in the Chukchi Sea. The Borough is currently receiving fiscal support from the State of Alaska as a result of the shipment of oil and gas through TAPS and associated infrastructure and from Alaska Native Corporation investments in oil companies. Individuals resident in the Borough also receive benefits from the Alaska Permanent Fund Dividend. Per Section 18 requirements of the OCSLA, the "Equitable sharing of Developmental Benefits and Environmental Risks" section (in Part IV.C) of the Proposed Final Program (PFP) discusses equitable sharing of development benefits and risks. The PFP describes the three current programs that contribute revenue to coastal producing states, including Section 8(g), Revenue Sharing, which provides coastal producing states with 27% of revenues from all leases within 4.8 km (3 mi) of a state's submerged lands boundary. While impact assistance and other such programs provide a share of Federal revenues to

States and political subdivisions adjacent to or near OCS development to help to mitigate environmental risk, the Secretary cannot expand, extend, or otherwise revise the provisions to further the equitable sharing of the developmental benefits and environmental risks. Although different revenue schemes could change the flow of economic benefits to different States, or indirectly to certain coastal communities, it is speculative at this phase what those impacts could be, given different, potentially wide-ranging revenue-sharing scenarios. Analysis of the impacts of OCS activities on sociocultural resources in the Northwest Arctic Borough is also presented in Section 4.4.13.3 of the PEIS.

Projected economic benefits of OCS activities in the Arctic region, including labor income and employment estimates, are described in Section 4.4.9.3 of the PEIS. Detailed analysis of economic flows to a specific local community is not ripe at the 5-year decision point, as the programmatic analysis is too broad to distinguish local economic impacts. It should be noted that direct benefits from OCS activity may come in the form of property taxes on onshore operations or other sources. A more detailed analysis of the potential fiscal impacts of OCS development in the Chukchi Sea would be undertaken at the lease sale level.

Potential environmental justice impacts of OCS activities in the Northwest Arctic Borough are included as part of the analysis of impacts in the Arctic region. These impacts are described in Section 4.4.14.3 of the PEIS.

4. NOAA has previously commented that public perception of contaminated seafood and market/price/economic impacts may be great, as was seen with Deepwater Horizon. NOAA recommends that the PEIS discuss public perception of contaminated seafood as a potential impact.

   Response: The impacts of the DWH event on commercial and recreational fishing are discussed in Sections 3.12.1.1 and 3.12.2.1 of the PEIS, and additional text has been added to Section 3.12 regarding public perception of contaminated seafood. The PEIS states that although the impact of the event on fish landings has not been determined, Federal waters were closed to fishing for two months after the event, to address the perception of contamination.

   The potential impacts of perceived contamination of commercial and recreational fish as a result of OCS accidents are discussed in Sections 4.4.11.1, 4.4.11.2, and 4.4.11.3 of the PEIS. Given the region-specific nature of fisheries, additional information on the impact of adverse perceptions on demand for fish in OCS areas would be analyzed at the lease sale level.

5. BOEM needs to better evaluate and present potential economic costs and benefits of the alternatives under its consideration, taking particular care to ensure that information about the potential economic impacts of various alternatives is accurate. It also must ensure that this information is fully and fairly depicted in the PEIS. Importantly, BOEM must revisit its analysis of the no action alternative in order to more fully depict the potential benefits of no action, ensure that costs are depicted appropriately for the Arctic region, appropriately incorporate conservation and efficiency, and include a discussion of option value. Once it

corrects those failings, BOEM must use this information in the PEIS to more accurately reflect the costs and benefits of alternatives relevant to the Arctic Ocean.

Response: An analysis of the economic impacts of each alternative, including the No Action Alternative, is included in the PEIS (Section 4.5.7). A cost-benefit analysis was prepared in support of the Program, and this analysis is discussed in Section 2.12 of the PEIS. Impacts of the proposed action on population, employment, and earnings, are presented in Section 4.4.9, on commercial and recreation fisheries in Section 4.4.11, and on recreation and tourism in Section 4.4.12. The impacts of the No Action Alternative, which includes population, employment, and earnings projections to 2030, assuming that currently leased OCS activities continue, are presented in Section 4.5.7, which has been revised to provide additional analyses. Energy substitutes that could be used in association with the No Action Alternative are described in this section. Presentation of more specific information, including a discussion of option value, is more appropriately included in the assessment of the impacts of individual lease sales.

6. The Deepwater Horizon event threatens the long-term productivity of over 100 species of fish, crustaceans, mollusks, and invertebrates that are commercially fished in the GOM. Commercial fisheries represents a revenue stream that drives part of the GOM economy. However, as demonstrated above, oil and gas drilling (and especially spills) threatens the long-term integrity of GOM species. This tradeoff needs to be acknowledged in Chapter 6 of the PEIS.

   Response: The discussion in Section 4.4.11.1 on the importance of commercial fisheries to the economy of the GOM has been revised to include more recent information. Chapter 6 has been revised to include a discussion of the potential effects of oil spills on the long-term productivity of the GOM.

7. The Draft PEIS makes several statements regarding the effects of the DWH event on the surrounding coastal housing markets. Many of the cited sources are inappropriate, and the statements ignore the general nation-wide collapse of the housing industry. The comment provides several citations and requests that the PEIS be revised to more accurately portray the housing market of the GOM.

   Response: Text in the PEIS has been revised in Section 3.10.7 to clarify the status of the GOM housing market and include data referenced in the comment.

8. Section 3.10.2.2: The percentage of individuals living in poverty in the North Slope Borough and the Northwest Arctic Borough were both compared to the community of Barrow; however, the comparison is for a community within the borough. Barrow is located within the North Slope Borough and not within the Northwest Arctic Borough.

   Response: The text and table in Section 3.10.2.2 have been revised to reflect the comment.

9. Section 3.13.3.2: There is only one casino in Alaska operated by Metlakatla Tsimshian Tribe, which is an Indian-owned establishment on their land. There are gaming (pull-tab and bingo) establishments operated for the benefit of non-profit organizations.

   Response: The text in Section 3.13.3.2 has been revised to reflect the comment.

10. Section 4.4.11.1.1 is extremely limited considering the biological, economic, and sociological attributes associated with commercial and recreational fishing in the GOM.

    Response: The biological, economic, and sociological aspects of commercial fishing in the GOM are covered in detail in Sections 3.8.4.1, 3.12.2.1, and 3.14.1 of the PEIS. The intention of Section 4.4.11.1 is to provide a description of expected cost impacts on commercial fisheries and the various regulatory limits on activity.

11. Section 5.3 has no discussion on 'Economic Activity' included in this subsection. Consider adding the section from either the Supplemental EISs for the GOM Central or Western Planning Areas (OCS EIS/EA BOEMRE 2011-027 or -034 respectively).

    Response: Text in Section 5.3 of the PEIS has been revised to include a discussion of economic activity.

12. The Draft PEIS states that the impacts to local economies and employment would be minimal with the expansion of leases. It was also noted that current employment related to oil and gas in the Gulf States is roughly 62,000 people, with most of those jobs located in Texas and Louisiana. In comparison, the recreation and tourism industries employ roughly 1,000,000 people across the Gulf Coast. While we understand the oil and gas leasing program's importance in ensuring adequate energy resources for the nation, it is important to recognize the oil and gas industry's potential to impact the health of other industries, as was clearly displayed by the 2010 Deepwater Horizon Event.

    Response: A description of the role of the recreation sector, including beach recreation, casino gambling, and recreation and tourism employment, as well as a description of the benefits of oil and gas development and also the economic impacts of historic oil spills, are included in Section 3.13. The economic impacts of the DWH event, including those on recreation and tourism, are described in Section 3.10.7; while the economic impacts of OCS activity (including impacts of expected and unexpected accidental oil spills) on recreation and tourism are discussed in Section 4.4.12 of the PEIS.

13. We are concerned that the analysis presented in the Draft PEIS does not appear to be considering the socioeconomic impacts of the Proposed 5-year Program on people living in all 50 States of this country. We strongly recommend that the final program and environmental impact statement fully consider the socioeconomic impacts on all the American people that would come from both producing energy from the offshore, and of not producing energy from many areas of the offshore. The resources of the OCS are owned by

all Americans, and the hardship created by withholding our energy resources from people in middle America should be considered in the decision-making process.

Response: Although BOEM agrees that the oil and gas sector affects the remainder of the United States, both in terms of capital and labor expenditures, the PEIS principally assessed the socioeconomic impact of existing oil and gas activity, and of proposed OCS activity, in the counties adjacent to the GOM, and in Alaska as a whole, as these would be the regions most affected by the proposed OCS activity. Impacts to specific states or communities in the remainder of the United States would be comparatively small and are not therefore specifically addressed in the analysis. However, the aggregate, national net benefits and costs of the Program are summarized in Chapter 2 of the PEIS and presented in detail in the Proposed Final Program.

14. The Draft PEIS erroneously concludes that in areas where tourism and recreation provide significant employment, accidental oil spills, including catastrophic discharge events, would result in only “short-term loss of employment, income and property values.” The Draft PEIS even goes so far as to imply that oil spills could benefit the economy in some affected coastal regions because “expenditures associated with spill clean-up activities would create short-term employment.” The conclusion that a catastrophic oil spill would only result in short-term economic impacts is totally unfounded and is contradicted elsewhere in the Draft PEIS where the Department acknowledges that the Deepwater Horizon event had “significant economic impacts throughout the (GOM) region, affecting population, employment, and regional earnings and incomes.

    Response: Although it is often not possible to quantify all the impacts that may occur as a result of an oil spill, the analysis in the PEIS does not intend to suggest that there would be no adverse impacts resulting from an accidental spill. There could be some longer-term economic impacts because of real or perceived changes in the quality of resources or recreational values, especially with an unexpected CDE. It is clear that there would be employment and income impacts from a spill with the loss of tourism and recreation spending, and the temporary loss of revenues from the sale of commercial fish catches. These losses have been documented in the PEIS where data are available. For small and large anticipated accidental spills, employment and income losses in these two sectors would be offset, at least to a certain extent, by spill cleanup expenditures and the resulting employment and income, offsetting adjustments that are likely to occur over a number of years. For an unexpected CDE, impacts could be much more long-term, depending on the location, size, and duration of the CDE and the effectiveness of spill control and cleanup activities.

8.4.4.4.20 Issue 4.20 Environmental Justice.

1. Indigenous peoples and tribal communities in the Arctic are disproportionately impacted by industrial activities in the Gulf of Alaska, Bering Sea, Chukchi Sea, and Beaufort Sea. Please refer to the recent MMS study entitled Three Decades of Research and Socioeconomic Impacts Related to Offshore Petroleum Development in Coastal Alaska

Response: Text in the PEIS has been revised to include the document referenced in the comment.

2. The co-existence of native subsistence hunting and fishing and modern commercial and industrial development in Alaska should be more fully explored in the context of the future lease sales. These uses of the OCS can co-exist with the proper stipulations and mitigations in place. The PEIS should include a discussion of the Inupiat customs and culture along with a description of the North Slope Borough and its villages and towns. The PEIS should also discuss some of the proposed oil and gas development activities in this region and the mitigation measures (e.g., the marine mammal monitoring program and the oil spill response plans) that have been developed to avoid or minimize potential adverse effects.

   Response: The impact of individual lease sales and Alaska Native hunting and fishing for subsistence purposes would be assessed in the relevant lease sale EIS. Sections 3.14 and 4.4.13 of the PEIS provides a discussion of the programmatic impact of oil and gas development on subsistence activities in Alaska. The PEIS also includes discussion of the sociocultural aspects of the North Slope, including descriptions of the villages and towns in Sections 3.14 and 4.4.13 of the PEIS. Demographic information on these communities, where data are available, is provided in Section 3.10.2 of the PEIS. Mitigation measures developed to protect species important to Alaska Native communities are presented in Appendix B of the PEIS.

3. An environmental justice analysis should be conducted that identifies whether and to what extent the Inupiat people are being asked to bear a disproportionate share of the environmental burdens created by the Nation’s 2012-17 offshore program.

   Response: Section 3.15 provides a description of the distribution of low-income and minority populations in the areas adjacent to the planning areas considered for leasing under the 2012-2017 Program, and Section 4.4.14.3 presents an assessment of the environmental justice impacts of OCS activities, that could occur on the North Slope under the 2012-2017 Program. BOEM uses the most up-to-date information that can be gathered from public participation, studies, and census bureau data.

4. While local communities in Northwest Alaska receive few benefits from OCS activities, they bear all direct risks from offshore oil and gas activities including threats to the environment, social structure, and Inupiat culture. Recommend the PEIS include a discussion of how revenue sharing could increase local economic benefits, and how environmental justice issues are involved with the leasing of the area, particularly with low-income minority communities being placed at risk.

   Response: Potential environmental justice impacts of OCS activities in the Chukchi Sea on the Northwest Arctic Borough are included as part of the analysis of impacts in the Arctic region, which also includes the North Slope Borough. These impacts are described in Section 4.4.14.3 of the PEIS. Analysis of the impacts of OCS activities on sociocultural resources in the Northwest Arctic Borough is also presented in Section 4.4.13.3 of the PEIS.

Projected benefits of OCS activities in the Arctic region are described in Section 4.4.9.3 of the PEIS. A more detailed analysis of the potential fiscal impacts of OCS development in the Chukchi Sea on the Northwest Arctic Borough would be undertaken at the lease sale level.

8.4.4.4.21 Issue 4.21 Invasive Species.

1. In the past, the threat of invasive species introductions has not been considered significant as it compares to the threat in other areas, because there has not been a large amount offshore drilling in the Alaska OCS. However, the potential for introduction may increase in the future with increased oil and gas development activities.

   Response: The text in Section 4.3.5, Invasive Species, has been revised to indicate that while introduction of invasive species through oil and gas activities was historically not considered significant because of the very low level of offshore drilling in Alaskan waters, the potential for introduction may increase with increased drilling, together with potential climate-related changes in environmental baseline conditions.

8.4.4.4.22 Issue 4.22 Sociocultural and Subsistence Issues.

1. Subsistence harvesting is essential to Arctic Alaska Native communities both as an important source of food and as a central defining aspect of their culture. Marine and coastal environments provide a significant part of their diet, which is both important to Native health and not easy to replace from outside sources. The exchange of resources harvested from the wild is important to the maintenance of social ties both within and between communities. Participation in learning subsistence harvesting skills is an essential part of passing Alaska Native culture on to the next generation. Arctic Alaska Native culture depends upon the maintenance of healthy ecosystems.

   Response: BOEM is aware of the central importance of subsistence harvesting, in particular the bowhead whale hunt, to Arctic Alaska Native communities with regard to food security, human health, traditional socio-cultural values, and cultural continuity. BOEM strives to manage oil and gas development on the OCS in a manner that minimizes or eliminates threats to subsistence harvesting. The importance of subsistence harvesting to native cultures is discussed in Sections 3.14.3 and 4.4.13.3.

2. Several Alaska Native commenters expressed concerns over the effects of an oil spill on subsistence marine resources. They feared that spilled oil could taint or eliminate species important to their survival. They expressed doubts that a spill could be contained in Arctic waters, that there was not sufficient local infrastructure or labor force for a quick, efficient response and that clean-up procedures in icy conditions are unproven.

   Response: BOEM understands these concerns regarding the possible effects of an oil spill in the Arctic and has updated Section 4.3.3, Risk of a Low-probability Catastrophic Discharge Event, with new information that pertains to oil spill response and containment in the Arctic.

BOEM has also added additional text in Section 4.3.2, Programmatic Deferrals and Mitigations, which discusses stakeholder requests to delay Arctic leasing until adequate oil spill response and containment is proven in the context of how these concerns will be further evaluated during the program. The effects of an oil spill on marine mammals are discussed in Section 4.4.7.1 of the PEIS

3. Several Alaska Native commenters related experiences in the past where off shore oil and gas exploration and development had had negative effects on subsistence resources.

   Response: The BOEM and BSEE take seriously Alaska Native concerns regarding subsistence resources and seek to take into account what has been learned about the effects of oil and gas development from past experience, including the experience of Alaska Natives, in developing and enforcing stipulations at future lease sale stages.

4. Several Alaska Native commenters have advocated additional spatial and\or temporal deferrals that would lessen adverse effects on marine mammal migration and behavior at critical times and in critical places such as whale migration routes at certain times of the year.

   Response: There has been an extensive dialog between the North Slope Borough and BOEM regarding prospective deferrals. BOEM seeks to work with stakeholders in formulating mitigation, particularly to protect bowhead whales and other marine mammals and minimize conflicts with subsistence practices. Section 4.3.2 of the PEIS discusses programmatic deferrals and mitigation, and describes a process that BOEM is putting in place to identify, evaluate, and prepare for implementation, and mitigation strategies (which may include deferrals) that may be applied at appropriate program decision points. This process includes stakeholder input into the development of mitigation strategies. BOEM has informed the North Slope Borough that consideration of deferrals will be carried forward into the lease sale stage.

5. Several commenters related their perception of climate change and its effects on the Arctic environment. These included warmer temperatures and diminished ice pack. They expressed concern over the loss of ready access to sea mammal haulouts because of retreating and thinning ice. They were also concerned that more ice free days would encourage an increase in shipping traffic, which in turn would interfere with whale migration patterns.

   Response: Section 3.14.3 has been revised to include more information on climate change and its possible effects on subsistence harvesting

6. Several commenters expressed the need for greater communication both with Federal Government agencies and oil and gas companies. They felt that Federal agencies were not listening to their concerns and requested more consultation. They requested increased avenues of communication among local populations. Alaska Natives requested additional training on how they could have more input into decisions related to oil and gas

development. They also felt that oil and gas company personnel would benefit from a better understanding of local culture.

Response: BOEM is committed to meaningful communication and consultation with the Alaska Native communities that rely on subsistence harvesting from Arctic waters. Consultations with Alaska Native tribal governments took place during the scoping process and in association with public meetings on the draft. Alaska Natives expressed their concerns in public meetings during the scoping period and submitted letters commenting on the draft. These comments have been taken into account in the PEIS. Under DOI Order No. 3117 issued in December 2011, meaningful consultation with Alaska Native villages is planned for early in the planning process for lease sale NEPA evaluations.

7. Several commenters raised the issue of the impacts of industrial noise, especially of the noise from seismic exploration, on the migration habits of whales and other marine mammals. Noise-induced deflection of whales from their normal migration routes increases the difficulty and danger of the whale hunt and can lead to a reduced or eliminated whale harvest with serious repercussions in subsistence-based communities.

   Response: BOEM has analyzed the potential effects of noise on marine mammals as discussed in Section 4.4.7.1 of the PEIS. The analysis of potential effects of noise in the PEIS has been expanded to take into account more recent studies of the effects of noise on marine mammals. BOEM will consider including stipulations meant to minimize or eliminate the deflection of marine mammals from their normal migration routes due to industrial noise at the lease sale phase.

8. Several commenters have indicated that BOEM should take traditional environmental knowledge acquired over many generations of experience with the local ecology into account in its long-term planning and leasing program.

   Response: BOEM has great respect for the accumulated knowledge of Alaska Native whalers and elders. BOEM strives to keep channels of communication with local native communities open and has striven to incorporate traditional knowledge throughout the PEIS.

9. An oil spill in the Arctic would have devastating and long-lasting effects. The GOM is still feeling the effects of the DWH event and traditional foods are still tainted.

   Response: The long-lasting effects of the DWH event have been investigated and the text of Section 4.4.13 of the PEIS updated as appropriate. The potential effects of accidental spills as well as of unexpected CDE-level spills are discussed on a resource-by-resource basis throughout Section 4.4 of the PEIS. These analyses acknowledge that an unexpected CDE spill in the Arctic would have major impacts on physical, biological, and sociocultural resources and systems in the Arctic.

10. The oil industry cannot prove that Alaska Native communities would not be disproportionately affected; that coastal communities would not be affected by pollution in waterways that they rely on for subsistence

    Response: The PEIS acknowledges in Section 4.4.14 that a large oil spill, especially a CDE that comes in contact with subsistence resources, could have disproportionately high impacts on the Alaska Native population, particularly if the subsistence resources were diminished or tainted as a result of the spill. In the event of a CDE, long-term impacts on subsistence resources would be expected, and these may lead to longer and greater environmental justice impacts. Similarly, the PEIS evaluates other potential impacts from routine operations, such as vessel and drilling discharges, on Alaska Native communities.

11. The results of whaling patterns and other hunting patterns should be made available and taken into account.

    Response: Studies of Alaska Native whale hunting patterns were taken into account in the description of the environment in Section 3.14.3.2.

12. A program sharing revenues from the royalties of off-shore oil and gas production would be of great benefit to local communities and would help fund research on the effects of oil and gas production on Arctic ecosystems.

    Response: Revenue sharing would require a change in the law and is beyond the scope of this PEIS. Also see the response to Comment 3 in Section 8.4.4.4.19, Issue 4.19, Socioeconomics, for additional discussion of revenue sharing.

13. Subsistence whaling is a difficult and dangerous activity. It is riskier if the bowhead whale are deflected from their normal migration pattern farther from land, both because of dangerous currents and the longer distance required to tow the whale to the butchering site. Camden Bay is utilized by whales as a calving area. If Shell develops a facility near Camden Bay, whalers fear the bowhead whales will be deflected from their usual migratory route, making the whale hunt riskier, more difficult, and likely less successful.

    Response: BOEM is aware of the difficulties and dangers associated with pursuing deflected whales. They are discussed in Section 4.4.13.3. Additional information on bowhead whale feeding habitat and migration routes in the Beaufort and Chukchi Seas has been added to Section 3.8.1.3 of the PEIS. Lease sale stage NEPA analysis will address potential impacts on bowhead whales in more detail. Lease-specific activities will also be required to comply with the requirements of the ESA and the MMPA, and will take traditional knowledge of Iñupiat whalers into account. For a discussion of possible deferrals that would restrict oil and gas activities at times and in places that could affect migrating whales, see the response to Comment 4 earlier in this section.

14. Captaining a whaling crew is an expensive proposition because of the equipment and number of people involved. Conflict avoidance agreements and enforcement of regulations and

stipulations are vital to the success of a whaling crew in that they reduce deflection of migrating whales. Since local communities have to deal with the impact of oil and gas development, it is only fair that they share in the revenues from that development.

Response: BOEM is aware of the socioeconomic challenges that whaling captains face. Working out conflict avoidance agreements between local subsistence-based communities and oil and gas developers is one of the lease stipulations intended to mitigate the effects of oil and gas development on subsistence whalers (see Appendix B.2.1.6). Sharing of the revenues from oil and gas development would require both a policy change and a change in the law. This is beyond the scope of this PEIS. For additional discussion regarding revenue sharing, see the response to Comment 3 in Section 8.4.4.4.19.

15. The commenter is a subsistence whaling captain who has experienced negative consequences from oil and gas development in the past, including a change in the taste of whale meat. Less regulated past development had great negative consequences including deflecting game, pollution form drill cuttings. There is less ice now than in days past.

    Response: BOEM acknowledges the effects of oil and gas development on the physical, biological, and human environments. The potential effects oil and gas development under the 2012-2017 leasing program are discussed on a resource-by-resource basis throughout Section 4.4 of the PEIS. A discussion of traditional knowledge of ice loss may be found in Section 3.14.3.2 of the PEIS. Also see responses to Comments 3 and 5 in Section 8.4.4.4.22.

16. Changes are appearing in the Arctic environment. Diseased ringed seals have recently been found that also have sores. Research is required to determine whether sores and disease among the seals is a result of oil and gas development activities for from some other source. There has also been a marked reduction in the amount of ice on the Arctic Sea.

    Response: A discussion of the UME that involves ringed seals and other pinniped species in the Arctic has been added to Section 3.8.1.3.1 and is also mentioned in Section 4.6.4.3. A discussion of climate change impacts on sea ice can also be found in those sections of the PEIS.

17. The Alaska Eskimo Whaling Commission seeks to protect whales and has learned to mitigate past impacts by working directly with industry, not always with government help.

    Response: BOEM seeks to work with stakeholders, including the Alaska Eskimo Whaling Commission, in formulating mitigation measures that minimize or eliminate adverse effects on Arctic whales.

18. The commenter feels a long-standing tie to the land and has seen the development of oil and gas in his lifetime. He is now barred from areas near Prudhoe Bay where he formerly ran a dog sled, fished, and hunted caribou. He would like to see his culture continue on to future generations of Alaska Natives.

Response: This perspective on changes at Prudhoe Bay has been used to enhance the discussion in Section 3.14.3.

19. Anaktuvak, while not on the coast, is tied to coastal communities through trade, barter, and good will, and receives marine mammals as subsistence foods. It supports the concerns of coastal communities.

    Response: Text explaining that Anaktuvak Pass is connected to the coastal economy by trade relationships, and is thus partially reliant on the harvest of wild marine resources, has been included in Section 3.14.3.2 of the PEIS.

20. The commenter is undecided as to whether he supports oil and gas development on the outer continental shelf. He is concerned for preserving his subsistence life style and would like to know what local economic benefits development could have.

    Response: While BOEM cannot control where workers will come from or where money earned will be spent, with proper job training there should be employment opportunities for the local population. See also the response to Comment 1 earlier in this section.

21. The commenter refers to past adverse effects of seismic surveys on seal and tomcod populations. The food chain was impacted and although studies were done on the dying seals, no information was provided to local communities.

    Response: Sections 4.4.7.1 and 4.4.7.3 discuss impacts of noise on mammals and fish, respectively. A discussion of the UME that involves ringed seals and other pinniped species in the Arctic has been added to Section 3.8.1.3.1 and is also mentioned in Section 4.6.4.3.

22. The Northwest Arctic Borough has passed a resolution establishing a policy for responsible resource development that protects important subsistence resources, Inupiaq culture, and health. Oil and gas companies do not have local traditional knowledge and will need local help to manage production in a responsible manner.

    Response: See the response to Comment 1 provided earlier in this Section. BOEM acknowledges Northwest Arctic Borough's desire to see responsible resource development off the coast of the Northwest Arctic Borough, and is committed to responsible development in any leasing program. It is the intent of BOEM and BSEE, through careful management of OCS activities, that minimal to no impacts on the marine subsistence harvest, Inupiaq culture, and health would occur. The management tools available to accomplish this would be mitigation measures, spatial and temporal deferrals, rigorous inspections, and implementation of rules and regulations. BOEM and BSEE also would seek to work with the Boroughs, tribes, and other relevant stakeholders to maximize the use of traditional knowledge to assist in the management and stewardship of OCS activities and resources.

23. The North Slope Borough and Northwest Arctic Borough are committed to being proactive and insisting that any development on the OCS be done in a responsible manner consistent

with Alaska Native values. They insist on proper planning, gathering and funding baseline data, sharing of data gaps and raw data so that industry can develop appropriate measures to mitigate impacts to subsistence resources and hunting, and the health of local communities.

Response: BOEM acknowledges Alaska Natives desire for responsible development and is committed to meaningful communication with all stakeholders including Alaska Native villages and organizations. BOEM funds a range of multidisciplinary studies relevant to the impacts of oil and gas development on Arctic Alaska. The results of these studies are made public; however, to ensure accuracy, raw data gathered cannot be released until vetted and peer-reviewed. Similarly, raw data from oil companies is often proprietary and can only be released with their permission. BOEM uses the results of these studies for baseline description of the environment and assessment of potential impacts for NEPA documents. It is the intent of BOEM and BSEE, through careful management of OCS activities, that minimal to no impacts on the marine subsistence harvest would occur. The means available to accomplish this could include mitigation measures, rigorous inspections, and implementation of rules and regulations. Mitigation measures are developed through the lease sale and plan processes.

24. Alaska Native communities of the Northwest Arctic Borough are directly affected by the success or failure of subsistence harvest of marine mammals in the Arctic because they are connected through a region wide bartering web. The Arctic marine harvest is an important part of the regional subsistence base through barter and exchange.

    Response: Section 3.14.3 has been revised to indicate that exchange and kinship ties bind coastal and inland Alaska Native communities and that inland communities are tied to the marine subsistence harvest even when they are not direct participants.

25. No one has demonstrated that an oil spill in the Arctic could be cleaned up effectively. A spill would be disastrous for subsistence harvesters. In addition, recent warming trends have resulted in a lessening of polar ice. More leasing will result in more shipping, including an increased presence of ice-breakers. This could make traveling on ice by subsistence hunters more hazardous.

    Response: Climate change and its effect on baseline environmental conditions are discussed in Section 3.3, and the condition of sea ice is discussed in Section 4.2.2 of the PEIS. Impacts from increased Arctic shipping are discussed in Section 4.6.5.3.5 and in other discussions of cumulative effects. The PEIS has been revised to strengthen the discussion of the impacts of increased ocean-going vessel traffic. Also see the responses to Comments 2 and 5 earlier in this section.

26. Industrial byproducts of oil and gas development will taint subsistence food supply. A very large oil spill would result in the contamination of marine food sources and would increase subsistence harvesting on land resulting in pressure on caribou, moose, and bird populations.

Response: Text discussing the potential shift of subsistence harvesting to inland resources in the event that marine resources were inaccessible or tainted has been added to Section 4.4.13.3. Also see responses to Comments 1 and 2 earlier in this section.

27. Gaps in our knowledge of the effects from a very large oil spill include studies of the cultural consequences of such a spill, consequences of the diversion of subsistence harvesting to inland sources, and the effects of chronic petroleum waste introduced into marine mammal diets.

    Response: The sociocultural effects of a very large oil spill, such as those from the *Exxon Valdez* incident, have been studied including effects on subsistence harvesters. These are discussed in Section 4.4.13.2. Text discussing the shift of subsistence hunting to inland resources as the result of an oil spill has been added to that section. Section 4.4.7.1 includes discussion of potential oil spill impacts on marine mammals and terrestrial mammals. Section 4.4.7.2 addresses impacts on marine and coastal birds.

28. The people of the Northwest Arctic Borough rely on the subsistence harvest, which plays a central role in Inupiaq culture. The Draft PEIS pays more attention to the North Slope Borough than the Northwest Arctic Borough. Northwest Arctic Borough communities would also be affected by oil and gas activities. All vessel traffic to the north coast would pass through Northwest Arctic Borough waters, and an oil spill could migrate into those waters as well. The Draft PEIS incorrectly asserts that Northwest Arctic Borough communities would be less directly affected than North Slope communities. More discussion of the impacts of routine operations on Northwest Arctic Borough communities are needed and must include a discussion of inland communities, all of which are included in coastal zone studies, that interact with coastal communities. Impacts on anadromous fish and other species that migrate long distances should be included. Effects of a CDE should not be considered temporary.

    Response: The discussions of subsistence patterns in the Northwest Arctic Borough in Sections 3.14.3.1 and 3.14.3.2 have been expanded to include inland communities with ties to the coast. The discussion of impacts from events in the Arctic planning areas in Section 4.4.13.3 has been expanded to include the Northwest Arctic Borough. Impacts of routine operations on sociocultural systems and subsistence in the Arctic are discussed in Section 4.4.13.3, which addresses impacts on communities both within the Northwest Arctic Borough and the North Slope Borough. BOEM understands your concerns regarding the possible effects of an oil spill in the Arctic. The impacts of oil spills in the Arctic are addressed on a resource-by-resource basis (including marine and terrestrial mammals, birds, and fish) throughout Section 4.4 of the PEIS. In addition, the discussion in Section 4.3.3 of a CDE has been updated with new information that pertains to oil spill response and containment in the Arctic.

29. The discussion of subsistence whaling should be expanded to include additional areas important to whaling crews such as areas to the east of fall hunting grounds where industrial activities could deflect whales around hunting grounds, and pursuit areas.

Response: Section 3.14.3.2 has been updated to include an expanded discussion of other key areas important to subsistence whalers as indicated in the comment.

30. The PEIS should include a discussion of Inupiat culture and North Slope Borough communities and monitoring and mitigation plans that have been made to avoid or minimize potential adverse effects of oil spills.

    Response: The discussion of North Slope communities and subsistence in Sections 3.14.3.1 and 3.14.3.2 have been expanded as appropriate for a PEIS. More detailed discussions of North Slope communities will be included in region- and lease-specific NEPA documents. BOEM has updated Section 4.3.3 with new information that pertains to oil spill response and containment in the Arctic. Also see the comments and responses related to Arctic oil spills presented in Section 8.4.4.6.3. BOEM has also added a new Section 4.3.2, Programmatic Deferrals and Mitigations, to the PEIS that discusses the process that BOEM will follow to identify mitigation measures in later stages of the Program.

31. Revise Summary, Social, Cultural, and Economic Resources section text, to "(including whales and other marine mammals, fish and birds)."

    Response: The suggested text has been added to the Summary.

32. Text should be added to the discussion of GOM subsistence harvesters to include mention of their psychosocial welfare now and following major disturbances to existing conditions. The commenter also identifies inaccuracies in the discussion of the Alaska Native Claims Settlement Act.

    Response: The suggested changes to the discussion of subsistence and renewable resource harvesting along the Gulf Coast have been made in Section 3.13.1.2. The discussion of land claim disputes between Alaska Native communities and the State of Alaska in Section 3.14.3.1 has been revised to state more accurately the roles played by the Alaska Statehood Act and the Alaska Native Claims Settlement Act (ANCSA) in resolving those disputes.

33. The characterization of Northwest Arctic Borough as small and relatively poor is not supported by the text. The Draft PEIS erroneously equates NANA with the Northwest Alaska Native Association. Currently NANA is not an acronym.

    Response: The indicated text corrections have been made in Section 3.14.3.1. The characterization of Northwest Arctic Borough communities as relatively poor has been removed.

34. U.S. law requires that the OCS be managed in a manner that considers economic, social, and environmental values of its renewable and nonrenewable resources, and the potential impact of oil and gas exploration on other resource values of the OCS and the marine, coastal, and

human environment. How will BOEM ensure that no unmitigatable adverse impacts to subsistence harvest will occur under the 5-year plan?

Response: It is the goal of BOEM and BSEE, through careful management of OCS activities, to minimize or prevent adverse impacts on the Arctic subsistence base. The means available to accomplish this could include mitigation measures, spatial and temporal deferrals, rigorous inspections, and implementation of rules and regulations. Specific mitigation measures, lease stipulations, and protections are developed at the lease sale and later stages. This PEIS considers economic, social, and environmental values.

35. BOEM does not have a science-based plan for meeting its obligations under the MMPA. Alaska Natives depend upon a healthy bowhead whale stock. If multiple oil and gas operations are implemented in the Arctic, and whale stocks are adversely impacted, the International Whaling Commission (IWC) could halt or curtail subsistence whaling to the detriment of local communities dependent on subsistence whaling.

    Response: BOEM does not have control over IWC decisions. BOEM coordinates with NOAA to ensure compliance with the MMPA. It is the intent of BOEM and BSEE, through careful management of OCS activities, to avoid or minimize to the extent possible impacts from OCS-related oil and gas development on the bowhead whale or other marine mammals. The means available to accomplish this could include mitigation measures, spatial and temporal deferrals, rigorous inspections, and implementation of rules and regulations. See Section 4.3.2 for a discussion of BOEM's approach for mitigation planning under the Program. Also see the response to Comment 1 earlier in this section.

36. Impact levels as defined in Section 4.1.4 do not address impacts on subsistence resources. Major impact levels do not comport with the MMPA if they threaten the viability of bowhead whales and other marine mammals that Alaska Natives depend on.

    Response: The impact levels presented in Section 4.1.4.2 apply to socio-cultural impacts, including subsistence harvesting. Text has been added to make this clearer. Adverse impacts on subsistence from routine oil and gas operations can be mitigated through consultation and scheduling (windows avoiding migrations). Major accidental spills that adversely affect marine mammals would be in violation of the MMPA and result in enforcement actions by NOAA. Section 3.8.1 discusses the MMPA and its requirements, as well as its relationship with Alaskan subsistence users. Additional discussion of the MMPA and the harassment or taking of marine mammals is provided in Section 4.4.7.1.

37. The PEIS includes some inaccurate statements regarding the Alaska Native subsistence whale hunt. It does not include subsistence whaling communities Kivalina, Wales, Savoonga, Gambell, and Little Diomede in its analyses and includes misstatements about the whale hunt from Barrow and Wainwright.

    Response: Corrections have been made to the discussion of whaling schedules in Section 3.14.3.2. The more distant whaling communities mentioned in the comment lie outside the planning areas that are the subject of this PEIS. While the whales and other marine resources upon which these communities depend for subsistence could be affected by oil and gas development in the Chukchi and Beaufort Seas, there will be no leases in the waters adjacent to these communities. Sections 3.14.3.2 and 4.4.13.3 have been revised to include these communities and to address the potential effects on them from oil and gas development in Chukchi and Beaufort Planning Areas.

38. BOEM needs to have accurate information about impacts to subsistence activities in Alaska to support decision making and to comply with its obligations under the MMPA.

    Response: In the PEIS, BOEM strives on the basis of scientific studies and literature, traditional knowledge, and public engagement to present accurate and current information on subsistence activities in the areas of the Arctic that could be affected by the 5-year plan.

39. The discussion of the impacts of noise from oil and gas operations on subsistence species only references traditional knowledge. Western science has reached similar conclusions and should be referenced.

    Response: Discussions of the impacts of noise on marine mammals (including subsistence species) are presented in Sections 4.4.7.1.1, 4.4.7.1.2, and 4.4.7.1.3 of the PEIS. Similar discussions on the effects of noise on birds and fish are presented in Sections 4.4.7.2 and 4.4.7.3, respectively.

40. BOEM needs to revamp the PEIS to adequately address impacts to subsistence communities in northern Alaska in compliance with the MMPA.

    Response: Section 4.4.13.3 has been revised to more adequately address potential impacts to subsistence communities in northern Alaska. BOEM has no direct responsibilities under the MMPA, and no authority to enforce the MMPA, but it does require oil and gas companies to comply with the MMPA and therefore, industry must obtain permits from NOAA for the incidental harassment of marine mammals before operating in the Arctic OCS. Under MMPA Section 101 (16 USC 1371 Sec. 101 (l)) such permits are issued only when the activity "…will not have an unmitigatable adverse impact on the availability of such species or stock for taking for subsistence uses." This permit then ensures that there will be no unmitigatable adverse impacts on the availability of a stock or species taken for subsistence uses.

41. The commenter disagrees with the statement made in Section 4.4.14.3.1 that altering the local availability of subsistence resources would be a short-term and local impact. The lack of subsistence resources would be significant. Since local communities exchange food and resources with other communities, it would not be local.

    Response: BOEM recognizes the importance of subsistence resources to Alaska Native communities and is aware of the exchange connections between villages. Discussions of subsistence harvesting and bartering are found in Section 4.4.13.3. BOEM seeks to work with stakeholders in formulating mitigation measures that would reduce or eliminate local impacts. There has been an extensive dialog regarding prospective temporal and spatial deferrals. BOEM has informed stakeholders that mitigation (which may include deferrals) will be carried forward into the lease sale NEPA documents. Section 4.3.2 of the PEIS discusses programmatic deferrals and mitigation, and describes a process that BOEM will put in place to identify, evaluate, and prepare for implementation, and mitigation strategies (which may include deferrals) that may be applied at appropriate program decision points. This process includes stakeholder input into the development of mitigation strategies.

42. There is a tension between unavoidable adverse impacts to the subsistence harvest under the 5-year plan listed in Chapter 5 of the Draft PEIS, and the prohibition against "unmitigatable adverse impacts" to subsistence hunts in the MMPA, which BOEM must resolve.

    Response: BOEM has no responsibilities under the MMPA, and no authority to enforce the MMPA, but it does require oil and gas companies to comply with the MMPA, and therefore, industry must obtain permits from NOAA for the incidental harassment of marine mammals before operating in the Arctic OCS. Under MMPA Section 101 (16 USC 1371 Section 101 (l)) such permits are issued only when the activity "will not have an unmitigatable adverse impact on the availability of such species or stock for taking for subsistence uses." This permit then ensures that there will be no unmitigatable adverse impacts on the availability of a stock or species taken for subsistence uses. There is a difference between "unavoidable" and "unmitigatable." An "unavoidable" impact may be susceptible to mitigation, resulting in a reduced level of effect, unavoidable though it may be. In contrast, no action could be implemented to reduce the level of effect from an "unmitigatable" impact.

43. The Inupiat Community of the Arctic urges BOEM not to offer additional leases in the Beaufort and Chukchi Seas during the next 5 years, because of potential damage to the environment and their subsistence culture which is sensitive to environmental damage. Loss of subsistence resources would result in damage to their physical, mental, and spiritual health.

    Response: The PEIS considers the potential for environmental damage, the potential for the discovery of oil and gas, and the potential for adverse impact on the coastal zone for a variety of alternative courses of action. Under Alternatives 5, 6, and 8 there would be no leasing in one or both of the Arctic planning areas. The PEIS seeks to clearly articulate the consequences of these alternatives as an aid to the decision-maker as he or she decides whether or not to move forward with the proposed action. Also see the response to Comment 1 in this section.

44. The Federal Government has not effectively analyzed the cumulative effects of oil and gas operations on multiple lease tracts. Alaska Natives who depend upon marine resources bear the brunt of potential risk from these activities. The Draft PEIS is greatly lacking in

information and analysis on subsistence activities necessary to understand what areas should be preserved.

Response: BOEM seeks to include current, complete, and accurate data appropriate for an EIS at the programmatic level. Subsistence activities in Alaska are discussed in Sections 3.14.2.2 and 3.14.3.2, while impacts on subsistence are discussed in Sections 4.4.13.2 and 4.4.13.3. The cumulative impacts of OCS oil and gas development on Alaskan subsistence activities are discussed in Sections 4.6.5.2.5 and 4.6.5.3.5. More detailed information on subsistence activities will be included in region- and lease sale NEPA documents. BOEM seeks to fill data gaps in part through consultation with local communities and through the scoping process.

45. The Draft PEIS lacks a sufficiently detailed discussion of subsistence whaling, and potential impacts of oil and gas development on the OCS on subsistence-based communities.

    Response: Section 1.4.2 discusses incomplete and unavailable information, and discusses the analytical requirements for programmatic analyses and decisions. The PEIS presents discussions of subsistence (see response to previous comment), which are appropriate for a programmatic EIS. More detailed information and analyses on subsistence activities will be included in region- and lease sale NEPA documents and later phases of the Program. BOEM seeks to fill data gaps in part through consultation with local communities and through the scoping process.

46. Inaccurate statements regarding the bowhead subsistence whale hunt must be corrected.

    Response: Information regarding the bowhead whale hunt in Section 3.14.3.2 has been corrected and brought up to date.

47. Traditional knowledge can help to fill in some of the gaps in our understanding of Arctic ecosystems as well as guide future efforts to collect necessary information. In order to incorporate traditional knowledge we need funding. Create indigenous science positions within BOEM, have those positions advertised and based in Alaska. A real collaborative approach to research and data sharing will result.

    Response: BOEM agrees that traditional knowledge can help to fill in some of the gaps in our understanding of Arctic ecosystems, and BOEM has partnered with members of Native communities to incorporate traditional knowledge in past environmental studies. These studies are in various stages of completion, and the information is continually utilized to support environmental analyses related to BOEM permitted activities in the Arctic. BOEM welcomes opportunities for future collaboration.

48. The leasing plan and subsequent exploration and development activities should comply with Executive Order 13175 and the Presidential memorandum regarding consultation with tribal governments. Commenters are concerned that BOEM intends to engage in “after the fact” government-to-government consultations, instead of consultations that may actually have an

impact on the design or conclusions in the plan. Merely holding hearings in a Native community does not constitute adequate government-to-government consultation. Commenters were pleased that the North Slope Borough was designated a cooperating agency in the preparation of the PEIS. However, they expressed that this participation alone will not satisfy BOEM's responsibility to engage local communities, especially tribal governments. It was recommended that BOEM have government-to-government meetings with the local tribes before public hearings. The tribal council members protect the native way of life. The tribes need partnership so that they can run smoothly and make clear decisions. They do not seem to have any real control over their destiny and the industry continues to move forward despite their concerns.

Response: In conjunction with the scoping meetings for this PEIS, BOEM scheduled multiple separate government-to-government consultation meetings with Native Alaskan tribal communities. BOEM appreciates the opportunity to meet with Native Alaskan tribal members and values the discussions that were had during these consultations. BOEM has communicated the Native Alaskan tribal concerns to the decision-maker through consideration in the PEIS. Furthermore, BOEM will continue our dialogue about possible plans and activities on the Arctic OCS, including any potential lease sales in the future. In that spirit, BOEM welcomes the opportunity to meet with Native Alaskan tribal communities on a government-to-government basis, and BOEM values the ongoing dialogues with Native Alaskan communities.

8.4.4.4.23 Issue 4.23 Geohazards.

1. Several comments were specific to the text and figures in Sections 4.2.1.2 and 4.2.1.3:

    - Figures 4.2.1-2 and 4.2.1-4: state in the legend that only earthquakes of M 7.0 are plotted. Also show Cook Inlet folds (fault-cored anticlines) on the figure, based on Haessler et al. (2000).
    - Delete statement on Border Ranges fault as current thinking holds that it is not active.
    - Specify the magnitude threshold for the 1,200 earthquakes.
    - The text discusses floods but not liquefaction and direct-shaking effects on structures which are of greater significance. Even though they are discussed in greater detail in the following paragraph, they should at least be listed in the first paragraph.
    - Provide more information on the 1964 event, especially its impacts on oil- and gas-related facilities (which was minimal). Also include a discussion of earthquake potential in the Cook Inlet fold belt, since these are some of the primary tectonic sources in the region.
    - Discuss lahars, the 2009 Redoubt eruption, and their impacts on the Drift River Terminal.
    - For the text: "…where a glacier-dammed lake at the headwaters of the Snow River fails every two to 2–5 years" — note that Post and Mayo (1971) report that flooding takes place on Snow River every 2–3 years.

- For the text: "Historically, the Knik River near Palmer (at the northernmost end of Cook Inlet) has flooded when glacier-dammed Lake George fails" — move this sentence because the preceding and following sentences refer to the Kenai River and they should follow one another. Move this sentence in front of the previous sentence.
- It should be stated that there is the possibility for creep along "listric growth faults," similar to what occurs in the GOM. This creep could affect infrastructure.
- Describe the seismicity on the Beaufort Shelf in more detail. Summarize any evidence of seismicity. Also clarify what is meant by "no seismicity in recent times." What is meant by the term "recent"?
- Note that there have been numerous events on the southern Chukchi Shelf and a few off Wainwright.

Response: The following responses address the comments in the order they appear above:

- Please see the seismicity discussion in Section 4.2.1.2.2, which states that since 1973, more than 1,200 earthquakes have been recorded in the Cook Inlet region; 10 of which had magnitudes greater than 6.0. The text here refers to Figure 4.2.1-2 for plots of the two largest earthquakes (the 1999 and 2001 M 7.0 earthquakes on the Kodiak and Sitkalidak Islands); they are shown on Figure 4.2.1-4 for consistency. Neither of these figures was intended to show all earthquakes in the region, just the largest two. The maps show faults that would fall into USGS Class A (Quaternary) faults; the text has been revised to discuss anticlinal folds in the region and these features are now shown on Figures 4.2.1-2 and 4.2.1-4.
- The text states that there has been no movement on the Border Ranges Fault in the past 24 million years. This indicates that the fault is "inactive," therefore, the statement (which cites a publication of the Alaska Division of Geological and Geophysical Surveys; Stevens and Craw 2004) is correct. The text has been revised to state more explicitly that the fault is considered inactive.
- The 1,200 earthquakes referred to in the seismicity discussion for Cook Inlet include those greater than M 3.0; the text has been revised to indicate this.
- The order of these paragraphs discussing flooding due to earthquakes, liquefaction, and direct-shaking effects has been reversed to indicate the importance of liquefaction and direct-shaking effects relative to potential flooding.
- The text in the seismicity discussion for Cook Inlet has been revised to state that there was minimal damage to oil and gas structures as a result of the 1964 Alaska earthquake. Discussion of movement potential along folds has also been added.
- Lahars that inundated the Drift River valley and their effects on the Drift River Oil Terminal are discussed in the next paragraph.
- The 2 to 5 year range of the outburst floods at the headwaters of the Snow River encompasses the 2- to 3-year range cited by Post and Mayo (1971); therefore, the text has been retained. Reference to Post and Mayo (1971) has

been included in the section to strengthen the support for range of these events.

- The last sentence of the first paragraph (Cook Inlet) refers to both glacial lakes and the Kenai River — summarizing that in both cases, floods occur more frequently in the fall and can be especially severe if the lakes or the Kenai River are already high or frozen. Therefore, the text has been retained.
- The text in Section 4.2.1.3.2 of the PEIS (Arctic Region — Seismicity) has been revised to indicate that slow movement (creep) can occur along listric growth faults and affect the integrity of infrastructure over time.
- The text of the seismicity discussion for the Arctic Region has been revised to include additional discussion on possible Quaternary movement along faults in Harrison Bay (using a new reference, Craig and Thrasher [1982]). The term "recent times" refers to post-Quaternary time (i.e., Holocene); this has been indicated in the text.
- A reference to seismicity on the southern Chukchi Shelf (and off of Wainwright) has been added to the seismicity discussion for the Arctic Region as suggested (as documented by Avetisov 1996). Search results from an Alaska Earthquake Information Center database query for earthquakes along the Chukchi coastal zone were also included.

2. There are several additional sources of information that are available regarding subsea permafrost in the Arctic lease areas and these should be considered for the discussion in Section 4.2.2.2 (Subsea and Coastal Permafrost – Arctic Region). The sources include:

- For information on subsea permafrost, see: Map showing extent of subsea permafrost in circum-Arctic: Brown, et al., eds. 1997. Circum-Arctic map of permafrost and ground-ice conditions. Washington, DC: U.S. Geological Survey in Cooperation with the Circum-Pacific Council for Energy and Mineral Resources. Circum-Pacific Map Series CP-45, scale 1:10,000,000, 1 sheet.
- Osterkamp and Harrison (1982) state that "Subzero temperatures were found in all holes drilled in Kotzebue Sound, and in the Chukchi and Beaufort Seas. Holes drilled in the Chukchi Sea near Barrow suggest that the shore-line is stable, or nearly so, and that ice-bearing permafrost is probably thin or absent a kilometer or more off-shore." (See Osterkamp, E., and D. Harrison, 1982, "Temperature Measurements in Subsea Permafrost off the Coast of Alaska," in: Proc. 4th Can. Permafrost Conf. Calgary, Alberta, 1981, Natl. Res. Council, Ottawa, pp. 238–248.)
- MMS (2007) states that "the presence and distribution of subsea permafrost is largely unknown (Grantz et al., 1982; Thurston and Theiss, 1987). Subsea permafrost is not yet recognized in most seismic data from the Chukchi Sea (Sellman and Hopkins, 1984). Rogers and Morack (1982) recognized ice-bonded material from seismic data collected in 5 m of water north of Icy Cape." (See *Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea Final Environmental Impact Statement*, OCS EIS/EA MMS 2007-026, Alaska OCS Region. Available at

http://www.alaska.boemre.gov/ref/EIS%20EA/Chukchi_FEIS_193/LS%20193%20FEIS%20Vol%20I.pdf.)

- MMS (2007) also states that "The presence of extensive subsea permafrost on the Beaufort Shelf (Craig et al. 1985) suggests that some subsea permafrost may exist along the northwest coast of Alaska. However, no anomalous near-surface seismic velocities that would indicate the presence of ice-bonded sediments have been reported. The near-surface consolidated rock present throughout much of the Chukchi Shelf may have inhibited development of permafrost during lowered sea level (Grantz et al., 1982). Another explanation for the apparent lack of relict permafrost offshore is that it was melted by the relatively warm currents moving north from the Bering Sea." (MMS: Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea - Final Environmental Impact).

Response: The references cited above have been reviewed and the text in Section 4.2.2.2 (Subsea and Coastal Permafrost — Arctic Region) has been revised to incorporate the findings of these reports as applicable.

8.4.4.5 Issue 5 Cumulative Impacts

1. The cumulative impacts analysis should include a discussion of additive, multiplicative, and synergistic effects on resources; conclusions regarding impact levels should be clarified and better supported.

   Response: Additive, multiplicative, and synergistic effects are "interactive" effects in which the net adverse cumulative effect is greater than the sum of the individual effects (CEQ 1997: "Considering Cumulative Effects Under the NEPA"). Summaries discussing these types of effects on resources have been added to the end of Sections 4.6.2, 4.6.3, 4.6.4, and 4.6.5, and an overall summary is now provided in a new section, Section 4.6.6. Similarly, the PEIS has been revised to integrate the eco-region concepts presented in the Affected Environment chapter in the cumulative effects analysis. This integrating framework provides a useful lens to discuss additive, multiplicative, and synergistic effects in context of resilient and/or stressed ecosystems. The text has been revised to ensure that impact levels are clearly identified (according to the definitions provided in Section 4.1.4 of the PEIS) and substantiated. The relevance of uncertainty and incomplete information in context of impact conclusions is also addressed.

2. The cumulative impacts analysis must include a more substantial analysis of the effects of climate change; in areas of uncertainty (i.e., where information is unavailable or incomplete), include a summary of the existing scientific evidence and information on known trends.

   Response: Section 1.4.2 discusses incomplete and unavailable information and the analytical requirements for programmatic analyses and decisions. The PEIS presents a discussion of climate change and its effect on baseline environmental conditions, in Section 3.3. The effect of climate change on baseline conditions was also considered in the resource-by-resource impact discussions presented in Section 4.4 of the PEIS. This level of consideration and analysis is appropriate for a programmatic EIS and programmatic decision-making. The cumulative impacts analysis draws on the summary of climate change effects discussed in Section 3.3; climate change is also discussed in relation to the various resources (as it applies) throughout Chapter 3. The text in Section 4.6 (Environmental Impacts of the Cumulative Case) has been revised, as appropriate, to integrate this information. In cases where credible scientific evidence is not available (or complete enough) to support conclusions, the text has been revised to state that future research and monitoring may be required as part of the NEPA review at the lease sale or project level (in accordance with CEQ 1997). The references cited in these comments have been reviewed and incorporated into the discussion of cumulative impacts as appropriate.

3. The analysis of cumulative impacts in the Arctic Region is inadequate in the areas of subsistence resources (whales, seals, fish, and caribou), human health, noise effects on marine mammals, sociocultural systems (because large impacts are unacceptable), biological systems (including additive and synergistic effects), ice movement, transboundary effects (from Russian and Canadian offshore oil and gas activities), and climate change.

   Response: The cumulative impacts analyses, in Section 4.6, addressing resources in the Arctic region have been strengthened by improving content integration and including additional information from various sources (earlier sections of the PEIS, as well as additional literature on potential impacts related to climate change, subsistence, and oil spills). The cumulative effects analysis presents a clearer description of cumulative actions, defining the spatial and temporal bounds considered in the cumulative analysis. The PEIS provides additional clarification of and supporting documentation for the impact levels identified (including interactive effects of multiple actions), and clarifies the role of mitigation and monitoring at the lease sale level. The PEIS is a programmatic NEPA document and as such, is meant to encompass the full breadth of potential cumulative impacts on important resources in the Arctic region and other regions of development. It is intended to guide subsequent lease-specific analyses that will focus on the effects of a particular proposed action. The NEPA analyses associated with the various stages of OCS oil and gas development are shown in Table 1-1. Note also that specific mitigation measures and lease stipulations are determined in the more in-depth NEPA analyses required for lease sales and projects.

4. The cumulative impact analysis should include additional reasonably foreseeable future actions (e.g., LNG facilities and those proposed by Shell and ConocoPhillips) and correct, update or reconsider the descriptions of other actions (i.e., gold mining and vessel traffic) in the Arctic Region. The breadth of actions considered should be expanded to include subsistence, transportation, tourism, commercial fisheries, and the effects of offshore activities conducted by neighboring countries.

   Response: The cumulative impacts section has been revised to include additional reasonably foreseeable future actions and to correct and update the description of gold mining in the Arctic Region as commenters have suggested. Section 4.6 includes a new table with a comprehensive listing of the types of past, present (ongoing), and reasonably foreseeable future activities that could affect important resources in the planning regions — including those mentioned in comments received.

5. The cumulative impacts of noise on marine mammals presented in Section 4.6.4 have not been adequately assessed.

   Response: The cumulative impacts of noise on marine mammals presented in Section 4.6.4 have been revised to incorporate more information on the long-term effects of undersea noise (including seismic surveys) on a regional scale.

6. The Deepwater Horizon event undermines statements about the small impacts of small oil spills relative to existing seeps and potential spills from foreign tankers. Mitigation measures for spills and their impacts (especially large ones) should be described in the PEIS.

   Response: The cumulative impact analysis differentiates between the occurrence and impacts of small, large, and catastrophic spill sizes. The text in the discussions of cumulative impacts has been revised to address large and CDE spills. BOEM and BSEE have developed a robust regulatory framework to minimize spill occurrence (see Section 4.3.3 for recent regulatory reforms).

7. How many generations does the PEIS address (i.e., what is the time frame of the cumulative impacts analysis)?

   Response: The time frame for the cumulative impacts assessment for the PEIS is 40 to 50 years. This information is presented in Tables 4.6.1-1 and 4.6.1-2 and new Section 4.6.2.

8. The Federal Government should continue to support research in the Arctic region, including ecosystem-based research that can contribute to a better understanding of cumulative impacts.

   Response: BOEM is in agreement.

9. Section 4.6.4.3.4, on Invertebrates and Lower Trophic Levels, suggests that there would not likely be overall population-level effects on invertebrate resources because there are a relatively small proportion of habitats that would come into contact with released oil; however, it is possible that oil could be transported to the east by currents in such a way that biologically active areas in the Arctic region could also be exposed (such as where baleen cetaceans congregate in summer and krill are present during winter and early spring). These impacts could propagate up the food web to Arctic cod and baleen whales.

   Response: New text has been added to Section 4.6.4.3.4 to more clearly address the potential transport and fate of oil in sensitive ecosystems and spill-related contamination of krill and its implications for higher trophic levels. See also Section 4.4.7.1.3, which provides information on potential impacts to marine mammals from consuming oil-contaminated prey. Lease-specific NEPA analyses will address this issue in more detail.

10. NOAA had recommended that a discussion of the effect of pipelines and pipeline safety buffers be included in the cumulative effects section on coastal habitats because the presence of pipelines can reduce or eliminate suitable areas for borrow material needed for barrier island and wetland restoration projects. Pipeline safety buffers would reduce areas available for restoration. Pipelines and their safety buffers could also result in impacts to seabird nesting areas and sea turtle nesting beaches.

    Response: Very few new pipelines will come to shore in the GOM due to the 5-year Program (see Table 4.6.1-1). Pipeline disturbance widths are generally small with modern placement methods, and the rights-of-way should be less than 200 m (656.2 ft) in width. Pipeline placement would avoid nesting locations and would not occur during active nesting. Operators are interested in protecting pipelines from coastal erosion so a synergy could be developed with coastal restoration projects. Because of demand for OCS material for coastal restoration, BOEM is trying to cluster pipelines and to keep pipelines away from known marine mineral resources. This information has been incorporated into Section 4.6.3.1.1 with the appropriate BOEM citations.

11. NOAA had commented previously that the cumulative effects section on commercial and recreational fishing (Section 4.6.4.4.4) contained an oversimplification of the factors impacting abundance of fish species because it does not account for the management strategies that are currently in place to prevent overfishing. We recommend that the section be revised to reflect NOAA's findings that recreational catches in some fisheries can have a larger impact on abundance of fish species than commercial fishing practices. NOAA can provide information on the number of fish stocks/species that are overfished in all regions.

    Response: The original text, which states that "Sportfishing may also contribute significantly to cumulative effects on some fishery resources. As a consequence of the pressure fishing places on fishery resources, appropriate management is required to reduce the potential for depletion of stocks due to overharvesting. Even with management, the possibility of overfishing still exists." is compatible with NOAA comments. However, the text in Section 4.6.4.4.4 was revised to discuss additional factors affecting fish stocks. For additional information on commercial fisheries, see Section 4.6.5.1.3 (Commercial and Recreational Fisheries).

12. NOAA recommends that BOEM define terms such as "small" areas and "short" time period as they relate to the effects of oil spills to marine benthic and pelagic habitats in Section 4.6.3.3.2. Discuss the effects of spills that occur when ice covers the area (as opposed to the open water period).

    Response: Because recovery time is a function of the specific spill, environmental conditions, and the resource of interest, it cannot be quantified in a general way. However, the text in Section 4.6.3.3.2 has been modified to give a range of time for oil breakdown. Currently, drilling is not allowed during periods of ice cover.

13. A true measure of the cumulative effects of oil spills cannot be accounted for until the effects of the Deepwater Horizon event is better understood. BOEM should revise the PEIS to analyze the full impact of the Deepwater Horizon event.

    Response: The Affected Environment, effects analysis, and cumulative impacts sections have been updated to reflect the most recent information relevant to a description of the environmental baseline conditions and potential for compounding effects in the GOM. BOEM has also disclosed instances where incomplete and unavailable information exists and discussed its relevance to a choice among alternatives. Section 1.4.2 discusses incomplete and unavailable information. The reader is also referred to Section 4.3.3, which discusses the risk and fate of a low-probability, catastrophic discharge event. The text in the cumulative impacts analysis has been revised, as appropriate, to more fully integrate this information.

14. NOAA has previously commented on the cumulative effects on sea turtles (Section 4.6.4.1.4) that it is not aware of data to support the statement that OCS impacts would be minor relative to non-OCS impacts. It recommends including references.

    Response: The text in Section 4.6.4.1.4 has been revised to include an impact level based on the available scientific information (independent of its magnitude relative to non-OCS activities).

15. It would be helpful to have a quantitative estimate of the cumulative effects on marine mammals in Section 4.6.4.3.1. The document indicates the possible number of drill sites and their likely locations; combining this information with marine mammal density information and known “takes” of marine mammals could provide a quantitative estimate of expected cumulative impacts (at least for some species).

    Response: A quantitative estimate of cumulative marine mammal “takes” would need to account for all cumulative actions, including State oil and gas exploration and development and other non-oil activities. In support of the lease sale and plan stage NEPA documents and consultations, BOEM, NMFS and USFWS, working in collaboration, develop equivalent estimates of marine mammal density and potential take. This PEIS qualitatively describes the cumulative effects on marine mammals in Section 4.6.4.3.1, assuming on- or off-lease activities would comply with the requirements of the ESA, MMPA, and resulting authorizations, which may stipulate “take” limits.

16. Clarify the term “Northern fur sea lion.”

    Response: The text has been revised to “Northern fur seal” in Section 4.6.4.2.1.

17. Section 4.4.1.3: Clarify whether there would be regulatory prohibitions against tankering or marine transportation of produced hydrocarbons. The environmental consequences of reductions in sea ice and opening of new sea routes on current navigational and economic conditions have not been fully addressed.

Response: There are no current regulations prohibiting the tankering or marine transportation of produced hydrocarbons. The effects of sea ice reduction and opening of new sea routes on the current navigational and economic conditions of the Arctic region has been included in the cumulative impacts analysis.

18. The discussion of natural hazards is disjointed because it is addressed under several topics (geologic hazards, ice hazards, and physical oceanography) in the PEIS. The discussion of potential impacts from certain hazards such as fog, high winds, storm surges, extreme temperatures, and seasonal darkness is incomplete. In addition, substantial information on the difficulties of recovering oil in broken ice conditions has not been included. The discussion of these topics would be improved if they were included in a single section. The Oil Spill Prevention and Response report (Nov. 2010) for the U.S. Arctic Ocean is a good example.

    Response: Natural hazards are discussed only in Section 4.2 (which discusses both geologic hazards and sea ice and permafrost). The hazards are further broken down by planning regions to reflect the way the sections on the affected environment and impacts on the various resources are organized. The Arctic Ocean report commissioned by the Pew Environment Group was already referenced in Section 4.3.3, but has also been incorporated in the climate change and physical oceanography sections (Sections 3.3 and 4.2, respectively), as appropriate.

19. Provide a source for the statement in Section 4.6.4.3.2: "Oil contamination of food resources may influence recovery of a local population by affecting reproductive success and survival, with the degree of impact largely dependent on the patterns of prey distribution." This statement should take into account compensating dynamic factors that affect wildlife populations (e.g., when population is reduced, the survival and productivity rates among remaining birds often increase).

    Response: Section 4.6.4.3.2 has been revised to include additional scientific sources and to provide more information about the population-level impacts of oil spills on bird species.

20. The discussions of the Deepwater Horizon event should be updated or qualified by noting the oil estimates still at or below the water surface are current as of August 2010. Include a statement to clarify that oil continues to weather and that much of the oil reported by the Georgia Sea Grant Oil Spill Update has either dissolved or dispersed and was not recoverable.

    Response: Section 4.6.2 has been updated to reflect the most recent information available on the effects of the DWH event, including the references cited in the comment.

21 The statement in Section 4.6.3.1.1, "Although much of the oil remaining after cleanup is highly weathered, several constituents have the potential to cause toxicological effects (OSAT-2 2011)," should clarify that oil weathering depleted a large portion of the hydrocarbons in oil, including PAHs. Add two references by Boehm et al. (2011) which cite

the high rates of biodegradation of oil from the Deepwater Horizon event: (1) "Distribution and Fate of PAH and Chemical Dispersants in the Water Column Following the Deepwater Horizon Oil Spill," SETAC North America 32nd Annual Meeting (November 13-17); and (2) "Aromatic Hydrocarbon Concentrations in Seawater: Deepwater Horizon Oil Spill," International Oil Spill Conference (May 23-26, 2011)

Response: The references cited in this comment have been reviewed and additional information regarding the breakdown of volatile compounds during weathering has been incorporated into Section 4.6.3.1.1.

22. The PEIS should do a better analysis of the cumulative and synergistic impacts of climate change and ocean acidification. BOEM should consider the impacts on climate change from the analysis of oil and gas consumption resulting from the Program's lease sales. The statement in Section 1.4.5.5 "consumption of the refined oil is not considered because the scope of this PEIS is limited to issues that have a bearing on the decisions for the proposed leasing program" is an example of circular reasoning and therefore, does not substantiate the omission of an analysis of the impacts of hydrocarbon consumption.

    Response: Section 4.6 evaluates the effects of climate change, ocean acidification, and other global trends as cumulative actions. Consistent with judicial guidance, BOEM does not provide an analysis of the impacts of oil and gas consumption on various resources; the rationale is stated in Chapter 1 (as noted in the comment). However, regional and national emissions from fuel combustion sources are accounted for in the air quality impacts analyses in the cumulative impacts section. Summaries discussing the additive, multiplicative, and synergistic effects on resources have been added to the end of Sections 4.6.2, 4.6.3, 4.6.4, and 4.6.5, and an overall summary is now provided in a new section, Section 4.6.6.

23. The statement in Section 4.6.2.1.1 that "as of January 2011, oiling was still present on many shorelines and on barrier islands" should be revised to "… some shorelines …" because it gives the erroneous impression that many shorelines are still oiled. Also, the statement in Section 4.6.3.1.1 "On Grand Isle, Louisiana, and Bon Secour, Alabama, oil was found up to 105 cm (41 in.) below the surface…" should be revised to indicate that supertidal buried oil was found.

    Response: Section 4.6.2 has been updated to reflect the most recent information available on the effects of the DWH event.

8.4.4.6 Issue 6 Oil Spills

8.4.4.6.1 Issue 6.1 General Oil Spill Concerns.

1. USEPA requested information on the potential effectiveness and impacts of using large-scale berm construction as a spill response technique.

Response: The PEIS principally describes typical measures used to respond to oil spills. Following the DWH event, sand berms were constructed in the GOM in an attempt to contain spill and prevent transport of oil into back-barrier and wetland ecosystems. All such response measures require advance approval of the On-Scene Federal Coordinator, U.S. Coast Guard. Section 4.3.3 of the PEIS has been revised to include a general discussion of the possibility of non-traditional spill response measures, the approval process, and potential ramifications of untested response tactics.

2. The PEIS does not adequately characterize the occurrence risk or potential impacts of a catastrophic discharge event that could result from OCS exploration or development operations during the proposed leasing program.

   Response: The PEIS addresses the risks of oil spills, including the risk of catastrophic discharge event, in Sections 4.3.3 and 4.4.2. While the PEIS does not assume that a catastrophic discharge will occur, the potential for significant effects because of such an event are considered throughout Chapter 4 by environmental and socioeconomic resource.

3. The PEIS should include analyses of direct, indirect, and cumulative effects of catastrophic discharge events. This includes downstream effects resulting from spill response measures.

   Response: The catastrophic discharge event is analyzed across all resource sections in Chapter 4 of the PEIS. Additional reference content has been provided in each resource section to further support the analysis therein.

8.4.4.6.2 Issue 6.2 Oil Spill Assumptions and Risks.

1. Spill risk and spill-associated impacts are related to the volume of oil produced. Larger reservoirs may pose a greater spill risk.

   Response: Changes were made to the PEIS to clarify the underlying spill risk assumptions. The relationship between reservoir size and oil produced is characterized in the PEIS in Section 1.5.5.6.

2. The unpublished paper “Anderson (in preparation)” used to calculate spill risk must be made publicly available before it can be used as the basis for the spill risk analysis in the PEIS.

   Response: Anderson et al. (2012) is now available on BOEM’s web site. Additional information has been added to the PEIS that includes the spill rates for platforms, pipelines, and tankers for 1996-2010. The rates for 1996–2010 were used in the estimation of the number of spills in each Planning Area. The basic assumptions of that spill rate analysis are summarized in the footnotes of the table.

3. The PEIS should include relevant reform information and recommendations from the National Oil Spill Commission Report on the Deepwater Horizon Event, the National

Academy of Engineering/National Research Council report, and other pertinent reports following the DWH event that specifically address the assessment of oil spill risk. The PEIS should address what BOEM and BSEE have accomplished or plan to accomplish to address the identified deficiencies. Moreover, the PEIS should demonstrate that the reform measures will contribute to improvements in offshore safety.

Response: The PEIS has been revised in Sections 1.3, 2.9, and 4.3.3 to address this concern. In particular, Section 4.3.3 has been revised to include a more complete discussion of both governmental and industry reform efforts, in place and ongoing, that are being implemented to respond to the reform considerations and recommendations. BOEM and BSEE have implemented and continue to implement many of the expert recommendations in the various DWH event investigation reports. Many of these enhanced measures, such as improved blowout preventer (BOP) reliability, improved cementing and other secondary barrier programs, better-defined operational and risk assessment procedures, and integrated treatment of human risk factors, have been benchmarked against international standards and experience where these improvements have been shown to effectively reduce risk (See DNV 2010b in Section 4.7 references).

4. The PEIS inadequately evaluates the risk of the occurrence of oil spills. The PEIS risk analysis is overly simplistic and relies on the same flawed historical approach. Using that methodology, BOEM underestimates the actual risk of accidental spills, especially those potentially occurring during higher-risk drilling operations. BOEM should improve the quantitative risk assessment of oil spills, considering the different risk profiles of different OCS operations, disclose the greater risk of drilling in deep water and Arctic conditions, and incorporate lessons learned from the DWH event.

   Response: BOEM included a substantial treatment of the different factors that can contribute a different risk profile across different OCS oil exploration and development operations relative to different environmental conditions and operational circumstances. The reader is referred to that detailed discussion in Section 4.3.3. In addition, the PEIS has been revised to incorporate the best available information addressing occurrence of oil spills, including small, large, and potentially catastrophic spill sizes, across different operational phases and environments. Additional quantitative treatment of spill risk is included in Sections 4.3.3 and 4.4.2. BOEM maintains that the risk of large and potentially catastrophic discharge events is rare, including those resulting from loss of well control.

8.4.4.6.3 Issue 6.3 Arctic Oil Spill Concerns.

1. Many commenters emphasized the limitations of governmental and industry response capability currently in place to effectively contain, respond to and clean up oil spills in the harsh arctic environment. Comments commonly referenced the general lack of response planning, existing response support infrastructure, Arctic-specific containment and mechanical recovery technology, as well as the remoteness, extreme weather and sea state, cold temperatures, seasonal darkness, and presence of sea ice in the Arctic. Some of these

commenters indicated that leasing should not be pursued in the Arctic until sufficient response capability was in place.

Response: These general comments about spill response capability are already reflected in the PEIS in Section 4.3.3 and do not warrant additional changes to the PEIS. Related comments providing or requesting additional information are included and addressed in comments below.

2. Numerous commenters expressed serious concern over the risk of a large spill occurring in the Arctic and the possibility for severe long-term impacts on sensitive environmental resources and native communities.

   Response: BOEM appreciates that the risk of oil spills is in the Arctic is a fundamental concern. The PEIS acknowledges this risk throughout Chapter 4 of the PEIS. The reader is referred to the following sections of Chapter 4: 4.3.3, 4.4.2, and 4.6.

3. A number of comments differentiated the risk of a catastrophic discharge event in the Arctic from the risk of a catastrophic discharge event in deepwater GOM. The shallow-water wells and low-pressure geology found in the Arctic are less technically complex than the deepwater wells and high-pressure/high-temperature conditions in the GOM, and as a result, the risk of blowout and oil spills is less. A catastrophic discharge event is extremely rare, and with new requirements in place, industry is prepared for such a remote event with oil spill response plans appropriate for the nature and risk of operations.

   Response: Section 4.3.3 describes the various factors that contribute to the risk of blowouts and catastrophic discharge events, as well as regional spill containment and response capability if such an event were to occur.

4. The PEIS should accurately disclose the effectiveness of mechanical recovery techniques of spilled oil in the Arctic. Commenters assert that Shell has incorrectly asserted that they can successfully recover up to 95% of oil if a spill occurs in the Arctic.

   Response: Comment noted. See PEIS Section 4.3.3 for a discussion of the efficacy of mechanical recovery methods, including the potential for reduced effectiveness in ice conditions and narrow windows for physical recovery owing to ice state and ice breaking capability.

5. No one has yet determined how to clean up oil in pack ice, which covers the Arctic during eight months of the year. The Coast Guard possesses only three heavy ice breakers, one of which has been converted to a research vessel, another that is slated to be junked, and another that awaits a similar fate in Seattle. Skimmers — the main tool used in the BP spill — have been proven by Canadian researchers to be ineffective even when the water is clear of ice because of choppy conditions. We cannot answer all of these questions between now and when the lease sales open in 2015. The National Commission made recommendations on how to close the response and research gaps in the Arctic, including launching an immediate

Federal research effort to gather more scientific data about the Arctic Ocean, conducting annual stock assessments of species, and creating an interagency research program to focus on spill response and containment in the Arctic. Until we have more information, the Department cannot make a sound decision as to whether to drill in the Arctic Ocean. Especially in an era of acute Federal budget constraints, there is no guarantee that the work necessary to close these gaps will be completed. Until these efforts are completed, it is not possible to assess the true risks to the Arctic environment, or to the Native communities that depend on the resources of the Arctic for their survival.

Response: The PEIS reasonably discloses the potential for oil spills in the Arctic Planning Areas and fairly characterizes the existing spill response capability and challenges to well containment and oil response in various ice states. The PEIS also discusses the scope of recent oil spill response plans industry has prepared in support of proposed Arctic operations under recent lease sales. The commenter incorrectly presumes that OCS activities under the 2012-2017 Program that could result in the oil spill size of concern will occur instantaneously within the same time frame as the lease sale schedule. Instead, given recent precedent in industry investments, BOEM anticipates that first exploration drilling operation under the new program may not actually occur until after the end date of the 2012-2017 Program. In the intervening time, as characterized in Section 4.3.3, BOEM, BSEE, and the oil and gas industry are actively pursuing a sophisticated research program focused on oil spill response in the Arctic. Many of these efforts have been described in revisions to Section 4.3.3.

The Arctic lease sales included in the Preferred Alternative are intentionally scheduled late in the Program so that new research and practical experience garnered from exploration activities proposed in 2012 and 2013 under existing leases, provided they are approved by BOEM and BSEE, can better inform those decisions. The PEIS already considers no Arctic sales alternatives if the Secretary of the Interior wanted to pursue a course of action to avoid the potential for oil spills in the Arctic associated with 50-year implementation of the 2012-2017 Program. That being said, it would still be possible for spills to occur during exploration and development operations under leases acquired under previous programs. At any time, the Secretary maintains the discretion to cancel or further delay the sales if new information suggests it is prudent to do so, or conversely, if the absence of information warrants a more precautionary approach. Similarly, the Secretary maintains the discretion to issue suspension orders for given exploration or development operations provided the need.

8.4.4.6.4 Issue 6.4 A Catastrophic Discharge Event.

1. The references are incorrect or are missing from Section 4.3.4 in the Draft PEIS.

   Response: The references cited in Section 4.3.3 were inadvertently not included in the reference section for Chapter 4. The PEIS includes all references relevant to the discussion of the risk of a low probability, catastrophic discharge event.

2. Section 4.3.4 of the Draft PEIS should reference the best available North Sea research efforts and demonstration projects regarding oil spill response measures and capability in ice conditions.

   Response: Section 4.3.3 of the PEIS has been revised to include additional information concerning oil spill response research in the North Sea. In addition, the PEIS includes information about ongoing BSEE, U.S. Coast Guard, National Research Council, and Joint Industry Project efforts to study and improve oil spill response capability in the Arctic.

3. Section 4.3.4.3.1 of the Draft PEIS needs to provide more detailed information about the assumptions underlying the catastrophic discharge event scenarios in each OCS Planning Area. This includes a more robust discussion of the likelihood of occurrence of such an event in context of new prevention and containment requirements. An estimate of the frequency of major spills could include factors such as historical domestic and international catastrophic spill occurrences, environmental factors, number of platforms, pipelines, and oil tankers, as well as the volume of production. Additionally, the PEIS should make reference to other rare events and the nature of impacts that can be expected.

   Response: Section 4.3.3 of the PEIS has been revised to better describe the methodologies used to derive the spill scenarios, clarifies the likelihood of occurrence, and identifies comparable spill examples. The PEIS indicates that the likelihood of occurrence of a catastrophic discharge event is small. BOEM maintains that the introduction of new prevention and containment requirements should further reduce the likelihood of occurrence, but, at the 5-year program stage, there is no definitive way to quantify that improvement given well-specific variables. BOEM has conservatively assumed for the purpose of its 40 CFR 1502.22 analysis that new prevention and containment requirements are not effective. Those assumptions are clearly specified in Section 4.3.3. The specific resource area analyses in Chapter 4 of the PEIS summarize the scale of possible environmental effects for small and large oil spills (which the analytical scenario assumes), as well as a low-probability catastrophic discharge event (which is unexpected).

4. The Northwest Arctic Borough expressed concern over the possibility of a catastrophic oil spill. Northwest Arctic Borough stressed the importance of spill prevention and response, including the need to have proven cleanup capabilities tested and deployed before any OCS activities begin. The Northwest Arctic Borough comments indicated that there were a range of deficiencies in the Draft PEIS. The Draft PEIS underestimated the likelihood of occurrence such a spill and the potential impacts from such a spill. Similarly, the Draft PEIS overestimated the response capabilities for such a spill. Table 4.3.4-1 failed to mention weather or broken ice conditions as factors that could lead to a catastrophic event. Northwest Arctic Borough questioned the accuracy of estimates that a catastrophic discharge would be contained within 40–75 days in the Chukchi Sea, as compared to greater estimates in the Beaufort, especially since the Chukchi Sea is further from infrastructure than either of the other two Alaska planning areas. NWAB requested that the PEIS clarify the reference to the 2010 SINTEF report on the Joint Industry Program on Oil Spill Response for Arctic Waters. The Joint Industry Program study used field trials to improve oil spill response techniques for in situ burning of oil and use of dispersants and mechanical recovery. The PEIS should have

indicated that the trials involved prepositioning of equipment and deployment during controlled conditions. The PEIS should also have emphasized the current challenges faced by the Coast Guard in the Arctic in terms of human and resource capital to respond to a spill in ice conditions.

Response: BOEM revised Section 4.3.3 to address the technical aspects of this comment. The reader is also referred to Section 4.2.2 for a characterization of the potential interactions between sea ice and oil and gas infrastructure on the OCS and the resulting risk potential. BOEM has also clarified the underlying assumptions about the duration of a catastrophic discharge event in the Chukchi region. The PEIS includes an expanded discussion of the current regulatory regime for spill response planning and implementation, as well as the regional spill response capability.

5. NOAA recommended that BOEM broaden the scope of its analysis to consider the impacts of all activities, including potential oil spills and the use of chemical dispersants in any oil spill response efforts, to Essential Fish Habitat and other vulnerable deep-water habitats such as deep-sea corals. NOAA also suggested that BOEM evaluate the potential impacts to EFH for each life stage of each managed species, as well as impacts to other vulnerable habitats, from a worst-case scenario oil spill, including impacts to benthic and pelagic coastal and offshore habitats, and prepare proposed mitigation requirements for such a spill.

   Response: Sections 4.4.6.4 and 4.4.7.3 of the PEIS include an analysis of potential impacts to EFH and fish appropriate for a programmatic NEPA document. Under CEQ requirements, the PEIS does not need to include an analysis of a worst-case oil spill. Rather, under the requirements of 40 CFR 1502.22, the PEIS must address reasonably foreseeable significant adverse effects resulting from a proposed action even if the probability of occurrence is low. To comply with this requirement, BOEM has analyzed the effects of a "catastrophic discharge scenario" for each Planning Area under consideration. The effects analysis for each resource in Chapter 4 considers events and impacts which may have catastrophic consequences, including population-level effects for sensitive biological resources and chronic disturbance to vulnerable or sensitive habitats. BOEM's overall approach to region-specific or plan-specific mitigation is explained in detail throughout the document, most notably in Section 1.3.1. BOEM refers the commenter to BSEE regulations at 30 CFR Part 254 and the 2010 Certification NTL (NTL 2010-N10) that require that OCS operations have an oil spill response plan that is adequate to contain the worst-case discharge for an individual exploration or development plan. The worst-case discharge under the BSEE regulations should not be confused with the NEPA requirement described above.

6. NOAA recommended that BOEM provide further analysis and support for the statement that oil in Arctic waters can be "suspended" in the water column. NOAA also cautioned against the language here regarding the benefits of ice in confining or cleaning-up spilled oil. NOAA disagreed with any characterization that oil trapped in ice prevents the oil from affecting sensitive habitats and from spreading.

Response: The PEIS has been revised to more accurately describe the potential for oil to be entrained in the water column. The PEIS does not indicate that there are explicit benefits to oil being confined to ice. Section 4.3.3 states that ice may either facilitate or hinder the clean-up of oil or the scale of cleanup operations in the Arctic, depending on the circumstances.

7. The PEIS only addressed well-control issues and associated technological applications. Because sub-sea pipelines are envisioned for product delivery, NOAA recommended the PEIS include a similar analysis of pipeline spills. Such spills may have relatively large volumes and may be considered catastrophic. Pipelines may transit the spring lead system through which thousands of marine mammals migrate each spring, and any spill may occur under ice — presenting challenges for timely detection.

   Response: BOEM acknowledges that pipeline spills can have sufficiently large volumes to contribute to significant environmental effects. However, the volume and duration of those spills will not be as large and long as spills that could potentially occur following loss of well control. BOEM has treated the likely frequency and size of pipeline spills in the small and large accidental spill analysis in Section 4.4.2 and throughout the Chapter 4 effects analyses. To comply with 40 CFR 1502.22 requirements, BOEM has deliberately used a long-duration loss of well control so as not to underestimate the potential spill size and duration of a low-probability catastrophic discharge event, and analyzed the potential for environmental effects from such an event. In general, the distance between two safety valves would not allow the volume to be catastrophic even from a rupture or equivalent occurrence. Subsea pipelines must be designed and constructed to operate safely in the harsh environment on the Arctic OCS where ice scour is prevalent. Arctic pipeline designs are based on extensive pipeline experience onshore in Arctic environments and offshore experiences in the Beaufort Sea and other parts of the world. The design goal for any pipeline is ultimately zero discharge of oil, and it must be in compliance with BSEE and U.S. Department of Transportation pipeline safety regulations. Any offshore pipeline system in the Beaufort and Chukchi Seas would be designed according to these codes, standards, and specifications. Should development be proposed, a joint technical review of the pipeline design by the BSEE and State Pipeline Coordinator's Office would be conducted in conjunction with the review processes for the right-of-way application. The pipeline would be hydrostatically tested before operation begins, have three leak-detection systems, and be monitored by pigging to ensure safe operations. During the development plan phase, mitigation can be considered to reduce the potential impacts of a spill further if determined to be necessary. For example, during the Northstar Development Project, British Petroleum proposed using a supplemental leak-detection system, LEOS, that increases the probability of detecting a pinhole leak from the pipeline under the ice that could potentially be below the pressure-point analysis and mass-balance line-pack compensation threshold.

8. In addition to ice, extreme temperatures, and shortness of the ice-free season mentioned here, seasonally limited available daylight is also likely to be a major constraint to a spill response, as aerial efforts are important to locate and track surface oil, direct response operations, and assess response effectiveness (aerial efforts are a requisite for certain response tactics).

BOEM should consider the limited infrastructure currently available in the Arctic to support large-scale response operations in the event of a well or pipeline blowout.

Response: BOEM has revised Section 4.3.3 to address and provide more detail about the unique challenges of oil spill response operations in the Arctic, including human capital and infrastructure needs.

9. In Section 4.3.4.2.2, the Draft PEIS states "since the toxicity of dispersants is an important consideration, mechanical containment methods are the preferred initial response. Very large spills may require immediate application of dispersants." This discussion should be expanded to discuss the fact that although mechanical response is preferred, it is not always adequate and that dispersant use involves trade-offs and can provide a net benefit.

Response: Section 4.4.3 of the PEIS has been revised to include a more inclusive discussion of the trade-offs of dispersant application.

10. Many risk factors for catastrophic discharge events positively correlate with water depth. Thus, water depth is not simply one variable among others that needs to be considered in regulating OCS oil and gas operations. Instead, water depth is broadly representative of the risk of offshore drilling. While water depth is not the only risk factor that should be considered for catastrophic discharges, environmental impacts may be significantly different in deepwater leasing, and as such, that possibility underscores the need to consider an alternative in which deepwater leasing would be deferred.

Response: The PEIS considers the various factors that potentially contribute to the risk of occurrence of loss of well control and potential consequences of such an event. Recent research has indicated that water depth is not or is either marginally correlated with safety incidents — not spill or pollution events. The principal factor associated with downhole risk is the true vertical depth of the well, which in turn drives borehole pressure conditions. Moreover, it is not uniformly true that all wells drilled in deepwater are drilled to a greater final depth than in shallow water. Section 4.3.3 of the PEIS includes a robust discussion of the risk potential that deepwater and ultra-deepwater operations introduce. Despite the conjecture offered in the comment, there is no definitive evidence that water depth actually contributes to significantly different effects, although it does complicate spill containment and response operations as already disclosed in the PEIS. Consider the following example. A given exploration well spudded in shallow water may be drilled to a true vertical depth greater than a given deepwater well, despite the fact that the deepwater well is in a water depth more than several hundred meters. The geology overlying and formation and reservoir pressure conditions in the reservoir in a shallow water well may be comparatively riskier. The proximity to the coast, assuming a blowout and spill does occur, may present the potential for greater environmental impacts because of the likelihood of wide-spread and immediate contact with coastal and estuarine resources. Section 4.3.3 addresses the relative importance of fate considerations and spill proximity to sensitive resources. As explained in the PEIS, BOEM's exploration and development scenario projects that the lion's share of oil from the GOM will be produced most economically from deepwater. Excluding deepwater is therefore inconsistent with the purpose and need of the proposed action which requires the Secretary to both develop OCS resources and protect the environment. Chapter 2 presents a detailed justification of why BOEM has not analyzed an alternative excluding deepwater leasing.

11. The PEIS overstates the relative risks associated with deepwater operations and fails to include important blowout and BOP pressure test data. Minerals Management Service studies indicate a significantly lower blowout rate for deepwater drilling operations. West Engineering, SINTEF, and OOC (Offshore Operators Committee) pressure test data show that critical pressure test failures are 19 to 27 times higher for surface BOPs than for subsurface stacks.

    Response: BOEM has incorporated the references suggested and clarified the point being made in the PEIS. Although blowout events in the deepwater GOM are limited, the most comprehensive blowout frequency analysis, based on SINTEF's international database of blowout events, suggests that there is a greater relative frequency of blowouts in high-pressure/high-temperature conditions.

12. In Section 4.3.4.2.1 of the Draft PEIS, the statement "in shallow water, the relatively lower formation pressure typically results in a higher margin of safety, although encountering shallow gas represents a substantial hazard" is misleading and should be revised. With regard to formation pressures, well depth (not water depth) is the primary consideration. While ultra-deep (subsurface) shelf wells like those at the Blackbeard prospect typically encounter very high formation pressures, the ultra-deepwater Perdido field has low reservoir pressures. In this section, the Draft PEIS also states that "deepwater drilling rigs are multi-point moored to the sea floor or, more recently, dynamically positioned" is incorrect. DP [dynamic positioning] systems have been in use for 40 years. The Glomar Challenger had a full DP system for coring operations in 1968, and the Sedco 445 had a DP system for drilling in 1971. In this section, the Draft PEIS also states that "the technologically advanced BP Thunder Horse platform, for instance, intended to be BP's largest producer in the GOM, flooded because of the backward installation of a valve" does not relate to the discussion.

    Response: Section 4.3.3 of the PEIS has been revised to address or clarify the text in the draft.

13. The PEIS states that "the number of incidents reported increases with more complex operations, in particular with deepwater operations which, by their very nature, often entail greater scale, expansion, and complexity (Cohen and Krupnick 2011)." Citing a reference is not helpful unless that reference includes data that substantiate the conclusions. Increased production from fewer manned surface facilities tends to reduce safety risks and the potential for operational failures, not increase them.

    Response: BOEM inadvertently cited the wrong reference. The correct reference is Muehlenbachs et al. (2011). BOEM has clarified the statement and provided additional references to support the principal idea.

14. In Section 4.3.4.3.4, the Draft PEIS states that "the DWH event demonstrated that advances in drilling, safety, and spill response did not keep pace with increasingly complex operations by raising the standards for drilling and workplace safety, spill containment, and spill response." This statement is not representative of the views of industry in general and should be removed. The Macondo incident has caused everyone to evaluate their operations. However, Macondo is not the sole performance measure for all operations and an entire industry. USDOI data indicate that drilling operations have been getting safer and that the blowout rate has decreased. In addition, since the DWH event, a number of regulatory, policy, and industry-led initiatives have been developed and implemented. Together, these initiatives will work to further reduce the risk of future incidents and improve the offshore industry's ability to respond to any accidents or oil spills that might occur in the future.

    Response: The PEIS has been revised. Section 4.3.3 includes a detailed discussion of recent and ongoing governmental and industry reforms. The language in question has been revised.

15. In Section 4.3.4.2.1 of the Draft PEIS, the measure used to quantify the three largest spills prior to the DWH event is not provided.

    Response: The PEIS has been revised to indicate that the spill sizes are expressed in barrels (bbl).

16. Table 4.3.4-1 of the Draft PEIS should be revised by removing the term "vs." from "capping at the well vs. drilling relief well vs. chemical and mechanical response" since the current structure suggests that there are different trade-offs amongst each.

    Response: Table 4.3.3-2 in the PEIS has been revised to clarify the intent. However, there are trade-offs associated with some of different response strategies, especially in chemical and mechanical response.

17. While catastrophic discharge event may be classified as a "spill of national significance," spills that may not be classified as a catastrophic discharge event may still be classified as a "spill of national significance." A discharge may be classified as a spill of national significance (SONS) by the Administrator of the USEPA for discharges occurring in the inland zone and the Commandant of the U.S. Coast Guard (USCG) for discharges occurring in the coastal zone (40 CFR 300.323). USEPA recommends that BOEM consider clarifying that a SONS may not necessarily be a "catastrophic discharge event."

    Response: Section 4.3.3 of the PEIS has been revised to clarify that a SONS may not necessarily be a catastrophic discharge event.

18. It is not enough that the PEIS lists potential hazards that could lead to an oil spill; it must analyze and describe how the hazards could cause a spill, and most importantly, whether and how these hazards could be mitigated to avoid a spill. For example, in Section 4.2, which describes the relationship of the physical environment to oil and gas operations, the PEIS describes seismic faults, weather conditions, and geological hazards in the Arctic that "may

present a risk to offshore oil and gas activities," but does not specify what those risks are, nor does it make recommendations as to whether or how these hazards can be treated to avoid those risks. In sum, the PEIS is not sufficient without a reasonable analysis of the significant impacts oil spills may have on the regions proposed for leasing, the state and availability of current technologies and infrastructure to effectively contain and clean up a major or catastrophic spill in the different regions, and of whether and how the risks and impacts of such a spill can be mitigated.

Response: BOEM believes the PEIS does sufficiently link geological, operational, and other hazards to the occurrence of a spill or other incidental events. The reader is referred to Sections 4.2 and 4.3.3 for a complete discussion of risk. While the exact cause of the spill may vary, Chapter 4 of the PEIS fully analyzes the effects of small, large, and very large oil spills and differentiates between the intensity and context of potential impacts.

19. In Section 4.3.4.2.2, the Draft PEIS discusses the Marine Well Containment Company's seabed containment system. The PEIS states "this system is intended to address the weakness of the BP containment dome that caused its failure during the DWH event. The system can inject antifreeze-like chemicals to inhibit natural gas hydrate build-up, which created spill containment complications during the DWH event. Of course, whether Marine Well Containment Company's system will work as effectively as it claims will not be known until another blowout event occurs." The commenter asked BOEM to revise this section of the document to note that the DWH response deployed other, more advanced systems later in the response that did have methane injection capabilities to control hydrate formation. Additionally, the capping and control systems deployed during the response in June 2010 were effective in capturing a significant portion of the released oil and gas. Accordingly, it has been shown that similar systems can be effective in similar situations.

    Response: Section 4.3.3 of the PEIS has been revised to reference the improved capability for containment after BP's containment dome was modified.

20. In Section 4.3.4.2.1, the Draft PEIS states "deepwater wells require subsea BOP placement at depths unreachable for human service; ROVs [remote operating vehicles] become necessary." This statement insinuates that there is an increased likelihood in spill occurrence or failure in well control or containment. The effective use of ROVs at deepwater sites has been clearly demonstrated.

    Response: BOEM provides additional reference to the Mide (2010) study that addresses the reliability of ROVs to clarify the dependency on ROVs for physical intervention on deepwater well equipment and associated risk.

21. In Section 4.3.4.2.1, the Draft PEIS states "important technology includes the acoustic backup system, which communicates with the BOP system in the event of electrical and hydraulic connection loss with the wellhead. DNV (2010) reported a 25% reliability of current acoustic backup systems. ROV activation of the BOP using the secondary control system had a 75% success rate." Why is the acoustic backup system highlighted as important

when it has significantly lower reliability than ROV activation? Acoustic backup systems are likely to have even lower reliability during turbulent blowout conditions.

Response: Section 4.3.3 of the PEIS has been revised to clarify the statement in question and to address the reliability of other primary and secondary control systems.

22. It is not clear if the effects analysis considers the new reforms that require industry to have plans in place for a worst-case discharge and the circumstance that a spill cannot be contained with the containment technology. Even with the new safeguards in place, there is always a chance that capping or other methods of containment will not be successful.

    Response: As stated in Section 4.3.3, the PEIS includes an effects analysis that assumes a catastrophic discharge event has occurred and, despite the new requirement for containment capability, containment is not possible or effective so the spill continues to until a relief well is drilled or the well naturally bridges. The effects analysis is provided by resource and region in Section 4.4.

23. In Section 4.3.4.3.4 of the Draft PEIS, the bulleted list characterizing the Certification NTL is incomplete.

    Response: The PEIS has been revised to clarify the requirements of the Certification NTL in Section 4.3.3.

24. Section 4.3.4.3.1 of the PEIS needs to provide more detailed information about the assumptions underlying the catastrophic discharge event scenarios in each OCS Planning Area. This includes a more robust discussion of the likelihood of occurrence of such an event in context of new prevention and containment requirements. An estimate of the frequency of major spills could include factors such as historical domestic and international catastrophic spill occurrences, environmental factors, number of platforms, pipelines, and oil tankers, as well as the volume of production. Additionally, the PEIS should make reference to other rare events and the nature of impacts that can be expected.

    There is no definition or the context for what is considered a reasonably foreseeable spill. Some comments criticized that the catastrophic discharge event scenarios were not reasonable because they failed to take into account new technology and procedures and instead were based on the time required to drill a relief well. In light of the new well containment capabilities, it is very likely that the oil flow would be stopped or substantially reduced in less than the minimum durations specified for GOM and Alaska OCS oil blowouts.

    Response: Section 4.3.3 of the PEIS has been revised to describe the methodologies used to derive the spill scenarios and clarifies the likelihood of occurrence. In Section 4.3.3, BOEM provides a clearer explanation of its conservative assumptions regarding an oil spill. The specific resource analyses in Chapter 4 of the PEIS summarize the scale of possible environmental effects for small and large oil spills (which our scenario assumes), as well as a low-probability catastrophic discharge event (which is unexpected). Consistent with the requirements of 40 CFR 1502.22, the PEIS includes an analysis of impacts with have catastrophic consequences even if their probability of occurrence is low.

25. The PEIS does not contain adequate information concerning the regulatory protocols, effectiveness of, and impacts of subsea dispersant injection as a method to minimize the fate and effects of an oil spill. Subsea physical containment technologies should still be required for OCS operators until the environmental consequences of subsea dispersants have been investigated.

    Response: The PEIS has been revised to provide additional information on the protocols and effectiveness of dispersant use in Section 4.3.3. Subsea physical containment is required under BSEE regulations and clarified by NTLs.

26. The PEIS does not adequately characterize the persistence of and re-exposure to spilled oil from a catastrophic discharge event.

    Response: Section 4.3.3 has been revised to describe the potential for the persistence and re-exposure of oil in the marine and coastal environment. Also, Sections 4.4.6 and 4.4.7 discuss the potential for oil spill impacts on coastal and marine habitat and associated fauna.

27. The effects analyses in the PEIS are premised on a flawed assumption concerning the potential occurrence or likelihood of occurrence of a catastrophic spill in each OCS Planning Area. BOEM should provide more detailed analysis of the likelihood of occurrence and scale of effects associated with such an event, especially in the Arctic. Otherwise, the effects analysis violates the NEPA requirement to provide a full and fair discussion of environmental impacts.

    Response: Assigning accurate probabilities to rare events is difficult as acknowledged in the PEIS. BOEM has expanded the analysis in the PEIS in an attempt to better characterize the risk of occurrence, although absolute quantification remains difficult given the relatively limited number of historical observations for both loss of well control and major pollution events and wide-ranging exposure variables. Even then, reliance on historical data presents its own set of challenges as the historical data may represent a trend associated with a different regulatory regime or industry practices. Quantitative risk assessment becomes most practical at the well design phase, much later in the phased OCSLA process, when the combined reliability of primary and secondary barriers or barrier-failure modes can be analyzed within a fault-tree approach. At the exploration and development phase, worst-case discharge is also calculated on a site-specific basis and can be useful in determining the potential scale of effects.

28. In Section 4.3.4.3.1, the Draft PEIS estimates the probabilities for risk for a 150,000 bbl spill in the Arctic and GOM to be 3.94×10^{-4} and 3.42×10^{-4} respectively. The fact that these risk probabilities are so similar, despite the many differences between these areas, is surprising. What "Arctic specific variables" are factored into the Bercha estimate?

Response: The PEIS (see Section 4.3.3.3.1) has been revised to include updated information and a description of the fault-tree approach used by the Bercha Group.

29. The Arctic Ocean is a unique operating environment. As discussed in the PEIS, the characteristics of the Arctic OCS — rough seas, dynamic sea ice, extreme cold, limited visibility and daylight — exacerbate the risks and consequences of an oil spill, while also complicating cleanup. Oil is also likely to persist in cold environments. Section 4.3.4 of the Draft PEIS needs to be updated to include more relevant information about spill response capability in the Arctic, including major challenges to timely and effective spill response, as well as recent planning and capability improvements to address those challenges. An updated discussion of the U.S. Coast Guard presence, ice-breaking capacity, and other support infrastructure needs to be provided. The PEIS needs to demonstrate the adequacy of existing preparedness and response capabilities. In the absence of this, the PEIS fails to demonstrate why the risk is acceptable and leasing is warranted.

    Response: Containment and response in the Arctic must plan for the challenges of mobilizing, staging, and delivering technology and equipment and the ability to deploy it and get it on location in a timely manner in remote locations. The PEIS analysis includes assumptions that are consistent with recent exploration plans and oil spill response plans approved by BOEM and BSEE that include unprecedented measures. All operations in the Arctic must comply with oil spill containment and preparedness requirements in BSEE regulations and Notices to Lessees, such as the Certification NTL described in Section 4.3.3. Current practices for oil spill response plans are largely based on the type, location, season, and duration for each exploration activity. If development and production from the Alaska OCS Region were proposed, additional requirements and practices for conducting oil spill response would be developed commensurate with the type, location, and scope of proposed activities.

    Secretary Salazar highlighted the work of U.S. agencies to ensure that the full scope of Federal command and control capabilities are in place in the event that an accident occurred during the limited period allowed for potential exploratory drilling in the Arctic. If drilling is allowed to go forward, the U.S. Coast Guard would be in charge of overall command and control activities. For example, the Coast Guard has committed to an on-scene, at-sea presence, with land-based support, in the event that exploratory drilling goes forward this summer. The Coast Guard's command and control activities, supported by BSEE, the USEPA, NOAA, and other Federal agencies, would proceed in conformance with federally mandated contingency plans for the North Slope area that have recently been revised and updated. Those plans include the identification of sensitive ecological resources in the region and outline protection strategies.

    Preparedness and response exercises are essential to actual response effectiveness. For the last several summers, the Coast Guard has deployed vessels, aircraft and personnel to North Slope areas to practice operations in the area and work with local officials and citizens. On December 8, 2011, members of the Coast Guard and the State of Alaska conducted an Incident Command Post workshop with Shell personnel to improve oil spill preparedness. BSEE coordinated a table-top exercise with Shell and Federal, State, and local representatives in May 2012. In addition, the Alaska Regional Response Team (ARRT), which is made up of 12 Federal agencies and the State of Alaska, is planning an exercise that will test ARRT processes for responding to an incident. Finally, BSEE will conduct a deployment test of a company's capping stack prior to the approval of their drilling permit application, as well as on-site unannounced inspections of deployed spill response equipment.

In its regulatory role, BSEE is proactively working with NOAA, USCG, State of Alaska, international bodies, and joint industry programs to review oil-spill response plans and preparedness by the oil-and-gas and maritime industries prior to exploration and development activities. BOEM and BSEE do not disagree that spill response preparedness and response capability may be improved by further research, planning, and regulatory reform. BOEM is only considering adding the Arctic Planning Areas to the 5-year Program, under which any drilling activity would not likely occur until sometime after 2020 following a number of subsequent NEPA analyses and project-specific approvals. In the intervening time, BOEM, BSEE, other governmental agencies, and industry may make significant strides and advances in Arctic spill preparedness. If exploration drilling occurs under past lease sales, valuable lessons and experience can be applied in context of OCS operations potentially conducted under this 5-year Program. Including the lease sales in the 5-year Program does not guarantee the lease sales will occur. However, excluding lease sales at this point may prematurely postpone the development of valuable oil and gas resources on the basis of the current state of preparedness as compared to what it will be at the timeframe relevant to actual operations.

30. In cold environments, there is the potential for oil to persist. Scientific studies documenting that phenomenon for the Exxon Valdez spill were provided.

    Response: Section 4.3.3 of the PEIS addresses the fate of oil in cold environments and in ice, including the potential for persistence and repeated exposure to biological resources. BOEM has supplemented the discussion with the references provided: Peterson, C.H., S.D. Rice, J.W. Short, D. Esler, J.L. Bodkin, B.E. Ballachey, and D.B. Irons, 2002, "Long-Term Ecosystem Response to the *Exxon Valdez* Oil Spill," *Science*:302 (5653), 2082–2086. Short, J.W., M.R. Lindeberg, P.M Harris, J.M. Maselko, J.J. Pella, S.D. Rice, 2004, "Estimate of Oil Persisting on the Beaches of Prince William Sound 12 Years after the *Exxon Valdez* Oil Spill," *Environmental Science and Technology* 38:19–25. Siron, R., et al., 2003, "Fate and Effects of Dispersed Crude Oil under Icy Conditions Simulated in Mesocosms," 35 *Marine Environmental Research* 273.

31. The last public "spill drill" in the Arctic, which tested booms and skimmers and other conventional methods of oil spill cleanup in only partial sea ice conditions was in 2000 and was deemed a failure. Since offshore exploration work has to be done in the short summer when the ice cap has melted, it is unlikely that an oil spill could be cleaned up before the sea freezes over in the fall, making clean-up essentially impossible until the next summer. If an oil leak continued after freeze up, the oil would freeze into the ice and be carried potentially great distances as the ice continues to move all winter. The oil industry has never conducted an offshore oil spill response drill in the Chukchi Sea to test its equipment and procedures.

Ice can clog skimmers, make vessel operations more challenging and make it difficult to deploy equipment. Oil spreads under ice, making it more difficult to track and clean up. Field exercises in the Beaufort Sea in 2000 showed that sea ice could shut down on-water recovery at very low concentrations.

Response: The PEIS discusses the importance of timing of OCS activities relative to the fate and transport of spilled oil and effectiveness of clean-up operations during ice conditions in the Arctic in Section 4.3.3. Nuka Research Planning Group and Pearson Consulting (2010) and Potter et al. (2012) describe more recent field drills and trials in the Arctic. Section 4.3.3 of the PEIS has been revised to include new information about spill response drills and research, including the new International Association of Oil and Gas Producers (OGP) Arctic Oil Spill Response Technology Joint Industry Program. BSEE and the U.S. Coast Guard are actively engaged in capacity-building with respect to oil spill preparedness and response capabilities.

32. The last time that clean-up was tested in the Arctic was in 2000 when BP Exploration tested the response tactics and strategies for North Slope Operations. BP's studies showed that the maximum oil expected to be recovered in calm seas with minimum icy Arctic conditions would be 0–1% in fall ice conditions, 10% in spring ice concentrations without ice management, and 30% in spring ice concentrations with extensive ice management. The trials also identified many mechanical response limitations in broken ice conditions. They discovered that booms do not work effectively in ice. Skimmers do not work effectively in broken ice.

    Response: The 2000 broken ice trials in the Alaska Beaufort Sea demonstrated that the actual operating limits for a barge-based mechanical recovery system using conventional booms and skimmers. A follow-up trial testing the barge-based tactic, conducted in 2002, showed no major improvements and was followed shortly thereafter by the removal of that barge (the Endeavor) from the Alaska North Slope spill response equipment. The PEIS has been revised to incorporate additional information about the expected physical recovery of oil in different ice states assuming different ice management practices. See Section 4.3.3 of the PEIS.

33. The Canadian National Energy Board has analyzed the Arctic response gap with the finding that cleanup would not be possible on average three to five days of each week during some timeframes during a given year. Cleanup would not be at all possible from 44 to 84% of the time during the short Arctic drilling open-water season. For seven to eight months out of the year during the winter, no spill clean-up would be possible. Shell's recent exploration plan acknowledges that if Shell cannot achieve well control or remove all oil before freeze-up, the operator would abandon the well and leave the oil uncontained under the ice until spring thaw. Shell then proposes to develop a clean-up plan during the winter months and initiate response activities after spring breakup. This is not a plan.

    Response: The PEIS has been revised to incorporate information about the potential response gap given the time of year. Although the recent Shell exploration plan and oil spill response plan include unprecedented measures in preparedness, it is possible that containment measures would be unsuccessful prior to ice-over. This assumption is implicit in the catastrophic discharge scenario and subsequent effects analysis. See Sections 4.3.3 and 4.4.2 of the PEIS.

34. The International Tanker Owners Pollution Federation has noted that "containment and recovery at sea rarely results in the removal of more than a relatively small portion of a large spill, at best only 10–15% and often considerably less." The US Arctic Research Commission recently echoed these concerns for the Arctic.

    Response: This comment is consistent with the discussion in Section 4.3.3 addressing the efficacy of containment and mechanical recovery of oil.

35. During the DWH event in 2010, 20,000 to 60,000 people were involved in the cleanup operations. There is an obvious human capital and resources problem with mobilizing that number of people to the North Slope and accommodating their needs with existing infrastructure. That further reality underscores the importance of prevention and containment.

    Response: The PEIS has been revised to incorporate the human capital challenges involved in mobilizing a large workforce into a remote area. Such a challenge underscores the fundamental importance of prevention and containment, the principal focus of BOEM, BSEE, and industry reform following the DWH event. See Section 4.3.3 of the PEIS.

36. The Proposed Program states that "the Beaufort Sea Planning Area has well-developed oil and gas infrastructure on adjacent land and in State waters." However, this superficial conclusion fails to take into account the fact that existing infrastructure in this region is concentrated on land at Prudhoe Bay and is not sufficient to support response and cleanup of an oil spill in marine waters. Transportation-related infrastructure is minimal, and what exists is concentrated in the Prudhoe Bay oil field area. Heavy lift cranes and protected small boat shelters are found only at Prudhoe Bay's West Dock. Getting this limited equipment to needed locations would be difficult given that the communities within this region are not connected by a permanent road system and airports and related facilities are limited. Airports at Barrow, Kotzebue, and Deadhorse have scheduled jet service and are owned and maintained by the State of Alaska.

    Response: Although this specific assertion is not made in the PEIS, BOEM acknowledges the limited existing infrastructure (Section 3.11) and the need for advance logistical planning by OCS operators to mobilize the necessary technology, human capital, and equipment in advance of operations (Section 4.3.3). The distribution and scale of infrastructure needed for mobilization and deployment of containment and response efforts substantially constrains timely mobilization of such resources after a major spill has occurred. The PEIS has been revised to incorporate this concern.

37. An oil spill response stipulation exists for the GOM (Appendix B.1.4); however, a similar stipulation does not exist for Alaska OCS Planning Areas. Nonetheless, operators in the Arctic have developed practices specifically for the Arctic operating conditions. Operator efforts to address these challenges have also included more than 30 years of laboratory studies, simulation in test tanks and field experiments under carefully managed conditions in the U.S. and Canadian waters of the Beaufort Sea, in the Norwegian High Arctic, in the Barents Sea, and around Svalbard Island. Many of these projects have involved collaboration with the MMS.

    Response: Additional information about ongoing research and relevant industry practices has been incorporated in the discussion of spill response in Section 4.3.3.

8.4.4.7 Issue 7 Mitigation

1. Appendix B provides only minimal and generic information on specific mitigation measures to be applied for reducing impacts. Although it is understood that this is a Programmatic document, a presentation of each regulatory rule or guidance (e.g., NTL No. 2010-G40, etc.), or a reference for accessing these, in place for reducing impacts should be provided in this appendix. Although many of these may be provided or generally discussed in the text of the document, it would aid the reader if all were provided comprehensively in Appendix B. The mitigation measures employed to reduce or eliminate impacts are critical to impact-level conclusions reached throughout the document. BOEM should provide a more comprehensive approach for disseminating these to the public. Furthermore, BOEM should specify the minimum required mitigation measures now rather than waiting for some later date to impose those conditions.

    Response: The PEIS establishes an environmental baseline in Chapter 3 and then analyzes the impact factors associated with OCS development according to a reasonable scenario of activity and mitigation. Mitigation and other protective measures include those required by statute and regulation, or those deemed necessary by BOEM policy and practice for each planning area considered in the proposed 2012-2017 Program (see Appendix B: Assumed Mitigation and Other Protective Measures). At this programmatic stage, we can commit to those general mitigation measures imposed by statute or regulations, but it is premature to make absolute commitments about more site-specific mitigation without the detailed analyses that occur at the lease sale phase. However, we believe the analysis in this PEIS provides a reasonable framework for future evaluation of mitigation measures at subsequent phases in the proposed 5-year Program, such as, for example, the lease sale phase or the exploration plan submittal phase. Appendix B has been expanded to include other protective measures commonly applied through laws and regulations, as they pertain to the analyses in Chapter 4 of the PEIS.

2. The Bureau of Land Management (BLM) has developed a method to address existing data gaps for the National Petroleum Reserve Area (NPR-A). In some instances, the BLM has required pre-activity, multi-year, site-specific studies, when relevant or recent data are not otherwise available, for the purpose of helping develop mitigation measures. BOEM should

make the same commitments for OCS areas identified in the Programmatic EIS for offshore energy development in the Arctic.

Response: Decisions regarding the relevance of missing scientific information, or the need for specific mitigation to minimize potentially adverse environmental effects, are best addressed at the lease sale or plan phase, when the specific issue or concern can be well-defined and addressed in the requisite detail and analytical rigor. The BLM's Northeast NPR-A Supplemental Integrated Activity Plan process cited by the North Slope Borough is more comparable to the lease sale planning step in the OCSLA-phased process. BOEM does not generally adopt or prescribe mitigation within the framework of the national 5-year PEIS, or make commitments to multi-year, site-specific study without first defining the need and purpose, which, generally speaking, is not sufficiently characterized or formulated within the 5-year framework. BOEM does not disagree that additional scientific information may be needed to enhance mitigation and otherwise refine program implementation in individual Planning Areas. In fact, in the Proposed Program and Proposed Final Program, the Secretary of the Interior has intentionally scheduled single Chukchi Sea and Beaufort Sea lease sales late in the Program to provide additional time to identify information gaps and gather pertinent scientific data, including the need for additional site-specific study or mitigation development, to better inform lease sale, exploration, and development plan decisions. As reflected in the 2011 U.S. Geological Survey report, *An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas, Alaska,* BOEM's Environmental Studies Program continues to be a principal mechanism in defining and meeting those information needs. BOEM is collaborating with Federal partners in government-wide research programs such as Synthesis of Arctic Research (SOAR), Arctic Science Engineering Education for Sustainability (ARCSEES) program, North Pacific Research Board, Interagency Arctic Research Policy Committee, and National Academy of Sciences Polar Research Board research initiatives, as well as the National Research Council "Responding to Oil Spills in the Arctic Environment" review. Similarly, industry has been proactive in funding site-specific studies in the Arctic; in the case of Shell, they have funded millions of dollars in independent studies to characterize the environmental baseline, oceanographic conditions, potential effects on sensitive marine species, and define mitigation/monitoring needs and protocols.

At this preliminary planning stage, BOEM maintains that it is premature to define information and study needs when the analytic granularity is too coarse for site-specific or resource-specific decisions, when information from new or ongoing scientific research may be available at the time of the lease sale, and new and needed consultation and coordination will have occurred with resource agencies, such as Fish and Wildlife Service and National Marine Fisheries Service. However, BOEM does not want to downplay the underlying concern expressed in these comments, especially when there is apprehension that the point being made is ignored and unfairly treated in a tiered analytical and decision framework. BOEM has included a new section in the Issues of Programmatic Concern (see Section 4.3.2) to memorialize the issue and better explain the process of considering and evaluating different alternatives and mitigation strategies that may need to be applied at appropriate program decision points. BOEM encourages North Slope Borough to provide this same recommendation during scoping for potential Arctic lease sales.

3. The Draft PEIS failed to include a discussion of planning area-specific mitigation measures, such as seasonal restrictions in the Arctic and protected species observer programs. BOEM's analysis also rests on the assumption that the mitigation measures in Appendix B are effective; Appendix B essentially outlines the stipulations contained in leases, without analyzing whether they are, in fact, sufficient to minimize negative environmental impacts. BOEM's inclusion of mitigation measures at the PEIS level also violates CEQ's requirement that there be actual capacity to implement the mitigation measures by the Federal agency that proposes said mitigation measures in the PEIS.

   Response: Mitigation and other protective measures are developed during the implementation phases of the Program. For analytical purposes only, this PEIS considers mitigation and other protective measures already established and required by existing statutes or regulations, as well as sale-specific measures (stipulations) that were commonly adopted in past sales and that will likely be implemented for any lease sales that would occur under the Program. However, it is at the lease sale stage that more detailed and geographically focused analyses are conducted to evaluate the magnitude of potential impacts and, if needed, to develop effective mitigation strategies to reduce the magnitude of those potential impacts to acceptable levels.

   The 5-year PEIS is a programmatic NEPA document that analyzes the "size, timing, and location" of possible lease sales in the next five years. In the phased OCSLA and tiered NEPA process, the 5-year program is followed by lease sale or plan where more focused NEPA analyses are performed. In this framework, BOEM fully considers the need for and development of mitigation, effectiveness of the mitigation in terms of its stated purpose, as well as the potential effects associated with implementation of the mitigation. Appendix B has been revised to clarify the protective measures required by law, regulation, or historical practice that are assumed for analytical purposes in the 5-year PEIS. The mitigation and other protective measures considered in Appendix B have generally been developed over a long period of time and/or historically implemented. The mitigation has been codified because of its historical effectiveness, or as best practice at the bequest of resource agencies external to BOEM or its predecessor bureaus.

   Monitoring the effectiveness of mitigation involves tracking the success of a mitigation effort in achieving expected outcomes and environmental effects. Consistent with CEQ's January 2011 guidance on "Appropriate Use of Mitigation," BOEM relies on scientific staff and outside experts familiar with the predicted environmental impacts to develop the means to monitor mitigation effectiveness, in the same way that BOEM also relies on agency and outside experts to develop and evaluate the effectiveness of mitigation. Implementation of mitigation and monitoring necessarily draws on the expertise of resource agencies with whom BOEM consults, such as U.S. Fish and Wildlife Service and National Marine Fisheries Service.

   One of the more tangible vehicles BOEM uses to evaluate the effectiveness of regulations and mitigations is through the linked environmental study and assessment process. For example, BOEM has been studying and monitoring conditions at the Flower Garden Banks through its Environmental Studies Program for more than two decades, although initial monitoring efforts date to the 1970s. By continually monitoring and assessing stipulations or mitigation measures that are based upon studies results, BOEM is positioned to change or strengthen environmental requirements. A clear-cut example of this is seen in BOEM's studies of deep-sea corals in the GOM. When it became apparent (due to new study results) that extensive deep-sea coral habitats were not being included in environmental reviews because they occurred slightly shallower than existing review triggers, BOEM moved quickly to notify operators of new guidance to avoid these sensitive communities. This type of adaptive reevaluation is continual and vitally important to the protection of our nation's precious offshore environments and resources. The same is true in the Arctic. An example is the ongoing BOEM study, entitled "Aggregate Effects Research and Environmental Mitigation Monitoring of Oil Industry Operations in the Vicinity of Nuiqsut." This study is using social science research methods to evaluate the effectiveness of specific mitigation measures being implemented to manage conflicts relative to onshore and offshore oil and gas exploration and development in the vicinity of subsistence use areas for the village of Nuiqsut. The added value from such studies can lead to new mitigation applied at the lease sale phase.

The implementation of mitigation by BOEM is also questioned in the comment. Following the October 2011 re-organization of BOEMRE, BOEM is now responsible for environmental analyses for all activities associated with leasing, authorization of on- and off-lease geological and geophysical surveys, and approvals of exploration and development plans. BOEM will develop and adaptively manage environmental protection measures specific to these activities. BSEE is responsible for environmental compliance related to issuing permits associated with plans (i.e., Applications for Permits to Drill), inspections of environmental measures, and enforcement for non-compliance. BSEE also reviews industry reporting and works with BOEM to adaptively manage environmental mitigation measures to ensure their effectiveness and enforceability. Under the new Safety and Environmental Management System (SEMS) requirements (clarified in BSEE National NTL 11-N09), OCS operators must address environmental information in all aspects of their SEMS program and specifically address requirements as set forth in regulation, lease stipulation, plan conditions of approval, etc. This includes verification and corrective actions and continual improvement related to mitigation measures. BSEE provides the regulatory oversight focused on compliance by operators with environmental regulations, as well as making sure operators comply with the measures required by BOEM.

The comment suggests that sufficient authority is not vested in BOEM to require mitigation in the 5-year PEIS. To be clear, the PEIS is not adopting specific mitigation within the 5-year Program decision, but rather, assumes it to be in place for analytical purposes because the mitigation has already been codified and/or is generally considered a matter of practice.

Further, CEQ requirements regarding mitigation do not specifically require that BOEM have express authority to require mitigation for it to be relevant to the decision. Consistent with CEQ's January 2011 guidance on the "Appropriate Use of Mitigation," BOEM is not making any commitments to mitigation without sufficient legal authority now or at a later stage. BOEM would like to point out that the bureau's underlying authority may provide the basis for its commitment to implement and monitor the mitigation at the lease sale or plan phase. However, the authority for the mitigation may also derive from legal requirements that are enforced by other Federal, State, or local government entities (e.g., air or water permits administered by local or State agencies). Both scenarios generally apply during implementation of the 5-year program when mitigation is applied through lease sale stipulations or plan approvals. BSEE will take an active role in clarifying and enforcing those requirements.

4. BOEM needs to ensure that mitigation measures to protect subsistence activities are negotiated between subsistence communities and oil and gas companies through vehicles like Conflict Avoidance Agreements (CAA) that the Alaska Eskimo Whaling Commission (AEWC) negotiates with oil and gas companies each year.

   Response: The 5-year PEIS is a programmatic NEPA document that analyzes the "size, timing, and location" of possible lease sales in the next five years. In the phased OCSLA and tiered NEPA process, the 5-year program is followed by lease sale- or plan-specific NEPA documents in which more focused NEPA analyses are performed and mitigation needs are identified and analyzed. This includes the effectiveness of the mitigation to achieve its stated purpose, as well as the effects of the mitigation. BOEM has not historically developed systematic or specific mitigation through the 5-year PEIS process. Instead, in the 5-year PEIS, BOEM assumes that certain mitigation and other protective measures already required by existing regulation or BOEM requirement/practice will be in place (see PEIS Chapter 1 and Appendix B). While BOEM believes mitigation is properly developed and analyzed in the phased OCSLA process — lease sale, exploration plan, development plan — the Bureau appreciates the importance of subsistence activities in the Arctic and stresses on that longstanding way of life. In recent years, oil and gas companies, such as Shell, have been proactively working with the Native communities and community interest groups to negotiate conflict avoidance agreements in advance of activities. Consistent with the framework of Coastal and Marine Spatial Planning, BOEM encourages multi-use and environmental conflict resolution. In the 5-year programmatic analytical approach, this issue is best addressed at the lease sale or plan phase when the spatial and temporal aspects can be defined and addressed in the requisite detail and analytical rigor. BOEM has included a new section in the Issues of Programmatic Concern (see Section 4.3.2) to memorialize the issue and better explain the process of considering and evaluating different alternatives and mitigation strategies that may need to be applied at appropriate program decision points. BOEM encourages the Alaska Eskimo Whaling Commission to provide this same recommendation during scoping for potential Arctic lease sales.

5. Noise impact mitigation measures should be included. Underwater noise is, as the USDOI has stated in the past, one of the most prevalent forms of environmental impact from offshore exploration, development, and production activities. (Preliminary Revised 5-year OCS Oil & Gas Leasing Program for 2007-2012 (2010)). It requires honest analysis, dedicated research, robust protected areas, and substantial mitigation of both acute and cumulative effects well beyond current practice. While BOEM and NMFS are considering mitigation measures for seismic surveys in the EISs for GOM, Arctic, and Atlantic planning areas, it is important — for purposes of consistency and resource allocation — for BOEM to address a number of mitigation alternatives at the leasing program stage.

Response: The PEIS establishes an environmental baseline in Chapter 3 and then analyzes the impact factors associated with OCS development according to a reasonable scenario of activity and mitigation. Section 4.1 of the PEIS describes the potential impact-producing factors, including noise. Mitigation measures, considered in the PEIS, including those required by statute and regulation, or those deemed necessary by BOEM policy and practice for each planning area are described in Appendix B: Assumed Mitigation and Other Protective Measures. At this programmatic stage, we can commit to those general mitigation measures imposed by statute or regulations, but it is premature to make absolute commitments about more site-specific mitigation without the detailed analyses that occur at the lease sale phase. As the comment acknowledges, BOEM is actively pursuing Programmatic Environmental Impact Statements in the GOM, Mid- and South Atlantic, and Arctic in collaboration with the National Marine Fisheries Service in specific recognition of the potential for environmental impacts from noise in the marine environment. Those deliberative, multi-year processes are still ongoing at this time, such that the outcomes are not yet available to incorporate in the 5-year planning process. The PEIS for the Arctic was published in January 2012. The PEIS for the Mid- and South Atlantic was published in March 2012. The PEIS for the GOM is expected to be published in late 2012. Absent specific decisions, BOEM is confident that some of the mitigation strategies proposed within the framework of those documents will ultimately be adopted and applied in context of exploration activities that may occur under leases in the 2012-2017 Program in the GOM and Alaska Planning Areas. However, we believe the analysis in this PEIS provides a reasonable framework for future evaluation of mitigation measures at subsequent phases in the proposed 5-year Program, such as, for example, during geophysical permitting, the lease sale phase, or the exploration plan phase.

8.4.4.8 Issue 8 Regulations and Safety

1. Many commenters requested BOEM and BSEE to reform their regulations and practices based on the numerous recommendations from various reports prepared following the DWH event, including the National Oil Spill Commission Report on the Deepwater Horizon Event, the National Academy of Engineering Report, the National Research Council Report, the Deepwater Horizon Joint Investigation Team Report, USDOI's Report Regarding the Causes of the April 20, 2010 Macondo Well Blowout, etc.

   Response: Both BOEM and BSEE are proactively addressing the opportunities and needs at the heart of the recommendations of the various reports written following the DWH event. BOEM and BSEE have reviewed all the reports, already incorporated many recommendations, and continue to pursue and implement aggressive regulatory reform that addresses many of these recommendations or underlying need for reform or regulatory changes. As discussed in Section 4.3.3, BOEM and BSEE have focused on drilling safety reforms, especially on loss of well control prevention and well containment. BOEM has revised Section 4.3.3 of the PEIS to provide a more detailed presentation of the ongoing governmental reform process, in addition to new measures that have already been processed or implemented since publication of the Draft. Section 4.3.3 was also revised to include pertinent information about ongoing reform being pursued by industry, such as new safety, risk assessment, and spill research initiatives. Please refer to Section 4.3.3 of the PEIS for more information.

2. BOEM should present a more balanced discussion of new safety and environmental regulations and other safety measures implemented since the DWH event, including ongoing challenges of reform implementation. The effectiveness of the regulatory framework and reform measures is relatively untested.

   Response: BOEM appreciates these comments and recognizes that a proactive government and industry are critical to ensure safe and environmentally sound OCS oil and gas operations. BOEM has revised Section 4.3.3 of the PEIS to clarify the bases of recent and ongoing reform measures, referencing reform reports, benchmarked international standards, and international trends following comparable regulatory overhauls. Section 4.3.3 presents a focused discussion of (1) ongoing reforms in BOEM, BSEE, other Federal agencies, and industry and (2) promising safety, risk assessment, and oil spill response research.

3. One comment requested that BOEM present in the PEIS a risk assessment of the 5-year Program drilling activities to aid in decision-making. The risk assessment should consist of a formal probabilistic risk analysis that evaluates human, environmental, and economic risks associated with drilling, well construction, temporary well abandonment, oil and gas production, and eventual well abandonment.

   Response: BOEM has focused its analytical effort in the PEIS on the occurrence and consequence of an oil spill, as compared to drilling-related safety incidences, or costs or losses of productive time. Section 4.3.3 includes a robust discussion of the various factors that may contribute to risk during drilling operations. The PEIS characterizes the risk of oil spills in Section 4.3.3 and 4.4.2 in detail appropriate for the proposed action. Quantification of the risk of oil spills, especially very large, unexpected spills, remains a challenging problem for the reasons explained in Section 4.3.3. The same section also includes a discussion of how risk is evaluated by both government and industry through the phased OCSLA process from the 5-year Program through site-specific drilling plans.

   BOEM appreciates this comment and recognizes that a proactive government and industry are critical to ensure safe and environmentally sound OCS oil and gas operations. BOEM has revised the PEIS (see Section 4.3.3) to elaborate on recent and ongoing reform measures, referencing reform reports, benchmarked international standards, and international trends following comparable regulatory overhauls. Specific to the issue of risk assessment for OCS drilling activities, Section 4.3.3 also presents a discussion of recent joint BSEE-industry research regarding the development of a blowout risk assessment methodology, model, and risk assessment tool for OCS drilling planning and operations in the GOM.

4. The PEIS is thorough in its presentation of the regulatory and policy reforms that BOEM and BSEE have undertaken subsequent to the DWH event to improve safety and environmental outcomes.

Response: The recognition of BOEM's concerted effort to treat this topic in the PEIS is appreciated. However, since many commenters requested further clarity and information on this topic, BOEM revised Section 4.3.3 of the PEIS to provide more information about previously implemented, and ongoing reforms, including those being pursued by BSEE and industry.

5. A commenter suggested the PEIS make specific reference to substantial reform measures implemented by industry to improve offshore exploration and development operations following the DWH event. These reforms include new and revised standards, recommended practices, and guidelines that incorporate lessons learned from the DWH event.

   Response: BOEM has updated the PEIS (see Section 4.3.3) to include new and/or revised industry standards, recommended practices, guidelines, etc., such as API Standard 65-Part 1 and 2, API RP 96, API Well Construction Interface Document Guidelines, API RP 53, API Specification Q2, and API Specification 16A. Similarly, the PEIS presents updated information about the reform initiatives of other joint industry efforts and task forces.

6. Many commenters expressed concern that BOEM, BSEE, and the U.S. Coast Guard does not have adequate oil spill planning and response measures in place to support oil and gas leasing on the OCS. BSEE should better reform its regulations and guidance to minimize the likelihood of a major oil spill and to enhance oil spill planning and response measures, ensuring adequate containment resources, oil spill response capability, and proven containment and clean-up technologies are in place to respond to a major oil spill, before allowing leasing, especially in the Beaufort and Chukchi Sea Planning Areas.

   Response: BSEE and the U.S. Coast Guard, among other Federal and State entities, are responsible for oil spill planning and response efforts on the OCS. Adjacent coastal States also bring substantial expertise and resources to spill planning and response. BOEM and BSEE regulations under Subpart B of 30 CFR Part 550 and 30 CFR Part 254, respectively, require industry to demonstrate adequate spill planning and response capability, including the need to respond to a major spill in remote areas such as the Arctic Ocean.

   Following the DWH event, BOEM and BSEE put into place new requirements regarding spill containment and response planning and capability. BSEE continues to participate in regional planning exercises, evaluate new spill response technologies, invest in new innovative spill response research, etc. Both BOEM and BSEE are funding a new NRC study that considers oil spill response capability in the Arctic. Section 4.3.3 of the PEIS provides information about ongoing spill planning and response reforms in government and industry.

7. Several commenters called for reform of, and improvement in, the governmental process used to evaluate oil spill prevention and response plans. Many comments questioned industry's ability to implement oil spill response measures in the event of a significant spill, suggesting that plans need to be benchmarked against the best international standards and/or real-world demonstrations of the effectiveness of planning exercises. The commenters expressed the need for BSEE to rigorously review operators' oil spill response plans prior to

approval in a manner that ensures adequate technical input. The review and approval process should ensure that plans include spill scenario information, such as containment and response capabilities. Oil spill response plans should be subject to review and approval by not only USDOI, but other agencies with relevant operational expertise, including the USCG, USEPA, and NOAA. The plans should be available to the public for comment.

BOEM and BSEE should routinely evaluate and continually improve oil spill prevention and response measures, especially in the Arctic. In the effort toward continual improvement, BOEM and BSEE should consider adopting the recommendations from the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling and the National Academy of Engineering/ National Research Council. For example, operators should be required to employ best-available technologies and practices; provide detailed plans for source control; redesign blowout preventer systems "to provide robust and reliable cutting, sealing, and separation capabilities for the drilling environment to which they are being applied and under all foreseeable operating conditions of the rig on which they are installed;" establish test and maintenance procedures "to ensure operability and reliability appropriate to their environment of application"; and seek approval of proposed well design to demonstrate that (1) well components are equipped with sensors or other tools to obtain accurate diagnostic information and (2) wells are designed to mitigate risks to well integrity during post-blowout containment efforts.

Response: BOEM and BSEE recognize the importance of routinely evaluating and continually improving oil spill prevention and response capabilities and measures. The implementing regulations found in 30 CFR Part 550 and 30 CFR Part 250 require industry to conduct OCS operations using best-available technology and following established best practices. BSEE continues to pursue and implement a systematic regulatory reform that, in part, responds to the various reform recommendations. With increased inspection and spill response resources, BSEE plans to enhance inspections and drills, such as rigorous announced and unannounced oil spill response drills. BSEE currently has a robust process for the review and approval of industry oil spill response plans that includes appropriate technical expert input. Oil spill response plans are required to include a description of operator containment and response methodologies and capabilities per recent NTL requirements. In addition, BSEE conducts a robust research portfolio of studies each year to analyze various aspects of oil spill containment, fate, and response. The results of this research are used to continually improve oil spill prevention and response measures.

As part of the Department's broad and continuing reform efforts, BSEE created a number of Implementation Teams to evaluate and, as warranted, pursue implementation of the various reform recommendations following the DWH event. The ongoing work of these teams lays the foundation for lasting change in the way the BSEE and BOEM will implement oil spill prevention and response measures in the future. The Oil Spill Response Team at BSEE is also conducting a comprehensive review of spill response and the adequacy of operators' oil spill response plans. This team is working closely with the U.S. Coast Guard and other Federal agencies on developing enhanced spill response plans and more effective reviews of those plans in light of lessons learned from the DWH event response. Similarly, industry, through the establishment of the Center for Offshore Safety, new joint industry task forces, and joint industry research programs, is proactively engaged in advancing oil spill prevention and response capabilities.

BOEM has revised the PEIS to provide more information about oil spill response planning roles and responsibilities, ongoing regulatory reforms, enhanced governmental and industry practices, and new spill response research and technology development (see Section 4.3.3).

8. Several commenters assert that prior to consideration of leasing in the Arctic OCS Planning Areas, BOEM should (1) add a stipulation to all Arctic leases requiring a certification for Oil Spill Response Organizations (OSROs) to verify their capability to respond given the environmental conditions and challenges in the Arctic, (2) require operators to have trained response personnel and Arctic-grade response equipment pre-staged along vulnerable Arctic coastlines, and (3) require key oil spill containment and response equipment be designed for and tested in Arctic conditions.

   Response: This comment is ripe for response at the lease sale phase when mitigation requirements are evaluated and, in part, determined. Even though this is not a regulatory requirement, the need for such certification can be analyzed at the lease sale phase as appropriate (refer to the PEIS Section 4.3.2, Programmatic Deferrals and Mitigations). Moreover, BOEM also considers spill response capability during exploration and/or development plan evaluation under 30 CFR Part 550, Subpart B. Under its authority, 30 CFR Part 254, BSEE must also evaluate the merit of an operator's oil spill response plan.

   A wide range of comments were submitted on the regulatory framework for oil spill planning and response, as well as the general state of capability. For a more detailed discussion, the reader is referred to Section 4.3.3.

9. A commenter stated that operators must obtain any necessary approvals and environmental permits from the appropriate State agency, if the project results in a discharge to waters of the State. Additionally, all precautions should be observed to control nonpoint source pollution from construction activities on the OCS.

   Response: Both BOEM and BSEE are aware of the water quality permits required from affected coastal States for OCS activities. Operators also have to obtain NPDES permits under the requirements of the Clean Water Act. BOEM evaluates the need for other precautions and mitigation related to pollution control and water quality at the lease sale or plan stages.

10. Since pipelines installed and anchored on the Arctic seafloor will be decommissioned by capping in place, a commenter suggested that BOEM reference the standards to which industry will be held to that ensure the pipelines will be cleaned and pollution will not result.

    Response: BSEE regulates the decommissioning of pipelines under 30 CFR Part 250, Subpart J, and pipeline decommissioning is addressed specifically in 30 CFR 250.1006 and 30 CFR 250.1750 through 250.1754. 30 CFR 250.1006 states that pipelines out of service for less than one year must be isolated with a blind flange or a closed block valve at each end. Pipelines out of service for more than one year but less than five years must be flushed and filled with inhibited seawater. Pipelines out of service for five years or more are addressed under 30 CFR 250.1750 through 250.1754, which states that operators "may decommission a pipeline in place when the Regional Supervisor determines that the pipeline does not constitute a hazard (obstruction) to navigation and commercial fishing operations, unduly interfere with other uses of the OCS, or have adverse environmental effects." 30 CFR 250.1751 describes the details of the pipeline decommissioning application process, including the information requirements to be submitted with the application. Section 4.1.1.4 of the PEIS has been updated with a summary of the pipeline decommissioning requirements.

8.4.4.9 Issue 9 Statutory Compliance

1. Appendix C (Federal Laws and Executive Orders) of the PEIS is missing several environmental statues and Executive Orders.

   Response: BOEM added the Migratory Bird Treaty Act of 1918, Executive Order 11990 — Protection of Wetlands, as well as other statues that were missing from Appendix C of the PEIS. The list of environmental statutes and Executive Orders added to Appendix C is as follows:

   - Rivers and Harbors Act (RHA) of 1899 (Sections 9 and 10) – 33 USC sec. 401 *et seq*.
   - Migratory Bird Treaty Act (MBTA) of 1968, as amended (1936, 1972, 1976, 2006) – 16 USC 703 *et seq*.
   - The new BOEM authorities in Alaska under the Clean Air Act (CAA) of 1963, as amended (1990, 2004) 42 USC sec. 7401 *et seq*.
   - Executive Orders:
     - Executive Order 11988, Floodplain Management (May 24, 1977), amended by EO 12148 (July 20, 1979)
     - Executive Order 11990: Wetlands Protection (May 24, 1977), amended by EO 12608 (September 9, 1987)
     - Executive Order 13175, Consultation and Coordination With Indian Tribal Governments
     - Executive Order 13186: Responsibilities of Federal Agencies To Protect Migratory Birds (January 10, 2001)

2. Commenters stated that the PEIS is not in compliance with or fails to adequately explain the provisions of various environmental statutes. One commenter expressed that an Alaska National Interest Lands Conservation Act Section 810 review for pipeline routes from the Chukchi Sea and Beaufort Sea to the Trans-Alaska Pipeline System needs to be conducted for the PEIS.

   Response: BOEM updated Appendix C, Section C.1.4 The Alaska National Interest Lands Conservation Act (ANILCA) accordingly to show that pipeline routes in State waters are subject to ANILCA requirements.

3. Another commenter expressed that all OCS activities in waters adjacent to Alabama's coast must be carried out in full compliance with relevant Alabama laws, rules, and regulations, and in a manner that is fully compliant and consistent with the Coastal Zone Management Act (CZMA).

   Response: All OCS activities that may affect Alabama's coastal resources will be conducted in a manner that is fully compliant and consistent with the CZMA. BOEM will comply with CZMA requirements at the lease sale phase of the 5-year Program. Please refer to Appendix C, Section C.1.7 The Coastal Zone Management Act (CZMA) and the Coastal Zone Reauthorization Amendments of 1990, for more information.

4. Several commenters expressed concern that the PEIS does not adequately address how BOEM complies with the Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA) for the 5-year Program.

   Response: BOEM will consult with the USFWS and NMFS under Section 7 of the ESA at the lease sale phase during implementation of the 5-year Program. BOEM revised the section heading for Section 1.4.5.4 of the PEIS from "Biological Assessment and Opinion for Threatened and Endangered Species" to "Endangered Species Act Section 7 Consultations for Threatened and Endangered Species" to clarify when BOEM will undertake these consultations with the USFWS and NMFS under Section 7 of the ESA. Please refer to Sections 1.4.5.4 and 4.4.7.1 of the PEIS for more detail.

5. One commenter expressed concern that the PEIS does not adequately address how BOEM complies with the Magnuson-Stevens Fishery Conservation and Management Act (FCMA) for the 5-year Program.

   Response: BOEM consults with NMFS under the Magnuson-Stevens FCMA for the western portion of the Eastern Planning Area of the GOM using a different mechanism than that used for the Western and Central GOM. Appendix C, Section C.1.9 The Magnuson-Stevens Fishery Conservation and Management Act, has been revised to clarify this difference in these consultations across the GOM Planning Areas.

6. One commenter requested the references to the incidental harassment authorization and letters of agreement be added to Section 4.4.5.4 of the PEIS. The inclusion of the conflict avoidance agreements (CAA) could be added but must note that the CAA is voluntary and the terms negotiated between individual operators and communities and subsistence user groups vary widely.

   Response: Since details like incidental harassment authorization and conflict avoidance agreements are more appropriate for inclusion in the lease sale NEPA documents, BOEM has not added the requested information to the PEIS. However, oil and gas activities on the Arctic OCS are subject to compliance with the MMPA and ESA. Compliance with these acts collectively ensures that (1) there is no more than a negligible impact on marine mammals; (2) there is no unmitigatable adverse impact on subsistence uses of marine mammals; and

(3) there is no jeopardy to ESA-listed species or adverse modification to any critical habitat designated for ESA-listed species. Authorizations under the MMPA and ESA contain mitigation and monitoring measures to ensure these thresholds are not exceeded. Examples of such authorizations can be found at the following websites:

- USFWS
  - http://alaska.fws.gov/fisheries/mmm/Beaufort_Sea/76FR47010.pdf
  - http://alaska.fws.gov/fisheries/mmm/Chukchi_Sea/pdf/73FR33212.pdf
  - http://alaska.fws.gov/fisheries/mmm/itr.htm
- NMFS
  - http://www.nmfs.noaa.gov/pr/permits/incidental.htm
- BOEM
  - http://www.alaska.boemre.gov/ref/Biological_opinions_evaluations.htm
  - http://www.alaska.boemre.gov/ref/eis_ea.htm.

7. Industry practices as mandated by the USFWS and NMFS include maintaining 1-mile exclusion zones around known polar bear dens, use of aerial FLIR surveys to identify polar bear dens, and Incidental Harassment Authorization and Polar Bear and Wildlife Interaction Plans, which specify the means by which industry minimizes contact, conflict, or stress upon the Polar Bears. These industry and regulatory practices should be specified to demonstrate protection of the polar bears. The PEIS should also note a prior USFWS finding that "documented impacts on polar bears by the oil and gas industry during the past 30 years are minimal" and "historically, oil and gas activities have resulted in little direct mortality to polar bears." (72 *Fed. Reg.* at 1,079).

   Response: Details such as specified exclusion zones for polar bears are more appropriate for inclusion and discussion at the lease sale phase; therefore, BOEM has not added the requested information to the PEIS. However, BOEM concurs that there are existing mitigation and monitoring measures as well as industry practices that are directed at minimizing or eliminating impacts to polar bears from oil/gas activities. The USFWS promulgated regulations under the MMPA that require a suite of mitigation measures in order to ensure a negligible impact (as defined under the MMPA) on polar bears. These regulations can be found at http://alaska.fws.gov/fisheries/mmm/Beaufort_Sea/76FR47010.pdf and http://alaska.fws.gov/fisheries/mmm/Chukchi_Sea/pdf/73FR33212.pdf. Additional detail on implementation of these measures can be found at http://alaska.fws.gov/fisheries/mmm/itr.htm. Further, the USFWS has also completed a consultation with BOEM under the Endangered Species Act that further ensures oil/gas activities permitted by BOEM do not result in jeopardizing the continued existence of polar bears (see http://www.nmfs.noaa.gov/pr/permits/incidental.htm).

8. Coastal and Marine Spatial Planning (CMSP) should not be characterized as a "national zoning plan."

   Response: The language has been revised in Section 4.3.1: Multiple Use Issues and Marine Spatial Planning, to read as follows, "In recent years, Coastal and Marine Spatial Planning (CMSP) has emerged as a new paradigm and planning strategy for coordinating all marine and coastal activities within an ecosystem-based framework."

9. Commenters expressed that the Executive Order instituting the National Ocean Policy and CMSP directly conflicts with the Congressionally-established OCSLA.

   Response: BOEM appreciates the concern over the overlapping requirements of the OCSLA and National Ocean Policy EO 13547. BOEM sees the planning frameworks of the OCSLA and CMSP as complementary. Please refer to Section 4.3.1: Multiple Use Issues and Marine Spatial Planning, of the PEIS for more information.

10. Several commenters suggested that the PEIS and 5-year Program should better integrate the National Policy for Stewardship of the Ocean, Our Coasts and the Great Lakes (referred to as NOP). Implementation of the NOP by using CMSP will help resolve issues of conflicting use.

    Response: BOEM has incorporated the requirements of the National Ocean Policy EO 13547 into its 5-year Program, which includes CMSP. Please refer to Section 4.3.1: Multiple Use Issues and Marine Spatial Planning, of the PEIS for more information.

11. The PEIS mentions participation of all GOM States in the Federal coastal management program, but it fails to mention Alaska's withdrawal from the program and how the sunset of the Alaska Coastal Management Program (ACMP) may affect regulation of oil and gas activities in the Alaska DCS (Drilling, Completion, and Stimulation) Program. Until July of 2011, the statewide ACMP standards included the statutes and regulations of the Alaska Department of Environmental Conservation which were more stringent than Federal requirements. The Final EIS should include an analysis of the impacts of the loss of the ACMP.

    Response: In 2011, the Alaska State Legislature did not pass legislation that would have extended the ACMP established under Section 303 of the CZMA. The ACMP expires in July 2011. Without a Federal Consistency Program and a supporting State regulatory regime in effect, BOEM will no longer have to coordinate under appropriate subparts of the CZMA consistency regulations, 15 CFR Part 930. However, under other Federal environmental mandates, including but not limited to NEPA and the OCSLA, BOEM must still consider the direct, indirect, and cumulative environmental effects on coastal resources on State lands or submerged lands from the proposed and connected actions. Under Section 19 of the OCSLA, any affected State may submit recommendations to the Secretary of the Interior regarding the size, timing, or location of a proposed lease sale or with respect to a proposed development and production plan (OCSLA Section 25). The lease sale phase is the usual decision-point for BOEM to evaluate the need for any mitigation that is now necessary absent former State requirements, applied pursuant to Section 307 of the CZMA, that were in place to avoid or minimize impacts to acceptable levels.

TABLE 8.4-1 Stakeholders Providing Issue-Specific Comments on the PEIS

Issue 1 — NEPA Process	
John Mueller	Natural Resources Defense Council
USACitizen1	Northwest Arctic Borough
World Wildlife Fund, U.S. Arctic Field Program	National Oceanic and Atmospheric Administration
Eleanore Huffins	Alaska Wilderness League
Pamela Miller	Alaska’s Big Village Network
Alaska Department of Natural Resources	International Dark Sky Association
Jason Brune	North Slope Borough
Tom Hendrix	Defenders of Wildlife
Center for Water Advocacy	Eyak Preservation Council
Oceana	Center for Biological Diversity
Qaiyaan Su’esu’e	Northern Alaska Environmental Center
Harry Brower	Pacific Environment
Heather Dingman	Republicans for Environmental Protection
Inupiat Community of the Arctic Slope	Sierra Club
Mobile Bay Sierra Club	The Wilderness Society
Carol Admans-Davis	Mobile Baykeeper
Darcie Warden	Ocean Conservancy
The Wilderness Society, Lois Epstein	National Audubon Society
Catherine Shed	Pew Environmental Group
Carla Sims Kayotuk	Gulf Restoration Network
Don McKie	
Issue 2 — NEPA Analysis	
US Fish and Wildlife Service, Southeast Region	North Slope Borough, Department of Wildlife Management
J. Capozzelli	Natural Resources Defense Council
Reed Secord	Natural Resources Development Council
U.S. Environmental Protection Agency	Sierra Club
Ted Tupper	Oceana
Isaac Blume	Lih Young
John Hocevar	Jenna Hertz
Henri Fourroux	Charles Edwardson
Rosemary Ahtuangaruak	Pamela Miller
Tidewater, Incorporated	Rick Steiner
Audubon Alaska	Jason Brune
Carl Portman	Tom Lohman
Tina Robinson	Kiersten Lippmann
Marjorie Ahnupkana	Leandra de Sousa
Isaac Nukapigak	Benjamin Craft-Rendon
George Edwardson	Billy Nashoalook
Bill Tracey, Sr	Native Village of Point Hope
Qaiyaan Su’esu’e	Kristi Frankson
Louisa Riley	Lois Epstein
Shell Exploration and Production Company	National Oceanic and Atmospheric Administration
Gulf Restoration Network	Chad Nordlum
Katharyn Reiser	Northwest Arctic Borough
Oasis Earth	Alaska Wilderness League
Marybeth Holleman	Alaska’s Big Village Network
Ted Tupper	Surfrider Foundation
Aleut Corporation	Center for Water Advocacy
Christopher Lish	Defenders of Wildlife
Alaska Oil and Gas Association	Eyak Preservation Council

TABLE 8.4-1 (Cont.)

National Ocean Industries Association	World Wildlife Fund Petition
Statoil USA E&P Inc.	Pew Environmental Group
The Nature Conservancy	Pacific Environment
American Petroleum Institute	Republicans for Environmental Protection
The Wilderness Society	Alaska Oil and Gas Association
World Wildlife Fund, U.S. Arctic Field Program	Independent Petroleum Association of America
International Association of Drilling Contractors	International Association of Geophysical Contractors
U.S. Oil and Gas Association	North Slope Borough
Northern Alaska Environmental Center	Center for Biological Diversity
Resource Development Council	Alaska Eskimo Whaling Commission
Ocean Conservancy	Iñupiat Community of the Arctic Slope
National Audubon Society	Arctic Slope Regional Corporation

Issue 3 — Alternatives

U.S. Environmental Protection Agency	Republicans for Environmental Protection
Michelle Waters	Sierra Club
Donny Williams	The Wilderness Society
Holly Hanks	Gulf Restoration Network
Natural Resources Development Council	Pacific Environment
Oceana	Alaska's Big Village Network
Rosemary Ahtuangaruak	Northern Alaska Environmental Center
Natural Resources Defense Council	Center for Water Advocacy
Northwest Arctic Borough	Defenders of Wildlife
National Oceanic and Atmospheric Administration	World Wildlife Fund, U.S. Arctic Field Program
Alaska Wilderness League	Ocean Conservation Research
Center for Biological Diversity	Sierra Club
Eyak Preservation Council	Alaska Oil and Gas Association
Iñupiat Community of the Arctic Slope	Surfrider Foundation
Alaska Department of Natural Resources	

Issue 4 — Environmental Issues and Concerns

Issue 4.1 — General Concerns

David Pisaneschi	Pew Environment
J. Capozelli	Natural Resource Defense Council
Ukallaysaaq Okleasik	Center for Water Advocacy
Oceana	Defenders of Wildlife
Alaska's Big Village Network	North Slope Borough
Gulf Restoration Network	Southern Environmental Law Center
Ocean Conservation Research	Sierra Club
National Oceanic and Atmospheric Administration	Center for Biological Diversity

Issue 4.2 — Climate

There were no specific comments on climate. Comments concerned with how climate change may affect impacts of oil and gas development are addressed within the other issue categories.

Issue 4.3 — Water

U.S. Environmental Protection Agency	Alaska Oil and Gas Association
Darcie Warden	National Ocean Industries Association
Northwest Arctic Borough	U.S. Oil and Gas Association
National Oceanic and Atmospheric Administration	International Association of Drilling Contractors

TABLE 8.4-1 (Cont.)

American Petroleum Institute	The Nature Conservancy
Independent Petroleum Association of America	International Association of Geophysical Contractors
Alaska Eskimo Whaling Commission	Iñupiat Community of the Arctic Slope
North Slope Borough	

Issue 4.4 — Air

U.S. Environmental Protection Agency	International Association of Geophysical Contractors
Daniel Lum	Alaska Oil and Gas Association
Oceana	National Ocean Industries Association
Alaska’s Big Village Network	U.S. Oil and Gas Association
Independent Petroleum Association of America	International Association of Drilling Contractors
Center for Water Advocacy	Alaska Eskimo Whaling Commission
Defenders of Wildlife	Iñupiat Community of the Arctic Slope
Gulf Restoration Network	Alaska Department of Natural Resources
Ocean Conservation Research	North Slope Borough
Sierra Club	American Petroleum Institute
Southern Environmental Law Center	Center for Biological Diversity

Issue 4.5 — Acoustics

U.S. Fish and Wildlife Service, Southeast Region	International Association of Geophysical Contractors
Northwest Arctic Borough	Alaska Eskimo Whaling Commission
National Oceanic and Atmospheric Administration	

Issue 4.6 — Coastal Habitats

National Oceanic and Atmospheric Administration	Independent Petroleum Association of America
Texas Parks and Wildlife Department	U.S. Oil and Gas Association
American Petroleum Institute	National Ocean Industries Association
International Association of Geophysical Contractors	International Association of Drilling Contractors
Alaska Oil and Gas Association	

Issue 4.7 — Marine Habitats

North Slope Borough	The Nature Conservancy
Alaska Wilderness League	Alaska Oil and Gas Association
Alaska Big Village Network	National Ocean Industries Association
Center for Biological Diversity	U.S. Oil and Gas Association
Center for Water Advocacy	American Petroleum Institute
Defenders of Wildlife	Republicans for Environmental Protection
Eyak Preservation Council	Sierra Club
National Resources Defense Council	The Wilderness Society
Northern Alaska Environmental Center	Pacific Environment
World Wildlife Fund, U.S. Arctic Field Program	National Oceanic and Atmospheric Administration
Independent Petroleum Association of America	International Association of Drilling Contractors
International Association of Geophysical Contractors	

Issue 4.8 — Mammals

U.S. Fish and Wildlife Service, Southeast Region	National Oceanic and Atmospheric Administration
Edward Nukapigak	North Slope Borough
George Edwardson	Iñupiat Community of the Arctic Slope
Bill Tracey, Sr.	American Petroleum Institute
Department of Wildlife Management, North Slope Borough	International Association of Drilling Contractors
Billy Nashoalook	The Nature Conservancy

TABLE 8.4-1 (Cont.)

Alysssa Agnasagga	Center for Biological Diversity
Terry Tagarook	Alaska Eskimo Whaling Commission
Kristi Frankson	Alaska Oil and Gas Association
Save the Manatee Club	National Ocean Industries Association
Center for Regulatory Effectiveness	U.S. Oil and Gas Association
Independent Petroleum Association of America	International Association of Geophysical Contractors
Natural Resources Defense Council	
Issue 4.9 — Birds	
U.S. Fish and Wildlife Service, Southeast Region	Independent Petroleum Association of America
Texas Parks and Wildlife Department	North Slope Borough
Oceana	Alaska Oil and Gas Association
Alaska’s Big Village Network	National Ocean Industries Association
Sierra Club	International Dark-Sky Association
Center for Water Advocacy	Center for Biological Diversity
Defenders of Wildlife	Gulf Restoration Network
Ocean Conservation Research	Southern Environmental Law Center
International Association of Drilling Contractors	International Association of Geophysical Contractors
International Association of Geophysical Contractors	U.S. Oil and Gas Association
American Petroleum Institute	
Issue 4.10 — Reptiles	
U.S. Fish and Wildlife Service, Southeast Region	National Oceanic and Atmospheric Administration
Center for Biological Diversity	Alaska Oil and Gas Association
Texas Parks and Wildlife Department	National Ocean Industries Association
American Petroleum Institute	U.S. Oil and Gas Association
Independent Petroleum Association of America	International Association of Drilling Contractors
International Association of Geophysical Contractors	International Dark-Sky Association
Issue 4.11 — Invertebrates	
National Oceanic and Atmospheric Administration	Independent Petroleum Association of America
American Petroleum Institute	North Slope Borough
International Association of Geophysical Contractors	International Association of Drilling Contractors
Alaska Oil and Gas Association	National Ocean Industries Association
International Association of Geophysical Contractors	U.S. Oil and Gas Association
Issue 4.12 — Threatened and Endangered Species	
Rick Steiner	U.S. Oil and Gas Association
Oasis Earth	National Ocean Industries Association
National Oceanic and Atmospheric Administration	International Association of Drilling Contractors
American Petroleum Institute	Alaska Oil and Gas Association
Independent Petroleum Association of America	International Association of Geophysical Contractors
Issue 4.13 — Land Use and Infrastructure	
U.S. Environmental Protection Agency	The Nature Conservancy
The Wilderness Society	Alaska Eskimo Whaling Commission
Bill Tracey, Sr.	North Slope Borough
Ira Ungudruk	Alaska Oil and Gas Association
Northwest Arctic Borough	National Ocean Industries Association
Ted Tupper	U.S. Oil and Gas Association

TABLE 8.4-1 (Cont.)

Independent Petroleum Association of America	International Association of Drilling Contractors
International Association of Geophysical Contractors	American Petroleum Institute

Issue 4.14 — Fish and Fisheries

U.S. Fish and Wildlife Service, Southeast Region	Independent Petroleum Association of America
Marjorie Ahnupkana	Southern Environmental Law Center
Alice Ipalook	American Petroleum Institute
Henri Fourroux	Alaska Oil and Gas Association
Nora Jane Burns	National Ocean Industries Association
Natural Resources Defense Council	U.S. Oil and Gas Association
National Oceanic and Atmospheric Administration	International Association of Drilling Contractors
Oceana	Gulf Restoration Network
Alaska’s Big Village Network	Ocean Conservation Research
Center for Biological Diversity	Sierra Club
Center for Water Advocacy	Defenders of Wildlife
Surfrider Foundation	North Slope Borough
International Association of Geophysical Contractors	

Issue 4.15 — Oceanography

The Wilderness Society	Alaska Department of Natural Resources
National Oceanic and Atmospheric Administration	

Issue 4.16 — Areas of Special Concern

Northwest Arctic Borough	U.S. Oil and Gas Association
National Oceanic and Atmospheric Administration	International Association of Drilling Contractors
Texas Parks and Wildlife Department	Alaska Oil and Gas Association
American Petroleum Institute	National Ocean Industries Association
Independent Petroleum Association of America	International Association of Geophysical Contractors

Issue 4.17 — Archeological and Historical Resources

Florida Division of Historical Resources, SHPO	Native Village of Point Hope

Issue 4.18 — Health Assessment

Delice Calcote	Iñupiat Community of the Arctic Slope
Rosemary Ahtuangaruak	North Slope Borough
Bernice Kaigelak	Alaska Oil and Gas Association
Rosemary Ahtuangaruak	National Ocean Industries Association
Heather Dingman	U.S. Oil and Gas Association
Henri Fourroux	Qaiyaan Su’esu’e
Bruce Inglangasak	American Petroleum Institute
Independent Petroleum Association of America	International Association of Drilling Contractors
International Association of Geophysical Contractors	

Issue 4.19 — Socioeconomics

Isaac Blume	Mark Wartes
Nicolette Nye	Northern Alaska Environmental Center
Qayaan Su’esu’e	Tidewater, Inc.
Jenna Hertz	Mobile Baykeeper
International Association of Geophysical Contractors	Charles Edwardson

TABLE 8.4-1 (Cont.)

Issue 4.20 — Environmental Justice

Center for Water Advocacy
Northwest Arctic Borough
American Petroleum Institute
Independent Petroleum Association of America
International Association of Geophysical Contractors
Alaska Oil and Gas Association
National Ocean Industries Association
U.S. Oil and Gas Association
International Association of Drilling Contractors
Iñupiat Community of the Arctic Slope

Issue 4.21 — Invasive Species

National Oceanic and Atmospheric Administration

Issue 4.22 — Sociocultural Systems

Isaac Blume
John Hocevar
Qayaan Su'esu'e
Charles Edwardson
Resisting Environmental Destruction on Indigenous Lands (REDOIL)
Delice Calcote
Center for Water Advocacy
Marjorie Ahnupkana
Alice Ipalook
Isaac Nukapigak
Edward Nukapigak
Johnny Aiken
Johnny Kunaq Brower
George Edwardson
Bill Tracey, Sr
Dallas-Lee Brower
Harry Brower
Rosemary Ahtuangaruak
Cilia Attungowruk
Lawrence Burris
American Petroleum Institute
Alaska Oil and Gas Association
National Ocean Industries Association
The Nature Conservancy
Oceana
Mobile Baykeeper
National Oceanic and Atmospheric Administration
International Association of Geophysical Contractors
Native Village of Point Hope
Janice Nashookpuk
North Slope Borough
Billy Stone, Sr.
International Association of Drilling Contractors
Ukallaysaaq Okleasik
Northwest Arctic Borough
Earl Kingik
Dood Lincoln
Catherine Shed
Juanita Oktollik
Carla Sims Kayotuk
Katharyn Reiser
Natural Resources Defense Council
Daniel Lum
Northwest Arctic Borough
Geoff Carroll
Pew Environment
Iñupiat Community of the Arctic Slope
Rossman Peetook
Ira Ungudruk
Ocean Conservancy
National Audubon Society
Pew Environmental Group
Alaska Eskimo Whaling Commission
Alaska's Big Village Network
Independent Petroleum Association of America
U.S. Oil and Gas Association

Issue 4.23 — Geohazards

Alaska Department of Natural Resources

Issue 5 — Cumulative Impacts

Oceana
Rick Steiner
Joshua Tucker
Bill Tracey, Sr.
Billy Nashoalook
Alaska's Big Village Network
Northern Alaska Environmental Center
Center for Water Advocacy
Defenders of Wildlife
Gulf Restoration Network

TABLE 8.4-1 (Cont.)

Raychelle Daniel	Ocean Conservation Research
Carla Sims Kayotuk	Sierra Club
Natural Resource Defense Council	Southern Environmental Law Center
Northwest Arctic Borough	American Petroleum Institute
National Oceanic and Atmospheric Administration	Independent Petroleum Association of America
Alaska Wilderness League	Iñupiat Community of the Arctic Slope
Alaska Department of Natural Resources	Pacific Environment
North Slope Borough	Republicans for Environmental Protection
National Audubon Society	Alaska Eskimo Whaling Commission
Pew Environmental Group	The Wilderness Society
Eyak Preservation Council	Center for Biological Diversity
Ocean Conservancy	National Ocean Industries Association
Northern Alaska Environmental Center	U.S. Oil and Gas Association
World Wildlife Fund, U.S. Arctic Field Program	International Association of Drilling Contractors
International Association of Geophysical Contractors	Alaska Oil and Gas Association
Issue 6 — Oil Spills	
North Star Terminal & Stevedore Co.	Alaska Wilderness League
North Star Equipment Services	Steve Bruckner
Sierra Club Campaign	National Audubon Society
David Pisaneschi	John Hocevar
Natural Resources Defense Council	Earthjustice
J. Capozzelli	Emilie Surrosco
U.S. Environmental Protection Agency	Mike Gravitz
J. Capozzelli	Sierra Club
Michelle Waters	Oceana
Larry Nelson	Catherine Shed
Helen Caswell	Daniel Lum
Shawn Lowry	Marybeth Holleman
Qaiyaan Su’esu’e	Judy Patrick
Jenna Hertz	Christopher Lish
Charles Edwardson	Bruce Inglangasak
Roger Burggraf	Doug Smith
Resisting Environmental Destruction On Indigenous Lands	U.S. Fish and Wildlife Service - Southeast Region
Debbie Miller	Defenders of Wildlife
Travis Jarrett	Daniel Lum
Pamela Miller	Northwest Arctic Borough
Darcy Warden	Charles Becker
Rick Steiner	Lincoln Saito
Heidi Zimmer	Alaska’s Big Village Network
Leah Frankson	Ocean Conservation Research
Joshua Tucker	Pew Environmental Group
The Wilderness Society	Ocean Conservancy
Audubon Alaska	Eyak Preservation Council
Eric Fox	Gulf Restoration Network
Kathleen Fisher	Alaska Oil and Gas Association
Marjorie Ahnupkana	Pacific Environment
Johnny Kunaq Brower	Republicans for Environmental Protection
George Edwardson	Earl Kingik
Ataamuk Shiedt	The Wilderness Society
Rosemary Ahtuangaruak	Mark Newell
Geoff Carroll	Statoil USA E&P Inc.
Raymond Aguvluk	MSI Communications
Earl Kingik	Jacquelyn Edmundson

TABLE 8.4-1 (Cont.)

Ukallaysaaq Okleasik	Center for Water Advocacy
Lois Epstein	Delta Constructors, LLC
Shell Oil Company	The Nature Conservancy
Katharyn Reiser	Surfrider Foundation
Diane Shoemaker	Center for Biological Diversity
Willard Chinn, Jr	Iñupiat Community of the Arctic Slope
Dan Schok	Alaska Department of Natural Resources
Ditch Witch of Alaska	Credo Action Campaign
Barbara Gregoire	Northern Alaska Environmental Center
Judy Wilde	North Slope Borough
Christina Mounce	Elke Joos
Scott Marler	Oasis Earth
Curtis Parr	Ziba Morisi
National Oceanic and Atmospheric Administration	World Wildlife Fund, U.S. Arctic Field Program
Issue 7 — Mitigation	
Alaska Eskimo Whaling Commission	North Slope Borough
National Oceanic and Atmospheric Administration	North Slope Borough, Department of Wildlife Management
American Petroleum Institute	U.S. Oil and Gas Association
International Association of Drilling Contractors	Independent Petroleum Association of America
Alaska Oil and Gas Association	National Audubon Society
National Ocean Industries Association	Pew Environmental Group
Ocean Conservancy	Oceana
International Association of Drilling Contractors	Natural Resources Defense Council
Issue 8 — Regulations and Safety	
J. Capozzelli	Aleut Corporation
Oceana	Christopher Lish
Rick Steiner	Natural Resources Defense Council
The Wilderness Society	Northern Alaska Environmental Center
Alaska Chamber of Commerce	Pacific Environment
Alaska’s Big Village Network	Republicans for Environmental Protection
Center for Water Advocacy	Pacific Environment
Defenders of Wildlife	Republicans for Environmental Protection
Eyak Preservation Council	Gulf Restoration Network
Alaska Wilderness League	Ocean Conservation Research
Alaska’s Big Village Network	Southern Environmental Law Center
Center for Water Advocacy	American Petroleum Institute
Sierra Club	Ocean Conservancy
Statoil USA E&P Inc	National Audubon Society
U.S. Oil and Gas Association	Arctic Slope Regional Corporation
Pew Environmental Group	Mobile Baykeeper
Alaska Oil and Gas Association	Center for Biological Diversity
International Association of Drilling Contractors	Louisiana Department of Environmental Quality
National Oceanic and Atmospheric Administration	World Wildlife Fund, U.S. Arctic Field Program
Alabama Department of Environmental Management	International Association of Geophysical Contractors
Independent Petroleum Association of America	Surfrider Foundation
National Ocean Industries Association	North Slope Borough
Issue 9 — Statutory Compliance	
Center for Regulatory Effectiveness	Alaska Oil and Gas Association
Natural Resources Defense Council	National Ocean Industries Association

TABLE 8.4-1 (Cont.)

Texas Parks and Wildlife Department	Northern Alaska Environmental Center
American Petroleum Institute	The Nature Conservancy
U.S. Oil and Gas Association	Alaska Eskimo Whaling Commission
U.S. Fish and Wildlife Service, Southeast Region	National Oceanic and Atmospheric Administration
Independent Petroleum Association of America	International Association of Geophysical Contractors
International Association of Drilling Contractors	Alabama Department of Environmental Management

9 LIST OF PREPARERS

Name	Education/Expertise	Contribution
Bureau of Ocean Energy Management		
Tamara Arzt	J.D./M.PA., NEPA, Environmental Law and Policy; 12 years of experience working on a variety of national, State, and local environmental policy and legal issues.	NEPA compliance reviewer
Gene Augustine	M.S., Biology, aquatic ecology concentration; B.S. Biology, environmental biology; 34 years of impact assessment and natural resource planning and management, including 30 years of experience in Alaska ecosystems.	NEPA coordinator for the Alaska region and technical review
Melissa Batum	M.S., Geology; 14 years of experience in the field of geology.	Project Coordinator, oil spill risk reform, Reviewer; physical environmental, geological hazards
Gregory Boland	M.S., Biological Oceanography; 37 years of experience in offshore environmental research, primarily benthic biology including coral reef and deep-sea ecology.	Reviewer; benthic habitat
Perry Boudreaux	M.S., Marine and Environmental Biology; 6 years of experience in wetland impact analysis and environmental assessment.	NEPA coordinator for the Gulf of Mexico region (Draft PEIS phase)
Jerry Brian	M.S., Applied Economics and Management with a focus on environmental and resource economics; 9 years of experience in socioeconomic research and environmental analysis.	Reviewer; socioeconomics
Megan Butterworth	M.S., Marine Science; B.S., Marine Science; B.S., Biology; 4 years of experience in biological oceanography and marine science.	Reviewer; human health impacts; marine mammals, reptiles, invertebrates, fish, EFH, Areas of Special Concern, water quality
Chris Campbell	M.A., Anthropology Cultural Resources; 40 years of experience in Alaskan anthropological research and field work; 33 years of NEPA experience.	Reviewer; socioeconomic, sociocultural, subsistence, environmental justice, archaeology
Bob Cameron	M.S., Meteorology; 30+ years of experience in meteorology and climate issues.	Reviewer; climate change

Name	Education/Expertise	Contribution
Sidney F. Chaky	M.A., Sociology; 19 years of experience.	Reviewer; land use and infrastructure, scenario
Douglas Choromanski	B.S., Geology; 30 years of experience in site clearance shallow hazards surveys.	Reviewer; site clearance surveys
Catherine Coon	M.S., Fishery Biology; 20 years of fisheries, habitat ecology, and spatial statistics of Alaska marine resources.	Reviewer; EFH, fish, lower trophics
James Craig	Ph.D., Geology; 29 years of experience in Alaska geology, E&D scenarios, costs, and fair market value evaluations.	Reviewer; provided exploration & development scenarios and schedules, inputs for both the MAG_PLAN and OECM models
Deborah Cranswick	32 years with OCS Program; 20 years NEPA; 9 years AK Region; 7 years EAS chief	NEPA compliance and OCS program reviewer
Christopher Crews	B.S., Wildlife Biology, minor Natural Resources; B.S. Biological Sciences; 6 years analytical experience (NEPA), 4 years landscape/grazing management	Reviewer; terrestrial mammals, pinnipeds
Jennifer Culbertson	Ph.D., Biology; 11 years of experience in coastal biology/chemistry and applied ecology	Reviewer; marine and coastal habitats; water quality; ecoregions
Jeffrey Denton	M.S., Wildlife Management; 38 years of experience in wildlife and wildlife habitat management, research, and environmental assessment.	Reviewer of biological resources
Nancy Deschu	B.A., Zoology/M.S., Civil Engineering (water resources).	Reviewer; water quality, fish, EFH
Norman Froomer	Ph.D., Geography and Environmental Engineering; 35 years of experience in coastal research and environmental assessment.	Project manager; purpose and need, alternatives, scenarios, marine spatial planning
Jeffrey Gleason	Ph.D., Zoology (avian ecology); 7 years of experience in analysis.	Reviewer; birds
Donald (Tre) W. Glenn, III	Ph.D., Environmental Engineering; 10 years of experience in impact analysis.	Reviewer; reptiles and marine mammals
Kelly Hammerle	MPA, Environmental Policy emphasis; B.S. Fisheries and Wildlife; 7 years of experience in environmental assessment.	Project manager, logistics coordinator, NEPA compliance, comment analysis and response, purpose and need, Alternatives, Reviewer

Name	Education/Expertise	Contribution
Larry Hartzog	M.S., Fisheries Limnology; 34 years of experience as environmental scientist preparing environmental impact analysis, endangered species coordination/ consultation and mitigation planning.	Reviewer; coastal and marine habitats and fish
Louis Heying	Obtaining B.S. in Geography and Environmental Planning; 4 months internship experience	Comment analysis
Dirk Herkhof	M.S., Meteorology; 36 years of experience in air quality impact analysis, meteorological and air quality studies, and NEPA.	Reviewer; air quality and climate; air emissions estimates
Tim Holder	Master of Urban Planning; 12 years of experience in urban planning, 19 years working for MMS in Alaska, 2 years for MMS in the GOM as a socioeconomic specialist, and 2 years in MMS/BOEMRE HQ as Arctic Liaison.	Coordinating with Alaska cooperating agencies; reviewer; sociocultural
Dan Holiday	Ph.D., Physical Sciences and Biological Oceanography; 8 years of experience in environmental modeling of primary productivity, and the biology and ecology of oceanographic and estuarine trophic systems.	Reviewer; lower trophics, vegetation and wetlands, oceanography, climate, and cumulative effects
Mark Jensen	M.S. Economics; 10 years of experience in economic analysis, research, and document preparation.	Reviewer; sociocultural, tourism/recreation, commercial/recreational fishing, Areas of Special Concern
Walter Johnson	Ph.D., Marine Science, Physical Oceanography; 30 years of experience in coastal oceanography and numerical ocean modeling; 22 years of oil spill modeling.	Reviewer; oil spill-related information
Brian Jordan	Ph.D., Natural Resource Science and Management; M.S., Forestry with specialization in wood science; B.A. Anthropology with a minor in classical studies; 18 years of experience in underwater archaeology, submerged cultural resource management, historic preservation, and marine policy.	Reviewer; sociocultural
Arie R. Kaller	Ph.D., Oceanography and Coastal Sciences; 11 years of experience in coastal vegetation and nekton research, and 2 years of NEPA document preparation.	Reviewer; coastal and marine habitats, EFH, and fish

Name	Education/Expertise	Contribution
Elizabeth Leonard	B.S., Agriculture; 28 years of agricultural, environmental, flood control, and navigation economic experience; 2 years as a Coastal Impact Assistance Project Officer, and 1 year of environmental science experience.	NEPA coordinator for the Gulf of Mexico region (Final PEIS phase)
Jill Lewandowski	M.S. Environmental Science and Policy; Ph.D. in progress; 15 years of experience in protected species assessment.	Reviewer; marine mammals, sea turtles, and acoustic environment
James Lima	Ph.D., Political Science; Socioeconomic Specialist; 25 years of experience in marine-related social science research, ocean and coastal management, and environmental assessment.	Reviewer; socioeconomics
Matthew Lux	B.S., Geography.	Reviewer; GIS data/maps
Robert Martinson	M.S., Zoology; B.S., Biological Science; 32 years NEPA and environmental compliance experience with particular emphasis on wetlands and aquatic and coastal ecology.	Reviewer and comment resolution for purpose and need; alternatives
Tershara Matthews	Ph.D. candidate, Coastal Sciences; 16 years of experience and research in coastal research.	Reviewer
Lori Monroe	J.D.; 26 years of legal experience, including preparing and reviewing legal documents, both environmental and non-environmental in nature.	Reviewer; legal review
Dave Moran	M.S., Zoology; 27 years professional experience in applied environmental science.	Reviewer; invertebrates and lower trophic levels
Constance Murphy	B.S., Soil Science; 16 years in environmental science, consulting, assessment, and remediation; 3 years in editing.	Administrative Record
Michelle K. Nannen	M.S., Marine Environmental Science; 10 years of experience in benthic and fisheries ecological studies and environmental assessment.	Reviewer; marine benthic habitats and marine pelagic habitats
S.E. O'Reilly	Ph.D., Environmental Geochemistry; 9 years of experience in mineralogy/ (bio) geochemistry as related to water quality.	Reviewer; water quality

Name	Education/Expertise	Contribution
Robert Peterson	M.S., Geology; 32 years offshore oil and gas experience; Chief Resource and Economic Analysis Section, AKOCS.	Reviewer; economic impacts
Richard Prentki	Ph.D., Chemical Oceanography; 30 years in Agency as OSRA Coordinator and COR.	Reviewer; geohazards
John Primo	Ph.D., MA Ecological and Applied Anthropology; marine, aquatic and coastal social science; experience with community and regional profiling (i.e., fishing communities, lakeside communities); experienced researcher; research portfolio and project management background.	Reviewer; sociocultural systems, environmental justice, and archaeological and historic resources
Virginia Raps	M.S., Aeronautical Science; B.S., Mathematics and Meteorology; 16 years of NEPA planning experience focusing on air quality impact analysis; 17 years of experience National Weather Service and Naval Weather Service surface and upper air analysis.	Reviewer; meteorology, climate change, and air quality impacts
Rick Raymond	M.S., Environmental Sciences; 23 years fish and wildlife analysis, wetlands, NEPA and environmental assessment.	Reviewer; avian sections for Alaska
Michael Routhier	J.D., M.S.E.L.; 3 years of experience in environmental planning and regulatory compliance.	NEPA reviewer
Mark Schroeder	M.S., Wildlife Biology; 25 years of government experience.	Reviewer
Lois Simenson	M.S., Environmental Science; 13 years of experience in coastal research and environmental assessment.	Coastal Zone Management Coordinator, BOEM Alaska
James Sinclair	M.S., Biological Sciences; 17 years of experience with coastal and offshore organisms and ecosystems research.	Reviewer; ecoregional settings
David Sire	B.S. Forest management; 23 years of experience in preparing and reviewing NEPA compliance documents.	NEPA compliance reviewer
Kimberly Skrupky	B.S., Environmental Science, Wildlife Conservation; 13 years of experience in environmental policy and marine biology.	Reviewer; marine mammals, sea turtles, and acoustic environment

Name	Education/Expertise	Contribution
Caryn Smith	M.S., Oceanography; 23 years of experience oil spill risk analysis and environmental assessment.	Reviewer; Alaska OCS region oceanography and sea ice, oil spill analysis
Bill Swears	M.A., English; 20 years of experience in reading, writing, and editing Federal technical documents and regulations.	Accuracy checking; language consistency: purpose and need, alternatives
Lisa Treichel	M.S., Technology Management, Environmental and Waste Management Option/B.S., Forestry and Wildlife; 24 years environmental experience.	NEPA compliance reviewer
Poojan Tripathi	M.S., Plant and Soil Science; 7 years of experience as an interdisciplinary environmental science with expertise hydrology, water quality, wetlands, and NEPA.	Comment analysis and response, Reviewer; water quality, purpose and need, alternatives
Sally Valdes	Ph.D., aquatic ecology; 25 years of science/science policy experience.	Reviewer; biological resources, commercial fisheries
Jeffrey Walker	B.S., Geological Engineering; 35 years of experience managing oil and gas projects on the Alaska OCS.	Reviewer
Sharon Warren	Program Analysis Officer; 10+ years of experience in review of environmental analyses related to land management and oil and gas activities in Alaska.	Reviewer
Kate Wedemeyer	M.S., Fisheries; M.S., Natural Resource Management; 24+ years in Alaskan fish and habitat management and related environmental assessments.	Reviewer; fisheries
Geoffrey Wikel	M.S., Marine Science; MPP; 11 years of experience in coastal geomorphology and oceanography.	Project manager, risk of a catastrophic discharge event, comment analysis and response, purpose and need, alternatives; Reviewer
James Woehr	Ph.D., Ecology, avian ecologist; 30+ years in avian research and management.	Reviewer; birds
Eric Wolvovsky	M.S., Geographic Information Systems; B.S., Meteorology; 1.5 years of air quality experience	Reviewer; air quality

Name	Education/Expertise	Contribution
Argonne National Laboratory		
Timothy Allison	M.S., Mineral and Energy Resource Economics; M.A., Geography; 20 years of experience in regional analysis and economic impact analysis.	Population, employment and income; environmental justice; tourism and recreation; commercial and recreational fisheries
Bruce Biwer	Ph.D., Chemistry; 20 years of experience in environmental assessment.	Document manager
Brian Cantwell	B.S., Forestry; 28 years of experience in mapping and geographic information systems.	Technical lead for maps and spatial analysis
Adrianne Carr	Ph.D., Geological and Environmental Sciences; 5 years of experience in hydrological studies and impact analysis.	Water quality
Young-Soo Chang	Ph.D., Chemical Engineering; 24 years of experience in air quality and noise impact analysis.	Meteorology and air quality; acoustic environment
Vic Comello	M.S., Physics; 34 years of experience in technical writing and editing.	Lead technical editor
Deborah Elcock	M.B.A.; 30 years of experience in energy and environmental assessment.	Public scoping
Laura Fox	B.S., Biology; 9 years of experience in environmental research and assessment.	Cumulative impacts research (Gulf of Mexico)
John Gasper	M.S., M.P.H.; Environmental Health Science; 37 years of experience in energy and environmental research and assessment.	Project management, public scoping
Linda Graf	Desktop publishing specialist; 40 years of experience in creating, revising, formatting, and printing documents.	Document assembly and production
Fontaine Grant	B.A., 20 years of experience in program management.	Public scoping
Mark Grippo	Ph.D., Biology; 5 years of experience in aquatic resource studies and impact analysis.	Marine benthic and pelagic habitats; essential fish habitat; invertebrates and lower trophic levels; areas of special concern; commercial and recreational fisheries

Name	Education/Expertise	Contribution
John Hayse	Ph.D., Zoology; 24 years of experience in marine and freshwater ecology research; 24 years of experience in environmental assessment.	Fish resources and essential fish habitat; seafloor habitats; areas of special concern; fisheries
Ihor Hlohowskyj	Ph.D., Zoology; 31 years of experience in ecological research; 27 years in environmental assessment.	Argonne project manager; purpose and need; marine and coastal ecoregions; exploration and development scenarios; accidental oil spill scenarios; marine and coastal birds
Elizabeth Hocking	J.D.; 25 years of experience in environmental and regulatory analysis.	Public scoping
Leslie Kirchler	Ph.D., Urban, Technological, and Environmental Planning; Ph.D., Landscape Architecture; 8 years of experience in land use planning and environmental assessment.	Land use and infrastructure
Louis Martino	M.S., Environmental Toxicology; 35 years of experience in environmental remediation and assessment.	Public scoping
Maureen McHugh	M.E.M., Environmental Economics and Policy; 3 years of experience in environmental research and assessment	Cumulative impacts research (Cook Inlet)
Robert N. McWhorter	B.S., MFR (Forest Resources); 25 years of experience in environmental assessment; 15 years of experience in public outreach.	Scoping meeting support
Ellen Moret	M.P.P., Public Policy; B.A., Environmental Studies; 7 years of experience in environmental assessment.	Public scoping comments
Michele Nelson	Graphic designer; 32 years of experience in graphical design and technical illustration.	Graphics
Ben O’Connor	Ph.D., Civil Engineering; 5 years of experience in hydrological studies and impact analysis.	Climate change; oceanography
Daniel O’Rourke	M.S., Industrial Archaeology; B.A. History and Anthropology; 17 years of experience in archaeology.	Archaeological and historic resources
Jana Padovano	B.A., Communications and Marketing; 20 years of experience in administrative support	Project administrative support lead; public scoping meeting support

Name	Education/Expertise	Contribution
Terri Patton	M.S., Geology; 22 years of experience in environmental research and assessment.	Geologic hazards; cumulative impacts
Pamela Richmond	M.S., Computer Information Systems; 16 years of experience in Web site development and related technology.	Public web site development
Lorenza Salinas	Desktop publishing specialist; 28 years of experience in creating, revising, formatting, and printing documents.	Document assembly and production
Kerri Schroeder	Desktop publishing specialist; 30 years of experience in creating, revising, formatting, and printing documents.	Document assembly and production
Albert E. Smith	Ph.D., Physics; 37 years of experience in policy analysis, air and noise impact assessment, and regulatory analysis.	Air quality impacts; acoustic impacts
Carolyn M. Steele	B.A., English; B.A., Rhetoric; 5 years of experience in technical writing and editing.	Editor
Robert Sullivan	M.L.A., Landscape Architecture; 24 years of experience in visual impact assessment and simulation.	Infrastructure and land use; public web site development
Robert Van Lonkhuyzen	B.A., Biology; 21 years of experience in ecological research and environmental assessment.	Coastal and estuarine habitats
Bruce Verhaaren	Ph.D., Archaeology; 21 years of experience in archaeological analysis; 17 years of experience in environmental assessments and records management.	Sociocultural systems; records management
William Vinikour	M.S., Biology with environmental emphasis; 34 years of experience in ecological research and environmental assessment.	Mammals
Leroy Walston, Jr.	M.S., Biology; 6 years of experience in ecological research and environmental assessment.	Reptiles
Angela Ziech	B.A., Chemistry, M.P.P., Public Policy; 5 years of experience in environmental research and assessment	Cumulative impacts research (Gulf of Mexico)
Emily Zvolanek	B.A., Environmental Science; 3 years of experience in GIS mapping.	GIS mapping

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APPENDIX A

GLOSSARY

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APPENDIX A

GLOSSARY

anadromous fish – fish that migrate up river from the sea to breed in fresh water.

anthropogenic – coming from human sources, relating to the effect of man on nature.

aphotic zone – zone where the levels of light entering through the surface are not sufficient for photosynthesis or for animal response.

archaeological interest – capable of providing scientific or humanistic understanding of past human behavior, cultural adaptation, and related topics through the application of scientific or scholarly techniques, such as controlled observation, contextual measurement, controlled collection, analysis, interpretation, and explanation.

archaeological resource – any material remains of human life or activities that are at least 50 years of age and that are of archaeological interest.

aromatic – applied to a class of organic compounds containing benzene rings or benzenoid structures.

attainment area – an area that is classified by the U.S. Environmental Protection Agency (USEPA) as meeting the primary or secondary ambient air quality standards for a particular air pollutant based on monitored data.

barrel – equal to 42 U.S. gallons or 158.99 liters.

benthic – bottom dwelling, associated with (in or on) the seafloor.

benthos – organisms that dwell in or on the seafloor, the organisms living in or associated with the benthic (or bottom) environment.

biological opinion – an appraisal from either the U.S. Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS) evaluating the impact of a proposed Federal action, if it is likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat, as required by Section 7 of the Endangered Species Act.

bivalves – general term for two-shelled mollusks (clams, oysters, scallops, mussels).

carrying capacity – the maximum number or weight of individuals that can exist in a given habitat; an appraisal from either USFWS or NMFS evaluating the impact of a proposed activity on endangered and threatened species.

cetacean – any of an order (Cetacea) of aquatic mostly marine mammals including the whales, dolphins, porpoises, and related forms with a large head, fusiform nearly hairless body, paddle-shaped forelimbs, vestigial concealed hind limbs, and horizontal flukes (tails).

chemosynthetic – organisms that obtain their energy from the oxidation of various inorganic compounds rather than from light (photosynthesis).

coastal wetlands – forested and nonforested habitats, mangroves, and all marsh islands that are exposed to coastal waters. Included in forested wetlands are hardwood hammocks, cypress-tupelogum swamps, and fluvial vegetation/bottomland hardwoods. Nonforested wetlands include fresh, brackish, and salt marshes. These areas directly contribute to the high biological productivity of coastal water by input of detritus and nutrients, by providing nursery and feeding areas for shellfish and finfish, by serving as habitat for many birds and other animals, and by providing waterfowl hunting and fur trapping.

coastal zone – the coastal waters (including the lands therein and thereunder) and the adjacent shore lands (including the waters therein and thereunder) strongly influenced by each other and in proximity to the shorelines of the several coastal States; and including islands, transitional and intertidal areas, salt marshes, wetlands, and beaches. The zone extends seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only the extent necessary to control shore lands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which are by law subject to the discretion of or which are held in trust by the Federal Government, its officers, or agents. (The State land and water area officially designated by the State as “coastal zone” in its State coastal zone program as approved by the U.S. Department of Commerce under the Coastal Zone Management Act [CZMA].)

coastal zone consistency review – State review of direct Federal activities or private individual activities requiring Federal licenses or permits, and outer continental shelf (OCS) plans pursuant to the CZMA to determine if the activity is consistent with the enforceable policies of the State’s federally approved Coastal Zone Management (CZM) program.

continental shelf – a broad, gently sloping, shallow feature extending from the shore to the continental slope, generally considered to exist to the depth of 200 m (656 ft); that part of the continental margin between the continental shelf and the continental rise (or oceanic trench).

continental slope – a relatively steep, narrow feature paralleling the continental shelf; the region in which the steepest descent to the ocean bottom occurs.

contingency plan – a plan for possible offshore emergencies prepared and submitted by the oil or gas operator as part of the plan of development and production, and which may be required for part of the plan of exploration.

critical habitat – a designated area that is essential to the conservation of an endangered or threatened species that may require special management considerations or protection.

crude oil – petroleum in its natural state as it emerges from a well, or after it passes through a gas-oil separator but before refining or distillation.

crustaceans – any aquatic invertebrate with jointed legs, such as crabs, shrimp, lobster, barnacles, amphipods, isopods, etc.; primarily an aquatic group.

deferral – action taken by the Secretary of the Interior or delegated official to remove certain areas/blocks from leasing.

delineation well – an exploratory well drilled to define the areal extent of a field. Also referred to as an "expendable well."

development – activities that take place following discovery of minerals in paying quantities, including geophysical activity, drilling, platform construction, and operation of all onshore support facilities, and that are for the purpose of ultimately producing the minerals discovered.

development and production plan (DPP) – a plan describing the specific work to be performed on an offshore lease, including all development and production activities that the lessee proposes to undertake during the time period covered by the plan and all actions to be undertaken up to and including the commencement of sustained production. The plan also includes descriptions of facilities and operations to be used, well locations, current geological and geophysical information, environmental safeguards, safety standards and features, time schedules, and other relevant information. All lease operators are required to formulate and obtain approval of such plans by the Bureau of Ocean Energy Management (BOEM) before development and production activities may begin; requirements for submittal of DPP are wholly identified in 30 CFR 250.34.

development well – a well drilled into a known producing formation in a previously discovered field, to be distinguished from a wildcat, exploratory, or offset well.

dilution – the reduction in the concentration of dissolved or suspended substances by mixing with water.

discharge – something that is emitted; flow rate of a fluid at a given instant expressed as volume per unit of time.

dispersion – a distribution of finely divided particles in a medium.

drillship – a self-propelled, self-contained vessel equipped with a derrick amidships for drilling wells in deep water.

drilling mud – a special mixture of clay, water, or refined oil, and chemical additives pumped downhole through the drill pipe and drill bit. The mud cools the rapidly rotating bit, lubricates the drill pipe as it turns in the wellbore, carries rock cuttings to the surface, serves to keep the hole from crumbling or collapsing, and provides the weight or hydrostatic head to prevent extraneous fluids from entering the wellbore and to control downhole pressures that may be encountered (drilling fluid).

effluent – the liquid waste of sewage and industrial processing.

emission offset – emission reductions obtained from facilities, either onshore or offshore, other than the facility or facilities covered by the proposed exploration plan or development and production plan. The emission reductions achieved must be sufficient so that there will be no net increase in emissions for the area.

endangered and threatened species (endangered species) – any species that is in danger of extinction throughout all or a significant portion of its range and has been officially listed by the appropriate Federal or State agency; a species is determined to be endangered (or threatened) because of any of the following factors: (1) the present or threatened destruction, modification, or curtailment of its habitat or range; (2) over utilization for commercial, sporting, scientific, or educational purposes; (3) disease or predation; (4) the inadequacy of existing regulatory mechanisms; or (5) other natural or man-made factors affecting its continued existence.

environmental assessment – a concise public document required by the National Environmental Policy Act of 1969 (NEPA). In the document, a Federal agency proposing (or reviewing) an action provides evidence and analysis for determining whether it must prepare an environmental impact statement (EIS) or whether it finds there is no significant impact (i.e., Finding of No Significant Impact [FONSI]).

environmental effect – a measurable alteration or change in environmental conditions.

environmental impact statement (EIS) – a statement required by the NEPA or similar State law in relation to any major action significantly affecting the environment; a NEPA document.

essential habitat – specific areas crucial to the conservation of a species that may necessitate special considerations.

essential fish habitat (EFH) – those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. This includes areas that are currently or historically used by fish, or that have substrate such as sediment, hard bottom, bottom structures, or associated biological communities required to support a sustainable fishery.

estuary – semi-enclosed coastal body of water that has a free connection with the open sea and within which seawater is measurably diluted with freshwater.

Exclusive Economic Zone (EEZ) – the maritime region adjacent to the territorial sea, extending 200 nautical miles from the baseline of the territorial sea, in which the United States has exclusive rights and jurisdiction over living and nonliving natural resources.

exploration – the process of searching for minerals. Exploration activities include:
(1) geophysical surveys where magnetic, gravity, seismic, or other systems are used to detect or infer the presence of such minerals; and (2) any drilling, except development drilling, whether on or off known geological structures. Exploration also includes the drilling of a well in which a discovery of oil or natural gas in paying quantities is made, and the drilling, after such a discovery, of any additional well that is needed to delineate a reservoir and to enable the lessee to determine whether to proceed with development and production.

exploration plan (EP) – a plan submitted by a lessee (30 CFR 250.33) that identifies all the potential hydrocarbon accumulations and wells that the lessee proposes to drill to evaluate the accumulations within the lease or unit area covered by the plan. All lease operators are required to obtain approval of such a plan by a BOEM Regional Supervisor before exploration activities may commence.

exploratory well – a well drilled in unproven or semi-proven territory for the purpose of ascertaining the presence underground of a commercially producible deposit of petroleum or natural gas.

fault – a fracture in the earth's crust accompanied by a displacement of one side of the fracture with respect to the other.

fauna – the animals of a particular region or time.

fixed or bottom founded – permanently or temporarily attached to the seafloor.

flyway – an established air route of migratory birds.

formation – a bed or deposit sufficiently homogeneous to be distinctive as a unit. Each different formation is given a name, frequently as a result of the study of the formation outcrop at the surface and sometimes based on fossils found in the formation.

fugitive emissions – emission into the atmosphere that could not reasonably pass through a stack, chimney, vent or other functionally equivalent opening.

geochemical – of or relating to the science dealing with the chemical composition of and the actual or possible chemical changes in the crust of the earth.

geologic hazard – a feature or condition that, if unmitigated, may seriously jeopardize offshore oil and gas exploration and development activities. Mitigation may necessitate special engineering procedures or relocation of a well.

geophysical – of or relating to the physics of the earth, especially the measurement and interpretation of geophysical properties of the rocks in an area.

geophysical data – facts, statistics, or samples that have not been analyzed or processed, pertaining to gravity, magnetic, seismic, or other surveys/systems.

geophysical survey – the exploration of an area during which geophysical properties and relationships unique to the area are measured by one or more geophysical methods.

habitat – a specific type of place that is occupied by an organism, a population, or a community; a specific type of place defined by its physical or biological environment that is occupied by an organism, a population, or a community.

harassment – an intentional or negligent act or omission that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns that include, but are not limited to, feeding or sheltering.

haulout area – specific locations where pinnipeds come ashore and concentrate in numbers to rest, breed, and/or bear young.

herbivores – animals whose diet consists of plant material.

hydrocarbon – any of a large class of organic compounds containing primarily carbon and hydrogen; comprising paraffins, olefins, members of the acetylene series, alicyclic hydrocarbons, and aromatic hydrocarbons; and occurring, in many cases, in petroleum, natural gas, coal, and bitumens.

hypothermia – subnormal temperature of the body, usually due to excessive heat loss.

hypoxia – depressed levels of dissolved oxygen in water, usually resulting in decreased metabolism.

incidental take – take of a threatened or endangered fish or wildlife species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by a Federal agency or applicant (see take).

indirect effects – effects caused by activities that are stimulated by an action but not directly related to it.

industry infrastructure – the facilities associated with oil and gas development (e.g., refineries, gas processing plants, etc.).

information to lessees – information included in the Notice of Sale to alert lessees and operators of special concerns in or near a sale area of regulatory provisions enforceable by Federal or State agencies.

jack-up rig – a barge-like floating platform with legs at each corner that can be lowered to the sea bottom to raise the platform above the water; a drilling platform with retractable legs that can be lowered to the sea bottom to raise the platform above the water.

landfall – the site at which a marine pipeline comes to shore.

lay barge – a shallow-draft, barge-like vessel used in the construction and laying of underwater pipelines.

lighter – a barge or small tanker used to move cargo from a large ship to port; also, to transport by lighter.

macroinvertebrate – animals such as worms, clams, or crabs that are large enough to be seen without the aid of a microscope.

mariculture – the breeding or growth of marine animals and plants to increase their stocks.

marine sanctuary – area protected under the Marine Protection, Research, and Sanctuaries Act of 1972.

marshes – persistent, emergent nonforested wetlands characterized by vegetation consisting predominantly of cordgrasses, rushes, and cattails.

microcrustacean – any relatively small crustacean (may range from microscopic to slightly over one centimeter in size) including organisms such as beach hoppers (amphipods), copepods, ostracods, isopods, and mysids.

military warning area – an area established by the U.S. Department of Defense within which the public is warned that military activities take place.

minerals – as used in this document, minerals include oil, gas, sulfur, and associated resources, and all other minerals authorized by an Act of Congress to be produced from public lands, as defined in Section 103 of the Federal Land Policy and Management Act of 1976.

mollusks – animal phylum characterized by soft body parts including clams, mussels, snails, squid, and octopus.

mud – the liquid circulated through the wellbore during rotary drilling operations. In addition to its function of bringing cuttings to the surface, drilling mud cools and lubricates the bit and drill stem, protects against blowouts by holding back subsurface pressures, and deposits a mud cake on the wall of the borehole to prevent loss of fluids to the formations; also called drilling mud or drilling fluid; also a sediment designation composed of silt and clay-sized particles.

mysids – small shrimp-like organisms, also known as opossum shrimp due to their method of egg incubation.

natural gas – hydrocarbons that are in a gaseous phase under atmospheric conditions of temperature and pressure.

nearshore waters – offshore open waters that extend from the shoreline out to the limit of the territorial seas (12 nautical miles).

nonattainment area – an area that is shown by monitoring data or air quality modeling calculations to exceed primary or secondary ambient air quality standards established by the USEPA.

offloading – another name for unloading; offloading refers more specifically to liquid cargo, crude oil, and refined products.

oil spill contingency plan – a plan submitted by the lease or unit operator along with or prior to a submission of a plan of exploration or a development/production plan that details provisions for fully defined specific actions to be taken following discovery and notification of an oil spill occurrence.

operational discharge – a release of oil that is part of the routine operation of a function.

operator – the person or company engaged in the business of drilling for, producing, or processing oil, gas, or other minerals and recognized by BOEM as the official contact and responsible for the lease activities or operations.

organic matter – material derived from living plant or animal organisms.

Outer Continental Shelf (OCS) – all submerged lands that comprise the continental margin adjacent to the United States and seaward of State offshore lands.

petroleum – an oily, flammable, bituminous liquid that occurs in many places in the upper strata of the earth, either in seepages or in reservoirs; essentially a complex mixture of hydrocarbons of different types with small amounts of other substances; any of various substances (as natural gas or shale oil) similar in composition to petroleum.

phytoplankton – plant (photosynthetic) plankton; microscopic, freefloating, photosynthetic organisms that drift passively in the water.

pinniped – any of a suborder (Pinnipedia) of aquatic carnivorous mammals (e.g., seals, sea lions, sea otters, walruses) with all four limbs modified into flippers.

plankton – passively floating or weakly motile aquatic plants and animals.

planning area – a subdivision of an offshore area used as the initial basis for considering blocks to be offered for lease in the U.S. Department of the Interior’s areawide offshore oil and gas leasing program.

platform – a steel, concrete, or gravel structure from which offshore development wells are drilled.

postlease – any activity on a block or blocks after the issuance of a lease on said block or blocks.

potential impact (effect) – the range of alterations or changes to environmental conditions that could be caused by an action.

primary production – production of carbon by a plant through photosynthesis over a given period of time; oil and gas production that occurs from the reservoir energy inherent in the formation.

produced water – total water produced from the oil and gas extraction process; the water may be discharged after treatment or reinjected; production water or production brine.

production – activities that take place after the successful completion, by any means, of the removal of minerals, including such removal, field operations, transfer of minerals to shore, operation monitoring, maintenance, and workover drilling.

production well – a well that is drilled for the purpose of producing oil or gas reserves; it is sometimes termed a development well.

prospect – an untested geologic feature having the potential for trapping and accumulating hydrocarbons.

recoverable reserves – portion of the identified oil or gas resources that can be economically extracted under current technological constraints.

recoverable resource estimate – an assessment of oil and gas resources that takes into account the fact that physical and technological constraints dictate that only a portion of resources or reserves can be brought to the surface.

refining – fractional distillation, usually followed by other processing (e.g., cracking).

reserves – portion of the identified oil or gas resource that can be economically extracted.

reservoir – a subsurface, porous, permeable rock body in which hydrocarbons have accumulated.

resources – concentrations of naturally occurring solid, liquid, or gaseous materials in or on the earth's crust some part of which is currently or potentially extractable. These include both identified and undiscovered resources.

rig – a structure used for drilling an oil or gas well.

right-of-way – a legal right of passage, an easement; the specific area or route for which permission has been granted to place a pipeline, (and) ancillary facilities, and for normal maintenance thereafter.

rookery – the nesting or breeding grounds of gregarious (i.e., social) birds or mammals; also a colony of such birds or mammals.

sale area – the geographical area of the OCS being offered for lease for the exploration, development, and production of mineral resources.

scoping – the process prior to EIS preparation to determine the range and significance of issues to be addressed in the EIS for each proposed major Federal action.

seagrass beds – more or less continuous mats of submerged, rooted marine flowering vascular plants occurring in shallow tropical and temperate waters. Seagrass beds provide habitat, including breeding and feeding grounds, for adults and/or juveniles of many of the economically important shellfish and finfish.

sediment – material that has been transported and deposited by water, wind, glacier, precipitation, or gravity; a mass of deposited material.

seeps (hydrocarbon) – gas or oil that reaches the surface along bedding planes, fractures, unconformities, or fault planes through connected porous rocks.

seismic – pertaining to, characteristic of, or produced by earthquakes or earth vibration; having to do with elastic waves in the earth; also geophysical when applied to surveys.

semisubmersible – a floating offshore drilling structure that has hulls submerged in the water but not resting on the seafloor.

shunting – a method used in offshore oil and gas drilling activities where expended drill cuttings and fluids are discharged near the ocean seafloor rather than at the surface, as in the case of normal offshore drilling operations.

significant archaeological resource – those archaeological resources that meet the criteria of significance for eligibility to the *National Register of Historic Places* as defined in 36 CFR 60.4 or its successor.

stipulations – specific measures imposed upon a lessee that apply to a lease. Stipulations are attached as a provision of a lease; they may apply to some or all tracts in a sale. For example, a stipulation might limit drilling to a certain time period of the year or certain areas.

subsistence uses – the customary and traditional uses by rural residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for making and selling of handcraft articles out of nonedible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade.

supply boat – a vessel that ferries food, water, fuel, and drilling supplies and equipment to a rig and returns to land with refuse that cannot be disposed of at sea.

take – to harass, harm, pursue, hunt, shoot, wound, kill, capture, or collect a threatened or endangered fish or wildlife species, or attempt to engage in any such conduct. (Harm includes habitat modification that impairs behavioral patterns, and harass includes actions that create the likelihood of injury to an extent that normal behavior patterns are disrupted.)

threatened species – any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range, and which has been officially listed by the appropriate Federal agency. Criteria for determination of threatened status can be found under "endangered species."

trawl – a large, tapered fishing net of flattened, conical shape that is typically towed along the sea bottom.

trophic – trophic levels refer to the hierarchy of organisms from photosynthetic plants to carnivores, such as man; feeding trophic levels refer to the hierarchy of organisms from photosynthetic plants to carnivores in which organisms at one level are fed upon by those at the next higher level (e.g., phytoplankton eaten by zooplankton eaten by fish).

turbidity – reduced water clarity resulting from the presence of suspended matter.

vascular plants – plants containing food and water conducting structures; higher plants that reproduce by seeds.

volatile organic compound (VOC) – any reactive organic compound that is emitted to the atmosphere as a vapor. The definition does not include methane.

vulnerability – the likelihood of being damaged by external influences. Vulnerability implies sensitivity of a system plus the risk of a damaging influence occurring.

weathering – the aging of oil due to its exposure to the atmosphere and environment causing marked alterations in its physical and chemical makeup.

wetlands – areas periodically inundated or saturated by surface or groundwater and predominantly supporting vegetation typically adapted for life in saturated soil conditions.

zooplankton – animal plankton, mostly dependent on phytoplankton for its food source; small, free-floating animals, may be passive drifters or motile, dependent on phytoplankton as a food source.

APPENDIX B

ASSUMED MITIGATION AND OTHER PROTECTIVE MEASURES

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APPENDIX B

ASSUMED MITIGATION AND OTHER PROTECTIVE MEASURES

All Bureau of Ocean Energy Management (BOEM) sale proposals include rules and regulations prescribing environmental controls to be imposed on lease operators. Lease stipulations, Outer Continental Shelf (OCS) regulations, and other measures provide a regulatory base for implementing environmental protection on leases issued as a result of a sale. The BOEM Environmental Studies Program and the analyses and monitoring of activities in a sale area provide information used in formulating the agency's regulatory control over the activities that occur during the life of the leases.

The Bureau of Safety and Environmental Enforcement (BSEE) has broad permitting and monitoring authority to ensure safe operations and environmental protection. Use of the best available and safest technologies during exploration, development, and production, as well as the adopted stipulations, are just a few of the measures designed to prevent environmental damage. BSEE also monitors operations after drilling has begun and carries out periodic inspections of facilities (in certain instances, in conjunction with other Federal agencies such as the U.S. Environmental Protection Agency) to ensure safe and clean operations over the life of the leases.

The analyses in the environmental impact statement assume the implementation of all impact-reducing mechanisms required by statute or regulation. In addition, the impact analysis assumes that sale-specific stipulations that were commonly adopted in past lease sales are in effect. The following is a brief description of the sale-specific stipulations or other impact-reducing mechanisms assumed in the analysis of potential effects of the proposed action. Because over 100 individual mitigations can be applied to exploration and development activities in the Gulf of Mexico region, only common lease stipulations are described individually. Both the lease stipulations and other protective environmental measures issued through Information to Lessees (ITL) in Alaska are described.

B.1 GULF OF MEXICO REGION

B.1.1 Lease Stipulations

B.1.1.1 Topographic Features

This stipulation designates a "No Activity Zone" around several underwater topographic features commonly called "banks" whose crests may contain biological communities including corals. The No Activity Zone is designed to protect the biota of these features from adverse effects of routine offshore oil and gas activities by preventing the emplacement of platforms, or the anchoring of service vessels or mobile drilling units, directly on the banks and requiring that drilling discharges be shunted in such a manner that they do not settle on the biota.

B.1.1.2 Live Bottom (Pinnacle Trend)

This stipulation is intended to protect the pinnacle trend area and the associated hard-bottom communities from damage from oil and gas activities. If the required live bottom survey report determines that the live bottom may be adversely impacted by the proposed activity, certain measures, such as relocation or monitoring, may be required.

B.1.1.3 Live Bottom (Low Relief)

This stipulation is intended to protect hard-bottom communities not associated with bathymetric features on the sea bottom. Biological communities such as seagrass beds, sponges, and corals may occur on smooth topography. If the required live bottom survey report determines that the live bottom may be adversely impacted by the proposed activity, certain measures, such as relocation or monitoring, may be required.

B.1.1.4 Oil-Spill Response (Eastern Gulf of Mexico)

This stipulation is intended to minimize the risk of oil spills reaching Florida State waters by requiring the staging of state-of-the-art mechanical oil-spill response equipment within specified timeframes and by requiring that oil dispersant chemicals and equipment be maintained in a state of readiness.

B.1.1.5 Military Areas

This stipulation has three sections: hold harmless, electromagnetic emissions, and operational. The hold harmless section serves to protect the U.S. Government from liability in the event of an accident involving a lessee and military activities. The electromagnetic emissions section requires the lessee and its agents to reduce and curtail the use of equipment emitting electromagnetic energy in certain areas. This reduces the impact of offshore oil and gas activities on military communications and missile testing. The operational section requires prior notification of the military when offshore oil and gas activities are scheduled within a military use area to assist in scheduling activities and to prevent potential conflicts.

A second stipulation requires the evacuation, upon the receipt of a directive from the BSEE Regional Director, of all personnel from all structures on the lease and the shutting in and securing of all wells and other equipment, including pipelines, on the lease.

Two additional stipulations are applied to leases in the Eastern Gulf of Mexico Planning Area only. In cooperation with the U.S. Air Force, “drilling windows” are established for

6-month periods during which exploratory operations or workover operations may be conducted on leases. This time-sharing arrangement allows military operations to proceed in areas containing leases without being disrupted by oil and gas activities, and without undue disturbance to the exploratory activity and workover operations.

An additional stipulation has been included for the Western Gulf of Mexico Planning Area only. The Naval Mine Warfare Stipulation is intended to eliminate potential impacts from multiple-use conflicts in the Western Planning Area, Mustang Island Area East Addition, Blocks 732, 733, and 734. The U.S. Department of the Navy has identified these blocks as needed for testing equipment and for training mine warfare personnel.

B.1.2 Other Mitigations Categories

B.1.2.1 Air Quality

This category includes eight mitigations that apply to offshore exploration, development, and pipeline activities.

B.1.2.2 Archaeology

There are 18 mitigations describing procedures for conducting archaeological surveys before bottom-disturbing activities can occur on a lease; the procedures operators must follow these to avoid impacts on potential prehistoric and shipwreck sites.

B.1.2.3 Artificial Reefs

Five mitigations exist to avoid impacts on artificial reef sites and permit areas.

B.1.2.4 Chemosynthetic Communities

There are five mitigations to avoid impacts on chemosynthetic communities in deepwater areas of the Gulf of Mexico.

B.1.2.5 Coastal Zone Management

Five mitigations describe the conditions of approval in each of the Gulf Coast States.

B.1.2.6 Topographic Features, Live Bottoms, and the Flower Garden Banks

There are 13 mitigations to protect the health and stability of these benthic features.

B.1.2.7 Miscellaneous Mitigations

These apply to space-use conflicts, oil spill preparedness, remote operating vehicle surveys in deep water, essential fish habitat, hydrogen sulfide, and other issues.

B.2 ALASKA REGION

B.2.1 Lease Stipulations

B.2.1.1 Orientation Program

This stipulation is designed to provide an increased understanding of, and appreciation for, local community values, customs, and lifestyles of Alaska Native communities. The required orientation program must be designed in sufficient detail to inform individuals working on OCS projects of specific types of environmental, social, and cultural concerns in the area. The orientation program must provide information to industry employees on protected species, biological resources used for commercial and subsistence purposes, archaeological resources of the area and appropriate ways to protect them, and reducing industrial noise and disturbance effects on marine mammals and marine and coastal birds. The program must also include information about avoiding conflicts with subsistence activities.

B.2.1.2 Protection of Biological Resources

This stipulation provides for identifying and protecting previously unknown important or unique biological populations or habitats that may occur in a lease area. If previously unknown sensitive biological resources are identified during the conduct of lease activities under an approved Plan of Exploration or Development and Production Plan, the lessee will be required to modify operations, if necessary, to minimize adverse impacts on those biological populations or habitats.

B.2.1.3 Protection of Fisheries (Cook Inlet Planning Area)

This stipulation is designed to minimize spatial conflicts between OCS activities and commercial, sport, and subsistence fishing activities. Lease-related uses will be restricted, if determined necessary by the BOEM Alaska Regional Supervisor for Field Operations, to prevent unreasonable conflicts with fishing operations. The stipulation requires the lessee to review planned exploration and development activities (including plans for seismic surveys, drilling rig transportation, or other vessel traffic) with potentially affected fishing organizations, subsistence communities, and port authorities to prevent unreasonable fishing gear conflicts.

B.2.1.4 Transportation of Hydrocarbons

This stipulation informs lessees that (1) BOEM reserves the right to require the placement of pipelines in certain designated management areas, (2) pipelines must be designed and constructed to withstand the hazardous conditions that may be encountered in the sale area, and (3) pipeline construction and associated activities must comply with regulations. This stipulation requires the use of pipelines if (1) pipeline rights-of-way can be determined and obtained; (2) laying such pipelines is technologically feasible and environmentally preferable; and (3) in the opinion of the lessor, pipelines can be laid without net social loss, taking into account any incremental costs of pipelines over alternative methods of transportation and any incremental benefits in the form of increased environmental protection or reduced multiple-use conflicts.

B.2.1.5 Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources (Arctic Planning Areas)

This stipulation requires industry to conduct a site-specific monitoring program to determine when marine mammals are present in the vicinity of exploration operations, including ancillary seismic surveys, during periods of subsistence use. The monitoring program and review process required for Marine Mammal Protection Act authorization will satisfy the requirements of this stipulation. The monitoring plan must provide for reports on marine mammal sightings and the extent of observed behavioral effects because of lease activities. It also provides a formal mechanism for the oil and gas industry to coordinate logistics activities with the BOEM Bowhead Whale Aerial Survey Program. The stipulation provides for an opportunity for recognized co-management organizations to review and comment on the proposed monitoring plan before BOEM approval. The stipulation requires the lessee to fund an independent peer review of the proposed monitoring plan and the draft reports on the results of the monitoring program. No monitoring program will be required if the BOEM Alaska Regional Supervisor for Field Operations, in consultation with the appropriate agencies and co-management organizations, determines that a monitoring program is not necessary based on the size, timing, duration, and scope of the proposed operations.

B.2.1.6 Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Marine Mammal Subsistence Activities (Arctic Planning Areas)

This stipulation is designed to reduce disturbance effects on Alaska Native subsistence practices from OCS oil and gas industry activities by requiring industry to make reasonable efforts to conduct all aspects of their operations in a manner that recognizes Alaska Native subsistence requirements and avoids conflict with local subsistence harvest activities. The stipulation applies to both on-lease operations and to support activities, such as vessel and aircraft traffic. The stipulation also requires industry to consult with directly affected subsistence communities, the North Slope Borough, and the recognized co-management organizations to discuss possible siting and timing conflicts and to assure that exploration, development, and production activities do not result in unreasonable conflicts with subsistence whaling and other subsistence harvests. The stipulation also provides a mechanism to address unresolved conflicts between the oil and gas industry and subsistence activities.

B.2.1.7 Measures to Minimize Effects on Spectacled and Steller's Eiders During Exploration Activities (Arctic Planning Areas)

This stipulation is designed to minimize the likelihood that spectacled or Steller's eiders will strike drilling structures or vessels. The stipulation requires specific lighting protocols for structures and vessels, a plan for recording and reporting bird strikes, and avoidance of specified blocks by OCS-related vessels engaged in exploration activities.

B.3 INFORMATION TO LESSEE

Several ITLs have been developed to notify lessees and operators about environmental, social, and cultural concerns.

Past ITLs have provided lessees information or advisories on the following:

- Community participation in operations planning;
- Bird and marine mammal protection laws;
- Endangered, threatened, and candidate species and designated critical habitat under the Endangered Species Act;
- Consideration in Oil Spill Response Plans of river deltas of the Beaufort Sea coastal plain that have been identified by the U.S. Fish and Wildlife Service as special habitats for bird nesting, fish overwintering, or for other species' use;
- Possible prohibition of shore-based facilities in river deltas that have been identified as special habitats;
- Potential effects of seismic surveys on marine mammals and subsistence activities;
- Requirements on the availability of bowhead whales for subsistence whaling;
- The BOEM bowhead whale aerial monitoring program;

- The possibility that BOEM may limit or modify operations if they could result in significant effects on the availability of bowhead whales for subsistence use;

- Requirements for protection of polar bears and to limit potential encounters and interactions between lease operations and polar bears;

- Requirements for archaeological and shallow geologic hazards reports in support of exploration and development plans;

- Navigational safety;

- Requirements for air quality permits;

- Designated Class I air quality areas;

- Requirements for National Pollutant Discharge Elimination System permits for discharge of produced water, drilling fluids, and cuttings;

- Sensitive areas to be considered when developing oil-spill contingency plans;

- Requirements for BSEE approval of Oil Spill Reponses Plans;

- Requirements for establishing and maintaining oil-spill financial responsibility;

- BOEM encouragement of the use of existing pads and islands wherever feasible;

- The importance of the area around Cross Island for Nuiqsut subsistence whaling activities;

- Requirements for mitigation of unreasonable conflicts with subsistence activities; and

- BOEM encouragement of industry to establish of a Good Neighbor Policy to provide an immediate compensation system to minimize disruption to subsistence activities and provide resources to relocate subsistence hunters to alternate hunting areas or provide temporary food supplies in the event an accidental oil spill adversely affects the harvest of marine subsistence resources.

B.4 OTHER PROTECTIVE MEASURES APPLIED THROUGH LAWS AND REGULATIONS

BOEM also assumes in this programmatic environmental impact statement (PEIS), for analytical purposes only, other protective measures that are most commonly applied through laws and regulations. BOEM assumes OCS activities will occur in compliance with all laws and regulations and that other protective measures will be applied through those laws and regulations. Though not exhaustive, below is a list of those measures that are most applicable to the resource areas fully analyzed in this PEIS. For more information on the related laws and regulations, see Appendix C. For more information on how these protective measures were analytically utilized in this PEIS, see Chapter 4.

- National Ambient Air Quality Standards (NAAQS) as required by the Clean Air Act and administered by the Environmental Protection Agency (EPA).

- Prevention of Significant Deterioration (PSD) Program for air pollutant concentrations as administered by the EPA.

- National Pollution Discharge Elimination System (NPDES) permitting as administered by the EPA.

- Liability and compensation for oil spill-related damages as required by the Oil Pollution Act (OPA) and administered by the U.S. Coast Guard.

- Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA) mitigation measures as applied through ESA and MMPA consultations with U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) aimed to ensure the protection of any endangered or threatened species, marine mammal, and their critical habitat. Examples of ESA/MMPA protective measures for OCS oil and gas activities are (but are not limited to):
  - Pre-activity survey requirements,
  - Activity ramp-up procedures,
  - Marine mammal observers,
  - Speed restrictions,
  - Activity exclusion zones, and
  - Incidental take authorizations.

- Archaeological survey and mitigation as required by the National Historic Preservation Act, State Historic Preservation Offices, and BOEM and BSEE regulations.

- Fishery management plans as required by the Magnuson-Stevens Fishery Conservation and Management Act (FCMA).

- Essential Fish Habitat designations and protections as required by FCMA and administered by NMFS.

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APPENDIX C

FEDERAL LAWS AND EXECUTIVE ORDERS

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APPENDIX C

FEDERAL LAWS AND EXECUTIVE ORDERS

C.1 FEDERAL LAWS

C.1.1 The Outer Continental Shelf Lands Act (OCSLA)

The Outer Continental Shelf Lands Act of 1953 (OCSLA) authorized the Secretary of the Interior to grant mineral leases and to prescribe regulations governing oil and gas activities on Outer Continental Shelf (OCS) lands. The OCSLA defines the OCS as:

> *. . . all submerged lands lying seaward and outside of the areas lands beneath navigable waters as defined in section 2 of the Submerged Lands Act and of which the subsoil and seabed appertain to the United States and are subject to its jurisdiction and control.*

The pertinent provision of the Submerged Lands Act defines "navigable waters" as:

> *. . . all lands permanently or periodically covered by tidal waters up to but not above the line of mean high tide and seaward to a line three geographical miles distant from the coast line of each such State and to the boundary line of each such State where in any case such boundary as it existed at the time such State became a member of the Union, or as heretofore approved by Congress, extends seaward (or into the Gulf of Mexico) beyond three geographical miles* . . . .

Under the OCSLA, the U.S. Department of the Interior (USDOI) is required to:

- Manage the orderly leasing, exploration, development, and production of oil and gas resources on the Federal OCS;
- Ensure the protection of the human, marine, and coastal environments;
- Ensure that the public receives a fair and equitable return for these resources; and
- Ensure that free-market competition is maintained.

Within the USDOI, the Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSSE) are charged with the responsibility of managing and regulating the development of OCS oil and gas resources in accordance with the provisions of the OCSLA. BOEM and BSEE oil and gas operating regulations are presented in Chapter 30, Code of Federal Regulations (CFR), Parts 250 and 550.

C.1.2 The National Environment Policy Act (NEPA)

The National Environmental Policy Act of 1969 (NEPA) is the foundation of environmental policymaking in the United States. The NEPA process is intended to help public officials make decisions based on an understanding of environmental consequences and take actions that protect, restore, and enhance the environment. The NEPA established two primary mechanisms for this purpose:

- The Council on Environmental Quality (CEQ) was established to advise Agencies on the environmental decision making process and to oversee and coordinate the development of Federal environmental policy.

- Agencies must include an environmental review process early in the planning for proposed actions.

The CEQ issued regulations in 1978 implementing NEPA. The regulations include procedures to be used by Federal Agencies for the environmental review process. These regulations provide for the use of the NEPA process to identify and assess reasonable alternatives to proposed actions that avoid or minimize adverse effects of these actions upon the quality of the human environment. Scoping is used to identify the scope and significance of important environmental issues associated with a proposed Federal action through coordination with Federal, State, and local agencies; the general public; and any interested individual or organization prior to the development of an impact statement. The process also identifies and eliminates from further detailed study issues that are not significant or that have been covered by prior environmental review.

The NEPA requires all Federal Agencies to use a systematic, interdisciplinary approach to protect the human environment. Such an approach ensures the integrated use of natural and social sciences in any planning and decision making that may have an impact on the environment. The NEPA also requires the preparation of a detailed environmental impact statement (EIS) on any major Federal action that may have a significant impact on the environment. The EIS must address any adverse environmental effects that cannot be avoided or mitigated, alternatives to the proposed action, the relationship between short-term resources and long-term productivity, and irreversible and irretrievable commitments of resources. Environmental assessments (EAs) are prepared to determine whether significant impacts may occur. If an EA finds that significant impacts may occur, NEPA requires preparation of an EIS. The briefest form of NEPA review is the categorical exclusion review (CER). The purpose of a CER is to verify that neither an EA nor an EIS is needed prior to making a decision on the activity being considered for approval.

C.1.3 The Energy Policy Act of 2005

This law, enacted in 2005, gives BOEM new responsibilities over Federal offshore renewable energy and related uses of the OCS. Section 388 of the Act gives the Secretary of the Interior the authority to grant leases, easements, or rights-of-way for renewable energy-related uses on the Federal OCS, and to monitor and regulate the facilities used for energy production and energy support services.

C.1.4 The Alaska National Interest Lands Conservation Act (ANILCA)

In 1980, the Alaska National Interest Lands Conservation Act (ANILCA) created over 40 million ha (100 million ac) of new national parks, refuges, monuments, conservation areas, recreation areas, forests, and wild and scenic rivers in the State of Alaska for the preservation of "nationally significant" natural resources. To address special issues and needs arising from the new land designations, ANILCA contains numerous provisions and special rules for managing Alaska's public lands and nationally important resource development potential. ANILCA requires Federal land managers to balance the national interest in Alaska's scenic and wildlife resources with recognition of Alaska's economy and infrastructure, and its distinctive rural way of life. Title VIII of ANILCA requires that subsistence uses by "rural" Alaska residents be given a priority over all other (sport and commercial) uses of fish and game on Federal public lands in Alaska. As a compromise, Congress allowed the State to continue managing fish and game uses on Federal public lands, but only on the condition that the State of Alaska adopt a statute that made the new Title VIII "rural" subsistence priority applicable on State, as well as on Federal lands. If the State ever fell out of compliance with Title VIII, Congress required the Secretary of the Interior to reassume management of fish and game on the Federal public lands. Section 810 of ANILCA creates special steps a Federal agency must take before it decides to "withdraw, reserve, lease, or otherwise permit the use, occupancy, or disposition of public land."

Specifically, the Federal agency must first evaluate three factors: the effect of its action on subsistence uses and needs; the availability of other lands for the purposes sought to be achieved; and alternatives that would "reduce or eliminate the use, occupancy, or disposition of public lands needed for subsistence purposes." If the Federal agency concludes that its action "would significantly restrict subsistence uses," it must notify the appropriate State agency, regional council, and local committee. It then must hold a hearing in the vicinity of the area involved, and must make the following findings:

- Such significant restriction of subsistence uses is necessary and consistent with sound management principles for the utilization of public lands.

- The proposed activity will involve the minimal amount of public lands necessary to accomplish the purpose of such use, occupancy, or other disposition.

- Reasonable steps will be taken to minimize adverse impacts upon subsistence uses and resources resulting from such actions (16 USC 3120(a)(3)).

In *Amoco Production v. Village of Gambell*, 480 U.S. 531 (1987), the U.S. Supreme Court ruled that ANILCA applies only to Federal lands within the State of Alaska's boundaries. The Act defines "public lands" to mean Federal lands situated "in Alaska," which the Court ruled to mean within the territorial boundaries of the State, which ends in coastal waters to a point

4.8 km (3 mi) from the coastline. Therefore, the OCS is not encompassed by the words "in Alaska" and pipelines on the OCS are not subject to ANILCA. However, the sections of these pipelines that eventually go into State waters are subject to ANILCA.

C.1.5 The Clean Air Act (CAA)

The Clean Air Act (CAA), as amended, delineates jurisdiction of air quality between the U.S. Environmental Protection Agency (USEPA) and BOEM. For OCS operations in the Gulf of Mexico, those west of 87.5°W longitude are subject to BOEM air quality regulations; operations east of 87.5°W longitude are subject to the USEPA air quality regulations. In December 2011, Congress passed the Consolidated Appropriations Act of 2012, which amended the CAA by transferring air quality permitting authority for the OCS off the North Slope Borough of Alaska from the USEPA to BOEM. This area includes the Beaufort Sea and Chukchi Sea OCS Planning Areas and the northern part of the Hope Basin OCS Planning Area.

Under the CAA, the Secretary of the Interior is required to consult with the USEPA Administrator "to assure coordination of air pollution control regulations for OCS emissions and emissions in adjacent onshore areas." BOEM implementing regulations established to comply with the CAA are 30 CFR 550.218, 550.249, 550.302, 550.303, and 550.304. The regulated pollutants include carbon monoxide, particulates, sulfur dioxide, nitrogen oxides, and volatile organic compounds (as a precursor to ozone). BOEM regulations allow for the collection of information about potential sources of pollution for the purpose of determining whether the projected emissions of air pollutants from a facility could result in ambient onshore air pollutant concentrations above maximum levels provided in the regulations. These regulations also stipulate appropriate emissions controls deemed necessary to prevent accidents and air quality deterioration.

C.1.6 The Federal Water Pollution Control Act (FWPCA) and Clean Water Act (CWA)

The Federal Water Pollution Control Act (FWPCA) establishes water pollution control activities to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. The Clean Water Act of 1977 (CWA) amended the FWPCA. Title III of the CWA requires the USEPA to establish national effluent limitation standards for existing point sources of wastewater discharges that reflect the application of the best practical control technology currently available. These standards apply to existing OCS exploratory drillships, semisubmersible vessels, and jack-up rigs used in exploration activities. The CWA also requires the USEPA to establish regulations for effluent limitations for categories and classes of point sources that require the application of "best available control technology economically achievable."

Section 311 of the CWA, as amended, prohibits the discharge of oil or hazardous substances into the navigable waters of the United States that may affect natural resources, except under limited circumstances, and establishes civil penalty liability and enforcement procedures to be administered by the U.S. Coast Guard (USCG). The CWA Title IV establishes requirements for Federal permits and licenses to conduct an activity (including construction or operation of facilities) that may result in any discharges into navigable waters. Section 402 of the CWA gives the USEPA the authority to issue National Pollutant Discharge Elimination System (NPDES) permits for the discharge of pollutants. The NPDES permits apply to all sources of wastewater discharges from exploratory vessels and production platforms operating on the OCS.

C.1.7 The Coastal Zone Management Act (CZMA) and the Coastal Zone Reauthorization Amendments of 1990

Congress passed the Coastal Zone Management Act (CZMA) and created the Coastal Zone Management Program to improve the management of our Nation's coastal areas. The program, a voluntary partnership between the Federal Government and the coastal States and territories, is administered at the Federal level by the National Oceanic and Atmospheric Administration (NOAA) within the U.S. Department of Commerce (USDOC). The program's goal is to reduce potential conflicts between environmental and economic interests in the coastal area through the use of federally approved coastal management programs (CMPs).

The CZMA allows a coastal State or territory, with a federally approved CMP, to review Federal activities for Federal consistency. Federal consistency is the CZMA requirement that all Federal actions that are reasonably likely to affect any land or water use or natural resource of the coastal zone be consistent with the enforceable policies of a State's/territory's CMP. Section 307 of the CZMA contains the Federal consistency provisions that impose certain requirements on Federal agencies to comply with enforceable policies detailed in the federally approved CMPs:

- Section 307(c)(1) requires that any direct Federal agency activities affecting any land or water use or natural resources of the coastal zone be consistent, to the maximum extent practicable, with enforceable policies of the State's CMP. This section applies to OCS lease sales.

- Section 307(c)(3)(A) requires that any Federal licenses/permit affecting any land or water use or natural resources of the coastal zone be consistent with enforceable policies of the State's CMP. This section applies to geological and geophysical permits. In addition, this section prohibits the Federal agency from issuing the license/permit until the affected State(s) has concurred with or presumed to concur with the applicant's consistency certification or until the Secretary of Commerce has overridden the State's consistency objection to the licensed/permitted activity.

- Section 307(c)(3)(B) requires that activities affecting any land or water use or natural resources of the coastal zone, described in detail in OCS exploration or development and production plans, be consistent with enforceable policies of the State's CMP. MMS is prohibited from approving an OCS plan until the affected State(s) has concurred with, or is presumed to concur with, the applicant's consistency certification or until the Secretary of Commerce has overridden the State's consistency objection.

C.1.8 The Endangered Species Act (ESA)

The Endangered Species Act of 1973 (ESA) establishes policy to protect and conserve threatened and endangered species and the ecosystems upon which they depend. The ESA is administered by the USDOI, U.S. Fish and Wildlife Service (USFWS), and the USDOC, National Marine Fisheries Service (NMFS). Section 7 of the ESA mandates that all Federal agencies consult with the USFWS or NMFS to ensure that any agency action is not likely to do the following:

- Jeopardize the continued existence of any endangered or threatened species, and/or

- Destroy or adversely modify an endangered or threatened species' critical habitat.

The ESA requires Federal agencies to formally consult when there is reason to believe that a listed (or proposed to be listed) species may be affected by a proposed action. Formal endangered species consultations provide a threshold examination and a biological opinion on the likelihood that the proposed activity will or will not jeopardize the continued existence of the resource, and on the effect of the proposed activity on the endangered species. The biological opinion may include recommendations for modification of the proposed activity. The USFWS or NMFS notifies the Federal agency in writing when insufficient information is available to conclude that the proposed activity is not likely to jeopardize the species or its habitat. In such cases, the Federal agency must obtain additional information, and, if recommended by the USFWS or NMFS, conduct appropriate biological surveys or studies to determine how the proposed activity may affect the endangered species or its critical habitat. After such additional information is received, the USFWS or NMFS would conclude the consultation process by issuing a formal biological opinion.

For OCS activities in the Western and Central Gulf of Mexico Planning Areas, BOEM consults with the USFWS and/or NMFS at the multisale stage. This consultation covers OCS activities from lease sale through the exploration, development, production, and decommission stages. For other OCS areas, BOEM consults with the USFWS and/or NMFS at the lease sale stage; however, this consultation only covers leasing and exploration activities. A separate consultation is conducted for development, production, and decommissioning stages.

C.1.9 The Magnuson-Stevens Fishery Conservation and Management Act (FCMA)

The Magnuson-Stevens Fishery Conservation and Management Act of 1976 (FCMA) established and delineated an area from the States' seaward boundary to approximately 200 nautical miles out as a fisheries conservation zone for the United States and its possessions.

The FCMA created eight regional fishery management councils (FMCs) and mandated a continuing planning program for marine fisheries management by the FMCs. In addition, the FCMA requires the FMC to prepare a fishery management plan (FMP), based upon the best available scientific and economic data, for each commercial species (or related group of species) of fish in need of conservation and management within each respective region.

When the Sustainable Fisheries Act of 1996 reauthorized the FCMA, Congress required NMFS to designate and conserve essential fish habitat (EFH) for those species managed under an existing FMP. By designating EFH, Congress hoped to minimize any adverse effects on habitat caused by fishing or nonfishing activities and to identify other actions to encourage the conservation and enhancement of such habitat. The phrase "essential fish habitat" encompasses "those waters and substrate necessary to fishes for spawning, breeding, feeding, or growth to maturity." As a result of this change, Federal agencies must consult with NMFS on those activities that may have direct (e.g., physical disruption) or indirect (e.g., loss of prey species) adverse effects on EFH. For OCS activities in the Western and Central Gulf of Mexico Planning Areas, BOEM consults with NMFS at the multisale stage. The proposed action includes OCS activities from lease sale through the exploration, development, production, and decommission stages for the Western and Central Gulf of Mexico Planning Areas. For the Eastern Planning Area in the GOM, BOEM initiates EFH consultation with NMFS individually for individual lease sales, exploration plans, or development and production plans.

C.1.10 The Migratory Bird Treaty Act (MBTA)

The Migratory Bird Treaty Act (MBTA) prohibits the take of migratory birds, in which it is unlawful to "pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, at any time, or in any manner, any covered migratory bird … or any part, nest, or egg of any such bird." The USDOI Secretary via the USFWS may authorize the otherwise prohibited take of migratory birds through regulations. Current USFWS regulations authorize the taking of migratory birds for specific purposes, such as hunting, depredation, and scientific study; however, the regulations do not expressly address the incidental take of migratory birds.

The Minerals Management Service (MMS), now BOEM, entered into a Memorandum of Understanding (MOU) with the USFWS to meet the requirements under Section 3 of Executive Order 13186 (66 FR 3853, January 17, 2001) (refer to C.2.10 below for full discussion) concerning the responsibilities of Federal agencies to protect migratory birds. The Executive Order directs executive departments and agencies to take certain actions to further implement the MBTA. The purpose of this MOU is to strengthen migratory bird conservation through enhanced collaboration between BOEM and the USFWS. The MOU identifies specific areas in which cooperation between the parties will substantially contribute to the conservation and management of migratory birds and their habitats.

C.1.11 The Marine Mammal Protection Act (MMPA)

The Marine Mammal Protection Act (MMPA) was enacted in 1972 to ensure that marine mammals are maintained at, or in some cases restored to, healthy population levels. Jurisdiction over marine mammals under the MMPA is split between two Federal Agencies, the USFWS and NMFS. The USFWS has jurisdiction over sea otters, polar bears, manatees, dugongs, and walrus, while NMFS has jurisdiction over all other marine mammals.

The MMPA established a moratorium on the taking or importing of marine mammals except during certain activities that are regulated and permitted. Such activities include scientific research, public display, commercial and educational photography, import and export of marine mammal parts, commercial fishing authorizations, and take incidental to non-fishing commercial activities. Taking is defined as "to harass, hunt, capture, or kill or attempt to harass, hunt, capture, or kill any marine mammal." Harass is defined as any act of pursuit, torment, or annoyance that has the potential to do the following:

- Injure a marine mammal or marine mammal stock in the wild, or

- Disturb a marine mammal or marine mammal stock in the wild by disrupting behavioral patterns (e.g., breathing, nursing, breeding).

Upon request, the Secretary (of either the USDOI or the USDOC, depending on jurisdiction) can authorize the unintentional taking of small numbers of marine mammals incidental to activities other than commercial fishing (e.g., offshore oil and gas exploration and development) for a period of 1–5 yr, depending on the level of anticipated take. To authorize the taking, the Secretary must find that the total of the taking during the 5-yr period (or less) would have a negligible impact on the affected species. In addition, the Secretary shall withdraw or suspend permission to take marine mammals incidental to oil and gas production, and other activities when the following take place:

- The applicable regulations concerning the methods of taking, monitoring, or reporting are not being complied with; or

- The taking is having, or may be having, more than a negligible impact on the affected species or stock.

BOEM coordinates with the USFWS and NMFS to ensure that BOEM and offshore operators comply with the MMPA, and to identify mitigation and monitoring requirements for permits or approvals for activities like seismic surveys and platform removals.

C.1.12 The International Convention of the Prevention of Pollution from Ships (MARPOL) and Marine Plastic Pollution Research and Control Act (MPPRCA)

In 1978, the International Convention of the Prevention of Pollution from Ships (MARPOL) was updated to include five annexes on ocean dumping. By signing onto MARPOL, countries agree to enforce Annexes I and II (oil and noxious liquid substances) of the treaty. Annexes III (hazardous substances), IV (sewage), and V (plastics) are optional. The United States is signatory to two of the optional MARPOL Annexes, III and V. Annex V is of particular importance to the maritime community (e.g., shippers, oil platform personnel, fishers, recreational boaters) because it prohibits the disposal of plastic at sea and regulates the disposal of other types of garbage at sea. The USCG is the enforcement agency for MARPOL Annex V within the U.S. Exclusive Economic Zone (EEZ) (within 322 km [200 mi] of the U.S. shoreline).

The Marine Plastic Pollution Research and Control Act (MPPRCA) is the Federal law implementing MARPOL Annex V in all U.S. waters. Under the MPPRCA, it is illegal to throw plastic trash off any vessel within the EEZ. It is also illegal to throw any other garbage (e.g., orange peels, paper plates, glass jars, and monofilament fishing line) overboard while navigating in inland waters or within 5 km (3 mi) offshore. The greater the distance from shore, the fewer restrictions apply to nonplastic garbage. However, dumping plastics overboard in any waters anywhere is illegal at anytime. Fixed and floating platforms, drilling rigs, manned production platforms, and support vessels operating under a Federal oil and gas lease are required to develop waste management plans and to post placards reflecting discharge limitations and restrictions. Garbage must be brought ashore and properly disposed of in a trash can, dumpster, or recycling container. Docks and marinas are required to provide facilities to handle normal amounts of garbage from their paying customers. Violations of MARPOL or MPPRCA may result in a fine of up to $50,000 for each incident. If criminal intent can be proven, an individual may be fined up to $250,000 and/or imprisoned up to 6 yr. If an organization is responsible, it may be fined up to $500,000 and/or be subject to 6 yr of imprisonment.

C.1.13 The Marine Protection, Research, and Sanctuaries Act (MPRSA)

The Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) regulates the ocean dumping of waste, provides for a research program on ocean dumping, and provides for the designation and regulation of marine sanctuaries. Also known as the Ocean Dumping Act, it regulates the ocean dumping of all material beyond the territorial limit (5 km [3 mi] from shore) and prevents or strictly limits dumping material that "would adversely affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities." Material includes, but is not limited to, dredged material; solid waste; incinerator residue; garbage; sewage; sewage sludge; munitions; chemical and biological warfare agents; radioactive materials; chemicals; biological and laboratory waste; wrecked or discarded equipment; rocks; sand; excavation debris; and industrial, municipal, agricultural, and other waste. The term does not include sewage from vessels or oil, unless the oil is transported via a vessel or aircraft for the purpose of dumping. Disposal by means of a pipe, regardless of how far at sea the discharge occurs, is regulated by the CWA through the NPDES permit process.

Title III of the MPRSA, later called the National Marine Sanctuaries Act, charged the Secretary of the Department of Commerce to identify, designate, and manage marine sites based on conservational, ecological, recreational, historical, aesthetic, scientific, or educational value within significant national ocean and Great Lake waters. The NOAA administers the National

Marine Sanctuary Program. Thirteen national marine sanctuaries and one national monument, representing a wide variety of ocean environments, have been designated.

C.1.14 The Merchant Marine Act of 1920 (Jones Act)

The Merchant Marine Act of 1920 (Jones Act) regulates coastal shipping between U.S. ports and inland waterways. The Jones Act provides that "no merchandise shall be transported by water, or by land and water . . . between points in the United States . . . in any other vessel than a vessel built in and documented under the laws of the United States and owned by persons who are citizens of the United States . . . ." Therefore, the Jones Act requires that all goods shipped between different ports in the United States or its territories must be:

- Carried on vessels built and documented (flagged) in the United States,
- Crewed by U.S. citizens or legal aliens licensed by the USCG, and
- Owned and operated by U.S. citizens.

The rationale behind the Jones Act and earlier sabotage laws was that the United States needed a merchant marine fleet to ensure that its domestic waterborne commerce remains under Government jurisdiction for regulatory, safety, and national defense considerations. The same general principles of safety regulations are applied to other modes of transportation in the United States. While other modes of transportation can operate foreign-built equipment, these units must comply with U.S. standards. However, many foreign-built ships do not meet the standards required of U.S.-built ships and, thus, are excluded from domestic shipping.

The U.S. Customs Service has determined that facilities fixed or attached to the OCS used for the purpose of oil exploration are considered points within the United States. The OCS oil facilities are considered U.S. sovereign territory and fall under the requirements of the Jones Act; so all shipping to and from these facilities related to OCS oil exploration can only be conducted by vessels meeting the requirements of the Jones Act. Shuttle tankering of oil that is produced at OCS facilities can only be legally provided by U.S.-registered vessels and aircraft that are properly endorsed for coastwise trade under the laws of the United States.

C.1.15 The National Fishing Enhancement Act

The National Fishing Enhancement Act of 1984, also known as the Artificial Reef Act, established broad artificial-reef development standards and a national policy to encourage the development of artificial reefs that will enhance fishery resources and commercial and recreational fishing. The national plan identifies oil and gas structures as acceptable material of opportunity for artificial-reef development. MMS, now BSEE, adopted a rigs-to-reefs policy in 1985 in response to this Act and to broaden interest in the use of petroleum platforms as artificial reefs.

C.1.16 The National Historic Preservation Act (NHPA)

The National Historic Preservation Act of 1966 (NHPA) requires the head of any Federal agency possessing licensing authority or having direct or indirect jurisdiction over a proposed Federal or federally assisted activity to consider the proposed activity's effect on any district, site, building, structure, or object that is included in or eligible for inclusion in the *National Register of Historic Places*. The historic properties (i.e., archaeological resources) on the OCS include historic shipwrecks, sunken aircraft, lighthouses, and prehistoric archaeological sites that have become inundated due to the 120-m (394-ft) rise in global sea level since the height of the last ice age (ca. 19,000 yr ago).

Because the OCS is not federally owned land and the Federal Government has not claimed direct ownership of historic properties on the OCS, BOEM and BSEE only have the authority to ensure that any agency-funded and permitted actions do not adversely affect significant historic properties. Beyond avoidance of adverse impacts, BOEM and BSEE do not possess the legal authority to manage the historic properties on the OCS. BOEM has conducted archaeological baseline studies of the OCS to determine where known historic properties may be located and to outline areas where presently unknown historic properties may be located. These baseline studies are used to identify "archaeologically sensitive" areas that may contain significant historic properties.

Prior to approving any OCS exploration or development activities within an archaeologically sensitive area, BOEM requires the lessee to conduct a marine remote sensing survey and to prepare an archaeological report. If the marine remote sensing survey indicates any evidence of a potential historic property, the lessee must do one of the following:

- Move the site of the proposed lease operations a sufficient distance to avoid the potential historic property, or

- Conduct further investigations to determine the nature and significance of the potential historic property.

If further investigation determines that there is a significant historic property within the area of proposed OCS operations, NHPA consultation procedures are followed.

C.1.17 The Oil Pollution Act (OPA 90)

The Oil Pollution Act (OPA 90) establishes a single uniform Federal system of liability and compensation for damages caused by oil spills in U.S. navigable waters. The OPA 90 requires removal of spilled oil and establishes a national system of planning for and responding to oil-spill incidents. In addition, OPA 90 includes provisions to do the following:

- Improve oil-spill prevention, preparedness, and response capability;

- Establish limitations on liability for damages resulting from oil pollution;

- Promote funding for natural resource damage assessment;
- Implement a fund for the payment of compensation for such damages; and
- Establish an oil pollution research and development program.

The USCG is responsible for enforcing vessel compliance with the OPA 90. The Secretary of the Interior is given authority over offshore facilities and associated pipelines (except deepwater ports) for all Federal and State waters, including responsibility for spill prevention, oil-spill contingency plans, oil-spill containment and cleanup equipment, financial responsibility certification, and civil penalties. The Secretary of the Interior delegated this authority to BOEM and BSEE.

BOEM regulations governing oil-spill financial responsibility (OSFR) for offshore facilities and related requirements for certain crude oil wells, production platforms, and pipelines located in the OCS and certain State waters became effective in October 1998. The regulations implement the OPA requirement for responsible parties to demonstrate they can pay for cleanup and damages caused by facility oil spills. Responsible parties can be required to demonstrate as much as $150 million in OSFR if BOEM determines that it is justified by the risks from potential oil spills from the covered offshore facilities. The minimum amount of OSFR that must be demonstrated is $35 million for covered offshore facilities located in the OCS, and $10 million for covered offshore facilities located in State waters. The regulation exempts persons responsible for facilities having a potential worst-case, oil-spill discharge of 1,000 bbl or less, unless the risks posed by a facility justify a lower threshold.

C.1.18 The Outer Continental Shelf Deep Water Royalty Relief Act

The Outer Continental Shelf Deep Water Royalty Relief Act of 1995 authorizes the Secretary of the Interior to offer OCS blocks for lease with suspension of royalties for a volume, value, or period of production. Deepwater royalty relief applies to blocks offered for lease in the western and central Gulf of Mexico in water depths exceeding 200 m (656 ft) through November 28, 2000. MMS, now the Office of Natural Resources Revenue (ONRR), developed procedures for suspension of royalty payment on production from eligible leases.

C.1.19 The Ports and Waterways Safety Act

The Ports and Waterways Safety Act authorizes the USCG to designate safety fairways, fairway anchorages, and traffic separation schemes to provide unobstructed approaches through oil fields for vessels using ports. The USCG regulations provide listings of these designated areas along with special conditions related to oil and gas production. In general, no fixed structures such as platforms are allowed in fairways. Temporary underwater obstacles such as anchors and attendant cables or chains attached to floating or semisubmersible drilling rigs may be placed in a fairway under certain conditions. Fixed structures may be placed in anchorages, but the number of structures is limited.

C.1.20 The Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act (RCRA) provides a framework for the safe disposal and management of hazardous and solid wastes. Most oil-field wastes have been exempted from coverage under RCRA hazardous waste regulations. Any hazardous wastes generated on the OCS that are not exempt must be transported to shore for disposal at a hazardous waste facility.

C.1.21 The Rivers and Harbors Act (RHA)

Section 10 of the Rivers and Harbors Act (RHA) of 1899 (33 USC 403) prohibits the unauthorized obstruction or alteration of any navigable water of the United States. This section provides that the construction of any structure in or over any navigable water of the United States, or the accomplishment of any other work affecting the course, location, condition, or physical capacity of such waters, is unlawful unless the work has been recommended by the Chief of Engineers of the U.S. Army Corps of Engineers (USACE) and authorized by the Secretary of the Army. The Secretary's approval authority has since been delegated to the Chief of Engineers of the USACE. This legislative authority to prevent inappropriate obstructions to navigation was extended to installations and devices and the seabed to the seaward limit of the Outer Continental Shelf by Section 4(e) of the Outer Continental Shelf Lands Act of 1953, as amended.

Operators planning to install structures for the exploration, production, and transportation of oil, gas, and minerals on the OCS must apply for a Section 10 Permit. The USACE can authorize these activities by a standard individual permit, letter-of-permission, general permit, nationwide permit, or regional permit, and makes this determination at the time of application. Typically, the USACE authorizes the installation of these OCS structures under a nationwide permit, Nationwide Permit 8. Under a Nationwide Permit 8, such structures shall not be placed (1) within the limits of any designated shipping safety fairway or traffic separation scheme, except temporary anchors that comply with the fairway regulations in 33 CFR 322.5(l), (2) within established danger zones or restricted areas as designated in 33 CFR Part 334, or (3) within USEPA- or USACE-designated dredged material disposal areas.

C.2 EXECUTIVE ORDERS (EO)

C.2.1 Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (February 1994)

In the memorandum to heads of departments and agencies that accompanied the Executive Order (EO), the President specifically recognized the importance of procedures under the NEPA for identifying and addressing environmental justice concerns. The memorandum states that "each Federal agency shall analyze the environmental effects, including human health, economic and social effects, of Federal actions, including effects on minority communities and low-income communities, when such analysis is required by [NEPA]." In August 1994, the Secretary of the Interior directed its bureaus to include environmental justice (EJ) in NEPA documentation, and in February 1998, the CEQ issued guidance to assist Federal Agencies in addressing EJ.

The issue of disproportionate, OCS-related impacts on minority and low-income populations is addressed in all OCS regions when such analysis is required by the NEPA. This issue is a primary focus in Alaska OCS Region environmental assessments where Native Alaskan subsistence hunting, fishing, and gathering activities occur in coastal areas.

Executive Order No. 12898 provides the following:

Section 1-1. IMPLEMENTATION.

1-101. *Agency Responsibilities*. To the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Marianas Islands.

1-102. *Creation of an Interagency Working Group on Environmental Justice*.

(a) Within 3 months of the date of this order, the Administrator of the Environmental Protection Agency ("Administrator") or the Administrator's designee shall convene an interagency Federal Working Group on Environmental Justice ("Working Group"). The Working Group shall comprise the heads of the following executive agencies and offices, or their designees: (a) Department of Defense; (b) Department of Health and Human Services; (c) Department of Housing and Urban Development; (d) Department of Labor; (e) Department of Agriculture; (f) Department of Transportation; (g) Department of Justice; (h) Department of the Interior; (i) Department of Commerce; (j) Department of Energy; (k) Environmental Protection Agency; (l) Office of Management and Budget; (m) Office of Science and Technology Policy; (n) Office of the Deputy Assistant to the President for Environmental Policy; (o) Office of the Assistant to the President for Domestic Policy; (p) National Economic Council; (q) Council of Economic Advisers; and (r) such other Government officials as the President may designate. The Working Group shall report to the President through the Deputy Assistant to the President for Environmental Policy and the Assistant to the President for Domestic Policy.

(b) The Working Group shall:

(1) provide guidance to Federal agencies on criteria for identifying disproportionately high and adverse human health or environmental effects on minority populations and low-income populations;

(2) coordinate with, provide guidance to, and serve as a clearinghouse for, each Federal agency as it develops an environmental justice strategy as required by section 1-103 of this order, in order to ensure that the administration, interpretation and enforcement of programs, activities and policies are undertaken in a consistent manner;

(3) assist in coordinating research by, and stimulating cooperation among, the Environmental Protection Agency, the Department of Health and Human Services, the Department of Housing and Urban Development, and other agencies conducting research or other activities in accordance with section 3-3 of this order;

(4) assist in coordinating data collection, required by this order;

(5) examine existing data and studies on environmental justice;

(6) hold public meetings as required in section 5-502(d) of this order; and

(7) develop interagency model projects on environmental justice that evidence cooperation among Federal agencies.

1-103. *Development of Agency Strategies*.

(a) Except as provided in section 6-605 of this order, each Federal agency shall develop an agency-wide environmental justice strategy, as set forth in subsections (b)–(e) of this section that identifies and addresses disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. The environmental justice strategy shall list programs, policies, planning and public participation processes, enforcement, and/or rulemakings related to human health or the environment that should be revised to, at a minimum: (1) promote enforcement of all health and environmental statutes in areas with minority populations and low-income populations; (2) ensure greater public participation; (3) improve research and data collection relating to the health of and environment of minority populations and low-income populations; and (4) identify differential patterns of consumption of natural resources among minority populations and low-income populations. In addition, the environmental justice strategy shall include, where appropriate, a timetable for undertaking identified revisions and consideration of economic and social implications of the revisions.

(b) Within 4 months of the date of this order, each Federal agency shall identify an internal administrative process for developing its environmental justice strategy, and shall inform this Working Group of the process.

(c) Within 6 months of the date of this order, each Federal agency shall provide the Working Group with an outline of its proposed environmental justice strategy.

(d) Within 10 months of the date of this order, each Federal agency shall provide the Working Group with its proposed environmental justice strategy.

(e) Within 12 months of the date of this order, each Federal agency shall finalize its environmental justice strategy and provide a copy and written description of its strategy to the Working Group. During the 12 month period from the date of this order, each Federal agency, as part of its environmental justice strategy, shall identify several specific projects that can be promptly undertaken to address particular concerns identified during the development of the proposed environmental justice strategy, and a schedule for implementing those projects.

(f) Within 24 months of the date of this order, each Federal agency shall report to the Working Group on its progress in implementing its agency-wide environmental justice strategy.

(g) Federal agencies shall provide additional periodic reports to the Working Group as requested by the Working Group.

1-104. *Reports to the President*. Within 14 months of the date of this order, the Working Group shall submit to the President, through the Office of the Deputy Assistant to the President for Environmental Policy and the Office of the Assistant to the President for Domestic Policy, a report that describes the implementation of this order, and includes the final environmental justice strategies described in section 1-103(e) of this order.

Sec. 2-2. FEDERAL AGENCY RESPONSIBILITIES FOR FEDERAL PROGRAMS.

Each Federal agency shall conduct its programs, policies, and activities that substantially affect human health or the environment, in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under, such programs, policies, and activities, because of their race, color, or national origin.

Sec. 3-3. RESEARCH, DATA COLLECTION, AND ANALYSIS.

3-301. *Human Health and Environmental Research and Analysis*.

(a) Environmental human health research, whenever practicable and appropriate, shall include diverse segments of the population in epidemiological and clinical studies, including segments at high risk from environmental hazards, such as minority populations, low-income populations and workers who may be exposed to substantial environmental hazards.

(b) Environmental human health analyses, whenever practicable and appropriate, shall identify multiple and cumulative exposures.

(c) Federal agencies shall provide minority populations and low-income populations the opportunity to comment on the development and design of research strategies undertaken pursuant to this order.

3-302. *Human Health and Environmental Data Collection and Analysis*. To the extent permitted by existing law, including the Privacy Act, as amended (5 U.S.C. § 552a):

(a) Each Federal agency, whenever practicable and appropriate, shall collect, maintain, and analyze information assessing and comparing environmental and human health risks borne by populations identified by race, national origin, or income. To the extent practical and appropriate, Federal agencies shall use this information to determine whether their programs, policies, and activities have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations;

(b) In connection with the development and implementation of agency strategies in section 1-103 of this order, each Federal agency, whenever practicable and appropriate, shall collect, maintain and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding facilities or sites expected to have a substantial environmental, human health, or economic effect on the surrounding populations, when such facilities or sites become the subject of a substantial Federal environmental administrative of judicial action. Such information shall be made available to the public unless prohibited by law; and

(c) Each Federal agency, whenever practicable and appropriate, shall collect, maintain, and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding Federal facilities that are: (1) subject to the reporting requirements under the Emergency Planning and Community Right-to-Know Act, 42 U.S.C. section 11001-11050 as mandated in Executive Order No. 12856; and (2) expected to have a substantial environmental, human health, or economic effect on surrounding populations. Such information shall be made available to the public, unless prohibited by law.

(d) In carrying out the responsibilities in this section, each Federal agency, whenever practicable and appropriate, shall share information and eliminate unnecessary duplication of efforts through the use of existing data systems and cooperative agreements among Federal agencies and with State, local, and tribal governments.

Sec. 4-4. SUBSISTENCE CONSUMPTION OF FISH AND WILDLIFE.

4-401. *Consumption Patterns*. In order to assist in identifying the need for ensuring protection of populations with differential patterns of subsistence consumption of fish and wildlife, Federal agencies, whenever practicable and appropriate, shall collect, maintain, and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence. Federal agencies shall communicate to the public the risks of those consumption patterns.

4-402. *Guidance*. Federal agencies, whenever practicable and appropriate, shall work in a coordinated manner to publish guidance reflecting the latest scientific information available concerning methods for evaluating the human health risks associated with the consumption of pollutant-bearing fish or wildlife. Agencies shall consider such guidance in developing their policies and rules.

Sec. 5-5. PUBLIC PARTICIPATION AND ACCESS TO INFORMATION.

(a) The public may submit recommendations to Federal agencies relating to the incorporation of environmental justice principles into Federal agency programs or policies. Each Federal agency shall convey such recommendations to the Working Group.

(b) Each Federal agency may, whenever practicable and appropriate, translate crucial public documents, notices, and hearings relating to human health or the environment for limited English speaking populations.

(c) Each Federal agency shall work to ensure that public documents, notices, and hearings relating to human health or the environment are concise, understandable, and readily accessible to the public.

(d) The Working Group shall hold public meetings, as appropriate, for the purpose of fact-finding, receiving public comments, and conducting inquiries concerning environmental justice. The Working Group shall prepare for public review a summary of the comments and recommendations discussed at the public meetings.

Sec. 6-6. GENERAL PROVISIONS.

6-601. *Responsibility for Agency Implementation*. The head of each Federal agency shall be responsible for ensuring compliance with this order. Each Federal agency shall conduct internal reviews and take such other steps as may be necessary to monitor compliance with this order.

6-602. *Executive Order No. 12250*. This Executive order is intended to supplement but not supersede Executive Order No. 12250, which requires consistent and effective implementation of various laws prohibiting discriminatory practices in programs receiving Federal financial assistance. Nothing herein shall limit the effect or mandate of Executive Order No. 12250.

6-603. *Executive Order No. 12875*. This Executive order is not intended to limit the effect or mandate of Executive Order No. 12875.

6-604. *Scope*. For purposes of this order, Federal agency means any agency on the Working Group, and such other agencies as may be designated by the President, that conducts any Federal program or activity that substantially affects human health or the environment. Independent agencies are requested to comply with the provisions of this order.

6-605. *Petitions for Exemptions*. The head of a Federal agency may petition the President for an exemption from the requirements of this order on the grounds that all or some of the petitioning agency's programs or activities should not be subject to the requirements of this order.

6-606. *Native American Programs*. Each Federal agency responsibility set forth under this order shall apply equally to Native American programs. In addition, the Department of the Interior, in coordination with the Working Group, and, after consultation with tribal leaders, shall coordinate steps to be taken pursuant to this order that address Federally-recognized Indian Tribes.

6-607. *Costs*. Unless otherwise provided by law, Federal agencies shall assume the financial costs of complying with this order.

6-608. *General*. Federal agencies shall implement this order consistent with, and to the extent permitted by, existing law.

6-609. *Judicial Review*. This order is intended only to improve the internal management of the executive branch and is not intended to, nor does it create any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity by a party against the United States, its agencies, its officers, or any person. This order shall not be construed to create any right to judicial review involving the compliance or noncompliance of the United States, its agencies, its officers, or any other person with this order.

C.2.2 Executive Order 13007: Indian Sacred Sites (May 1996)

The Indian Sacred Sites EO directs Federal land managing Agencies to accommodate access to, and ceremonial use of, Indian sacred sites by Indian religious practitioners, and to avoid adversely affecting the physical integrity of such sacred sites. It is BOEM's policy to consider the potential effects of all aspects of plans, projects, programs, and activities on Indian sacred sites, and to consult, to the greatest extent practicable and to the extent permitted by law, with tribal governments before taking actions that may affect Indian sacred sites located on Federal lands.

C.2.3 Executive Order 13089: Coral Reef Protection (June 1998)

This EO directs the U.S. Coral Reef Task Force, co-chaired by the Secretaries of Interior and Commerce, to develop and implement a comprehensive program of research and mapping to inventory, monitor, and "identify the major causes and consequences of degradation of coral reef ecosystems." In addition, the EO directs Federal agencies to protect coral reef ecosystems and, to the extent permitted by law, prohibits them from authorizing funding or carrying out any actions that will degrade these ecosystems. Relatedly, the USDOI works with domestic and international partners through the Coral Reef Initiative. This initiative focuses efforts to protect and monitor coral reefs around the world by building and sustaining partnerships, programs, and institutional capacities at the local, national, regional, and international levels.

C.2.4 Executive Order 12114: Environmental Effects Abroad (January 1979)

This EO requires that Federal officials be informed of environmental considerations, and take those considerations into account when making decisions on major Federal actions that could have environmental impacts anywhere beyond the borders of the United States, including Antarctica. Such Federal actions include the following:

- All major Federal actions significantly affecting the environment outside the jurisdiction of any nation (the oceans or Antarctica). This would apply to proposals that result in actions within the United States, which because of ocean currents, winds, stream flow, or other natural processes, may affect parts of the oceans not claimed by any nation (high seas). Included in this category would be an OCS project that, because of ocean currents, could result in effluents or spilled oil reaching fishing grounds or areas not claimed by another nation.

- All major Federal actions significantly affecting the environment of a foreign nation not involved in the action. This would apply to proposals that result in actions within U.S. territory or within the EEZ that, because of ocean currents, winds, stream flow, or other natural processes, may affect parts of another nation, or seas or oceans within the jurisdiction of other nations. This category would include an OCS project located up-current from the Mexican coastline that could affect Mexico's territory in the event of an oil spill. Also in this category are all major Federal actions in which a foreign nation is a participant and that would normally be covered by the EIS addressing the U.S. part of the proposal. An example would be an OCS right-of-way pipeline bringing Canadian energy resources to the northeast United States.

- All major Federal actions providing a foreign nation with a product, or involving a project that produces an emission or effluent prohibited or regulated by U.S. Federal law because of its effects on the environment or the creation of a serious public health risk.

Federal actions causing significant impacts on environments outside the United States are to be addressed in the following:

- EISs (generic), program (5-Year OCS Leasing Program) EISs, and project-specific (OCS lease sale) EISs;

- Documents prepared for decision makers containing reviews of environmental issues involved in Federal actions, or summaries of environmental analyses (e.g., OCS lease sale decision documents, Records of Decision); and

- Environmental studies or research prepared by the United States and one or more foreign nations, or by an international body in which the United States is a member or participant.

The United States, Canada, and Mexico are negotiating a Transboundary Environmental Impact Assessments (TEIA) Agreement through the North Atlantic Free Trade Agreement (NAFTA) Commission on Environmental Cooperation (CEC). The CEC deals with a wide range of environmental and natural resource protection issues common to Canada, the United States, and Mexico. Developing a TEIA process is one of the requirements of the 199l North American Agreement on Environmental Cooperation. Under this agreement, a transboundary environmental impact is any impact on the environment within the area under the jurisdiction of Canada, the United States, or Mexico caused by a proposed project, the physical origin of which is situated wholly or in part within the area under the jurisdiction of one of the three countries. For example, a proposed project on the United States OCS that, because of ocean currents, winds, or proximity to the Mexican coastline, could affect Mexican waters (fishing industry, fish resources, etc.) or the Mexican coastline (oil spill contacts, etc.) would be a project considered to have the potential to cause transboundary environmental impacts. The agreement recognizes that there is a significant bilateral nature to many transboundary issues and calls upon the three countries to develop an agreement to do the following:

- Assess the environmental impacts of proposed projects in any of the three countries party to the agreement (NAFTA) that would be likely to cause significant adverse transboundary impacts within the jurisdiction of any of the other parties;

- Develop a system of notification, consultation, and sharing of relevant information between countries with respect to such projects; and

- Give consideration to mitigating measures to address the potential adverse effects of such projects.

Negotiations are currently underway between the three parties to the agreement, but the final language has yet to be worked out. Because the requirements of the assessment portion of the agreement are somewhat similar to the requirements imposed by EO 12114 (i.e., impacts on foreign territory must be addressed in NEPA documents), BOEM requires that EISs prepared on major Federal OCS actions contain an assessment of potential significant impacts on foreign territory.

C.2.5 Executive Order 13158: Marine Protected Areas (MPAs) (May 2000)

The EO defines an MPA as "any area of the marine environment that has been reserved by Federal, State, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein." The EO directs Federal agencies to work closely with State, local, and nongovernmental partners to create a comprehensive system of MPAs "representing diverse U.S. marine ecosystems, and the Nation's natural and cultural resources." Ultimately, the MPA system will include new sites, as well as enhancements to the conservation of existing sites. Five principal components of the EO are the following:

- **National MPA List:** The USDOC and the USDOI will develop and maintain a national list of MPAs in U.S. waters. Candidate sites for the list are drawn from existing programs for Federal, tribal, State and local protected areas. When completed, the list and the companion data on each site will serve several purposes, such as ensuring that agencies "avoid harm" to MPAs, providing a foundation for the analysis of gaps in the existing system of protections, and helping improve the effectiveness of existing MPAs.

- **The MPA Web Site:** The USDOC and USDOI will develop and maintain a publicly accessible Web site to provide information on MPAs and Federal agency reports required by the EO. In addition, the Web site will be used to publish and maintain the National MPA List and other useful information, such as maps of MPAs; a virtual library of MPA reference materials, including links to other web sites; information on the MPA Advisory Committee; activities of the national MPA Center; MPA program summaries; and background materials such as MPA definitions, benefits, management challenges, and management tools.

- **The MPA Federal Advisory Committee:** Created to provide expert advice on, and recommendations for, a national system of MPAs, this advisory committee will include nonfederal representatives from science, resource management, environmental organizations, and industry.

- **The Mandate to Avoid Harmful Federal Actions:** This mandate directs Federal Agencies to avoid harm to MPAs or their resources through activities that they undertake, fund, or approve.

- **The Marine Protected Areas Center:** The EO directs NOAA to create a Marine Protected Areas Center (MPA Center). In cooperation with the USDOI and working closely with other organizations, the MPA Center will coordinate the effort to implement the EO and will do the following:
  - develop the framework for a national system of MPAs;
  - coordinate the development of information, tools, and strategies;
  - provide guidance that will encourage efforts to enhance and expand the protection of existing MPAs and to establish or recommend new ones;
  - coordinate the MPA Web site;
  - partner with Federal and nonfederal organizations to conduct research, analysis, and exploration;
  - help maintain the National MPA List; and
  - support the MPA Advisory Committee.

C.2.6 Executive Order 13112: Invasive Species (February 1999)

The EO defines an "invasive species" as a species that is nonnative (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause, economic or environmental harm or harm to human health. This EO requires all Federal agencies to do as follows:

- Identify any actions affecting the status of invasive species;

- Prevent invasive species introduction;

- Detect and respond to and control populations of invasive species in a cost-effective and environmentally sound manner;

- Monitor invasive species populations accurately and reliably;

- Provide for restoration of native species and habitat conditions in invaded ecosystems;

- Conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species;

- Promote public education on invasive species and the means to address them; and

- Refrain from authorizing, funding, or carrying out actions that are likely to cause or promote invasive species introduction or spread, unless the agency has determined that the benefits of such actions clearly outweigh the potential harm caused by invasive species and that all feasible and prudent measures to minimize risk of harm will be taken.

In addition, the EO established the National Invasive Species Council (Council), co-chaired by the Secretaries of Agriculture, Commerce and the Interior, and comprised of the Secretaries of State, Treasury, Defense, and Transportation, and the Administrator of the USEPA. The Council does the following:

- Provides national leadership on invasive species;
- Sees that Federal efforts are coordinated and effective;
- Promotes action at local, State, tribal and ecosystem levels;
- Identifies recommendations for international cooperation;
- Facilitates a coordinated network to document and monitor invasive species;
- Develops a web-based information network;
- Provides guidance on invasive species for Federal Agencies to use in implementing the NEPA; and
- Prepares an Invasive Species Management Plan to serve as the blueprint for Federal action to prevent introduction; provide control; and minimize economic, environmental, and human health impacts of invasive species.

BOEM requires that EISs prepared on major Federal OCS actions (e.g., 5-Year OCS Leasing Program and OCS lease sales) contain an assessment of the proposed action's contribution to the invasive species problem.

C.2.7 Executive Order 11988, Floodplain Management (May 24, 1977), amended by EO 12148 (July 20, 1979)

EO 11988 requires Federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities" for the following actions:

- Acquiring, managing, and disposing of Federal lands and facilities;
- Providing federally undertaken, financed, or assisted construction and improvements;

- Conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing activities.

The EO outlines an eight-step process (summarized below) that Federal agencies should carry out as part of their decision-making on projects that may have potential impacts to or within a floodplain.

1. Determine if a proposed action is in the base floodplain (that area which has a one percent or greater chance of flooding in any given year).

2. Conduct early public review, including public notice.

3. Identify and evaluate practicable alternatives to locating in the base floodplain, including alterative sites outside of the floodplain.

4. Identify impacts of the proposed action.

5. If impacts cannot be avoided, develop measures to minimize the impacts and restore and preserve the floodplain, as appropriate.

6. Reevaluate alternatives.

7. Present the findings and a public explanation.

8. Implement the action.

C.2.8 Executive Order 11990: Wetlands Protection (May 24, 1977), amended by EO 12608 (September 9, 1987)

The purpose of EO 11990 is to "minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands." To meet these objectives, the order requires Federal agencies, in planning their actions, to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided. The order applies to the following Federal actions:

- Acquisition, management, and disposition of Federal lands and facilities;

- Federally undertaken, financed, or assisted construction and improvements;

- Improvement projects which are undertaken, financed, or assisted by Federal agencies;

- Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing activities.

The EO outlines a similar eight-step process as that required in EO 11988 for floodplain management that Federal agencies should carry out as part of their decision-making on projects that may have potential impacts to or within wetlands.

C.2.9 Executive Order 13175 – Consultation and Coordination with Indian Tribal Governments

Pursuant to EO 13175, executive departments and agencies are charged with engaging in consultation and collaboration with Indian tribal governments, strengthening the government-to-government relationship between the United States and Indian tribes, and reducing the imposition of unfunded mandates upon Indian tribes.

The EO applies to the formulation or implementation of rules, policies, and guidance with tribal implications. Agencies shall adhere, to the extent permitted by law, to the following criteria when formulating and implementing policies that have tribal implications:

- Agencies shall respect Indian tribal self-government and sovereignty, honor tribal treaty and other rights, and strive to meet the responsibilities that arise from the unique legal relationship between the Federal Government and Indian tribal governments.

- With respect to Federal statutes and regulations administered by Indian tribal governments, the Federal Government shall grant Indian tribal governments the maximum administrative discretion possible.

- When undertaking to formulate and implement policies that have tribal implications, agencies shall:
  - Encourage Indian tribes to develop their own policies to achieve program objectives;
  - Where possible, defer to Indian tribes to establish standards; and
  - In determining whether to establish Federal standards, consult with tribal officials as to the need for Federal standards and any alternatives that would limit the scope of Federal standards or otherwise preserve the prerogatives and authority of Indian tribes.

C.2.10 Executive Order 13186: Responsibilities of Federal Agencies To Protect Migratory Birds (January 10, 2001)

EO 13186 directs executive departments and Federal agencies to take certain actions to further implement the MBTA. Any executive department or Federal agency taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations is directed to develop and implement a MOU with the USFWS that shall promote the conservation of migratory bird populations.