OCS EIS/EA
BOEM 2016-001

Outer Continental Shelf
Oil and Gas Leasing Program: 2017-2022

Draft Programmatic Environmental Impact Statement

March 2016

Volume I: Chapters 1-6

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COVER SHEET

Programmatic Environmental Impact Statement for Outer Continental Shelf Oil and Gas Leasing Program: 2017-2022

Draft (x) **Final ( )**

Type of Action: Administrative (x) Legislative ( )

Area of Potential Impact: Offshore Marine Environment and Coastal States of Alaska, Virginia, North Carolina, South Carolina, Georgia, Texas, Louisiana, Mississippi, and Alabama

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ABSTRACT

This Programmatic Environmental Impact Statement (EIS) addresses the 2017-2022 Outer Continental Shelf (OCS) Oil and Gas Leasing Program, published as a Draft Proposed Program (DPP) in January 2015 (USDOI, BOEM, 2015).

The Proposed Action is considered to be a major federal action with potential national implications, and the Programmatic EIS will be used to inform decisions on the 2017-2022 oil and gas program proposal. In accordance with the National Environmental Policy Act (NEPA) and its implementing regulations; the Programmatic EIS addresses the purpose of and need for action; identifies alternatives and their screening; describes the affected environment; and analyzes the potential environmental impacts of the Proposed Action, alternatives, and expected and potential mitigation. Potential contributions to cumulative impacts resulting from activities associated with the Proposed Action are also analyzed. Hypothetical scenarios were developed for the Proposed Action to help depict the levels of activities, number and size of accidental events (such as oil spills), and focus analyses of potential impacts that might result.

This Programmatic EIS explores alternatives and discloses potential environmental effects of oil and natural gas leasing, exploration, development, and production in the OCS areas selected in the DPP in addition to analyzing the potential impacts on coastal environments, offshore marine resources, and socioeconomic resources. This Programmatic EIS was prepared using the best scientific information publicly available at the time of preparation. Where relevant information on reasonably foreseeable significant adverse impacts was incomplete or unavailable, the need for the information was evaluated to determine if it was essential to making a reasoned choice among the alternatives and, if so, that it was either acquired or accepted scientific methodologies were applied in its place in the event it was impossible or exorbitant to acquire.

Additional copies of this Programmatic EIS may be obtained from the Bureau of Ocean Energy Management, Attn: Dr. Jill Lewandowski, by telephone at 703-787-1703, or it can be downloaded from the website http://www.boemoceaninfo.com.

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SUMMARY

Section 18 of the Outer Continental Shelf Lands Act (OCSLA) requires the Secretary of the Interior to prepare and maintain a schedule of proposed Outer Continental Shelf (OCS) oil and gas lease sales that "best meet national energy needs for the 5-year period following its approval or reapproval." The Bureau of Ocean Energy Management (BOEM) has decided to prepare a Programmatic Environmental Impact Statement (Programmatic EIS) under the National Environmental Policy Act (NEPA) to address environmental and predictive information requirements required under Section 18 of OCSLA. BOEM's decision to prepare a Programmatic EIS under Council on Environmental Quality (CEQ) regulations implementing NEPA at 40 Code of Federal Regulations (CFR) 1508.28 is discretionary because the United States (U.S.) Court of Appeals for the District of Columbia has ruled that the approval of a Five-Year Program (Program) does not constitute an irreversible and irretrievable commitment of resources and that, in the context of the multiple stage leasing program, the obligation to fully comply with NEPA does not mature until leases are issued. This Draft Programmatic EIS addresses potential environmental impacts that could result if activities occur under leases issued under the proposed schedule of lease sales for 2017-2022.

The Proposed Action

The Proposed Action, or Alternative A, includes a schedule of 14 lease sales in 5 OCS "Program Areas" (**Table ES-1**). All or portions of eight different OCS planning areas make up the five Program Areas and have been identified for leasing consideration as part of the Proposed Action. Alternative A proposes 10 region-wide sales in the Gulf of Mexico Program Area; one sale each in the Chukchi Sea, Beaufort Sea, and Cook Inlet Program Areas offshore Alaska; and one sale in the Atlantic Program Area.

Table ES-1. Proposed 2017-2022 Program Lease Sale Schedule.

Sale Number	Program Area	Year
249	Gulf of Mexico	2017
250	Gulf of Mexico	2018
251	Gulf of Mexico	2018
252	Gulf of Mexico	2019
253	Gulf of Mexico	2019
254	Gulf of Mexico	2020
255	Beaufort Sea	2020
256	Gulf of Mexico	2020
257	Gulf of Mexico	2021
258	Cook Inlet	2021
259	Gulf of Mexico	2021
260	Atlantic (Mid- and South Atlantic)	2021
261	Gulf of Mexico	2022
262	Chukchi Sea	2022

Oil and gas activities may occur on OCS leases only after a lease sale is held pursuant to the Proposed Action, and these activities may extend over a period of 40 to 70 years. These activities may include (1) geophysical surveys; (2) drilling of oil and natural gas exploration and production wells; (3) installation and operation of offshore platforms and pipelines, onshore pipelines, and support facilities; (4) transport of hydrocarbons using tankers or pipelines; and (5) decommissioning activities.

Alternatives

The development of the 2017-2022 Five Year Program and the contents of this Programmatic EIS follow a landscape-scale and mitigation hierarchy approach to look across the entire OCS to identify areas suitable and unsuitable for oil and gas development after considering economic, social, and environmental values of the renewable and nonrenewable OCS resources, and the potential impact of oil and gas exploration on other resource values of the OCS and the marine, coastal, and human environments. This approach is in line with numerous administrative orders and guidance, which are outlined in **Section 1.4.4**.

Specifically, Alternative A (Proposed Action) considers lease sales in a more limited set of program areas than what is allowable under OCSLA. Alternative B (Reduced Proposed Program) analyzes further reductions in the Proposed Action through two complementary approaches that could affect the size or location of leasing: (1) the exclusion of each Program Areas, and (2) the exclusion of or application of programmatic mitigation within Environmentally Important Areas (EIAs) in relevant Program Areas (**Table ES-2**). Alternative C (No Action Alternative) would not schedule any new lease sales during the 2017-2022 period.

EIAs represent regions of important environmental value where there is potential for conflict between ecologically important or sensitive habitats; maintenance of social, cultural, and economic resources; and possible oil and gas development. Specific EIAs that could be geographically defined, were supported by adequate data, and could affect the size or location of potential leasing in each Program Area are identified in **Table ES-2**.

Table ES-2. Summary of Alternative B in the Programmatic EIS. Environmentally Important Areas Analyzed in Beaufort Sea, Chukchi Sea, Cook Inlet, and Atlantic Program Areas under Alternative B.

Beaufort Sea Program Area	Chukchi Sea Program Area	Cook Inlet Program Area	Gulf of Mexico Program Area	Atlantic Program Area
B(1)(a) No new leasing in entire Beaufort Sea Program Area	B(2)(a) No new leasing in entire Chukchi Sea Program Area	B(3)(a) No new leasing in entire Cook Inlet Program Area	B(4)(a) No new leasing in entire Gulf of Mexico Program Area	B(5)(a) No new leasing in entire Atlantic Program Area
B(1)(b) Programmatic mitigation or exclusion of Barrow Canyon, Camden Bay, Cross Island, and Kaktovik	B(2)(b) Programmatic mitigation or exclusion of Hanna Shoal Walrus Foraging Area and Movement Corridor	B(3)(b) Exclusion of designated Cook Inlet beluga whale critical habitat		B(5)(b) Programmatic mitigation or exclusion of Washington and Norfolk Canyons

In addition to the EIAs analyzed as part of Alternative B, the application of additional mitigation was considered separately in context of additional EIAs:

Beaufort Sea: Harrison Bay
Chukchi Sea: Chukchi corridor expansion
Gulf of Mexico: Topographic stipulation blocks
Atlantic: Right whale biologically important area and loggerhead sea turtle overwintering habitat

These EIAs were differentiated from the other areas included in Alternative B because the application of mitigation *would not* directly affect the size or location of potential leasing.

Issues and Concerns

Impact-Producing Factors. It is important to note that establishing a schedule of lease sales has no irreversible and irretrievable effects. With the exception of pre-sale geophysical surveys used to inform lease sale bid decisions, most activities that impact resources would only occur following a lease sale, and then only after approval for exploration and development plans within leased areas. 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 Draft Programmatic EIS are based on assumptions about future activity types and levels.

Chapter 3 presents the range, nature, and timing of activities that could occur in each Program Area. 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.

The impact-producing factors (IPFs) related to OCS activities and evaluated in this Programmatic EIS include the following:

- Noise from geophysical surveys, ship and aircraft traffic, drilling and production operations, trenching, onshore and offshore construction, and explosive platform removals.
- Traffic associated with the movement of ships and aircraft.
- Routine discharges associated with the offshore and onshore disposal of liquid wastes, including ballast water and sanitary and gray wastewater generated by OCS-related activities.
- Drilling, mud cuttings, and debris, 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.
- Bottom/land disturbance from drilling, infrastructure emplacement (e.g., platforms, pipelines, onshore infrastructures), and structure removal.
- Air emissions from offshore and onshore facilities and transportation vessels and aircraft.
- Lighting from onshore and offshore facilities.
- Visible onshore and offshore facilities from shore.
- Space-use conflicts with onshore and offshore facilities, including oil tankers and barges, supply/support vessels and aircraft, and seismic survey vessels and aircraft.
- 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.

Environmental Resources and Conditions. This Draft Programmatic EIS evaluates 17 environmental, sociocultural, or socioeconomic resources and 2 other environmental conditions that could be affected by oil and gas leasing and activities that may occur at later stages. The resources and other environmental conditions evaluated in the Programmatic EIS are highlighted in **Table ES-3**.

Table ES-3. Environmental, sociocultural, or socioeconomic resources and other environmental conditions considered in this Programmatic EIS.

Natural, Social, Cultural, and Economic Resources	
Air Quality	Areas of Special Concern
Water Quality	Archaeological and Historical Resources
Coastal and Estuarine Habitats	Population, Employment, and Income
Marine Benthic Communities	Land Use and Infrastructure
Pelagic Communities	Commercial and Recreational Fisheries
Marine Mammals	Tourism and Recreation
Sea Turtles	Sociocultural Systems
Marine and Coastal Birds	Environmental Justice
Fishes and Essential Fish Habitat	
Other Environmental Conditions	
Acoustic Environment	Climate Change

Sensitive Biological and Ecological Resources and Critical Habitats

The Program 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. The Programmatic EIS focuses on aspects of marine and coastal resources that are unique, ecologically important, or most susceptible to impacts from offshore oil and gas activities. The Programmatic EIS also concentrates on life stages and habitats that may be most sensitive to moderate and major impacts from routine oil and gas activities. The animal groups evaluated include 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. Key sociocultural, socioeconomic, and archeological topics analyzed in this Draft Programmatic EIS include the following:

- 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;
- Sociocultural systems effects, including concerns about the effects on subsistence resources and activities, 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);
- Commercial and recreational fisheries;
- Tourism and recreation; and
- Archaeological resources, including historic shipwrecks and sites inhabited by humans during prehistoric times.

Impacts from Oil Spills. The greatest concern related to oil and gas development under Alternative A and Alternative B 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 type of product spilled (e.g., light crude, diesel, etc.), 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 also could result in short-term disturbance of fauna and human activities in the vicinity of containment cleanup activities.

The Programmatic EIS presents analyses of the effects of varying sizes of oil spills on sensitive resources. BOEM estimates the number of small (<1,000 barrels [bbl]) and large (≥1,000 bbl) oil spills that are expected during the 2017-2022 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.

In all Program Areas, the analyses consider the effects of a catastrophic discharge event, even though the occurrence of such a spill is unexpected. Although unlikely to 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.

Impacts from Routine Activities. The analyses in this Programmatic EIS describe the nature and extent of potential impacts of future oil and gas activities, including direct, indirect, and cumulative impacts that result from routine operations and associated IPFs. Cumulative effects are addressed in the Programmatic EIS but are not summarized here. The analyses assume the implementation of all mitigation and other protective measures currently required by statute, regulation, or BOEM policy and practice.

Under Alternative A and Alternative B, routine operations associated with each of these phases will have similar IPFs 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 Alternative A and Alternative B. The principal difference in potential impacts among those alternatives would be in where those impacts may be incurred as well as the nature of exposure. **Table ES-4** highlights principal differences in impacts between Alternative A and the part of Alternative B that considers EIAs. In many cases, potential impacts are expressed as a range, such as "minor to moderate." Where the analysis determines that a range of impacts are possible, **Table ES-4** shows only the highest impact level for that resource.

Table ES-4. Comparison of Impacts of Action Alternatives. Major Impacts are Possible from Oil Spills for All Program Areas and Action Alternatives and Thus are not Included.

	Beaufort Program Area		Chukchi Program Area		Cook Inlet Program Area		Gulf of Mexico Program Area	Atlantic Program Area	
Resource	A	B(1)(b)	A	B(2)(b)	A	B(3)(b)	A	A	B(5)(b)
Air Quality	Minor	Minor	Minor	Minor	Negligible	Negligible	Moderate	Negligible	Negligible
Water Quality	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor
Coastal and Estuarine Habitats	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor
Marine Benthic Communities	Moderate	Minor	Moderate	Minor	Moderate	Moderate	Moderate	Moderate	Moderate
Pelagic Communities	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Marine Mammals	Moderate	Negligible	Moderate	Negligible	Moderate	Negligible	Moderate	Moderate	Minor
Sea Turtles	--	--	--	--	--	--	Moderate	Moderate	Minor
Marine and Coastal Birds	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor
Fishes and EFH	Minor	Minor	Minor	Minor	Negligible	Negligible	Minor	Negligible	Negligible
Archaeological and Historical	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor
Population, Employment, and Income	Moderate	Moderate	Moderate	Moderate	Minor	Minor	Minor	Minor	Minor
Land Use and Infrastructure	Minor	Minor	Moderate	Minor	Negligible	Negligible	Negligible	Moderate	Moderate
Fisheries	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor
Tourism and Recreation	Moderate	Moderate	Moderate	Moderate	Minor	Minor	Minor	Minor	Minor
Sociocultural Systems	Major	Negligible	Major	Negligible	Minor	Minor	Negligible	Negligible	Negligible
Environmental Justice	Major	Minor	Major	Minor	Minor	Minor	Minor	Minor	Minor

Negligible; Minor; Moderate; Major; -- = resource not found in Program Area.

Alternative B also considers the exclusion of one of the five Program Areas included in the Proposed Action (B(1)(a) – Beaufort Sea, B(2)(a) – Chukchi Sea, B(3)(a) – Cook Inlet, B(4)(a) – Gulf of Mexico, and B(5)(a) – Atlantic); thus, most resources in an excluded Program Area would not be expected to be affected by routine operations occurring in other Program Areas. Similarly, positive socioeconomic effects would not occur under the no new leasing options of Alternative B. Varying environmental effects related to substitution energy sources would instead occur under these options of Alternative B proportional to the amount of energy needed to meet demand. In this regard, the No Action Alternative and Alternative B options are proportional.

Because routine operations include some IPFs (such as seismic survey noise and support vessel traffic) that may extend beyond planning area boundaries, resources in an excluded Program Area may be affected by some of the routine operations associated with development in adjacent area. Similarly, accidental oil spills may be transported from the Program Area in which the spill occurs to adjacent Program Areas, affecting resources in those other areas.

The evaluation of a No Action Alternative (Alternative C) is required by the CEQ regulations implementing NEPA (40 CFR 1502.14(d)). If the Secretary of the Interior were to adopt this alternative, it would result in no new OCS leasing from 2017 to 2012, even in the Gulf of Mexico Program Area. 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. The amount of OCS oil and natural gas 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. The eventual selection of Alternative C would be a major departure from past Program decisions, but it must remain a possibility.

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 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 renewable 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).

Examples of environmental impacts that could result from the development and transportation of energy substitutions include the following:

- Harm to habitat and wildlife from oil spills that may occur during oil tankering or from nuclear accidents;
- Habitat destruction or deterioration of habitat quality from onshore energy exploration and development activities, coal mining, and/or processing and storage of industry wastes;
- Groundwater contamination or air quality deterioration from onshore oil and gas development and coal mining; and
- Habitat and wildlife disturbance from onshore oil and gas, hydropower, or onshore and offshore renewable energy.

Conclusions

This Programmatic EIS is consistent with the requirements of the OCSLA, NEPA, and CEQ regulations implementing NEPA (40 CFR part 1500). On the basis of the analyses in this Programmatic EIS, the types of impacts that could occur during routine Program activities would be similar in Alternative A and Alternative B; however, the impacts would be less under Alternative B in individual planning areas with no leasing. In addition, under Alternative B, EIAs would be protected and would result in less impacts than under Alternative A. The alternatives differ principally on the basis of where the impacts could occur and to what extent, which is directly related to the Program Areas, exclusions, or mitigations ultimately selected.

Routine operations are expected to result in impacts that range from negligible to major, with most being short-term and recovering after completion of the routine activities. Accidental spills also may 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 catastrophic discharge event, 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.

BOEM's process for implementing a Five-Year Program through the various OCSLA stages represents an opportunity for adaptive management and more detailed treatment of long-standing and developing concerns. The Secretary of the Interior's decision to address size, timing, and location of potential lease sales is the initial step in a multi-year deliberative process; the actual Program is materialized through numerous subsequent decisions on lease sales, geological and geophysical permits, exploration and development plans, and, ultimately, decommissioning.

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LIST OF ACRONYMS

2D	two-demensional
3D	three-dimensional
Ac	acre
ACHP	Advisory Council on Historic Preservation
ACP	Alaska Coastal Plain
ACS	American Community Survey
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADFG	Alaska Department of Fish and Game
ADLWD	Alaska Department of Labor and Workforce Development
ADNR	Alaska Department of Natural Resources
AFB	Air Force Base
AFPM	American Fuel and Petrochemical Manufacturers
AHTS	anchor handling towing supply
AMAP	Arctic Monitoring Assessment Program
AMOC	Atlantic Meridional Overturning Circulation
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Land Conservation Act
ASAMM	Aerial Surveys of Arctic Marine Mammals
ASD	Alaska School District
ASFPM	Association of State Floodplain Managers
BA	Biological Assessment
bbl	barrels of oil
Bbbl	billion barrels of oil
bcf	billion cubic feet
BCRs	bird conservation regions
BIA	Biologically Important Area
BLM	Bureau of Land Management
BO	Biological Opinion
BOE	barrel of oil equivalent
BOEM	Bureau of Ocean Energy Management
BOEM OPA	BOEM's Office of Public Affairs
BOEMRE	Bureau of Ocean Energy, Management, Regulation and Enforcement
BOP	blowout preventer
Bpd	barrels per day
BSEE	Bureau of Safety and Environmental Enforcement
CAA	Clean Air Act
CATEX	categorical exclusion
CDE	catastrophic discharge event
CEI	Coastal Environments, Inc.
CEQ	Council on Environmental Quality
CETAP	Cetacean and Turtle Assessment Program
CFR	Code of Federal Regulations
CH4	methane

LIST OF ACRONYMS
(Continued)

CHSRA	Cape Hatteras Special Research Area
CI	confidence interval
CMSP	Coastal and Marine Spatial Planning
CO	carbon monoxide
CO_2	carbon dioxide
CO2e	carbon dioxide equivalent
COST	continental offshore strategic test
CPRA	Coastal Protection and Restoration Authority
CV	coefficient variation
CW	continuous wave
CWA	Clean Water Act
CZ	Convergence Zone
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
DECC	Department of Energy and Climate Change
DNR	Department of Natural Resources
DP	dynamic positioning
DPP	Draft Proposed Program
DPS	Distinct Population Segment
E	endangered
E&D	Exploration and development
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
Eh	oxidation reduction potential
EIA	Environmentally Important Area
EIS	Environmental Impact Statement
EO	Executive Order
EP	Exploration Plan
EPAct	Energy Policy Act of 2005
ESA	Endangered Species Act
ESI	Environmental Sensitivity Index
FAA	Federal Aviation Administration
FCMA	Magnuson-Stevens Fishery Conservation and Management Act
FDEP	Florida Department of Environmental Protection
FKNMS	Florida Keys National Marine Sanctuary
FMC	Fisheries Management Council
FMP	Fisheries Management Plan
FONSI	Finding of No Significant Impact
FPSO	floating production, storage, and offloading
ft	feet

LIST OF ACRONYMS
(Continued)

FWC	Florida Fish and Wildlife Conservations Commission
FWCA	Fish and Wildlife Coordination Act
FWPCA	Federal Water Pollution Control Act
GAO	General Accounting Office
G&G	geological and geophysical
GDP	Gross Domestic Product
GHG	greenhouse gas
GIS	Geographic Information System
GMFMC	Gulf of Mexico Fishery Management Council
GNOR	Greater New Orleans Region
GOA	Gulf of Alaska
GOADS	Gulfwide Offshore Activity Data System
GRT	gross register tonnage
GSFC	Goddard Space Flight Center
HAPC	Habitat Areas of Particular Concern
HCA	Habitat Conservation Area
Hertz	Hz
HFCs	hydrofluorocarbons
HMS	Highly Migratory Species
HPA	Habitat Protection Area
HSSE	health, safety, security, and environment
HSWUA	Hanna Shoal Walrus Use Area
IBA	Important Bird Area
IHA	incidental harassment authorization
IPCC	International Panel on Climate Change
IPF	impact-producing factor
ITL	Information to Lessees
ITS	incidental take statement
JBER	Joint Base Elmendorf-Richardson
kn	knot
KPB	Kenai Peninsula Borough
lbs	pound
LCI	Lower Cook Inlet
LME	large marine ecosystems
LNG	liquefied natural gas
LOA	letters of authorization
LOOP	Louisiana Offshore Oil Port
LRRS	Long-Range Radar Sites

LIST OF ACRONYMS
(Continued)

MAB	Mid-Atlantic Bight
MAFMC	Mid-Atlantic Fisheries Management Council
MARPOL	International Convention of the Prevention of Pollution from Ships
MARS	Mid-Atlantic Regional Spaceport
Mat-Su	Matanuska-Susitna
MBAC	Microbiome Analysis Center
MBTA	Migratory Bird Treaty Act
MCBI	Marine Conservation Biology Institute
mcf	million cubic feet
MESA	most environmentally significant area
μPa	micropascals
μs	microseconds
MMbl	million barrels of oil
MMBOE	million barrels of oil equivalent
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MoA	Municipality of Anchorage
MODUs	mobile offshore drilling units
MOU	Memorandum of Understanding
MPA	Marine Protected Areas
MPPRCA	Marine Plastic Pollution Research and Control Act
MPRSA	Marine Protection, Research, and Sanctuaries Act
MRIP	Marine Recreational Information Program
ms	milliseconds
MUA	Municipal Utility Authority
N_20	nitrous oxide
NAA	No Action Alternative
NAAQS	National Ambient Air Quality Standards
NABCI	North American Bird Conservation Initiative
NARW	North Atlantic right whale
NASA	National Aeronautics and Space Administration
NASA	National Aeronautics and Space Administration
NAST	National Assessment Synthesis Team
NCA	National Coastal Assessment
NCDOT	North Carolina Department of Transportation
NEFMC	New England Fishery Management Council
NEP	National Estuary Program
NEPA	National Environmental Policy Act
NERR	National Estuarine Research Reserves
NEV	net economic value
NGO	non-government organization
NHPA	National Historic Preservation Act

LIST OF ACRONYMS
(Continued)

NIC	National Incident Command
NIT	Norfolk International Terminals
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NMSA	National Marine Sanctuary Act
NO_2	nitrous dioxide
NO_x	nitrogen oxides
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NORM	naturally occurring radioactive material
NOS	National Ocean Service
NPDES	National Pollution Elimination System
NPFMC	North Pacific Fisheries Management Council
NPP	National Park and Preserve
NPR-A	National Petroleum Reserve - Alaska
NPS	National Park Service
NRC	National Research Council
NRDC	National Resources Defense Council
NSB	North Slope Borough
NSIDC	National Snow and Ice Data Center
NTEL	National Energy Technology Laboratory
NTL	Notice to Lessee and Operators
NWAB	Northwest Arctic Borough
NWP	Nationwide Permit
NWR	National Wildlife Refuge
O_3	ozone
OCD	Offshore and Coast Dispersion
OCM	Office for Coastal Management
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
ODMDS	offshore dredged material disposal site
OECM	Offshore Environmental Cost Model
ONMS	Office of National Marine Sanctuaries
OPA	Oil Pollution Act
OPAREAs	Operating Areas
ORPC	Ocean Renewable Power Company
ORR	Office of Resource Restoration
OSAT	Operational Science Advisory Team
OSFR	oil-spill financial responsibility
OSPAR Convention	Convention for the Protection of the Marine Environment of the North-East Atlantic

LIST OF ACRONYMS
(Continued)

OSV	offshore support vessel
P	pressure
PAHs	polycyclic aromatic hydrocarbons
Pb	lead
PCBs	polychlorinated biphenyls
PE	Parabolic Equation
PFCs	perfluorocarbons
pH	potential of hydrogen
PINS	Padre Island National Seashore
PM	particulate matter
PM_{10}	course particulate matter
$PM_{2.5}$	fine particulate matter
PP	Proposed Program
Programmatic EIS	Programmatic Environmental Impact Statement
PSD	Prevention of Significant Deterioration
PSOs	Protected Species Observers
PTS	Permanent threshold shift
RCRA	Resource Conservation and Recovery Act
RD	Regional Director
RHA	Rivers and Harbors Act
RMS	root-mean-squared
s	seconds
SAB	South Atlantic Bight
SAFMC	South Atlantic Fishery Management Council
SBM	synthetic-based muds
SCDNR	South Carolina Department of Natural Resources
SEL	sound exposure level
SFA	Sustainable Fisheries Act
SI	International System of Units
SLR	sea level rise
SO_2	sulfur dioxide
SO_x	sulfur oxides
SPL	Sound Pressure Level
SST	sea surface temperature
SVP	sound velocity profiles
T	threatened
TAPS	Trans-Alaska Pipeline System
TATEC	Turnagain Arm Tidal Energy Corporation
tcf	trillion cubic feet
TL	transmission loss

LIST OF ACRONYMS
(Continued)

TLP	Tension leg platform
TOC	total organic carbon
TTS	Temporary threshold shift
UME	unusual mortality event
UCI	Upper Cook Inlet
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDOC	U.S. Department of Commerce
USDOD	U.S. Department of Defense
USDOI	U.S. Department of the Interior
USDOT, FAA	U.S. Department of Transportation, Federal Aviation Administration
USEIA	U.S. Energy Information Administration
USEPA	U.S. Environmental Protection Agency
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VACAPES	Virginia Capes
VOCs	volatile organic compounds
VPA	Virginia Port Authority
WBM	water-based muds
WEA	wind energy area
WEA	wind energy area
WFF	Wallops Flight Facility
WHSRN	Western Hemisphere Shorebird Reserve Network

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1. INTRODUCTION

1.1. BACKGROUND

Federal management of oil and gas resources on the continental shelf of the United States (U.S.) is governed by the Outer Continental Shelf Lands Act (OCSLA) (43 United States Code [U.S.C.] 1331 *et seq*.). OCSLA addresses federal regulation of leasing, exploration, development, and production of oil and gas on the Outer Continental Shelf (OCS). The OCS is defined to include all submerged lands lying seaward of state coastal waters and subject to U.S. jurisdiction and control.

Section 18 of OCSLA (43 U.S.C. 1344) requires the Secretary of the Interior to prepare, periodically revise, and maintain an OCS oil and gas leasing program. The Bureau of Ocean Energy Management (BOEM) within the U.S. Department of the Interior (USDOI) is responsible for implementing the requirements of OCSLA for the program. The program is to consist of a schedule of proposed lease sales that the Secretary of the Interior determines will best meet national energy needs for the five-year period following approval of the program. The program must address, as precisely as possible, the size, timing, and location of leasing activity.

Section 18 (a) of OCSLA requires the program to be prepared and maintained in a manner consistent with enumerated principles, one of which includes consideration of environmental impacts and protection. Specifically, management of the OCS is to be conducted in a manner that considers environmental values and the potential impact of activities on the marine, coastal, and human environment. Development of the program must consider ecological characteristics, equitable sharing of environmental risks, the location of oil- and gas-bearing regions in relation to other uses of the sea and seafloor (such as fisheries), relative environmental sensitivity and marine productivity of different areas, relevant environmental information, and the potential for adverse impact on the coastal zone.

BOEM is currently developing the program for the years 2017 to 2022 (hereinafter the "Program"). As a vehicle for conducting and disclosing its environmental analyses for the Program, BOEM has decided, in its discretion, to prepare a Programmatic Environmental Impact Statement (Programmatic EIS) under the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 *et seq*.) and its implementing regulations. BOEM's decision to prepare the Programmatic EIS is discretionary because the U.S. Court of Appeals for the District of Columbia has ruled that the approval of a program does not constitute an irreversible and irretrievable commitment of resources and that, in the context of the multiple stage leasing program, the obligation to fully comply with NEPA does not mature until leases are issued (*Center for Biological Diversity* v. *Department of the Interior*, 385 563 F.3d 466 (D.C. Cir. 2009*); Center for Sustainable Economy v. Jewell*, 779 F.3d 588 [D.C. Cir. 2015]). Because approval of the Program will not cause an irretrievable and irreversible commitment of resources, BOEM has chosen to analyze in the Programmatic EIS potential environmental impacts that could result if exploration and development activities occur under leases issued under the proposed schedule of lease sales for 2017 to 2022 (hereinafter, for impact analyses purposes, the "Proposed Action" defined as Alternative A in **Table 2.2-1** in **Chapter 2**). BOEM may opt to tier from, or incorporate by reference, the analysis within this Programmatic EIS at later stages of the leasing process.

The Proposed Action is a schedule of 14 possible lease sales in 5 OCS "Program Areas." This schedule of lease sales was first announced in the 2017-2022 Draft Proposed Program (DPP) published on January 29, 2015 and has since been analyzed in the Proposed Program (PP) published in February/March 2016. The Programmatic EIS also evaluates two additional alternatives to the Proposed Action that could avoid or minimize potential environmental impacts. Alternative B (Reduced Proposed Program) analyzes reductions in leasing from the Proposed Action through two approaches: (1) the exclusion of certain Program Areas and (2) the exclusion or programmatic mitigation of "Environmentally Important Areas" (EIAs) within these Program Areas that may affect the size or location of leasing. Alternative C (No Action Alternative) would not schedule any new lease sales during the Program. The foregoing represents a reasonable range of alternatives.

1.2. Purpose and Need

The purpose of the Proposed Action is to implement the requirements of Section 18 of OCSLA for the Secretary of the Interior to schedule size, timing, and location of the 2017-2022 proposed OCS oil and gas lease sales that will best meet national energy needs while balancing environmental and coastal zone protection with potential oil and gas development.

According to the President's *The All-of-the-Above Energy Strategy as a Path to Sustainable Economic Growth* (Executive Office of the President, 2014), oil and natural gas supplies are integral to meeting national energy demand. The need is demonstrated in **Figure 1.2-1**. Offshore oil and gas production represents approximately 11 percent of the total national oil and gas production. Domestic oil and natural gas supplies contribute to meeting domestic demand and enhance national economic security. The development of an OCS oil and gas lease sale schedule for 2017-2022 will facilitate domestic oil and gas production to meet this need.

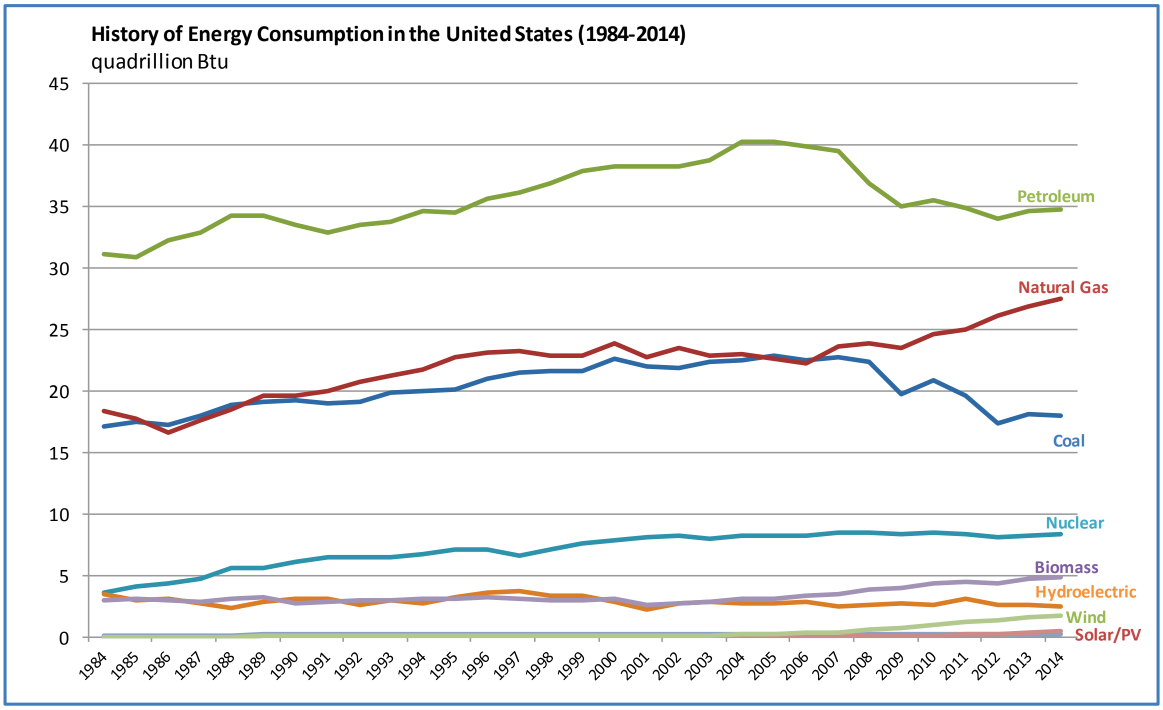

Figure 1.2-1. Energy Use in the United States by Type (Data from: U.S. Energy Information Administration [USEIA], 2015).

1.3. Key Agency Responsibilities

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 regulations related to offshore oil and gas operations are promulgated in 30 Code of Federal Regulations (CFR) parts 550, 551, 552, and 556.

The Bureau of Safety and Environmental Enforcement (BSEE), a separate bureau within the USDOI, is responsible for the 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 regulations related to offshore oil and gas operations are promulgated in 30 CFR parts 250 and 254.

The OCSLA leasing and development process for oil and gas consists of four major stages (**Figure 1.3-1**). The first stage, the subject of the Programmatic EIS, involves the development of a five-year Program that establishes a schedule of lease sales. Oil and gas development and production may occur for 40 to 70 years after the related Program is actually approved. The second stage involves the decision whether to hold individual lease sales included in the Program as well as the terms and areas that may be included in the sale. During the third stage, lessees must submit an Exploration Plan (EP) to BOEM for approval before an operator may begin exploratory drilling. 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. In the fourth stage, and if the lessee discovers and wants to develop economically recoverable oil or gas, a Development and Production Plan must be submitted for approval that describes the number of wells, well locations, type of structure that will be used, how the operator will transport the oil and natural gas, and an analysis of potential offshore and onshore impacts. Environmental reviews are done at each of these four stages so that subsequent decisions can consider information not previously available and address site-specific actions in more detail. This includes evaluations under NEPA and coordination with other regulatory requirements, such as the Coastal Zone Management Act (CZMA), Endangered Species Act (ESA), National Historic Preservation Act (NHPA), and Marine Mammal Protection Act (MMPA). In addition to the above, operators must obtain from BSEE a permit to drill individual wells pursuant to a BOEM-approved plan.

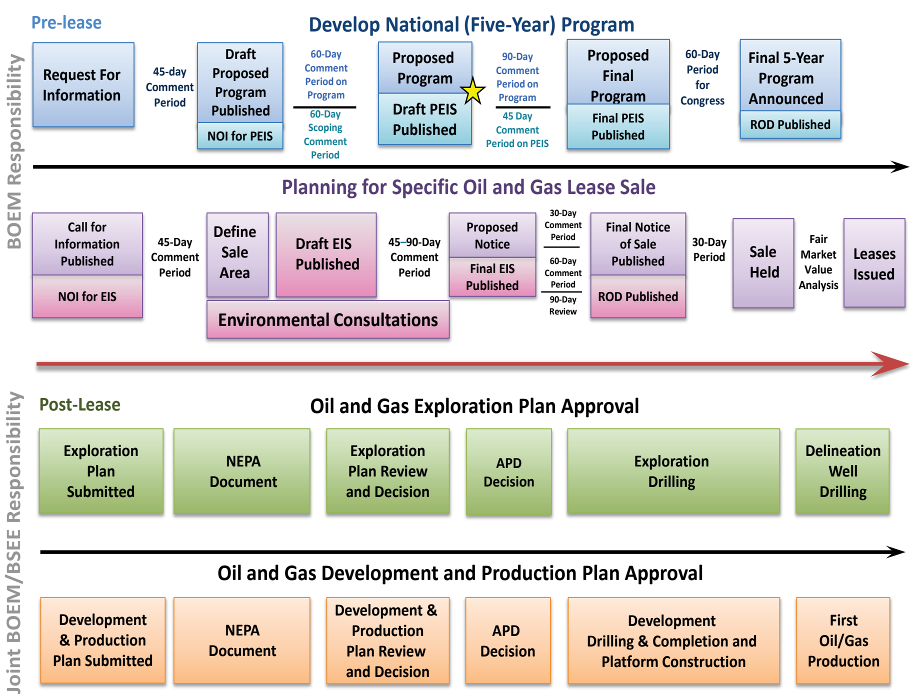

Figure 1.3-1. BOEM's OCS Oil and Gas Leasing, Exploration, and Development Process.

1.4. SCOPE AND PARAMETERS OF THE PROGRAMMATIC EIS

Twenty-six OCS Planning Areas are defined and managed by BOEM offshore the lower 48 states and Alaska. All or portions of eight OCS Planning Areas have been identified for leasing consideration as part of the Proposed Action and are evaluated in the Programmatic EIS. These eight OCS Planning Areas have also been grouped into five "Program Areas": Beaufort Sea, Chukchi Sea, Cook Inlet, Gulf of Mexico, and Atlantic (**Figures 2.1-1**, **2.1-2**, and **2.1-3**).

The Programmatic EIS focuses on potential impacts that could result in moderate to major adverse effects from new lease sales or through activities that would occur from these sales (e.g., exploration, production, decommissioning). Lower level impacts (negligible to minor) were also considered and are described in **Appendix D**.

There are three alternatives that represent a reasonable range of alternatives. These include Alternative A (Proposed Action), Alternative B (Reduced Proposed Action), and Alternative C (No Action Alternative).

The analyses in the Programmatic EIS focus on national and regional scales (versus impacts of individual lease sales or project-specific actions). Programmatic-level analyses and decisions on oil and gas leasing activities are inherently more general than lease sale decisions and the even more specific decisions on project plans. The Programmatic EIS and the staged OCSLA process described in **Figure 1.3-1** are based on the premise that more specific environmental information and review will be considered at later decision stages. The level and detail appropriate for the Programmatic EIS is that necessary to allow the Secretary of the Interior to make an informed decision on the programmatic alternatives and mitigations identified for the 2017-2022 Program.

1.4.1. Public Involvement in Determining the Scope of the Programmatic EIS

On January 29, 2015, BOEM issued a Notice of Intent (NOI) to prepare a Programmatic EIS for the 2017-2022 OCS Oil and Gas Leasing Program and requested comments for determining the scope of the Programmatic EIS. On the same date, BOEM issued a Notice of Availability (NOA) for the DPP. The NOI for the Programmatic EIS also announced that scoping meetings would be held during February and March 2015 in coastal state communities bordering the Mid- and South Atlantic and Western and Central Gulf of Mexico Planning Areas as well as in Alaska. An additional notice on March 6, 2015 announced that three more scoping meetings would be held during March 2015 in coastal states bordering the Mid- and South Atlantic Planning Areas. After the meetings were completed, comments were analyzed for possible impacting factors, affected resources, and alternatives and mitigation ideas to help focus analyses and develop alternatives. Relevant scoping comments were used in the development of this Programmatic EIS, including but not limited to the alternatives and resources carried forward for analysis. Scoping comments were summarized in a scoping report made available on June 9, 2015 and posted online at boemoceaninfo.com.

1.4.2. Impact-Producing Factors

An impact-producing factor (IPF) represents an activity or process that causes impacts to the environmental or socioeconomic setting. Different types of IPFs have been identified for consideration across the resource categories evaluated in this Programmatic EIS. These IPFs also are evaluated for later phases in the oil and gas process, including exploration, development, production, operation, and decommissioning. The following IPFs are further discussed in **Chapter 3**.

- Noise from geophysical surveys, ship and aircraft traffic, drilling and production operations, trenching, onshore and offshore construction, and explosive platform removals.
- Traffic associated with the movement of ships and aircraft.
- Routine discharges associated with the offshore and onshore disposal of liquid wastes, including ballast water and sanitary and gray wastewater generated by OCS-related activities.

- Drilling, mud cuttings, and debris, 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.
- Bottom/land disturbance from drilling, infrastructure emplacement (e.g., platforms, pipelines, onshore infrastructures), and structure removal.
- Air emissions from offshore and onshore facilities and transportation vessels and aircraft.
- Lighting from onshore and offshore facilities.
- Visible onshore and offshore facilities from shore.
- Space-use conflicts with onshore and offshore facilities, including oil tankers and barges, supply/support vessels and aircraft, and seismic survey vessels and aircraft.
- 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.

1.4.3. Potentially Affected Resources and Environmental Conditions

The Programmatic EIS evaluates 17 resources and 2 other environmental conditions that could be affected by oil and gas leasing and activities that may occur at later stages in the oil and gas development process. The resources evaluated include natural resources (physical and biological) as well as social, cultural, and economic resources. The resources and other environmental conditions evaluated in the Programmatic EIS are provided in **Figure 1.4.3-1**.

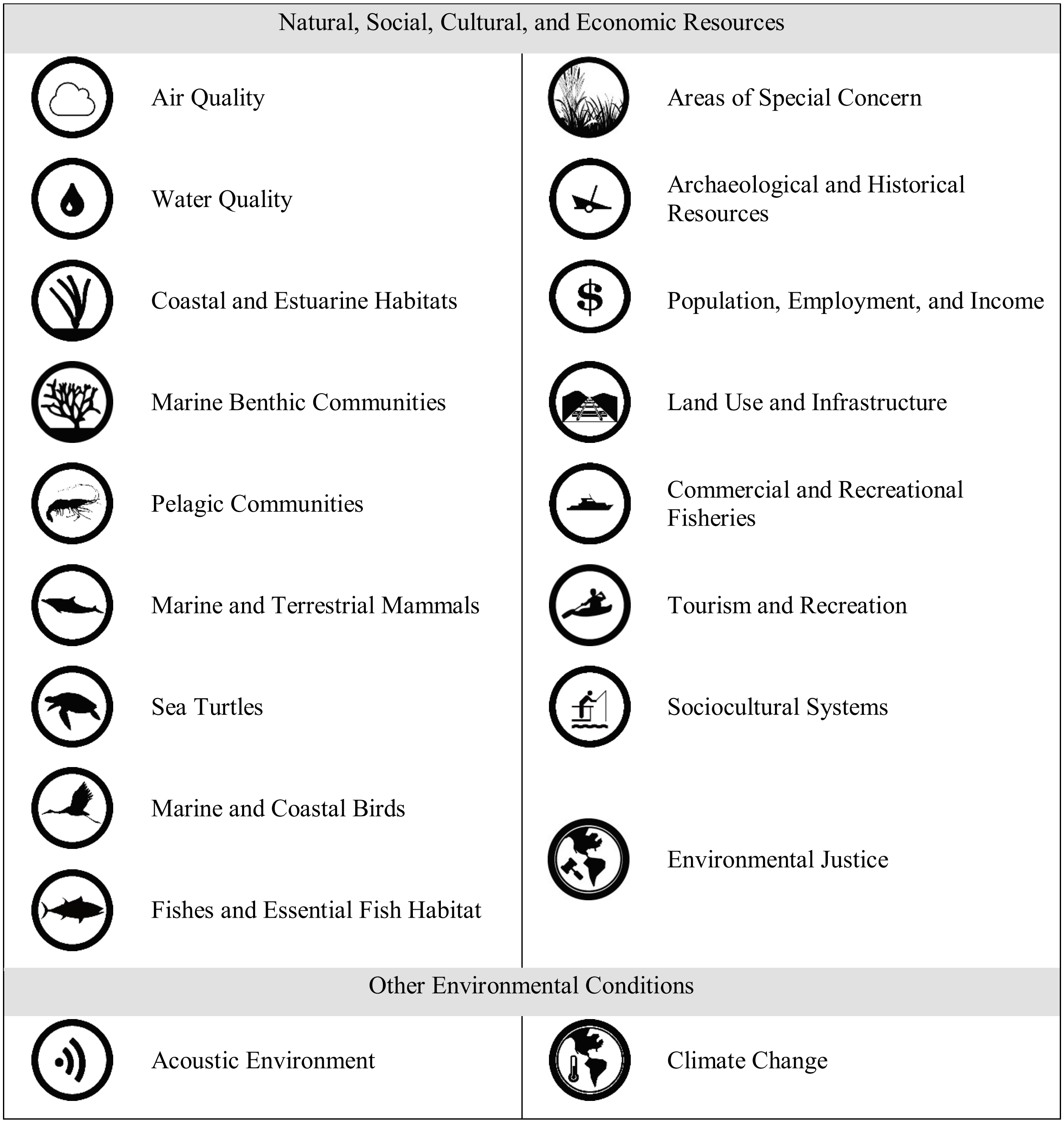

Figure 1.4.3-1. Resources and Other Environmental Conditions Evaluated in the Programmatic EIS.

1.4.4. Landscape-scale Approach and Mitigation Hierarchy

On October 31, 2013, the Secretary of the Interior issued Secretarial Order No. 3330, entitled *Improving Mitigation Policies and Practices of the Department of the Interior* (the "Secretarial Order"). The Secretarial Order states:

> [T]he Department seeks to avoid potential environmental impacts from projects through steps such as advanced landscape-level planning that identifies areas suitable for development because of low or relatively low natural and cultural

> resource conflicts. Where impacts cannot be avoided altogether, the Department must work to ensure that projects minimize impacts to the extent practicable. Finally, for impacts that cannot be avoided or effectively minimized, the Department should seek ways to offset or compensate for those impacts to ensure the continued resilience and viability of our natural resources over time.

As contemplated by the Secretarial Order, the USDOI issued a report in April 2014 entitled *Strategy for Improving the Mitigation Policies and Practices of the Department of the Interior: A Report to the Secretary of the Interior from the Energy and Climate Change Task Force* (the "Report"). Both Order No. 3330 and the Report call for a department-wide mitigation strategy that focuses on using a landscape-scale approach, employing the full mitigation hierarchy of avoidance, minimization, and compensation to protect resources potentially impacted by activities engaged in under the USDOI's auspices.

On November 3, 2015, fully consistent with and supportive of the USDOI's mitigation strategy, the President issued a memorandum (*Mitigating Impacts on Natural Resources from Development and Encouraging Related Private Investment*) directing federal agencies responsible for public resources – including the USDOI – to apply the mitigation hierarchy at scales appropriate for the country's wide-ranging natural and cultural resources, and, at a minimum, to set a no net loss goal when permitting impacts to key resources we are entrusted to protect. This Presidential memorandum emphasizes the importance of protecting the environment while also providing efficient federal permitting to American businesses and communities.

On the same day that the President issued his memorandum on mitigation, the USDOI issued a new Departmental Policy (Department Manual Release, Landscape-Scale Mitigation Policy [600 DM 6]) that provides goals and guidance for implementing landscape-scale mitigation associated with the management of resources under the jurisdiction of the USDOI. The Department's Mitigation Policy, which stems from the Secretarial Order and is fully in line with the President's Mitigation Memorandum, reaffirms the USDOI's authority and commitment to use landscape-level planning to implement the full hierarchy of mitigation, including compensatory mitigation when needed.

The planning process envisioned by Congress in OCSLA pairs well with the USDOI's landscape-scale mitigation policy. OCSLA provides for a four-stage process to lease and develop offshore resources that is pyramidal in structure, proceeding from broad-based, landscape-level planning to an increasingly narrower focus as actual development grows more imminent. Moreover, the statute requires the Secretary of the Interior, in preparing the Five-Year Oil and Gas Leasing Program (the "Five-Year Program"), to consider "economic, social, and environmental values of the renewable and nonrenewable resources contained in the outer Continental Shelf, and the potential impact of oil and gas exploration on other resource values of the outer Continental Shelf and the marine, coastal, and human environments" (43 U.S.C. §1344(a)(1)). Thus, OCSLA envisions a landscape-level planning process that takes into account environmental, social, and economic values and allows for the employment of the full hierarchy of mitigation as the process proceeds from development of the Five-Year Program to leasing and ultimately exploration and development. Taking into account, at the programmatic level, the value of OCS resources and impacts that could result from oil and gas activities on the OCS enables the Secretary of the Interior to use a landscape-level analysis to determine areas most suitable for development. This landscape-level analysis also allows the Secretary of the Interior to consider future impacts to valuable resources that could result from the exploration and development of an area.

The development of the 2017-2022 DPP followed this approach and looked across the entire OCS to identify areas suitable and not suitable for oil and gas development after considering economic, social, and environmental values of the renewable and nonrenewable OCS resources, and the potential impact of oil and gas exploration on other resource values of the OCS and the marine, coastal, and human environments. Particularly emphasizing avoidance and minimization of impacts at the early stage of the process and those areas with negligible hydrocarbon resources or industry interest at this time, the DPP eliminated numerous Planning Areas from potential leasing and minimized effects to certain areas through the Secretary of the Interior's size, timing, and location decisions. **Section 1.4.5** of this Programmatic EIS summarizes additional EIAs and identifies how and where they are discussed throughout the document. This information is provided to allow the public and the Secretary of the Interior to consider whether any of these EIAs should be programmatically mitigated or excluded in the Proposed Final 2017-2022 Program.

Following the approval of the 2017-2022 Program, BOEM will consider and, where appropriate, employ additional mitigation (including the full hierarchy of avoidance, minimization, and compensation) in the later stages of the oil and gas development process under OCSLA.

Appropriately scaled analyses at these later decisions for leasing, exploration, development, and production can best identify specific mitigation measures, including required compensatory mitigation measures. At all decision stages, coordination with state and tribal governments as well as other federal agencies will help inform appropriate mitigation, including avoidance, minimization, and needed compensatory mitigation.

Development and implementation of the 2017-2022 Program using this approach allows for the application of a landscape-scale strategy to oil and gas activities on the OCS that promotes the USDOI's Mitigation Policy and the President's Mitigation Memorandum. This approach also allows BOEM to integrate the mitigation hierarchy into the entire leasing process (i.e., from the Five-Year Program stage, to the lease sale stage, to the development and production stage). The 2017-2022 Program's landscape-scale approach and OCSLA's integration of the use of the full mitigation hierarchy allows for the identification of the best combination of mitigation measures – including compensatory mitigation – to avoid, minimize, and compensate for potential impacts to resources throughout the entire leasing process. Such an approach considers reasonably foreseeable impacts and applies the mitigation hierarchy in the context of the needs, conditions, and trends of resources, at all relevant scales.

1.4.5. Treatment of Identified Environmentally Important Areas

As discussed in **Section 1.4.4**, the identification of landscape-scale strategies allows for a regionally tailored framework that identifies broad objectives, commitments, and mechanisms to avoid, minimize, or compensate for environmental impacts. Mitigation is defined within this Programmatic EIS as measures to limit impacts in areas where lease activity may occur as well as the exclusion of areas from leasing activity (per the Council on Environmental Quality [CEQ] NEPA regulations [40 CFR 1508.20]).

In the spirit of this Secretarial Order No. 3330, and to achieve a reasonable range of alternatives under NEPA, this Programmatic EIS considers programmatic mitigation or exclusion of EIAs. EIAs were identified by BOEM during scoping and represent regions of important environmental value where there is potential for conflict between ecologically important or sensitive habitats; maintenance of social, cultural, and economic resources; and possible oil and gas development. After EIAs were identified, BOEM analyzed and grouped them into the following categories. **Figure 1.4.5-1** shows the process for categorization of these EIAs. Each category also indicates where and how these specific EIAs are further discussed within this Programmatic EIS.

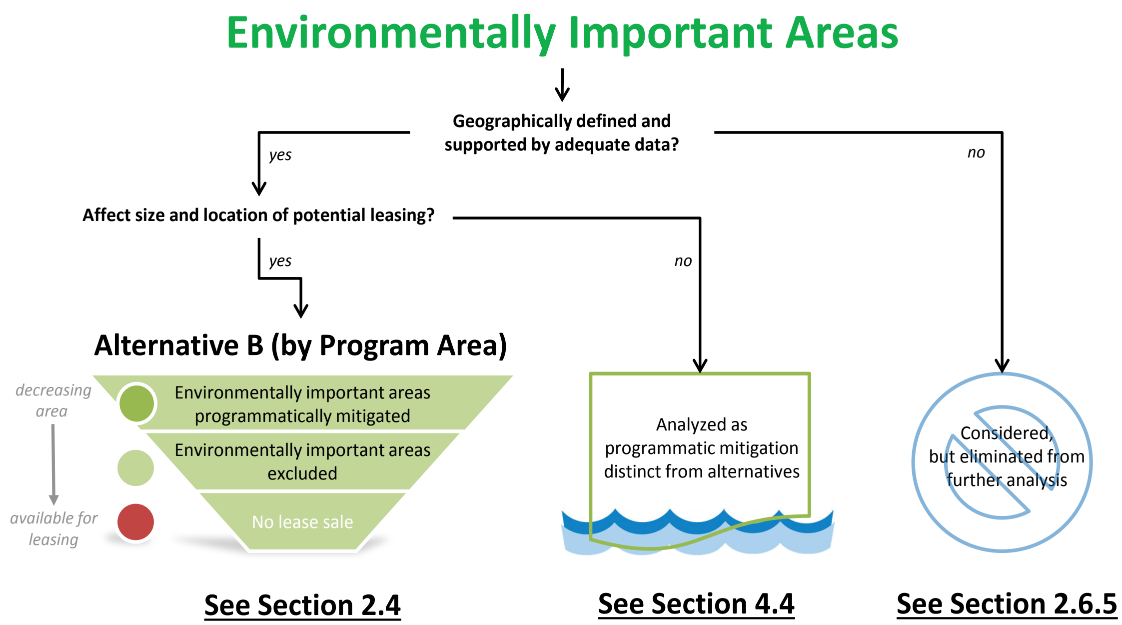

Figure 1.4.5-1. Process of Categorizing Environmentally Important Areas Identified During Scoping.

(1) **Analyzed as programmatic mitigations or exclusions under Alternative B (Section 2.4)**: EIAs that could be geographically defined, were supported by adequate data, *and* could affect the size or location of potential leasing.

Beaufort Sea:	Barrow Canyon, Camden Bay, Cross Island, and Kaktovik
Chukchi Sea:	Hanna Shoal Walrus Foraging Area and Movement Corridor
Cook Inlet:	Beluga Whale Critical Habitat
Atlantic:	Norfolk and Washington Canyons

(2) **Analyzed as programmatic mitigations separate from any alternative (Section 4.4)**: EIAs that could be geographically defined, were supported by adequate data, but *would not* affect the size or location of potential leasing.

Beaufort Sea:	Harrison Bay
Chukchi Sea:	Chukchi corridor expansion and Ledyard Bay Spectacled Eider Critical Habitat
Gulf of Mexico:	Topographic stipulation blocks
Atlantic:	Right whale biologically important areas and loggerhead sea turtle overwintering habitat

(3) **Not Analyzed Further (Section 2.6)**: EIAs that (a) were not spatially discrete, (b) lacked adequate support at this point to include as an alternative, as a component thereof, or as eligible for programmatic mitigation, or (c) were unlikely to coincide with potential leasing under the Proposed Action were eliminated from further analysis within this Programmatic EIS, given they are not essential for decision-making at this stage. These EIAs may still be considered in subsequent NEPA analyses.

Beaufort Sea:	Offshore beluga whale feeding area and Beaufort Sea deepwater area
Chukchi Sea:	Chukchi Sea deepwater area
Gulf of Mexico:	Buffer offshore Gulf Islands National Seashore and sperm whale high-use area
Atlantic:	Cape Hatteras exclusion, soft coral habitat areas, hard bottom habitat areas, Atlantic shelf break/slope between the 500- and 1,500-meter (m) (1,640- and 4,921-foot [ft]) isobaths, and Atlantic Habitat Areas of Particular Concern

Ultimately, the treatment of identified EIAs within this Programmatic EIS is meant to provide the Secretary of the Interior with information to determine, at her discretion, whether to exclude areas from the Program, adopt programmatic mitigation measures into the Program, or defer application of exclusions or programmatic mitigations to the lease sale decision stage.

1.4.6. Incomplete and Unavailable Information

In conducting this analysis, the Programmatic EIS examines existing scientific evidence relevant to evaluating the reasonably foreseeable significant adverse impacts of oil and gas exploration and development activities on the human environment. The subject matter experts that prepared the Programmatic EIS diligently searched for pertinent information, and BOEM's evaluation of such impacts is based on research methods and theory generally accepted in the scientific community. BOEM's subject matter experts acquired and used previously developed and newly available scientifically credible information and, where gaps remained, exercised their best professional judgment to extrapolate baseline conditions and impact analyses using accepted methodologies based on credible information. For purposes of this Programmatic EIS, all impacts reasonably foreseeable at later stages of the oil and gas development process have been considered, and the characterization of impact magnitude and duration is supported by scientific evidence. BOEM's assessment of impacts is not based on conjecture, media reports, or public perception; it is based on research methods, theory, and modeling applications generally accepted by the scientific community.

1.4.7. Issues not Analyzed in the Programmatic EIS

Several issues were identified during scoping but are not analyzed in the Programmatic EIS. The rationale for their exclusion is described the following subsections.

1.4.7.1. Renewable Energy

Numerous scoping comments stated support for alternative or renewable energy options. While many were not specific, some provided supporting materials, literature, and data addressing the feasibility, economic value, or environmental benefits of renewable energy. Some comments provided specific technologies and designs for expanded renewable energy solutions. Other comments explicitly requested that renewable energy be analyzed as an alternative to the Proposed Action in the Programmatic EIS.

BOEM implements the OCS Renewable Energy Program as authorized by the Energy Policy Act of 2005 (EPAct). This Renewable Energy Program is responsible for regulating offshore renewable energy development on the OCS and anticipates future development from three general energy sources: offshore wind, ocean wave, and current wave energy. BOEM's renewable energy regulations provide the framework for issuing leases, easements, and rights-of-way for OCS development activities that support production and transmission of energy from renewable energy sources. The areas BOEM has leased to date could support more than 12,000 megawatts (MW) of commercial wind generation. Information on BOEM's Renewable Energy Program and renewable energy projects proposed or currently in development is available at http://www.boem.gov/Renewable-Energy/. The development of renewable energy sources is strategically important, but the development of these resources in the foreseeable future does not fully or partially satisfy the purpose and need for the Proposed Action at this time, as described in **Section 1.2**. Therefore, development of renewable energy as an alternative to oil and gas development has not been carried forward for analysis in this Programmatic EIS.

1.4.7.2. Oil Spill Modeling

Many scoping comments expressed concern about oil spills, of which approximately 90 percent included concerns regarding potential severe impacts from oil and dispersants on biological resources, wildlife, commercial fisheries, and tourism-based economies. Related concerns were that the impacts from oil spills can persist for decades. Perceived deficiencies in data concerning impacts to wildlife from toxins in oil dispersants were mentioned repeatedly in the comments in addition to a need for better ocean current modeling data to model and consider spill trajectories. Comments also stated that oil spill trajectory analyses should be conducted.

The potential impacts from oil spills are evaluated in detail in **Chapter 4**. Because the locations of potential development will be determined in subsequent phases and oil spill modeling requires substantial investment, it is premature to perform oil spill trajectory modeling at this Programmatic EIS stage. BOEM does perform oil spill modeling during the evaluation of lease sales and certain exploration or development plans.

1.4.7.3. Oil and Gas Global Markets and Consumption

The scope of the Proposed Action analyzed in the Programmatic EIS encompasses OCS activities done at later stages of the oil and gas development process (e.g., exploration, development, production, operation, and transport of crude oil as well as decommissioning). Some commenters recommended that market prices and stability, supply of the nation's energy needs, reduced reliance on foreign oil, and consumption of refined oil and gas should be addressed in the Programmatic EIS. The Programmatic EIS addresses these issues to the extent necessary to perform a programmatic comparison of effects between alternatives and inform the Secretary of the Interior's final Program decision.

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2. ALTERNATIVES

2.1. PROPOSED ACTION

The Proposed Action includes 14 lease sales in 5 OCS Program Areas and the activities that may reasonably result from these lease sales. Ten region-wide sales are proposed in the Gulf of Mexico Program Area; one sale each in the Chukchi Sea, Beaufort Sea, and Cook Inlet Program Areas offshore Alaska; and one sale in the Atlantic Program Area. No lease sales are proposed for the Pacific region. Additional information on the Program is available at http://www.boem.gov/Five-Year-Program/.

The schedule of sales and affected areas under the Proposed Action are summarized in **Table 2.1-1** as well as **Figures 2.1-1**, **2.1-2**, and **2.1-3**. Most sales are proposed for the Gulf of Mexico where oil and gas resources and infrastructure are most developed. Fewer lease sales are scheduled for the Program Areas in the Atlantic and Alaska where offshore oil and gas experience is much more limited. Furthermore, the lease sales are proposed for later in the Program in order to allow more time to evaluate hydrocarbon resource potential and environmental resources, as well as conduct infrastructure needs planning.

Table 2.1-1. Proposed Schedule of 2017-2022 Lease Sales.

	Sale Number	Program Area	Year
1.	249	Gulf of Mexico	2017
2.	250	Gulf of Mexico	2018
3.	251	Gulf of Mexico	2018
4.	252	Gulf of Mexico	2019
5.	253	Gulf of Mexico	2019
6.	254	Gulf of Mexico	2020
7.	255	Beaufort Sea	2020
8.	256	Gulf of Mexico	2020
9.	257	Gulf of Mexico	2021
10.	258	Cook Inlet	2021
11.	259	Gulf of Mexico	2021
12.	260	Mid- and South Atlantic	2021
13.	261	Gulf of Mexico	2022
14.	262	Chukchi Sea	2022

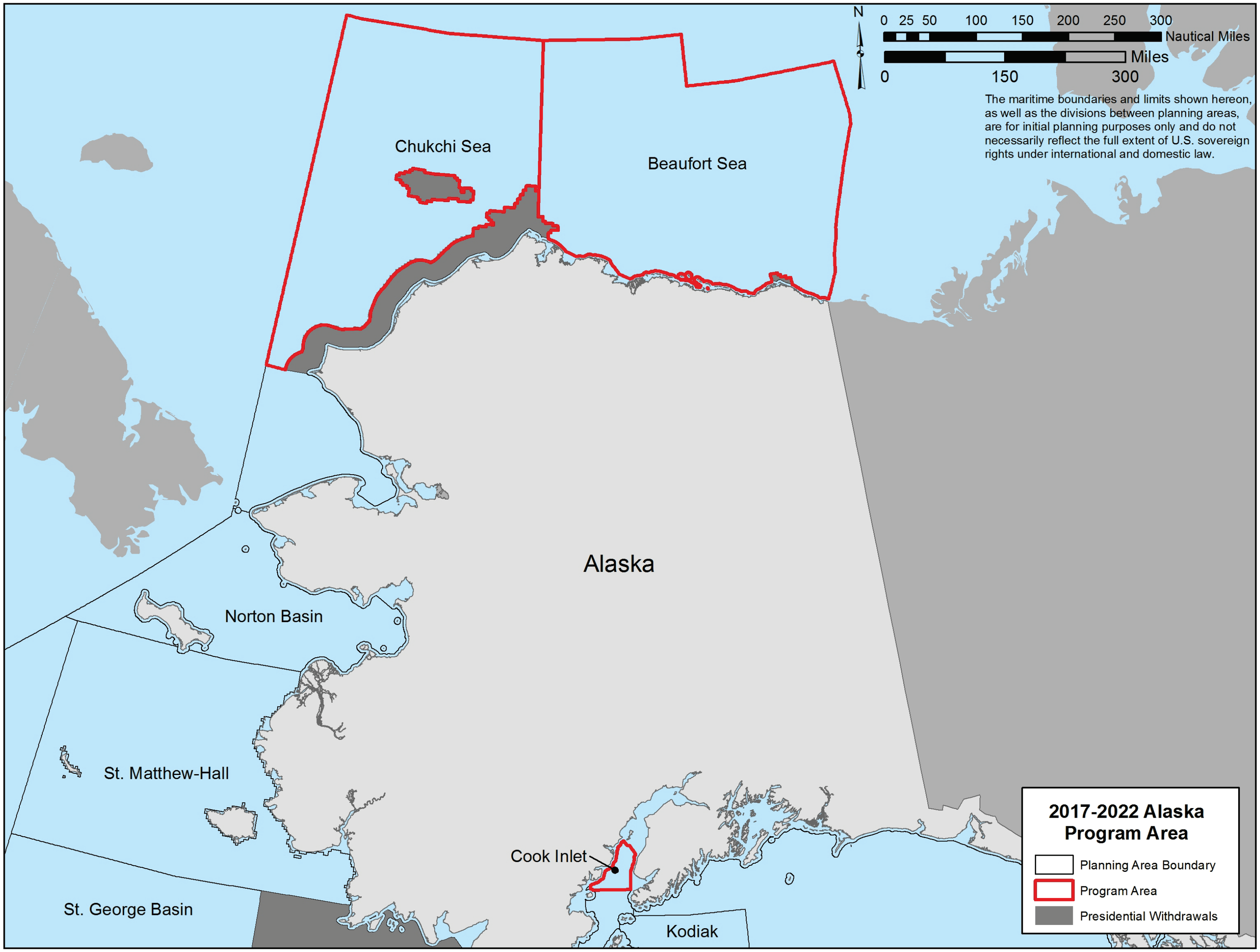

Figure 2.1-1. Location of the Program Areas in the Alaska OCS Region.

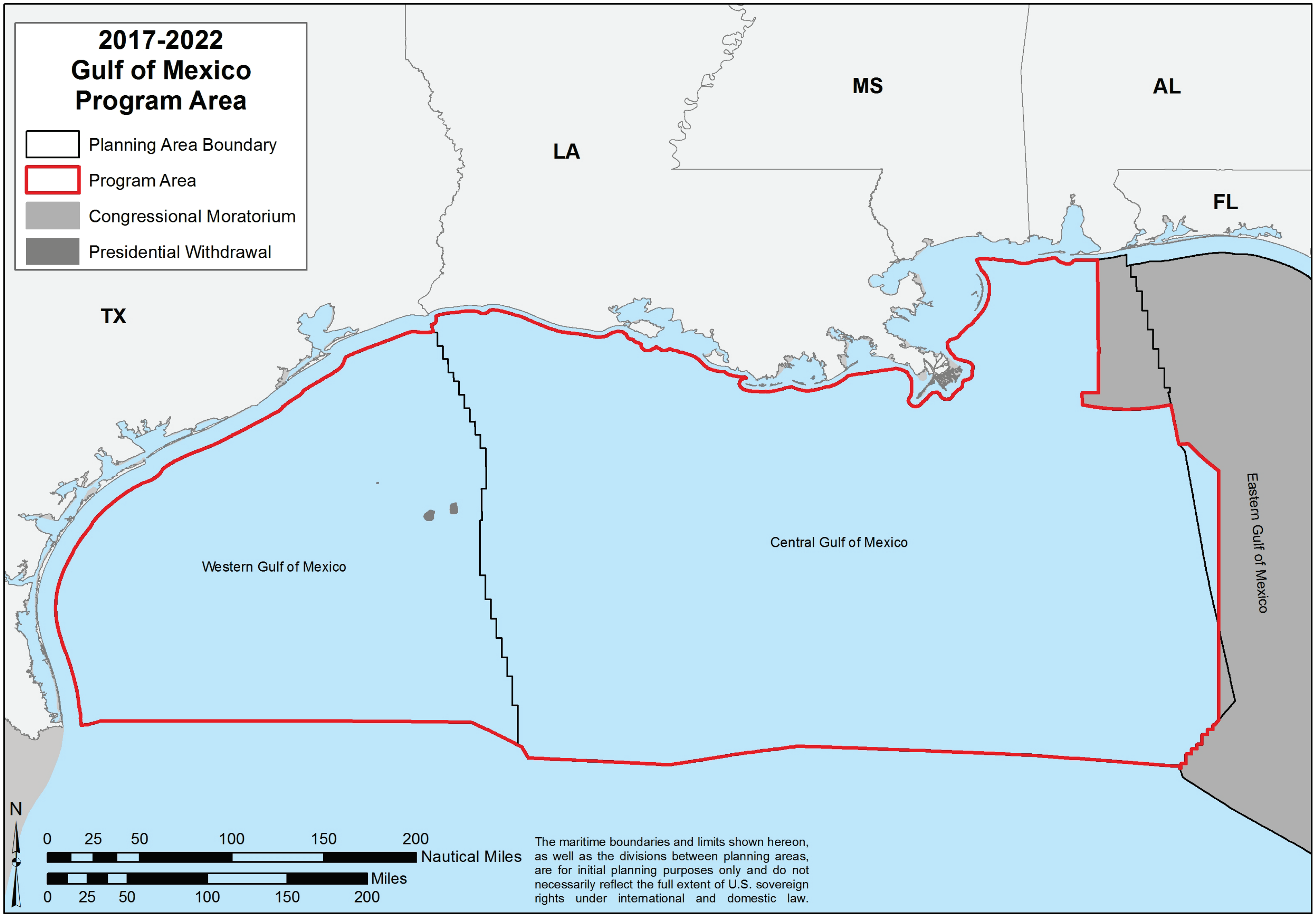

Figure 2.1-2. Location of the Program Areas in the Gulf of Mexico.

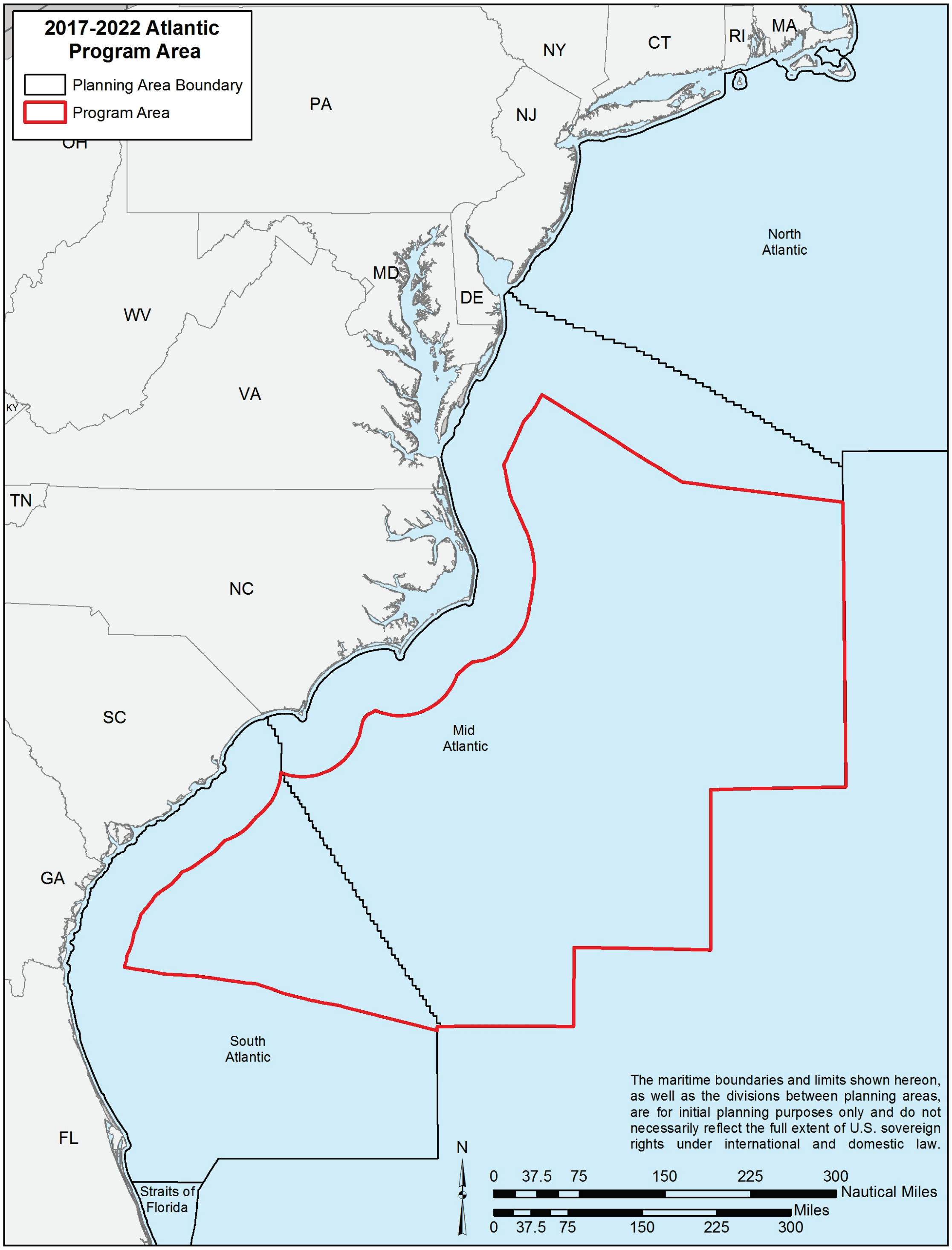

Figure 2.1-3. Location of the Program Areas in the Atlantic.

2.2. RANGE OF ALTERNATIVES

Public scoping informed which alternatives to analyze in the five Program Areas. Additional information provided by BOEM's Environmental Studies Program and subject matter experts was considered as well. Alternatives to the Proposed Action were evaluated in context of environmental consequences of the Proposed Action. First, five broad screening criteria were applied to all alternative recommendations:

- Does the alternative meet the purpose and need?
- Does the alternative address size, timing, or location factors?
- Is the alternative substantially different from another alternative?
- Is the alternative technically and economically feasible (not remote or speculative)?
- Is the alternative consistent with the requirements of OCSLA?

Subsequently, more detailed screening criteria were applied to determine whether the remaining concepts were suitable for incorporation as an alternative:

- Rigor of available data addressing sensitivity, geographic specificity, and ecological importance;
- Species or habitat status (e.g., listed or designated under the ESA); and
- Whether exclusion or other mitigation would reduce impacts on target resource(s).

As a result of the foregoing screening process, the Programmatic EIS analyzes three alternatives across five Program Areas: Alternative A (Proposed Action), Alternative B (Reduced Proposed Action), and Alternative C (No Action). **Table 2.2-1** summarizes these alternatives.

The alternatives considered in the Programmatic EIS principally address the size and location of proposed lease sales. A change in timing (i.e., year of scheduled lease sale) is expected to have little influence on the context and intensity of impacts. The number, nature, and timing of activities following a sale are not known precisely at the program stage and vary by Program Area and other factors. Also, any impacts related to lease sales under the Program are expected to occur over an extended number of years, making a 1- or 2-year timing difference in impacts inconsequential.

The DPP, released on January 29, 2015, provided the basis of the Proposed Action for this Programmatic EIS. In this decision, the Secretary of the Interior also included a supplemental Program option for a 24–kilometer (km) (15-mile [mi]) no-leasing buffer south of Baldwin County, Alabama, as requested by the Governor of Alabama. The environmental impact analysis for Alternative A (Proposed Action) in this Programmatic EIS incorporates the option of this buffer and assumes that the buffer may or may not be established. However, the buffer option is not singled out in the analysis for Alternative A because the area covered is very small when compared to the Gulf of Mexico Program Area and would result in comparatively negligible environmental impact differences. Furthermore, the area traditionally has been subject to a lease sale stipulation that requires no new surface structures south and within 24 km (15 mi) of Baldwin County. BOEM expects this stipulation to be analyzed and decided on during each individual lease sale stage in the 2017-2022 Program, if lease sales are scheduled for this Program Area; therefore, at this time, no visual impacts would be expected to occur.

The Programmatic EIS assumes continuing implementation of protective measures required by statute, regulation, or current lease sale stipulations that would likely continue to be adopted in the future (**Appendix G**). It also assumes that BSEE will implement requirements for safe operations and environmental protection, including requiring the use of the best technologies and operational practices. Changes to these assumptions, and reconsideration of any related environmental impacts, would be addressed in subsequent lease sale environmental evaluations.

Table 2.2-1. Summary of Alternatives Analyzed in the Programmatic EIS.

Alternative	Proposed Action				
	Beaufort Sea Program Area **Figure 2.1-1**	Chukchi Sea Program Area **Figure 2.1-1**	Cook Inlet Program Area **Figure 2.1-1**	Gulf of Mexico Program Area **Figure 2.1-2**	Atlantic Program Area **Figure 2.1-3**
Alternative A	One sale in 2020 OR advance sale to 2019	One sale in 2022	One sale in 2021	Region-wide leasing: 10 sales offering all unleased acreage in the Western, Central, and portions of the Eastern Planning Areas not subject to Congressional moratorium or otherwise excluded. OR Traditional leasing of 10 separate, alternating sales (one sale each year in the Western and another sale in the combined Central and Eastern Gulf of Mexico) for areas not subject to Congressional moratorium or otherwise excluded. * The supplemental 24-km (15-mi) no-leasing buffer south of Baldwin County, Alabama could be combined with either option.	One sale in 2021
Alternative B	Reduced Proposed Action – Includes the Proposed Action subject to the following exclusions and/or programmatic mitigations:				
	Beaufort Sea Program Area **Figure 2.4-1**	Chukchi Sea Program Area **Figure 2.4-2**	Cook Inlet Program Area **Figure 2.4-3**	Gulf of Mexico Program Area	Atlantic Program Area **Figure 2.4-4**
	B(1)(a) No new leasing in entire Beaufort Sea Program Area B(1)(b) Programmatic mitigation or exclusion of Barrow Canyon, Camden Bay, Cross Island and/or Kaktovik	B(2)(a) No new leasing in entire Chukchi Sea Program Area B(2)(b) Programmatic mitigation or exclusion of Hanna Shoal Walrus Foraging Area and Movement Corridor	B(3)(a) No new leasing in entire Cook Inlet Program Area B(3)(b) Exclusion of designated Cook Inlet Beluga Whale Critical Habitat	B(4)(a) No new leasing in entire Gulf of Mexico Program Area	B(5)(a) No new leasing in entire Atlantic Program Area B(5)(b) Programmatic mitigation or exclusion of Washington and Norfolk Canyons
Alternative C	No Action – No new leasing from Proposed Action				

2.3. PROPOSED ACTION (ALTERNATIVE A)

Alternative A, the Proposed Action, is the schedule of 14 lease sales across 5 Program Areas and considers supplemental options for the timing of lease sales in the Gulf of Mexico and Beaufort Sea Program Areas (**Table 2.2-1**). The schedule of lease sales is discussed by Program Area in **Sections 2.3.1** through **2.3.3** and **2.4**. Additional information on the Program is available at http://www.boem.gov/Five-Year-Program/.

2.3.1. Proposed Action – Beaufort Sea, Chukchi Sea, and Cook Inlet Program Areas

The Proposed Action includes one sale each in the Beaufort Sea (in 2019 or 2020), Cook Inlet (2021), and Chukchi Sea (2022) Program Areas (**Figure 2.1-1**). In 2015, President Obama withdrew several areas from potential leasing consideration: Kaktovik Whaling Area, Chukchi Sea Corridor, Barrow Whaling Area, and Hanna Shoal. These areas are referred to as Presidential withdrawal areas in this Programmatic EIS. Sales in the Alaska Program Areas are scheduled later in the five-year period to provide additional opportunity to evaluate and obtain information regarding environmental issues, subsistence use needs, infrastructure capabilities, and results from any exploration activity associated with existing leases. The Proposed Action also considers an option to advance the Beaufort Sea sale to 2019. This option would change the date of the sale by just 1 year and would make no substantive difference in environmental impacts because oil and gas activities could occur 40 to 70 years following any leasing.

2.3.2. Proposed Action – Gulf of Mexico

The Proposed Action in the Gulf of Mexico entails 10 region-wide sales composed of unleased acreage in the Western, Central, and Eastern Gulf of Mexico Planning Areas not subject to statutory moratoria, presidential withdrawal, or other exclusions (**Figure 2.1-2**). In the past, BOEM has scheduled two sales annually, alternating between the Gulf of Mexico Western Planning Area and the Gulf of Mexico Central Planning Area, as well as periodic sales in the portion of the Eastern Gulf of Mexico not under moratorium. The Proposed Action considers an option for a minor variation on this schedule with two sales annually, one for the Western Planning Area and one for the combined Central and Eastern Planning Areas (excluding any area under moratoria or otherwise not available for future leasing). Choice of the Proposed Action with or without the supplemental option would make no substantive difference in environmental impacts because there are no overall differences expected in activity levels resulting from lease sales (annually or over the long term) from these changes in timing.

2.3.3. Proposed Action – Atlantic

The Proposed Action includes one Atlantic Program Area lease sale in 2021. The areas available for leasing would be located at least 80.5 km (50 mi) offshore the coasts of Virginia, North Carolina, South Carolina, and Georgia in the Atlantic Program Area (**Figure 2.1-3**). The 80.5-km (50-mi) coastal buffer would limit potential impacts to the environment and space-use conflicts while leaving substantial acreage with hydrocarbon potential available for leasing.

2.4. REDUCED PROPOSED ACTION (ALTERNATIVE B)

Alternative B, the Reduced Proposed Action, analyzes reductions in leasing from the Proposed Action through two approaches: (1) the exclusion of certain Program Areas, and (2) the exclusion or programmatic mitigation of EIAs within these Program Areas that may affect the size or location of leasing under the Proposed Action.

EIAs were identified by BOEM during scoping and represent regions of important environmental value where there is potential for conflict between ecologically important or sensitive habitats;

maintenance of social, cultural, and economic resources; and possible oil and gas development. Furthermore, the exclusion of or identification of mitigation for these specific EIAs could affect the size or location of leasing under the Proposed Action.

After scoping, BOEM analyzed all EIAs and grouped them into the following categories:

(1) EIAs that could be geographically defined, were supported by adequate data, *and* could affect the size or location of potential leasing (analyzed under Alternative B in **Section 2.4**);
(2) EIAs that could be geographically defined, were supported by adequate data, but *would not* affect the size or location of potential leasing (analyzed in **Section 4.4.5**); and
(3) EIAs that (a) were not spatially discrete;(b) lacked adequate support at this point to include as an alternative, as a component thereof, or as programmatic mitigation; or(c) were unlikely to coincide with potential leasing under the Proposed Action. These were eliminated from further analysis within this Programmatic EIS given they are not essential for decision-making at this stage. These EIAs may still be considered in subsequent NEPA analyses (**Section 2.6.5**).

For the first two categories, BOEM evaluated a range of measures within this Programmatic EIS to address impacts to EIAs. Again, EIAs with analyzed mitigation measures that may affect size or location of leasing under the Proposed Action are evaluated under Alternative B. EIAs where mitigations do not affect size or location are analyzed as programmatic mitigation for additional EIAs in **Section 4.4.5**. The analyses provide the Secretary of the Interior with information to determine, at her discretion, whether to exclude areas from the Program, adopt programmatic mitigation measures into the Program, or defer application of exclusions or programmatic mitigations to the lease sale decision stage.

2.4.1. Reduced Proposed Action – Beaufort Sea Program Area

Alternative B(1)(a) is the exclusion (no new leasing) of the entire Beaufort Program Area (**Figure 2.1-1**). Alternative B(1)(b) considers new leasing in the Program Area, but analyzes exclusion or programmatic mitigation (through temporal closures) of the following four EIAs (**Figure 2.4-1**).

The first EIA is a portion of Barrow Canyon. This is an important migration and foraging area for beluga whales, bowhead whales, gray whales, and seabirds. This core area of the Barrow Canyon complex has high benthic biomass and high biological productivity. The canyon area is in the vicinity of the North Slope Borough, is at the nexus of the Chukchi and Beaufort Seas, and is an important area for subsistence hunting. Alternative B(1)(b) considers exclusion (no new leasing) of this area as well as a temporal closure from June through October of each year.

The second EIA is Camden Bay. This area is important ecologically and for subsistence use. Several stakeholders provided data and studies supporting both aspects. The Camden Bay area is important to bowhead whale, beluga whale, and seal feeding and is also an important bowhead whale hunting area in the fall. Alternative B(1)(b) considers exclusion (no new leasing) of this area as well as a temporal closure from August through October of each year.

The third EIA is Cross Island and the surrounding area. This is an important and historically significant subsistence hunting area. The larger Cross Island area is important to the bowhead whale migration, beluga whales, pinnipeds, and as a feeding and denning area for polar bears. As with Camden Bay, this area was highlighted by several stakeholders during scoping; stakeholders provided testimony, data, and studies to demonstrate its ecological and cultural importance. It is also supported by recent studies of subsistence hunting activity that showed, over the past decade, that whaling has occurred between Thetis Island to the west and Barter Island (Kaktovik) to the east, and offshore up to approximately 80.5 km (50 mi). The highest density of whaling areas were reported offshore up to 48 km (30 mi) in a radius around Cross Island and east of Cross Island as far as Flaxman Island. Hunters generally reported traveling primarily north or east of Cross Island when searching for bowhead whales; they hunt west of the island as well, but to a lesser extent. Respondents described hunting bowhead whales at varying distances from Cross Island depending on the location of the migrating bowhead whales, the location of the ice pack, and travel conditions (Braund, 2010). Alternative B(1)(b) considers exclusion (no new leasing) of this area as well as a temporal closure from August through October of each year.

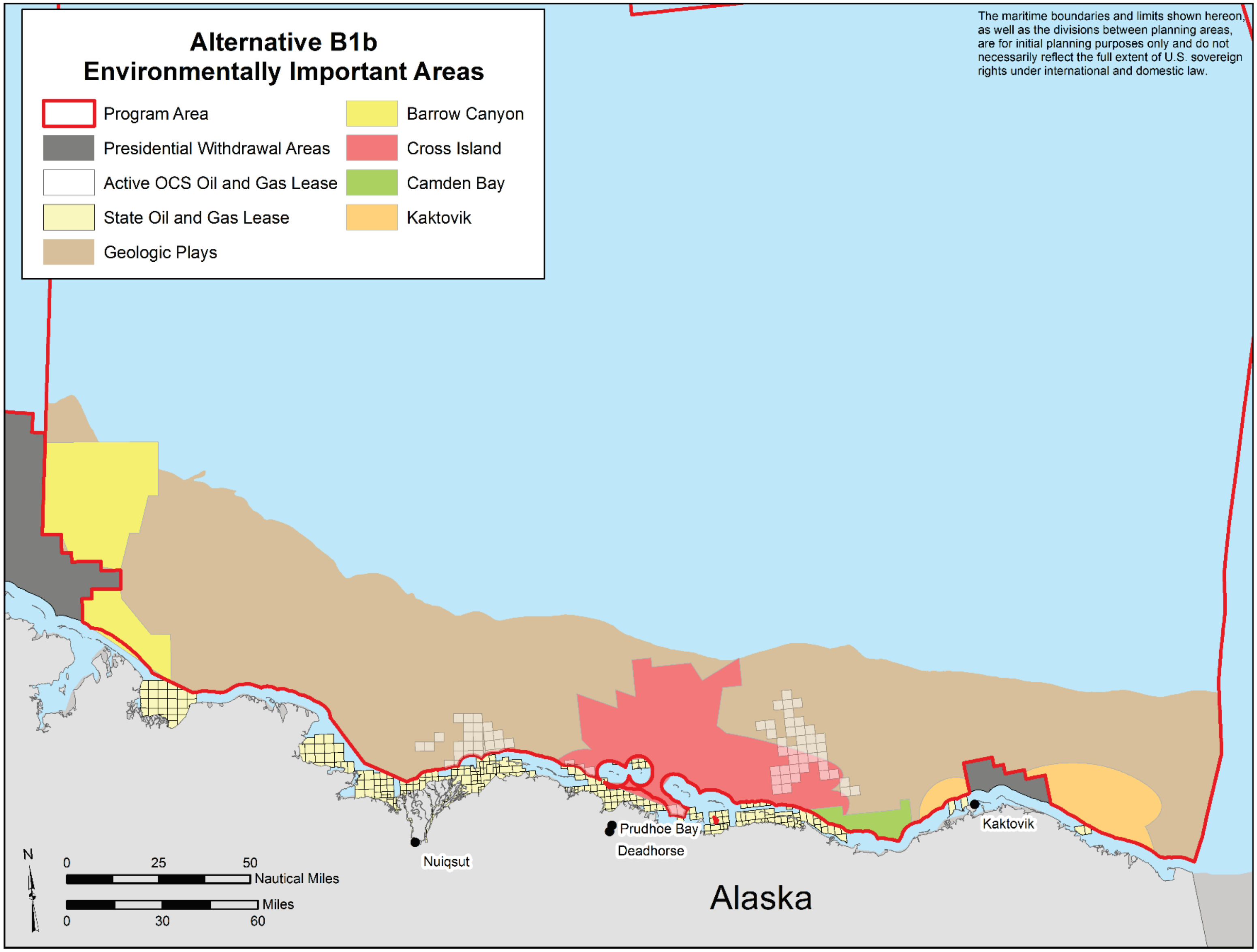

Figure 2.4-1. Beaufort Sea Program Area – Alternative B(1)(b).

The fourth EIA is Kaktovik (Barter Island) and the surrounding area. This area is subject to subsistence use around the existing Presidential withdrawal and was highlighted during public scoping as important ecologically and for subsistence use with data and studies supporting both aspects. This area is important to feeding bowhead and beluga whales (especially in the fall), seabirds, pinnipeds, and feeding and denning polar bears. Alternative B(1)(b) considers exclusion (no new leasing) of this area and a temporal closure from August through October of each year.

Exclusions apply toward all activities discussed as part of or resulting from the Proposed Action. The temporal closures apply specifically to geophysical exploration and exploratory drilling activities. They do not apply to construction, production, or decommissioning activities given production occurs year-round and the specific methods and technology to be used for construction, production, and decommissioning are not yet known; potential environmental effects can be better analyzed at the lease sale or plan stage when more detailed information becomes available.

BOEM recognizes that the proposed temporal closures in the Beaufort Sea can overlap with the open water season, which is the only time that geophysical exploration and exploratory drilling activities can occur. In this scenario, the temporal closure may represent the equivalent of an exclusion as there may be no available, feasible, or safe time period for industry to conduct these activities. Some exploration activities may occur outside of the open water season (e.g., with seismic surveys utilizing an icebreaker or on-ice, nearshore seismic surveys using tracked vehicles in the Beaufort Sea). For the most part however, industry generally conducts exploration activities during the open water season in the U.S. Arctic; the sea ice, extreme cold, and dark increase the difficulty and expense while decreasing the amount of work that can be accomplished in winter. A closure from June through October would almost entirely preclude exploration activities; while a closure from August through October would allow only very limited work in the shoulder seasons. If the dynamics of sea ice continue to change under the influence of climate change, the window of feasibility for geophysical exploration and exploratory drilling activities may expand in the shoulder seasons. The open water season is increasing rapidly, which may increase the length of the shoulder season, but would not impact the challenge of working in darkness

2.4.2. Reduced Proposed Action – Chukchi Sea Program Area

Alternative B(2)(a) is the exclusion (no new leasing) of the Chukchi Sea Program Area (**Figure 2.1-1**). Alternative B(2)(b) considers new leasing in the Program Area but analyzes exclusion or programmatic mitigation (through temporal closure) of two related EIAs (**Figure 2.4-2**).

The EIAs in this area include two interrelated subareas: the Hanna Shoal Walrus Foraging Area and the Walrus Movement Corridor. The Hanna Shoal Walrus Foraging Area surrounds the current Hanna Shoal Presidential withdrawal; the Walrus Movement Corridor captures the area between Hanna Shoal and the existing Chukchi Corridor Presidential withdrawal and includes the area walruses use to transit from nearshore and onshore haul out areas and feeding areas around Hanna Shoal. The Hanna Shoal Walrus Foraging Area includes important habitat for the Pacific walrus, including areas of high benthic biomass within shallow waters where sea ice persists into the summer, and provides habitat for foraging walrus. Alternative B(2)(b) considers exclusion of this area as well as annual temporal closures in the foraging areas (June through October) and in the movement corridor (from the time ice moves off the shelf through October).

Exclusions apply toward all activities discussed as part of or resulting from the Proposed Action. The temporal closures apply specifically to geophysical exploration and exploratory drilling activities. They do not apply to construction, production, or decommissioning activities given production occurs year-round and the specific methods and technology to be used for construction, production, and decommissioning are not yet known and potential environmental effects can be better analyzed at the lease sale or plan stage when more detailed information becomes available.

Although there is more open water time available in the Chukchi Sea than the Beaufort Sea (e.g., during the months of June and July), BOEM recognizes that the proposed temporal closures in the Chukchi Sea can substantially overlap with the open water season necessary for geophysical exploration and exploratory drilling activities. In this scenario, the temporal closure may effectively limit activity to the point of deterring industry interest. If the dynamics of sea ice continue to change under the influence of climate change, the window of feasibility for geophysical exploration and exploratory drilling activities may expand in the shoulder seasons.

2.4.3. Cook Inlet Program Area Alternative

Alternative B(3)(a) is the exclusion (no new leasing) of the Cook Inlet Program Area. Alternative B(3)(b) considers new leasing in the Program Area but analyzes exclusion of one EIA: the Beluga Whale Critical Habitat (**Figure 2.4-3**). This is critical habitat for the Cook Inlet Distinct Population Segment (DPS) of beluga whales and is federally designated under the ESA. The Cook Inlet beluga DPS, which are listed as endangered under the ESA, has declined by approximately 74 percent since 1979 and numbers in the vicinity of 300 animals. Alternative B(3)(b) considers exclusion of this area.

2.4.4. Reduced Proposed Action – Gulf of Mexico Program Area

Alternative B(4)(a) is the exclusion (no new leasing) of the entire Gulf of Mexico Program Area (**Figure 2.1-2**). No EIAs are analyzed under this alternative for the Gulf of Mexico Program Area. There was one EIA identified, but BOEM determined it met an EIA Category 2 (**Section 1.4.4**). It is further discussed under programmatic mitigation for additional EIAs given implementation of the proposed mitigation in this area would not affect size or location of new leasing under the Proposed Action (**Section 4.4.5**).

2.4.5. Reduced Proposed Action – Atlantic Program Area

Alternative B(5)(a) is the exclusion (no new leasing) of the entire Atlantic Program Area (**Figure 2.1-3**). Alternative B(5)(b) considers new leasing in the Program Area, but analyzes exclusion or programmatic mitigation of one EIA: Washington and Norfolk Canyons (**Figure 2.4-4**). The canyons are analyzed under this alternative because they support high levels of benthic and pelagic biodiversity. Each area serves as important habitat for fishes and corals and is associated with important foraging habitat for whales and seabirds.

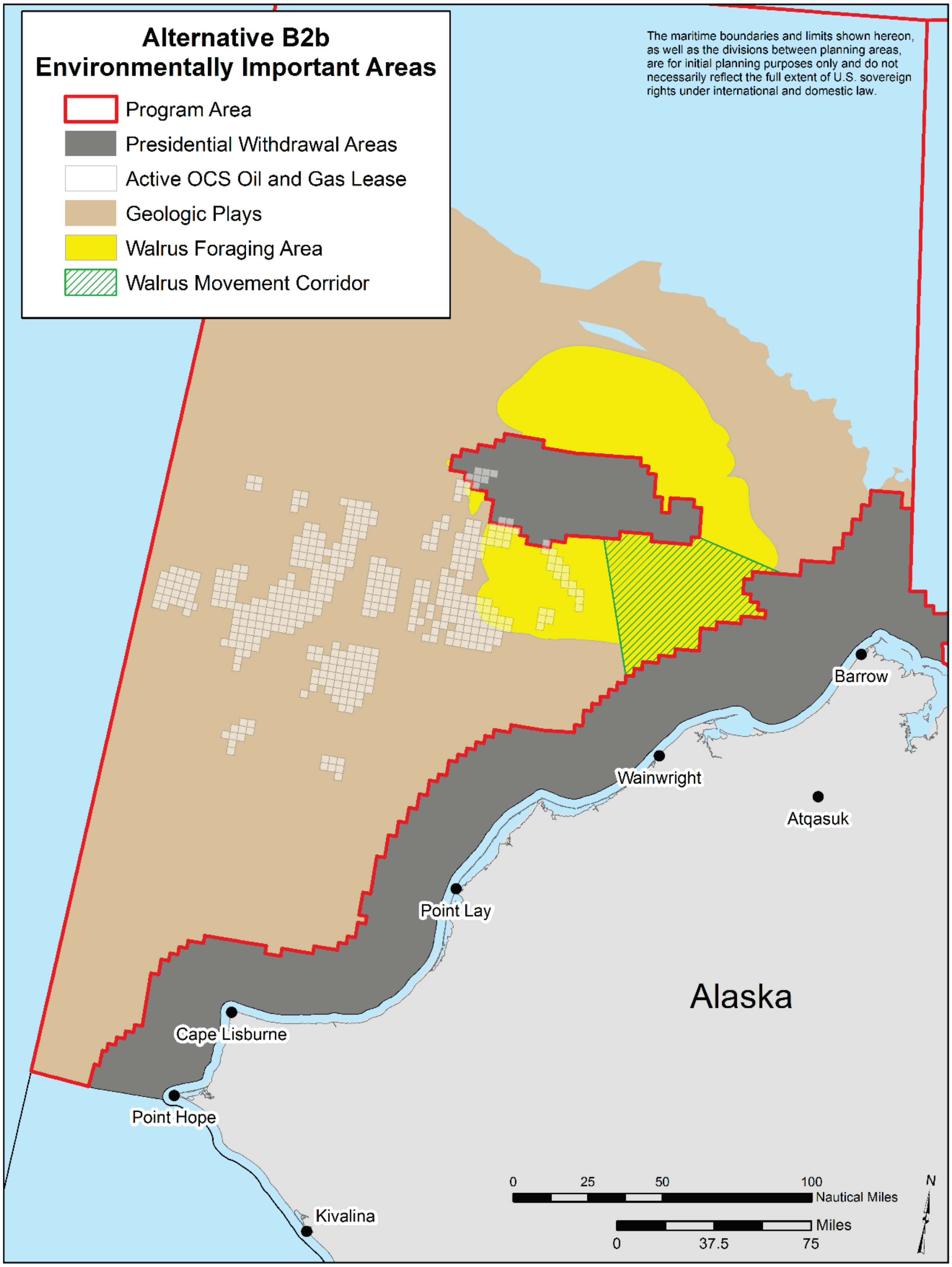

Figure 2.4-2. Chukchi Sea Program Area – Alternative B(2)(b).

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2 Figure 2.4-3. Cook Inlet Program Area – Alternative B(3)(b).

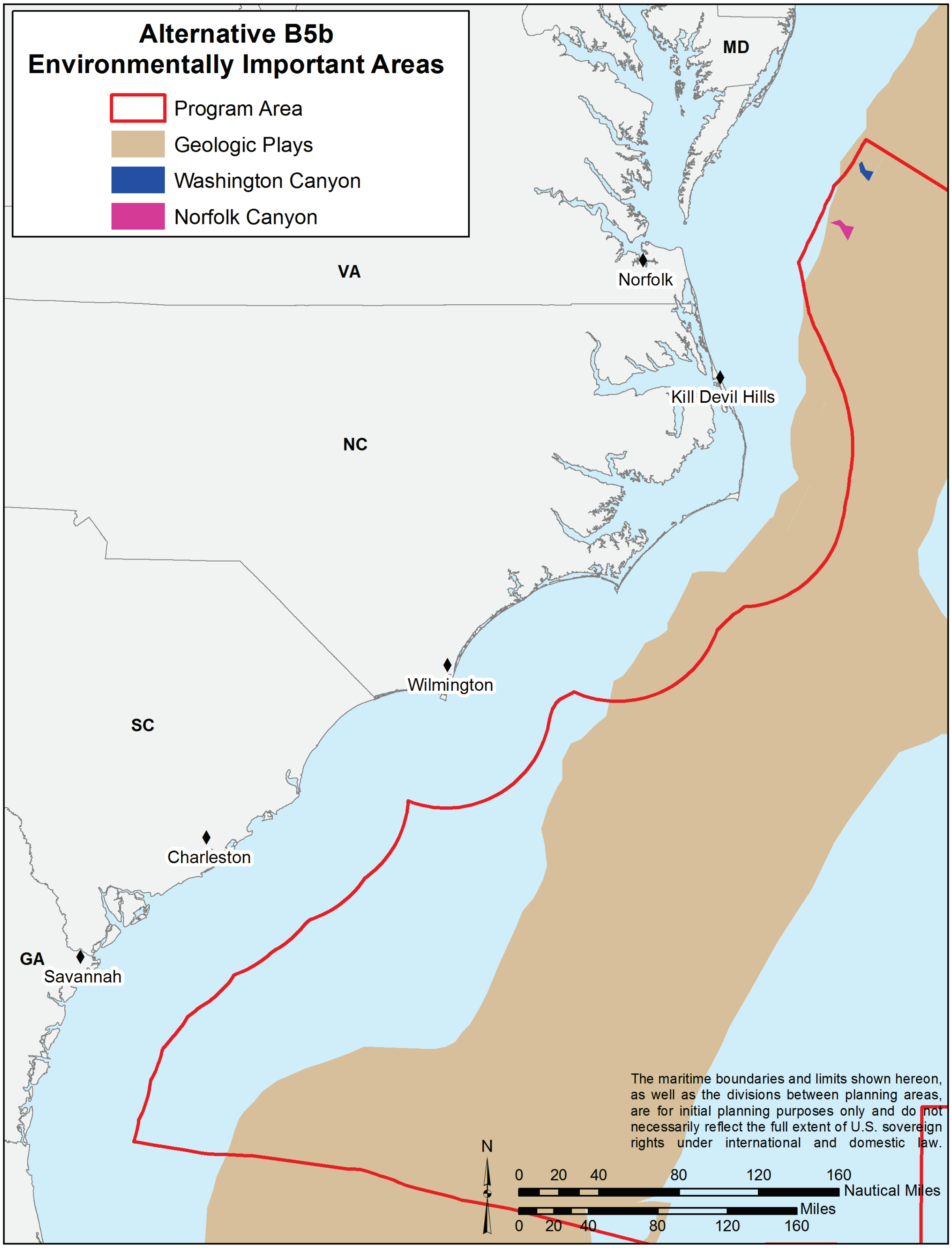

Figure 2.4-4. Atlantic Program Area – Alternative B(5)(b).

2.5. NO ACTION (ALTERNATIVE C)

Alternative C, the No Action Alternative, evaluates environmental effects of having no new lease sales during the 2017-2022 Program. However, oil and gas activities stemming from leasing under the 2012-2017 Program and previous programs would continue. As such, the current and previous Programs form the baseline of the analysis, and the No Action Alternative considers the incremental impacts that would not occur if there is no 2017-2022 Program. For example, in the Arctic, there are no currently planned exploration activities, and with no new leasing there might be less incentive to consider any new exploration activities. Development activities on past leasing would still proceed. In the Gulf of Mexico, OCS oil and gas activities from past leasing and any leasing remaining in the existing program through 2017 would be expected to continue. In the Gulf of Mexico, there would be little decline in existing OCS activity for 3 to 5 years because of a large inventory of leases. After that, there would be a much sharper drop in activity compared with the Proposed Action. In Cook Inlet and the Atlantic, there are no existing OCS oil and gas leases, so Alternative C equates with no activity on the Cook Inlet OCS and Atlantic OCS. None of the potential environmental impacts under the Proposed Action would occur to the physical and biological resources (e.g., air quality, water quality, coastal and estuarine habitats) in the Atlantic and Cook Inlet Program Areas. These precluded impacts would include the anticipated effects under the Proposed Action of routine operations and non-routine events. For the Arctic and particularly for the Gulf of Mexico Program Area, Alternative C still would have potential physical and ecological impacts from current and past programs, but at reduced levels. Impacts to vulnerable communities (environmental justice) still could occur from existing leases issued prior to the Proposed Action in the Gulf of Mexico, Chukchi Sea, and Beaufort Sea Program Areas. In the Gulf of Mexico, potential impacts from the Alternative C would decline rapidly compared to the Proposed Action, and they could be eliminated under the Alternative C after approximately 40 years. However, because the Alternative C would eliminate all oil and gas activities that are projected to occur under the Proposed Action, there would be impacts on socioeconomic and sociocultural resources (i.e., population, employment, and income; land use and infrastructure; commercial and recreational fisheries; tourism and recreation; sociocultural systems; environmental justice) resulting from the loss of leasing, mainly in the Gulf of Mexico and to a lesser extent in the Arctic.

Under Alternative C, other sources of nonrenewable and renewable energy and/or conservation measures would be required to address the equivalent energy demand. Energy substitutes are discussed in detail in BOEM (2015a). Energy substitutions introduce the potential for a different suite of environmental impacts that could occur within or outside of OCS Program Areas. The potential impacts from substitute energy sources (e.g., more tankers bringing offshore oil) would be quite variable (USDOI, BOEM, 2015a) and depend by the type, degree, and location of substitution (e.g., increase in foreign oil imports, increase in onshore renewable energy, and increase in onshore oil and gas production). Examples of environmental impacts that could result from the development and transportation of energy substitutions include the following:

- Harm to habitat and wildlife from oil spills that may occur during oil tankering or from nuclear accidents;
- Habitat destruction or deterioration of habitat quality from onshore energy exploration and development activities, coal mining, or processing and storage of industry wastes;
- Groundwater contamination or air quality deterioration from onshore oil and gas development and coal mining; and
- Habitat and wildlife disturbance from onshore oil and gas, hydropower, or onshore and offshore renewable energy.

2.6. ALTERNATIVES CONSIDERED BUT ELIMINATED FROM PROGRAMMATIC EVALUATION

Other alternatives considered but not analyzed in this Programmatic EIS are as follows:

- Add additional sales;
- Change frequency or timing of lease sales;
- Delay lease sales pending new technologies development or regulatory reform;
- Develop alternative or renewable energy sources as a complete or partial substitute for oil and gas leasing on the OCS; and
- Add additional spatial exclusions within Program Areas.

2.6.1. Add Additional Sales

This Programmatic EIS does not analyze sales in other OCS planning areas that are not already included as part of the Proposed Action. The Proposed Action is adoption of the 2017-2022 DPP, published on January 29, 2015, and this Draft Programmatic EIS analyzes activities that may result from implementation of the DPP. Given that Section 18 of OCSLA does not allow for areas (sales) to be added back into the Program once they are removed and comments were not solicited on other areas at the DPP stage, this Programmatic EIS cannot consider alternatives for inclusion of other sales or areas.

In addition to OCSLA Section 18 requirements for adding new sales or areas, there are additional authorities that also withdraw specific areas on the OCS from leasing. For example, in March 2010, President Obama withdrew Bristol Bay in the North Aleutian Basin Planning Area from leasing consideration through June 30, 2017. In December 2014, President Obama withdrew the entire North Aleutian Basin in Alaska from consideration of leasing. In January 2015, President Obama withdrew the areas in the Beaufort and Chukchi Planning Areas previously highlighted. Additionally, Congress may withdraw areas from leasing. In the Gulf of Mexico, most of the Eastern Planning Area and part of the Central Planning Area within 161 km (100 mi) of the Florida coast are under Congressional moratorium restricting leasing and development until 2022. Lease sales cannot be held in these areas.

2.6.2. Change Frequency or Timing of Lease Sales

The approval of a Program only establishes a general schedule for potential lease sales, and all scheduled lease sales can be delayed or cancelled at any time during a Program, especially if new conditions or circumstances warrant that course of action. The Program already considers an option in the timing of the Beaufort lease sale and timing options for annual sales in the Gulf of Mexico. In addition, the Program schedules potential lease sales in the Atlantic, Beaufort, Chukchi, and Cook Inlet Program Areas later in the Program to provide a balanced and prudent approach to potential development in frontier areas. The frequency and timing proposed for lease sales reflects careful consideration of the factors set forth in Section 18 of OCSLA. Furthermore, a change in timing (i.e., year of scheduled lease sale), while potentially important for a Program decision, is expected to have little influence on the context and intensity of environmental impacts. The number, nature, and timing of activities following a sale are not known precisely at the program stage and vary by Program Area and other factors. Also, any impacts related to lease sales under the Program are expected to occur over 40 to 70 years, making a 1- or 2-year timing difference in environmental impacts inconsequential. Therefore, the addition of an alternative that addresses other changes in frequency or timing of lease sales would not represent a meaningfully different alternative than those already considered within this Programmatic EIS.

2.6.3. Delay Lease Sales Pending New Technologies Development or Regulatory Reform

Technologies, safety standards, and industry practices evolve continually, and agency regulations are revised with regularity. OCSLA's staged decision process allows for the adaptive management and incorporation of new technologies and regulations at each stage of oil and gas development (**Figure 1.3-1**). Delaying lease sales is not necessary because, under OCSLA and lease terms, new regulations and Best Available and Safest Technology (BAST) determinations apply to existing leases.

2.6.4. Develop Alternative or Renewable Energy Sources as a Complete or Partial Substitute for Oil and Gas Leasing on the OCS

As noted in **Section 1.2**, OCS oil and gas production substantially contributes to meeting U.S. energy demand and is expected to supply this demand into the future. BOEM recognizes the importance of decreasing atmospheric greenhouse gas emissions and advancing the use of wind and other renewable energy toward that end. BOEM has an OCS Renewable Energy Program currently leasing areas for offshore wind development, which is a subset of its overall regulatory purview for renewable energy. Renewable energy, however, is not enough of an energy substitute within the 2017-2022 Oil and Gas Program framework (**Figure 1.2-1**). BOEM's market substitution analysis supports not separately analyzing alternative energy as a reasonable alternative to some or all oil and gas OCS development (USDOI, BOEM, 2016b, Appendix B).

2.6.5. Add Other Spatial Exclusions in Program Areas

As discussed in **Sections 1.4.4** and **2.4**, EIAs represent regions of important environmental value where there is potential for conflict between ecologically important or sensitive habitats; maintenance of social, cultural, and economic resources; and possible oil and gas development.

EIAs that (a) were not spatially discrete; (b) lacked adequate support at this point to include as an alternative, as a component thereof, or as programmatic mitigation; or (c) were unlikely to coincide with potential leasing under the Proposed Action were eliminated from further analysis.

Gulf of Mexico Program Area

- *24-km (15-mi) buffer offshore Gulf Islands National Seashore*: The National Park Service (NPS) requested leasing exclusion of blocks within 24 km *(*15 mi) of Gulf Islands National Seashore islands along the Mississippi coast. The NPS made the request to minimize potential adverse effects (primarily from visual/lighting effects) on the integrity and experience of wild and scenic places and for the protection of federally designated wilderness. BOEM has carefully considered this request and has decided that it is not appropriate for inclusion as an alternative at the programmatic level. BOEM has already committed to coordination with the NPS at the lease sale and plan stages through the mechanisms described in "Gulf Island National Seashore" Information to Lessees (ITL). Furthermore, even if leasing were to occur, existing lease stipulations would mitigate potential environmental impacts. Under the ITL, BOEM must review any lessee's plans in the area of concern to determine if visual impacts are expected to cause serious harm and if any additional mitigative action is required. Mitigations that could be applied at the plan stage may include, but are not limited to, requested changes in location, modifications to design or direction of proposed structures, pursuing joint use of existing structures on neighboring blocks, changes in color design, or other plan modifications. This is consistent with the NPS proposed management strategy for maintaining optimal night sky viewing conditions, which include cooperating with partners to minimize intrusion of artificial light into the night scene in the national seashore, and evaluating the impacts on the night sky caused by national seashore facilities (USDOI, NPS, 2011).

- *Sperm whale high-use area*: Sperm whales, protected under the ESA, often concentrate in the deepwater area offshore the Mississippi River Delta, especially in the vicinity of the Mississippi Canyon and adjacent continental slope. Current long-term biological data do not support additional mitigation measures or exclusion of this area beyond the long-standing practices already in place.

Beaufort Sea Program Area

- *Offshore beluga feeding area*: This area, located north of Kaktovik and along the Eastern Beaufort shelf break, may be important for beluga whale feeding as the animals move along the shelf break. However, sighting data are not robust enough to evaluate long-term trends in beluga whale feeding in the area. BOEM began additional research in this area in 2015, to continue for several years. This recommendation should be analyzed further at the lease sale stage when BOEM and other agencies can consider the most up-to-date information.

- *Beaufort Sea deepwater area* (seaward of the 200-m [656-ft] isobath): The Beaufort Sea deepwater area includes the continental slope and all basin waters deeper than 200 m (656 ft). The deepwater area may be used by bearded and ringed seals, polar bears, and beluga and bowhead whales for various life functions. Most of the area is well north of the geologic plays currently mapped by BOEM. The higher latitude waters have a higher likelihood of persistent sea ice throughout the open water season, even in years of minimal ice cover, potentially making oil and gas operations more challenging. Although this area can be geographically defined, there are insufficient data for this proposed area to make a determination as to its effectiveness as a protective measure.

Chukchi Sea Program Area

- *Chukchi Sea deepwater area*: This area includes deep water in the Chukchi Sea north of 72° N Latitude. The higher latitude waters have a higher likelihood of persistent sea ice throughout the open water season, even in years of minimal ice cover, potentially making oil and gas operations more challenging. Some of the area also overlaps with the Hanna Shoal priority area. Although this area can be geographically defined, there are insufficient data for this proposed area to make a determination as to its effectiveness as a protective measure.

Atlantic Program Area

- *Cape Hatteras exclusion*: This highly productive area east of Cape Hatteras (North Carolina) out to the Atlantic Gulf Stream and shelf break is important to a variety of seabirds, marine mammals, sea turtles, and fishes. Although ecologically important, the area was eliminated from consideration because it is largely within the existing 80.5-km (50-mi) buffer included in the Proposed Action for the Atlantic Program Area. The area, is therefore, unlikely to be considered for leasing under the Proposed Action.

- *Soft coral habitat*: Models developed by National Center for Coastal Ocean Science predict the location of deepsea and cold water corals in ocean depths between 50 and 2,000 m (164 and 6,562 ft). These fragile, slow-growing corals, which include stony corals, soft corals and gorgonians, and black corals, serve an important ecosystem function. Modeled habitat was determined by combining limited data of known deepsea coral location with more broadly available environmental and oceanographic data. More site-specific data are needed to give more confidence in modeling, and that information is best developed through mapping assessments conducted at subsequent stages, such as the lease or planning stage.

- *Hard bottom habitat*: Hard bottom habitat in the Mid- and South Atlantic Planning Areas provides stable substrate for colonization by algae, corals, sponges, and bryozoans. These hard and live bottom habitat types are important to other marine organisms such as mollusks, crustaceans, sea turtles, and demersal fish. Hard bottom habitat generally occurs along the shelf break in the Mid-Atlantic and broader shelf platform in the South Atlantic. Existing information about habitat occurrence and quality is based on limited observations and model predictions. More site-specific data are needed to determine which avoidance and impact minimization schemes are most appropriate. These mitigations would be better developed later with the information from site-specific mapping assessments conducted at subsequent stages, such as the lease or plan stage.

- *Atlantic shelf break and slope between the 500- and 1,500-m (1,640- to 4,921-ft) isobaths*: The shelf break and upper slope, between the 500- and 1,500-m (1,640- and 4,921-ft) isobaths, features the highest diversity of marine mammals in the Mid-Atlantic and South Atlantic (Kenney, 2001). Methane seeps, chemosynthetic communities, and tilefish habitat of particular concern also occur within this broader area. However, current information does not support exclusion or programmatic mitigation of this EIA. Furthermore, BOEM-sponsored studies and research are planned in the Mid- and South Atlantic Planning Areas in 2016 and subsequent years. BOEM and other agencies will be able to consider relevant information from these studies at a later decision stage when developing mitigation if leasing were to proceed in the Atlantic Program Area.

- *Atlantic Habitat Areas of Particular Concern (HAPCs)*: HAPCs are a subset of designated Essential Fish Habitat (EFH); these areas are identified and designated by the National Marine Fisheries Service (NMFS) for a variety of reasons, including the need to focus attention on certain habitats for research and conservation and for consultation with other agencies authorizing or conducting activities that could affect EFH. HAPCs are representative of the ecology of diverse species; not all HAPCs are equally sensitive to the same IPFs nor would species in a complex benefit equally from implementation of a broad programmatic exclusion or mitigation. Rather, decisions regarding exclusion or mitigation should be evaluated at subsequent NEPA stages when there is more specificity on the data available, the area that may be impacted, and the activities that may result in impacts to species with designated HAPCs. Furthermore, it is at the lease sale stage that EFH consultations are conducted with NMFS.

2.7. SUMMARY OF IMPACTS ANTICIPATED FROM THE PROPOSED ACTION AND ALTERNATIVES

Section 2.5 describes the environmental effects avoided as well as effects from energy substitutes under Alternative C. Many of the same adverse environmental effects would also not occur in a given Program Area under the various options of Alternative B (B(1)(a) – Beaufort Sea, B(2)(a) – Chukchi Sea, B(3)(a) – Cook Inlet, B(4)(a) – Gulf of Mexico, and B(5)(a) – Atlantic) wherein no new leasing is proposed in that Program Area. Similarly, positive socioeconomic effects would not occur under the no new leasing options of Alternative B. Varying environmental effects related to substitution energy sources would instead occur under these options of Alternative B proportional to the amount of energy needed to meet demand. In this regard, the No Action Alternative and Alternative B options are proportional.

Table 2.7-1 compares the overall level of effect per resource group and across each Program Area for the action alternatives, including the Proposed Action (Alternative A) and the Proposed Action minus EIAs (Alternative B). Comparisons are made only across the action alternatives for each Program Area in order to provide a more simplified summary that best focuses on the alternatives that may lead to increased impacts to resources from new leasing and activities that result from this leasing.

There are a number of assumptions built into **Table 2.7-1**, such as the following:

- The underlying analysis reflects an average of the predicted level of effect by resource group.
- Impacts to a particular resource within a grouping may be higher than reflected by **Table 2.7-1**; for example, decommissioning-related impacts to some reef fishes in the Gulf of Mexico may be greater than the overall impact to fishes.
- Where the analysis determines that a range of impacts are possible, **Table 2.7-1** shows only the highest impact level for that resource.
- This analysis is based on routine operations and does not take into consideration large or catastrophic oil spills. In the event of an oil spill, impacts could be major across all resources, depending on the size, location, and timing of the spill.
- The underlying analysis assumes that all standard mitigations would be applied.
- Increases in employment and income are positive impacts. Increases in population generally are positive; however, there may be some negative impacts associated with large-percentage population increases. (See individual sections in **Chapter 4** for more details.) Impact levels ultimately will depend on the level of offshore activities and the location of new population, employment, and spending.

Table 2-7.1. Comparison of Impacts of Action Alternatives. Oil Spills not Considered.

	Beaufort Program Area		Chukchi Program Area		Cook Inlet Program Area		Gulf of Mexico Program Area	Atlantic Program Area	
Resource	A	B(1)(b)	A	B(2)(b)	A	B(3)(b)	A	A	B(5)(b)
Air Quality									
Water Quality									
Coastal and Estuarine Habitats									
Marine Benthic Communities									
Pelagic Communities									
Marine Mammals									
Sea Turtles	--	--	--	--	--	--			
Marine and Coastal Birds									
Fishes and EFH									
Archaeological and Historical									
Population, Employment, and Income									
Land Use and Infrastructure									
Fisheries									
Tourism and Recreation									
Sociocultural Systems									
Environmental Justice									

Negligible; Minor; Moderate; Major; -- = resource not found in Program Area.

2.8. Cost (Net)-Benefit Analysis of Alternatives

The 2017-2022 Outer Continental Shelf Oil and Gas Leasing Proposed Program document provides estimates of benefits and costs to society from the expected activities from lease sales held in the Program. The Net Benefits Analysis is a cost-benefit analysis that considers the impacts of the Program options as well as the impacts of the option to not have a sale in a Program Area (the selection to not have sales in all Program Areas is equivalent to Alternative C). The Net Benefits Analysis provides the Secretary of the Interior with an estimate of the impacts of specific Program options, so that a fully informed and reasoned decision may be made about the size, timing, and location of lease sales. Pursuant to CEQ regulations § 1502.23, the Net Benefits Analysis is incorporated by reference into the Programmatic EIS.

The Net Benefits Analysis is composed of three components, each of which considers the impacts of OCS production and the energy substitutes. The first is a calculation of the incremental net economic value (NEV), which is the gross revenues of the program less the private costs of extracting the resources. The second component is a calculation of incremental environmental and social costs. To calculate these costs, BOEM uses its own Offshore Environmental Cost Model (OECM), a model designed to focus on capturing the most significant reasonably foreseeable environmental and social costs from the Proposed Action and No Action Alternative. Cost factors that were not expected to contribute significantly to results or lacked sufficient transferable data are not included. BOEM continuously re-evaluates the categories considered in the OECM and incorporates additional data and significant factors as information becomes available. The Net Benefits Analysis currently quantifies and monetizes the impacts associated with OCS production activity and oil spills across six cost categories: (1) recreation; (2) air quality; (3) property values; (4) subsistence harvests; (5) commercial fishing; and (6) ecological impacts. The Programmatic EIS qualitatively addresses the same types of impacts to the same resources. The third component is the calculation of economic surplus, which is the welfare change to producers and consumers from a change in energy prices.

While the Net Benefits Analysis captures most of the stream of economic value, it does not quantify all potential costs and benefits of the Proposed Action or alternatives. CEQ regulations § 1502.23 require that the Programmatic EIS discuss the "relationship between the [cost-benefit] analysis and any analyses of unquantified environmental impacts, values, and amenities." Unquantified costs and benefits not presently captured in the cost-benefit model are described qualitatively in BOEM (2015a, b). The unquantified costs and benefits are discussed in **Chapter 4**. The following summarizes the unquantified costs in the Program's Net Benefit Analysis compared to those described qualitatively in the Programmatic EIS:

a. The net benefit analysis does not include monetized impacts from catastrophic spills. The analysis only considers reasonably foreseeable impacts, which do not include those from a highly unlikely catastrophic oil spill. Instead, impacts to resources from a low-probability catastrophic discharge event are discussed in the separate Economic Analysis Methodology paper (Industrial Economics, Inc., 2015) and in Chapter 4.

b. While the Net Benefits Analysis does quantify the costs of animal mortality and lost habitat from an oil spill through habitat equivalency analysis (where costs are estimated in terms of the anticipated expense to restore or recreate damaged habitat), it does not quantify the values above the restoration cost at which society may value the damaged resource (e.g., it does not monetize the impacts to unique resources). These costs are not monetized in the Net Benefits Analysis, but additional information is provided in BOEM (2015a, b). Furthermore, the model does not include ecological costs associated with the use of dispersants or the air quality costs associated with response vessel activity in the event of an oil spill. However, the equivalent environmental effects are addressed in **Chapter 4**.

c. As discussed, the Net Benefits Analysis includes monetized impacts to ecological resources through oil spills, but does not monetize the impacts to these resources from general operations. For example, it does not capture costs to habitats or organisms from waste cuttings and drilling muds deposited on the seafloor near offshore structures during their construction, operation, or removal; auditory impacts and vessel strikes to marine mammals; or water quality impacts associated with produced water discharged from wells or non-oil discharges from platforms and vessels. The equivalent environmental effects from operations are qualitatively addressed by resource category in **Chapter 4**.

d. With one exception, the Net Benefits Analysis does not quantitatively address environmental impacts related to the construction and operation of onshore infrastructure to support OCS activities. The equivalent environmental effects to air and water quality are qualitatively addressed in **Chapter 4**. The Net Benefits Analysis includes air quality impacts from onshore pipeline construction associated with development in the Chukchi Sea Program Area, but does not capture changes in air quality, impacts from reductions in coastal marshland, the value of the ecosystem services lost (e.g., flood protection), or impacts to water quality associated with onshore infrastructure construction.

e. The Economic Analysis Methodology paper estimates changes in greenhouse gas emissions from Alternative A and Alternative C, but does not monetize the environmental and social costs of these emissions (e.g., ocean acidification and eutrophication). The equivalent environmental effects are qualitatively addressed in **Chapter 4**. Furthermore, the methodology paper discusses ecosystem services and certain passive-use values such as bequest value, option value, existence value, and altruistic value. Although these values can exist for stakeholders under both alternatives, they are only considered qualitatively. The Programmatic EIS refers the reader to Industrial Economics, Inc. (2015b) for a complete discussion of non-use values.

Just as there are non-monetized environmental impacts from the program analysis, there are also non-monetized impacts associated with Alternative C. These costs not captured relate to increased onshore energy production, including the environmental costs associated with new infrastructure construction. The analysis of No Action does not account for the ecological costs associated with increased terrestrial oil spills or pollution from produced water discharges associated with increased onshore oil and gas production; increased emissions and increased oil spill risk associated with transporting onshore oil; air emissions associated with the production of biomass energy sources; or ecosystem and health damages related to releases from coal mines. More information on these costs is included in BOEM (2015a, b).

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3. ACTIVITY SCENARIOS AND IMPACT-PRODUCING FACTORS

3.1. OCS OIL AND GAS ACTIVITIES

3.1.1. Phases

OCS oil and gas activities generally occur in four phases: (1) exploration to locate viable oil or natural gas deposits; (2) development well drilling, platform construction, and pipeline infrastructure placement; (3) operation (oil or gas production and transport); and (4) decommissioning of facilities once a reservoir is no longer productive or profitable. Under the Proposed Action, activities would occur on OCS leases only after a lease sale is held in the Gulf of Mexico, Atlantic, and Alaska Program Areas (**Figure 3.1-1**). Ensuing activities may extend over a period of 40 to 70 years depending on the Program Area.

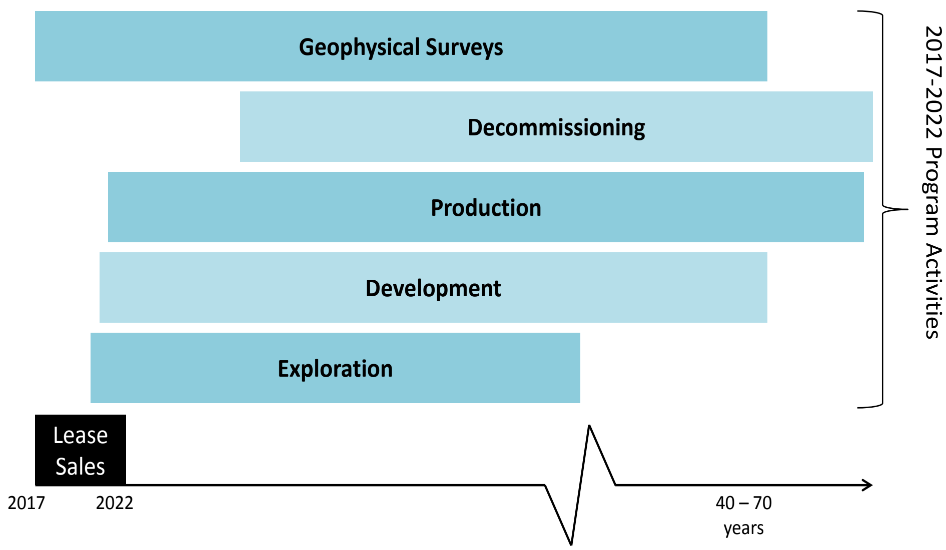


Figure 3.1-1. OCS Activities Resulting from the 14 Lease Sales to be Held in the 2017-2022 Program Would Occur over a Protracted Period of Time. In Mature Areas such as the Gulf of Mexico OCS, Similar Oil and Gas Activities also Occur Under Different Five-Year Programs and Lease Sales not Part of this Program.

3.1.1.1. Exploration

Exploration may include the conduct of geophysical surveys and drilling of exploration wells. During geophysical surveys, typically seismic surveys, one or more airguns (or other sound sources) are towed behind a ship 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 typically are towed behind the survey ship. While most of the energy is focused downward and the short duration of each pulse limits the total energy into the water column, the sound can propagate horizontally and vertically for several kilometers depending on water depth, seafloor type, and oceanographic conditions (Greene and Richardson, 1988; Hall et al., 1994).

One or more exploratory wells may be drilled to confirm the presence and determine the viability of potential hydrocarbon reservoirs identified by the geophysical survey. Exploration drilling operations are likely to employ mobile offshore drilling units (MODUs). Examples of MODUs include drillships, semisubmersibles, and jack-up rigs (**Figure 3.1-2**). Drilling operations vary in length and operational scale at different wellsites, but often are between 30 and 60 days, depending on the depth of the well, delays encountered during drilling, and time needed for well logging and testing operations.

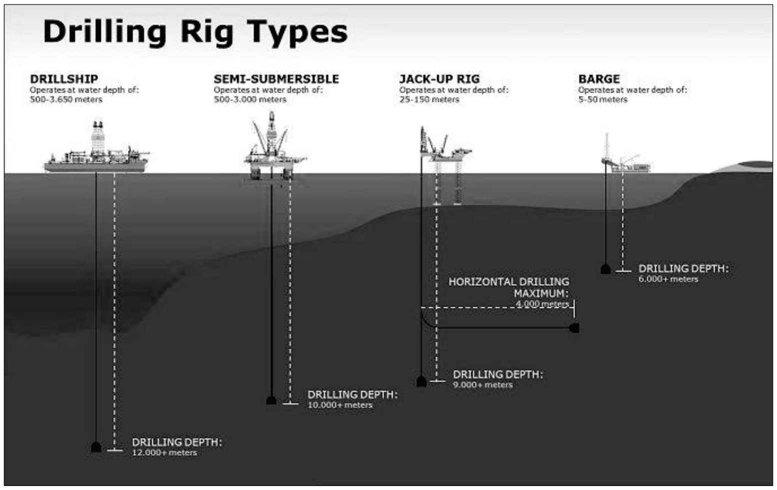


Figure 3.1-2. Representative Rigs used in OCS Exploration Drilling. Special Rigs may be Employed for use in the Arctic to Better Manage Different Ice States (From: http://www.maerskdrilling.com/en/about-us/the-drilling-industry).

After a discovery is made by an exploratory well, an operator will often drill delineation wells to determine the areal extent of the reservoir. Operators can verify that sufficient volumes of hydrocarbons are present to justify the expense of proceeding to development.

Prior to drilling exploration wells, operators will be required to examine the proposed exploration drilling locations for geologic hazards, archaeological features, and biological populations, using various techniques such as geohazard seismic surveys and geotechnical studies. The suite of equipment used during a typical shallow hazards survey consists of single-beam and multibeam echosounders that provide water depths and seafloor morphology; side-scan sonar that provides acoustic images of the seafloor; and a subbottom profiler, boomer, and airgun system that provide for a range of subseafloor penetration to detect geologic hazards such as shallow gas. Magnetometers, to detect ferrous items, also may be deployed. Typical acoustic characteristics of these sources are described in Richardson et al. (1995), Hildebrand (2009), and California State Lands Commission (2013). **Section 3.5** identifies the IPFs associated with exploration.

3.1.1.2. Development

Once exploration has confirmed the presence of a commercially viable reservoir, the next phase of activities includes the construction of the production platform and drilling of development (or production) wells. Temporarily abandoned exploration wells also may be re-entered and completed for production. Development wells are drilled using MODUs. Production platforms may be fixed, floating, or, in deep water, subsea (**Figure 3.1-3**). 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 typical in waters deeper than 400 m (1,312 ft). Floating platforms are attached to the seafloor using line-mooring systems and anchors. The type and scale of platform installed will depend on the water depth of the site, oceanographic and ice conditions, the expected facility lifecycle, the type and quantity of hydrocarbon product (e.g., oil or gas) expected, the number of wells to be drilled, and use of subsea tie-backs.

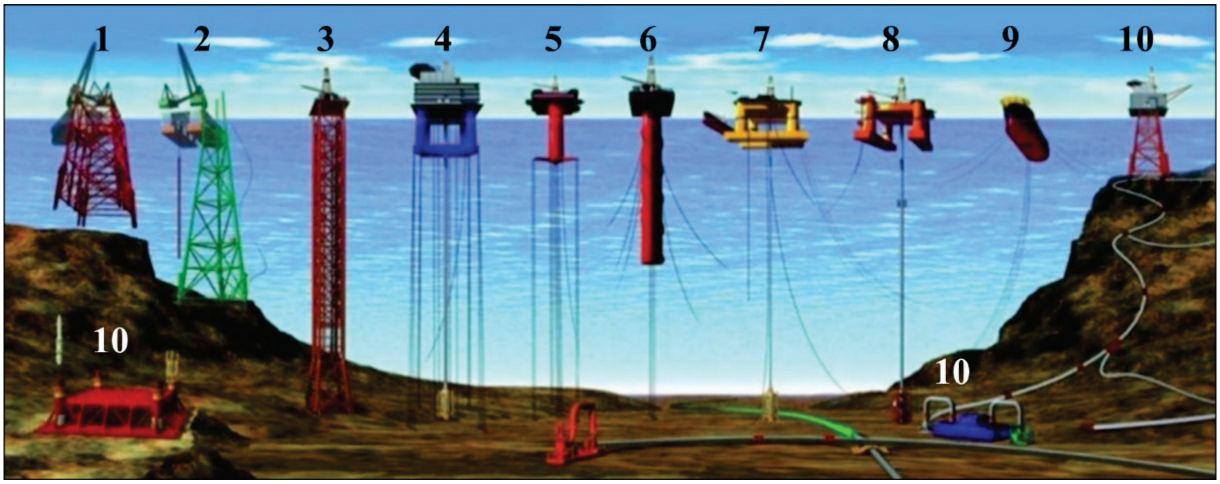


Figure 3.1-3. Representative Oil and Gas Structures Include (left to right): (1,2) Fixed Platforms; (3) Compliant Tower; (4,5) Vertically Moored Tension Leg and Mini-Tension Leg Platform; (6) Spar; (7,8) SemisSubmersibles; (9) Floating Production, Storage, and Offloading Facility; and (10) Subsea Completion and Tie-Back to Platform. Special Platforms or Gravel Islands (not shown) may be Employed for use in the Arctic to Better Manage Different Ice States (From: NOAA Ocean Explorer, 2010).

Development will 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 1 m (3 ft) below the mudline. Pipelines may be buried (trenched) in deeper waters, depending on conditions along the subsea pipeline corridor. Additional requirements are necessary in ice-prone OCS areas to avoid damage from ice gouging and ice keels.

Prior to drilling development wells, constructing platforms, or installing pipelines, operators will be required to examine the proposed locations for site clearance, including geologic hazards, archaeological features, and biological populations, using various techniques such as geohazard seismic surveys and geotechnical studies. **Section 3.5** identifies the IPFs associated with development.

3.1.1.3. Production

Oil production and well maintenance follow drilling and completion of development wells and platform construction. Additional development wells may be drilled and completed once a platform is constructed and other wells have begun producing.

Following completion of the production wells and platform, the facilities are operated to extract the hydrocarbon resource and transport it to processing facilities. Historically, the processing facilities have been onshore. In recent years, offshore processing facilities, including floating production, storage, and offloading (FPSO) and liquefied natural gas (LNG) processing facilities, have played a role in storage and processing as well. During the operation phase, activities center on the maintenance of production wells (workover operations) and platforms. Pipelines are inspected and cleaned regularly by internal devices (pipeline inspection gauges or “pigs”).

To maintain reservoir pressure and aid in oil and gas recovery, gas (in the case of oil production) and water will be reinjected into the reservoirs by service wells until the oil is depleted. Operators will continue to re-inject produced water throughout production operations. A commonly used well stimulation technique that has been used in the Gulf of Mexico for more than 25 years is the “frac pack” completion process. This technique, which is typically used for moderate- to high-permeability reservoirs, is used to reduce the movement of sand and other fine particulate matter within the reservoir, reduce the concentration of sand and silt in the produced fluids, improve the flow of reservoir fluids into the wellbore, increase production rates, and maximize production efficiency. **Section 3.5** identifies the IPFs associated with development.

3.1.1.4. Decommissioning

Following lease termination or relinquishment, all facilities and seafloor obstructions usually are removed. Facilities and obstructions may include platforms, production and pipeline risers, umbilicals, anchors, mooring lines, wellheads, well protection devices, subsea trees, and manifolds. Typically, wells will be permanently plugged with cement below the sediment surface and the wellhead equipment removed. Processing modules will be moved off the platforms. The platform is frequently disassembled and removed from the area, and the seafloor will be restored to some practicable pre-development condition. Bottom-founded infrastructure generally is severed at least 5 m (16 ft) below the mudline. Production infrastructure may be removed using explosive or nonexplosive methods. In the Gulf of Mexico, rigs-to-reef programs provide alternatives for in-water placement of suitably sized and cleaned platform components. After a pipeline is purged of its contents, it may be decommissioned in place or physically recovered. Pipelines that are out of service for <1 year must be isolated at each end. When out of service for >1 year but <5 years, a pipeline must be flushed and filled with inhibited seawater. Pipelines out of service for >5 years may be decommissioned in place, but only if multiple use conflicts do not limit such a practice, such as oil and gas pipelines located within critical sand resources areas on the shallow Gulf of Mexico shelf. Geophysical surveys would be required to confirm that no debris remains and pipelines were decommissioned properly. **Section 3.5** identifies the IPFs associated with decommissioning.

3.1.1.5. Supporting Oil and Gas Infrastructure Facilities

Various infrastructure is required to support the production of oil and gas: ports and support facilities, construction facilities, transportation, and processing facilities. Coastal oil- and gas-related infrastructure has developed over many decades in the Gulf of Mexico and is not subject to rapid fluctuations because of a new program. A mature area like the Gulf of Mexico will not require a significant investment in new infrastructure as compared to the potential build-out or tailoring or transport of product and wastes necessary in frontier areas like the Atlantic or Arctic (Commonwealth of Virginia, 2015). A detailed discussion describing supporting oil and gas infrastructure can be found in Dismukes (2011, 2014).

Port Facilities: Ports are major maritime staging areas for movement between onshore industries and infrastructure and OCS leases. Ports play a vital role in supporting the maritime industry, specifically the offshore exploration and production sector. Vehicles that support offshore platforms (notably ships, barges, and helicopters) are based and maintained at ports. Ports act as launching points for delivery and transfer of the necessary structures, equipment, supplies, crew, and other important products to offshore installations. OCS exploration, development, and production operations depend heavily on a readily available supply of these goods and services, making ports an invaluable centralized location for meeting logistical needs. In general, there are two major types of port facilities: (1) deep-draft seaports, and (2) inland river and intracoastal waterway port facilities. Deep-draft seaports are ports that accommodate mostly ocean-going vessels and, for exploration and production activities, are the ones most likely to serve and supply infrastructure.

Support Facilities: Support facilities are multi-varied service providers that support OCS activities, including supply bases, repair and maintenance yards, and crew support services. Transportation facilities such as heliports also support the industry; transportation is discussed later in this section. Support facilities may take many forms; however, one common feature is close proximity to or integration with a port. Oil spill response equipment must be strategically and regionally staged at response centers or service bases along the coast, including spill response vessels. In the Arctic, oil spill response equipment is regionally staged; however, due to the remoteness, exploration and development drilling programs also necessitate the added precaution and mobilization of specific oil spill containment, response, and cleanup vessels and equipment in case of an incident.

Repair and Maintenance Yards: These support facilities usually are located at platform fabrication facilities or shipyards and are focused on maintaining vessels and equipment for drilling and production activities. These must be situated with access to sufficient channel size to accommodate a given vessel type. Yards with the capacity to handle larger vessels tend to be less common and often geographically distant from a given exploration and production activity.

Crew Services: These companies provide services to crews living on offshore rigs, including catering, laundry services, and on-site paramedics.

Heliports: Heliports are located throughout the U.S., but those that service the offshore oil and gas industry are more prevalent in the Gulf of Mexico region. Offshore helicopter support is most often used for personnel transfer, medical evacuation, and delivery of small parts and supplies. Helicopters used in this way generally have a range of 483 to 805 km (300 to 500 mi), depending on their size and configuration. Due to the high hourly cost of helicopter operations, OCS service companies locate their heliports as close to the center of drilling and production as is practical (Commonwealth of Virginia, 2015).

Construction Facilities

Platform Fabrication Yards: These are facilities where platforms are constructed and assembled for transportation to OCS areas. Such facilities may be used for maintenance and storage. Traditionally, platform fabrication yards are located onshore near intracoastal waterways. However, there is some potential to locate certain assembly operations directly offshore to minimize costs and maximize flexibility.

Shipyards and Shipbuilding Yards: Such yards have facilities where ships, drilling platforms, and crew boats are constructed and maintained. These facilities range in size from those that construct or repair small vessels for coastal or inland use to those that focus on construction or maintenance of large ocean-going naval and commercial ships. The repair facilities vary in size, from those with topside capability (i.e., tending to vessels while still afloat) to those that have dry-docking capability for small ships, boats, and barges and those that have dry-docking capability for large ocean-going vessels, which, like repair yards, are often less abundant than the smaller yards.

Pipecoating Facilities and Yards: Pipelines that transport oil and natural gas from offshore production locations have exterior coatings to protect against corrosion and other types of physical damage. Pipes may be treated with interior coatings to protect against corrosion from the fluids moving within them or to improve flow rates. Offshore oil and natural gas pipes are often coated with a layer of concrete to increase line weight to ensure stability on and in the seafloor.

Transportation

OCS Support Vessels: OCS support vessels serve exploratory and development drilling rigs and production facilities through offshore and subsea construction support, installation, and decommissioning activities. OCS support vessels are unique in that they are designed for cargo-carrying flexibility and transport of deck cargo (e.g., pipe, equipment, or drummed material), mud, potable and drinking water, diesel fuel, dry bulk cement, and personnel. There are seven major types of offshore support vessels: tugs, marine platform supply vessels, anchor handling tug and supply vessels, fast support vessels, lift boats, mini-supply vessels, and FPSOs.

Shuttle Tankers: Before establishing an OCS pipeline network to support development, double-hulled oil tankers may be necessary to transport crude oil to shore. Shuttle tankers are used when economics or site conditions prevent installation of an export pipeline. Shuttle tankers are specialized ships built to transport crude oil and condensate from offshore oil field installations to onshore terminals and refineries and are often referred to as “floating pipelines” (Commonwealth of Virginia, 2015).

Navigation Channels: Deep and wide navigation channels for accessing ports, yards, and refineries are particularly important for the OCS support industry’s ports, especially as a new generation of larger boats is built to service deepwater installations. Improving and maintaining navigation channels is critical to sustaining the rapidly growing marine transport industry.

Pipelines: Pipelines transport oil and gas from OCS facilities to onshore processing sites and ultimately to end users. The movement of natural gas and other hydrocarbons from producing regions to consumption regions requires an extensive and elaborate transportation system. In many instances, natural gas produced from a particular well travels long distances before it reaches the location where it is further processed or used.

Processing Facilities

Natural Gas Processing Facilities: These sites process natural gas and separate it into its component parts for the market. All natural gas is processed in some manner to remove unwanted water vapor, solids, and other contaminants that would interfere with its pipeline transportation or sale. The total number of gas processing plants operating in the U.S. has been declining over the past several years as companies merge, exchange assets, and close older, less efficient plants (USEIA, 2012).

Natural Gas Storage Facilities: Natural gas storage facilities store processed natural gas for use during peak periods. Generally, underground natural gas storage is filled during low-use (off-peak) periods (April to October) and withdrawn during high-use (peak) periods (winter).

LNG Facilities: Large marine-based LNG terminals have been proposed onshore and offshore across different areas of the coastal U.S. Additional information about LNG terminals can be obtained from the Federal Energy Regulatory Commission and U.S. Maritime Administration.

Refineries: Refineries are industrial facilities that process crude oil into numerous end-use and intermediate-use products. A refinery is an organized arrangement of manufacturing units designed to produce physical and chemical changes that turn the different varieties of crude oil into final petroleum products. Refineries remove most of the non-hydrocarbon substances from crude oil and break down the remaining hydrocarbons into various components that are blended into useful refined products. Refineries vary in size, sophistication, and cost, depending on their location, crude input types, and the products they manufacture.

Waste Management Facilities: These sites process drilling and production wastes associated with oil and gas activities (Dismukes, 2011, 2014). Several different types of wastes are generated by oil and gas exploration and production activities. Some wastes are common to most commercial-scale operations (e.g., disposal of garbage, sanitary waste [toilets], and domestic waste [sinks, showers]), while other wastes are unique to the oil and gas exploration and production industry (e.g., disposal of different types of drill fluids, cuttings, and produced water). While some wastes can be discharged on site, many others must be transported to shore-based facilities for reclamation, storage and disposal, or transfer to longer-term storage sites. The most common methods of disposal of oil and gas exploration and production waste include subsurface injection into salt caverns or other subsurface reservoirs, sea discharge, and onshore disposal.

3.1.2. Exploration and Development (E&D) scenarios

Exploration and development (E&D) scenarios are coarse estimates of the types, location, and timing of oil- and gas-related activities that may result from a Five-Year Program following lease sales. E&D scenarios are useful to understand the content and intensity of potential environmental effects that may occur. E&D scenarios describe the potential resources available for leasing and how those potential resources would be explored, developed, and produced if found. Factors such as oil and gas resource potential, economic viability, and historical activity data are considered during preparation of E&D scenarios.

E&D scenarios were developed around three different possible price scenarios: a low price scenario—$40 per barrel (bbl) of oil and $2.14 per million cubic feet (mcf) of natural gas; a mid-price scenario—$100 per bbl of oil and $5.34 per mcf of natural gas; and a high price scenario—$160 per bbl of oil and $8.54 per mcf of natural gas. The three price scenarios include a range of prices that capture the range of volatility that can be expected over the life of the program. The price scenarios are not intended to be an exact forecast of oil or gas prices at the time of the Program decision. The three price scenarios are determined from short- and long-term price forecasts by the USEIA as well as historical price trends. The price of oil (per bbl) ranges between $40 and $160, representing the 95 percent confidence interval of oil prices. Gas prices were determined using a 0.3 gas-oil equivalency factor based on current and forecast market conditions. The Programmatic EIS considers the potential effects of OCS activities that could result depending on the full range of different price scenarios.

3.1.2.1. Alaska Program Areas

Single lease sales are considered in each of the following Program Areas:

- Beaufort Sea Program Area;
- Chukchi Sea Program Area; and
- Cook Inlet Program Area.

Ice state and open water accessibility largely dictates the window for exploration and development drilling, platform and structure construction, and pipeline installation in the Arctic (**Figure 3.1-4**). Open water season, although variable, generally runs from June/July through October when the ice pack recedes. Operational restrictions related to the Chukchi ice leads, well containment capability, and spill response measures generally constrain access to July through October. Once a production facility is operational, operations would occur year-round, but access would be limited to transport over ice or by helicopter. Operations at remote locations require transportation of supplies and personnel by different means, depending on seasonal constraints and phase of the operations. During winter months, ice conditions may prevent the use of vessels (including supply or service vessels) for production activities. Under these conditions, helicopters would be used for basic resupply and crew rotation operations. While Cook Inlet experiences broken ice in winter, winter weather conditions may limit operations by logistics or the additional expense required to conduct winter operations.

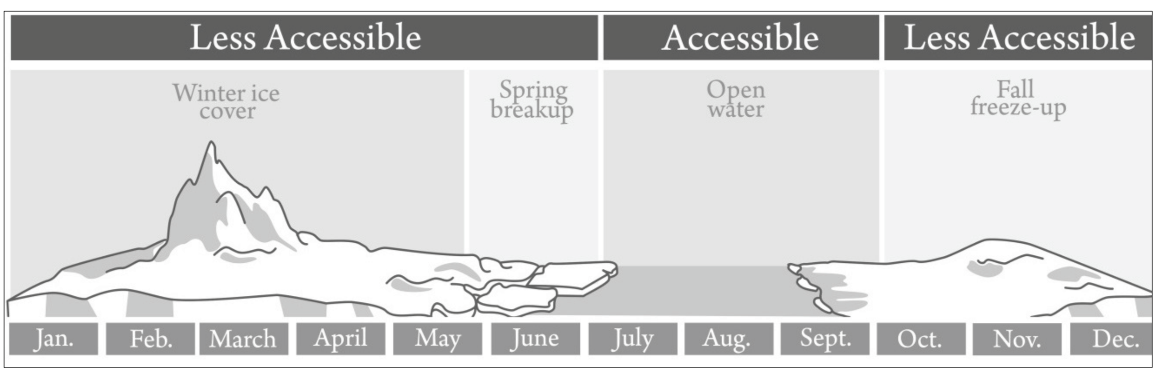


Figure 3.1-4. Simplified Illustration of Timing and Variability of Ice and Sea State in the Arctic Limits Vessel-Based Access for Exploration and Development Activities. Ice-Breaking Capabilities or Changing Climate may Influence Open Water Access over the Life of the Program (Modified from: Pew Charitable Trusts, 2013).

Another critical factor in the Arctic is how to transport oil and gas produced to markets. Oil produced at the platforms generally will be delivered via trenched subsea pipelines to existing or new onshore facilities. The Chukchi Sea Planning Area has no existing oil and gas infrastructure or transportation system for oil and gas. Not only would all the offshore platforms, wells, and pipelines have to be constructed, but Arctic onshore support facilities such as airfields, docks, storage, and processing facilities must be built if development and production are to occur. Unlike the Chukchi Sea Planning

Area, the Beaufort Sea Planning Area has an existing network of onshore oil and gas infrastructure and a transportation system for oil based out of Prudhoe Bay, Alaska. This allows for potential sharing of existing support facilities. In both areas, elevated onshore pipelines will convey the oil and gas from the landfall facilities to production facilities at Prudhoe Bay for ultimate entry to the Trans-Alaska Pipeline System (TAPS). Natural gas produced from Alaska's North Slope is currently separated from the oil and, minus the gas used to operate facilities, is reinjected into the producing reservoirs. Once 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. Another new pipeline would be required to transport gas from shore. Natural gas from the Chukchi and Beaufort Seas may be transported from shore by new and existing aboveground pipelines to a main transportation hub near Prudhoe Bay, based on the assumption that a natural gas pipeline connecting the North Slope with southern Alaska would be in place and operational. As this gas pipeline is not yet funded, all Arctic production scenarios assume that gas would be reinjected into the reservoirs until oil reserves are depleted and or a gas pipeline is operational.

Beaufort Sea Program Area

The Proposed Action in the Beaufort Sea Program Area focuses on exploration and development of two prospects, each associated with a separate geologic play. **Table 3.1-1** provides an overview of exploration, development, and production activities that may occur. Note that under the low price scenario only exploration would occur.

Table 3.1-1. E&D Scenario Summary for the Beaufort Program Area. Range Reflects Low to High Price Scenarios.

Scenario Element	Beaufort Sea
Number of sales	1
Years of activity	60 to <70
Oil (Bbbl)	0 to 3.7
Natural gas (tcf)	0 to 6.4
Exploration and delineation wells	25 to 90
Development and production wells	0 to 1,840
Platforms/structures	0 to 25
New offshore pipeline miles	0 to 410 oil, 410 gas
New onshore pipeline miles	0 to <10
Vessel trips	Varies with phase of activity
Helicopter operations	Varies with phase of activity
New pipeline landfalls	0 to <10

Note: Values have been rounded for presentation.
Bbbl = billion barrels; tcf = trillion cubic feet.

Exploration

Two-dimensional (2D) and three-dimensional (3D) seismic surveys would begin 2 to 3 years prior to a lease sale, enabling operators to determine which offered OCS lease blocks are of greatest interest. Approximately 5 to 12 different geophysical surveys will occur over a period of 10 to 25 years before the lease sale or on lease. The typical 2D exploration survey would collect approximately 9,656 km (6,000 line mi), whereas a 3D exploration survey would cover approximately 100 OCS lease blocks. Thereafter, operators would conduct smaller-scale geohazard surveys and geotechnical studies in advance of exploration drilling or site-specific operations. Similar smaller-scale surveys typically are required for development drilling, platform and pipeline installation, and decommissioning. Approximately 7 to 70 geohazard and geotechnical surveys (in total) would be conducted in the Beaufort Sea Program Area within 30 years of the lease sale. Exploration drilling would begin within a few years after the lease sale and extend approximately 15 years (**Figure 3.1-5**). Exploration drilling operations are most likely to employ MODUs, such as jack-up rigs or drillships, but it is possible that artificial ice islands would be used as a cost-effective alternative in the shallowest water depths. **Figure 3.1-6** shows where exploration activities may occur under a mid-price scenario. Because of severe winter ice conditions, it is assumed that exploration and development drilling would be limited to the shelf and would occur only in the open water season. Most exploration and development operations would involve mobilization of operation-specific oil spill containment and response equipment given the remote nature and challenging operating environment of the Arctic.

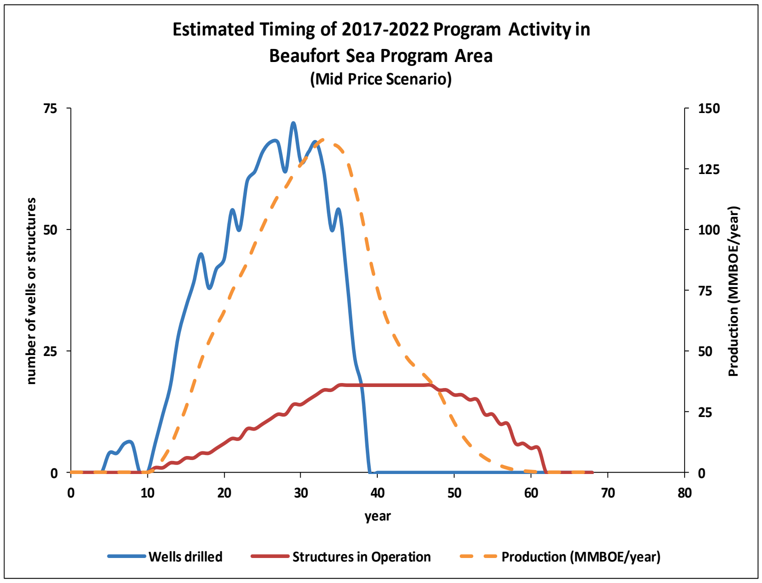


Figure 3.1-5. Timing and Magnitude of Wells, Structures in Operation, and Production in the Beaufort Sea Program Area, Mid-Price Scenario; Year 0 = 2017.

Development

Compared to offshore development in the Chukchi Sea OCS, development in the Beaufort Sea OCS is expected to require significantly more wells. This is related to distribution and characteristics of the reservoirs and geologic formations. Although highly dependent on market forces, up to 1,840 development wells may be drilled within 35 years of the lease sale (**Table 3.1-1**). Water depth, sea conditions, and ice conditions are important factors in selecting a platform type. In waters shallower than 10 m (33 ft), the most likely production platform would be a reinforced gravel island. For water depths up to 100 m (330 ft), a larger bottom-founded structure such as a concrete gravity base structure would likely be used. There are no subsea wells identified in the scenario due to the lower well yields expected and relatively shallower water depths where leasing is most likely to occur. In addition, the short open-water season makes performing maintenance or repair work on subsea wells impractical if they have to be shut in for extended periods to time due to seasonal inaccessibility issues.

Production

Hydrocarbon production in the Beaufort Sea would begin around 2030 and end almost 50 years later. Hydrocarbon production would gradually increase during the first 20 years and decrease thereafter (**Figure 3.1-5**). **Figure 3.1-6** shows the total number of structures in operation and annual for the mid-price scenario. Gas and water would be reinjected into the reservoirs by service wells until the oil is depleted. As each oil well becomes depleted, it would be recompleted as a gas well. Gas production would be assumed to start around 2045 to 2050.

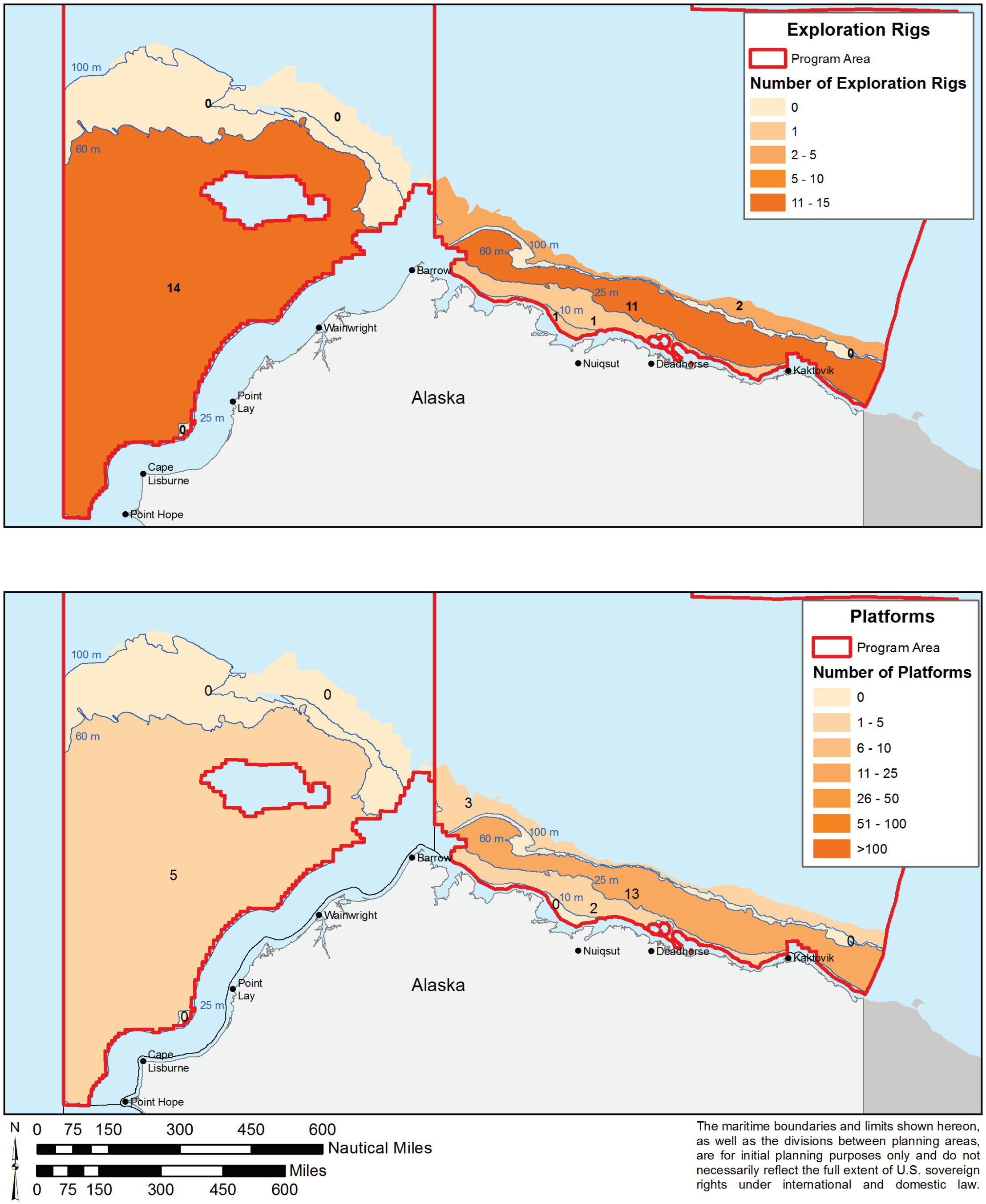


Figure 3.1-6. Estimated Distribution of OCS Exploration (*Top*: Exploration Rigs) and Development/Production (*Bottom*: Platforms) by Depth Range in the Beaufort and Chukchi Program Areas for the Mid-Price Scenario. Color Scale is Consistent Across Similar Figures to Illustrate Relative Differences in Platforms Across Program Areas.

Pipelines

Subsea pipelines would connect the platforms to existing facilities located nearshore. The existing facilities at Prudhoe Bay connect with TAPS; any gas pipelines would connect with the proposed gas pipeline to carry gas from Prudhoe Bay to south-central Alaska. New offshore and onshore pipelines are described in **Table 3.1-1**.

Decommissioning

Removal of infrastructure would occur within approximately 60 years of the lease sale (around year 2080). Gravity-based structures would be disassembled and moved offsite; subsea pipelines would be decommissioned by cleaning the pipeline, plugging both ends, and leaving them buried in the seafloor. Geophysical surveys would be required to confirm that no debris remained and pipelines were decommissioned properly.

Chukchi Sea Program Area

The Chukchi Sea Program Area scenario reflects the activity level that is assumed to occur after the development of the Chukchi Sea anchor field and two satellite fields first described in the Second Supplemental EIS for Chukchi Sea Lease Sale 193 (USDOI, BOEM, 2015d). The cumulative scenario highlighted in **Section 3.6.3** accounts for the activities apportioned to Lease Sale 193. Exploration and development, assumed to stem from this Program, would be able to use the infrastructure installed for the larger anchor field, although recent industry decisions may warrant reconsideration of such an assumption at the lease sale phase when a more definitive trend may be clear. **Table 3.1-2** provides an overview of exploration, development, and production activities that may occur. Note that under the low price scenario only exploration would occur.

Table 3.1-2. E&D Scenario Summary for the Chukchi Program Area. Range Reflects Low to High Price Scenarios.

Scenario Element	Chukchi Sea
Number of sales	1
Years of activity	60 to <70
Oil (Bbbl)	0 to 2.8
Natural gas (tcf)	0 to 3
Exploration and delineation wells	10 to 30
Development and production wells	0 to 500
Platforms/structures	0 to 6
New offshore pipeline miles	0 to 120
New onshore pipeline miles	0 to 300 oil, 300 gas
Vessel trips	Varies with phase of activity
Helicopter operations	Varies with phase of activity
New pipeline landfalls	0 to 2

Note: Values have been rounded for presentation.
Bbbl = billion barrels; tcf = trillion cubic feet.

Exploration

2D and 3D seismic surveys would begin several years prior to a lease sale. Approximately 2 to 5 different seismic surveys will occur over a period of 10 to 20 years. The typical 2D survey would collect approximately 9,656 km (6,000 line mi), whereas a 3D survey would cover approximately 100 OCS lease blocks.

Prior to exploration drilling, operators would conduct geohazard surveys and geotechnical studies. Similar surveys typically are required for development drilling, platform and pipeline installation, and decommissioning. Approximately 4 to 16 geohazard and geotechnical surveys (in total) would be conducted in the Chukchi Sea Program Area within 20 years of the lease sale. Exploration drilling would begin around 2025 with exploratory drilling extending approximately 15 to 20 years (**Figure 3.1-7**). Exploration drilling operations are most likely to employ drillships or jack-up rigs. **Figure 3.1-6** shows where exploration activities may occur under a mid-price scenario. Because of severe winter ice conditions, it is assumed that exploration and development drilling would be limited to the shelf and would occur only in the open water season. Similar to the Beaufort, most exploration and development operations would involve mobilization of operation-specific oil spill containment and response equipment given the remote nature and challenging operating environment.

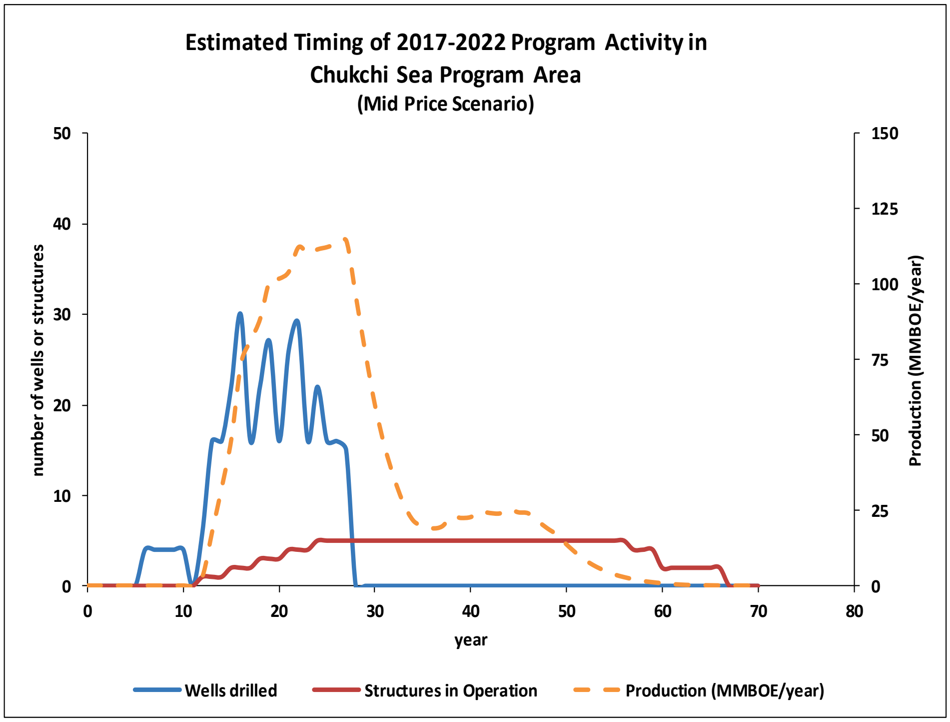


Figure 3.1-7. Timing and Magnitude of Wells, Structures in Operation, and Production in the Chukchi Sea Program Area, Mid-Price Scenario; Year 0 = 2017.

Development

Compared to an offshore development in the Beaufort Sea OCS, development in the Chukchi Sea OCS is expected to require fewer wells. This is related to distribution and characteristics of the reservoirs and geologic formations expected to be explored and discovered as a result of the Program subsequent to activities related to Lease Sale 193. Although highly dependent on market forces, up to 500 development wells may be drilled within 25 years of the lease sale (**Table 3.1-2**). There are no subsea wells identified in the scenario. All platforms are expected to be constructed in water depths less than 60 m (200 ft) (**Figure 3.1-6**). Production operations will use large gravity-based structures with trenched subsea pipelines to transport the oil to landfalls.

Production

Hydrocarbon production in the Chukchi Sea would begin around 2030 and end almost 50 years later. Hydrocarbon production gradually would increase during the first 15 years and would decrease thereafter (**Figure 3.1-7**). **Figure 3.1-7** shows the total number of structures in operation and annual production for the mid-price scenario. Gas and water would be reinjected into the reservoirs by service wells until the oil is depleted. As each oil well becomes depleted, it would be recompleted as a gas well. Gas production would be assumed to start around 2045 to 2050.

Pipelines

Subsea pipelines would connect the platforms to existing facilities located nearshore. An additional 483 km (300 mi) of overland oil pipeline would have to be constructed to connect the Chukchi Sea OCS to TAPS at Prudhoe Bay. Gas production from the Chukchi Sea OCS would have to be transported via a 483-km (300-mi) overland gas pipeline to Prudhoe Bay to connect with the proposed gas pipeline to southern Alaska. The existing facilities at Prudhoe Bay connect with TAPS; any gas pipelines would connect with the proposed gas pipeline to carry gas from Prudhoe Bay to south-central Alaska. New offshore and onshore pipeline are described in **Table 3.1-2**.

Decommissioning

Removal of infrastructure would occur within approximately 60 years of the lease sale. Gravity-based structures would be disassembled and moved offsite; subsea pipelines would be decommissioned by cleaning the pipeline, plugging both ends, and leaving them buried in the seafloor. Geophysical surveys would be required to confirm that no debris remained and pipelines were decommissioned properly.

Cook Inlet

One sale would be held in 2021 in the northern portion of the Cook Inlet Planning Area. Although there has been no oil and gas activity in the Cook Inlet OCS, there is an available market nearby for oil and gas. 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. OCS activities may occur in the Cook Inlet Planning Area related to Lease Sale 244, which is scheduled to be held in 2017 under the 2012-2017 OCS Oil and Gas Leasing Program.

Unlike Arctic OCS areas with limited infrastructure, the gas associated with oil production in Cook Inlet can be brought to market at the same time as the oil production. **Table 3.1-3** provides an overview of exploration, development, and production activities that may occur.

Table 3.1-3. E&D Scenario Summary for the Cook Inlet Program Area. Range Reflects Low to High Price Scenarios.

Scenario Element	Cook Inlet
Number of sales	1
Years of activity	<35
Oil (Bbbl)	0.08 to 0.34
Natural gas (tcf)	0.04 to 0.15
Exploration and delineation wells	5 to 15
Development and production wells	30 to 100
Platforms/structures	2 to 5
New offshore pipeline miles	90 to 190
New onshore pipeline miles	0
Vessel trips	Varies with phase of activity
Helicopter operations	Varies with phase of activity
New pipeline landfalls	1 to 5

Note: values have been rounded for presentation.
Bbbl = billion barrels; tcf = trillion cubic feet.

Exploration

3D seismic surveys would begin several years prior to the lease sale. Approximately two to three different seismic surveys will occur coincident with the lease sale. A 3D survey would cover approximately 30 to 60 OCS lease blocks.

Prior to exploration drilling, operators would conduct geohazard surveys and geotechnical studies. Similar surveys typically are required for development drilling, platform and pipeline installation, and decommissioning. Approximately 6 to 15 geohazard and geotechnical surveys (in total) would be conducted in the Cook Inlet Program Area within 10 years of the lease sale. Exploration drilling would begin around 2025 with exploratory drilling extending less than 10 years (**Figure 3.1-8**). Exploration drilling operations are most likely to employ jack-up rigs.

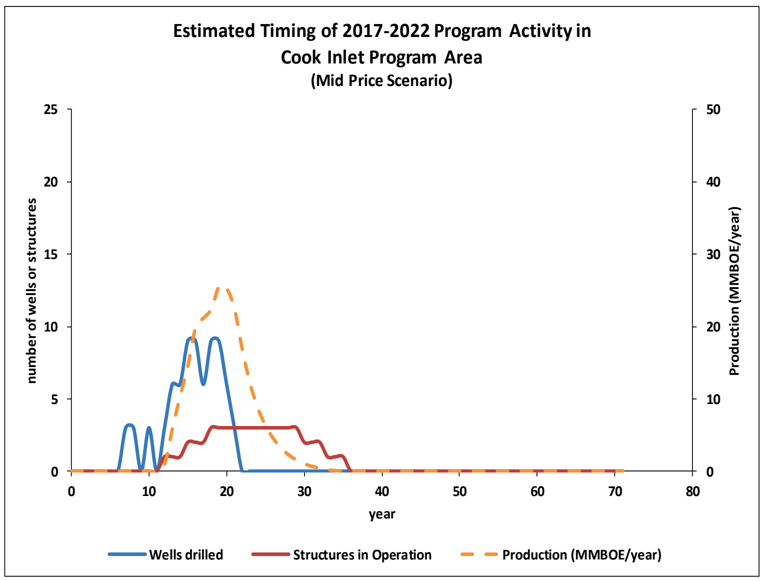


Figure 3.1-8. Timing and Magnitude of Wells, Structures in Operation, and Production in the Cook Inlet Program Area, Mid-Price Scenario; Year 0 = 2017.

Development

Although highly dependent on market forces, up to 100 development wells may be drilled within 20 years of the lease sale (**Table 3.1-3**). There are no subsea wells due to strong tides. Only two to five platforms are expected to be constructed in water depths less than 100 m (330 ft) (**Table 3.1-3**). Production operations will use fixed, jacketed platforms with trenched subsea pipelines to transport the oil to landfalls.

Production

Hydrocarbon production in the Cook Inlet would begin before 2030 and end almost 20 years later. **Figure 3.1-8** shows the total number of structures in operation and annual production for the mid-price scenario.

Pipelines

The preferred method to transport oil and gas from the platform would be subsea pipelines to the nearest landfall location, probably on the southern Kenai Peninsula near Homer or Nikiski, depending on where the first commercial oil discovery is located. It is not anticipated that any of the production facilities would be able to use any existing pipelines. Approximately 72 to 152 km (45 to 95 mi) of oil and gas offshore pipeline would need to be installed.

Decommissioning

Removal of infrastructure would occur within approximately 35 years of the lease sale. Fixed structures would be disassembled and moved offsite; subsea pipelines would be decommissioned by cleaning the pipeline, plugging both ends, and leaving them buried in the seafloor. Geophysical surveys would be required to confirm that no debris remained and pipelines were decommissioned properly.

3.1.2.2. Gulf of Mexico Program Area

The Gulf of Mexico Program Area being considered for leasing largely includes the Central and Western Planning Areas; a small number of OCS lease blocks in the Eastern Planning Area is also included. The area not included in the Gulf of Mexico Program Area is the portion of the Eastern Planning Area within 201 km (125 mi) of Florida, all areas in the Gulf of Mexico east of the Military Mission Line (86°41' W longitude), and the area within the Central Planning Area within 161 km (100 mi) of Florida. Ten region-wide sales would be held in the Gulf of Mexico Program Area. **Table 3.1-4** provides an overview of exploration, development, and production activities that may occur.

Table 3.1-4. E&D Scenario Summary for the Gulf of Mexico Program Area. Range Reflects Low to High Price Scenarios.

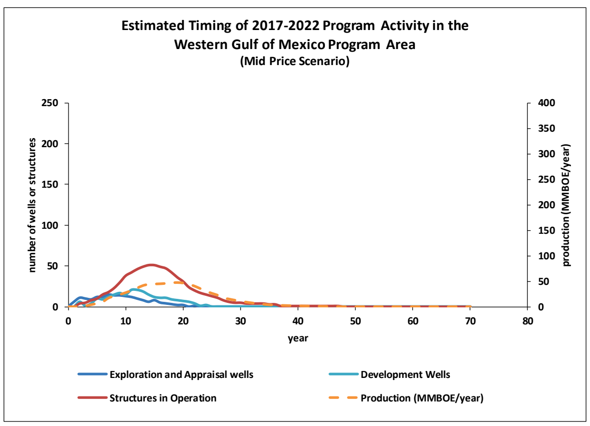
Scenario Element	Gulf of Mexico
Number of sales	10
Years of activity	<50
Oil (Bbbl)	2.1 to 5.6
Natural gas (tcf)	5.5 to 22
Exploration and delineation wells	375 to 4275
Development and production wells	425 to 3750
Platforms/structures	90 to 1350
Subsea structures	50 to 165
Floating, production, storage, and offloading (FPSOs)	0 to 2
New pipeline miles	1,800 to 6,500
Vessel trips (thousands of round trips)	200 to 2,500
Helicopter operations (1,000 operations)	600 to 18,000
New pipeline landfalls	0 to 10
New onshore facilities	0
New natural gas processing facilities	0 to 3

Note: values have been rounded for presentation.
Bbbl = billion barrels; tcf = trillion cubic feet.

In the Gulf of Mexico, substantially more E&D activity would occur in the Central Planning Area compared to the Western Planning Area (**Figure 3.1-9**). Oil and natural gas production is distributed across the shelf and slope in the Gulf of Mexico. Relatively more exploration and development drilling and structure installation (not including subsea structures) would occur on the shelf (in depths <200 m [660 ft]) than in deep water. In comparison, most oil production (>90 percent) would come from deepwater (>200 m [660 ft]) areas (**Table 3.1-5**). A combination of factors such as the availability of leasing acreage, hydrocarbon resource potential, scalability of operations, economic viability, and diverse business strategies drive these trends. In general, deepwater reservoirs and fields tend to have greater oil and natural gas potential; the cost to explore and develop those resources is substantially greater. This results in relatively few wells and platforms targeted on high oil and gas producers.

Table 3.1-5. Depth Distribution Within the Gulf of Mexico Program Area; Mid-Price Scenario.

OCS Depth Zone	Geographic Province	Percent Wells		Percent Platforms		Percent Gas Production		Percent Oil Production	
		Shelf or Slope Area	Depth Zone Area	Shelf or Slope Area	Depth Zone Area	Shelf or Slope Area	Depth Zone Area	Shelf or Slope Area	Depth Zone Area
0 to 60 m (0 to 197 ft)	Shelf	76	51	95	68	31	20	3	2
60 to 200 m (197 to 656 ft)			25		27		11		1
200 to 800 m (656 to 2,625 ft)	Slope	24	8	5	1	69	7	97	10
800 to 1,600 m (2,625 to 5,249 ft)			7		1		26		28
1,600 to 2,400 m (5,249 to 7,874 ft)			4		1		15		27
>2,400 m (>7,874 ft)			5		1		20		30



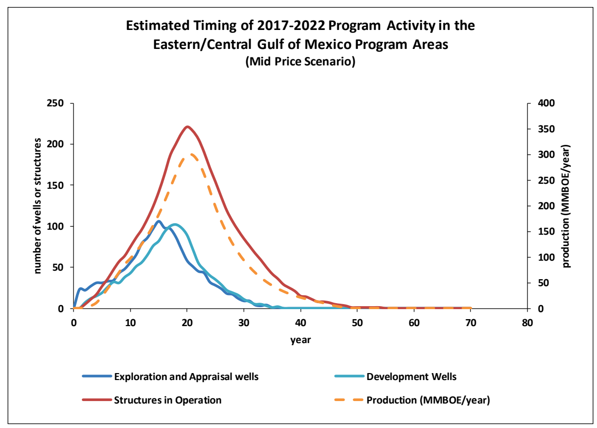


Figure 3.1-9. Timing and Magnitude of Exploration and Appraisal Wells, Development Wells, Structures in Operation, and Production in the Gulf of Mexico Program Area, Mid-Price Scenario. Development Wells may Include some Exploration Wells Re-Entered and Completed; Structures do not Include Subsea Structures; Year 0 = 2017. Vertical Scale is Consistent Across Similar Figures to Illustrate the Relative Differences Within and Across Program Areas.

Exploration

Geophysical surveys generally would be the first activities to occur within the Gulf of Mexico Program. **Table 3.1.6** presents estimated levels of seismic and high-resolution geophysical (HRG) survey activity in the Gulf of Mexico Program Area.

Table 3.1-6. Exploration Seismic Survey Activity for the Gulf of Mexico Program Area.

	2D Surveys	2D Permits	3D Lease Blocks	3D Permits	Ancillary Permits
Central/Eastern	576,145 to 1,657,624 km (358,000 to 1,030,000 mi)	170 to 485	102,700 to 292,500	65 to 190	60 to 1,000
Western	4,989 to 15,128 km (3,100 to 9,400 mi)	10 to 20	18,600 to 56,800	15 to 40	10 to 115

HRG surveys generally occur before exploration drilling, but also occur before development drilling, platform and pipeline installation, and decommissioning activities. HRG survey activities are not included in the activities listed in **Table 3.1-6**.

Exploration drilling, development drilling, and platform installation would begin within a few years after the first lease sale. Peak exploration drilling is expected to occur within 15 years, although a decreasing number of exploration wells will be drilled over the entire Program window. **Figure 3.1-9** shows estimated timing and magnitude of OCS activities under a mid-price scenario. Shallow-water exploration drilling generally occurs before deepwater drilling. **Figure 3.1-10** shows the exploratory drilling activity by depth range in the Gulf of Mexico for the Proposed Action.

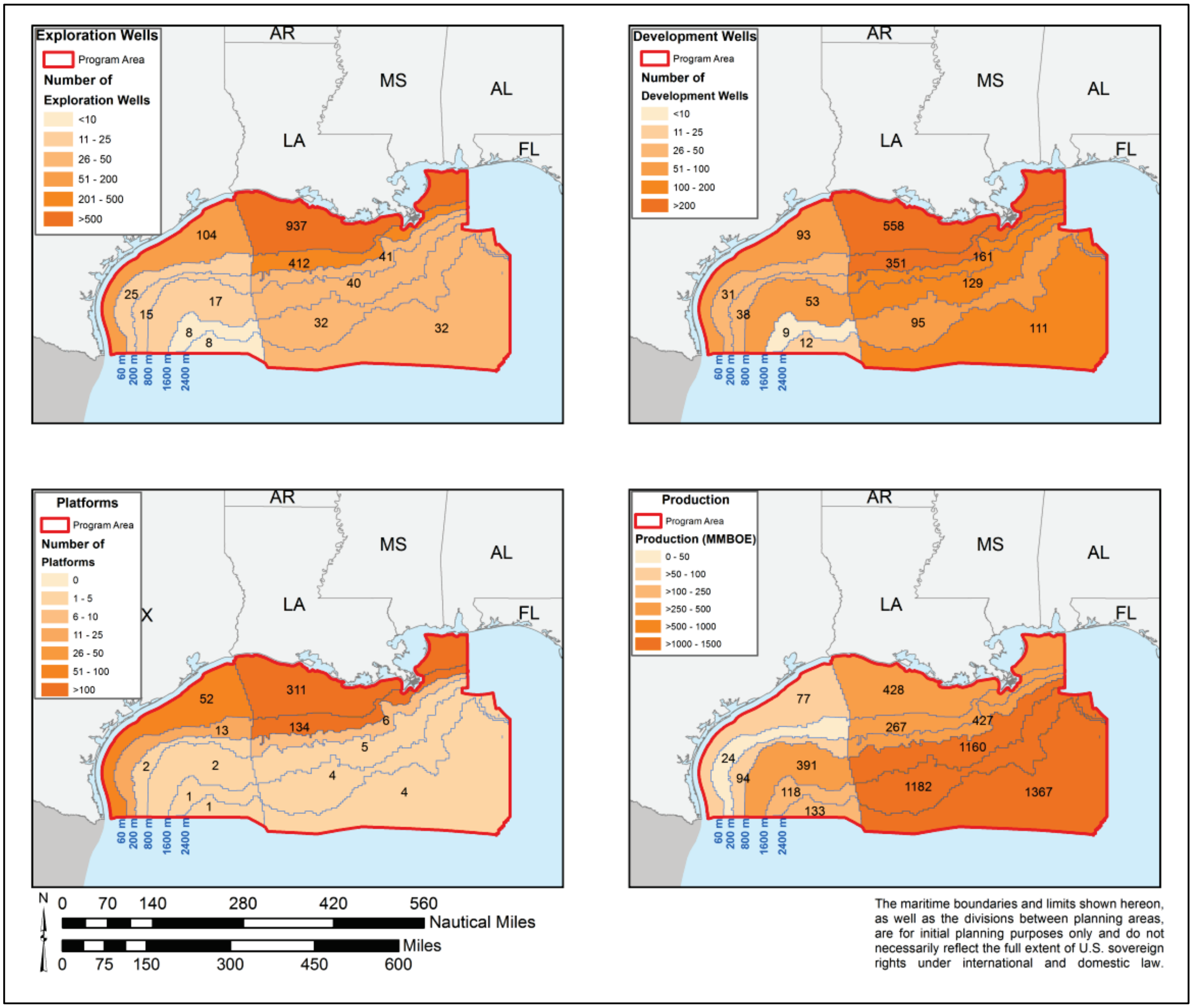


Figure 3.1-10. OCS Exploration (*Top Left*: Exploration Wells), Development (*Top Right*: Development Wells), and Production (*Bottom Left*: Platforms; *Bottom Right*: Oil and Gas Production) in Million Barrels of Oil Equivalent (MMBOE) by Depth Range in the Gulf of Mexico Program Area, Mid-Price Scenario. Color Scale is Consistent Across Similar Figures to Illustrate the Relative Differences in Wells, Platforms, and Production Within and Across Program Areas.

Development

The peak in development drilling and platform installation would lag behind the peak in exploration drilling (**Figure 3.1-9**). The distribution and number of development wells to be drilled and completed in the Central and Eastern Planning Areas and in the Western Planning Area, under the mid-price scenario, are illustrated in **Figure 3.1-11**.

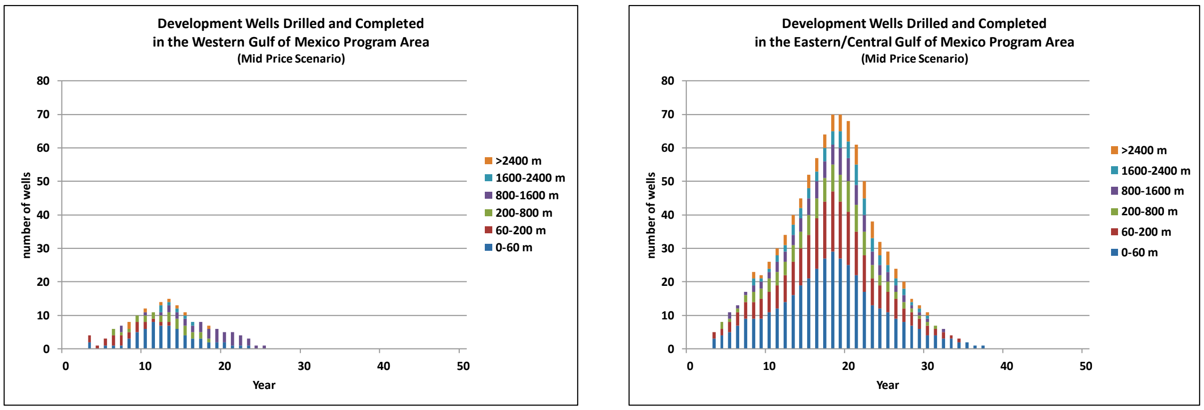


Figure 3.1-11. Distribution and Number of Development Wells Drilled and Completed in the Gulf of Mexico Program Area, Mid-Price Scenario; Year 0 = 2017. Vertical Scale is Consistent Across Similar Figures to Illustrate the Relative Differences Within and Across Program Areas.

Production

Figure 3.1-12 depicts the estimated distribution and number of structures in operation in the Gulf of Mexico, with the exception of subsea systems, over the life of the Program. **Figure 3.1-12** also shows the depth distribution of platforms and structures in the Gulf of Mexico. Various single well to multi-well structures would be installed and commissioned depending on the water depth. There would be a slight temporal lag between peak development drilling and platform installation. The final remaining platforms would be operated in the last 10 to 20 years to maximize production from remaining production wells.

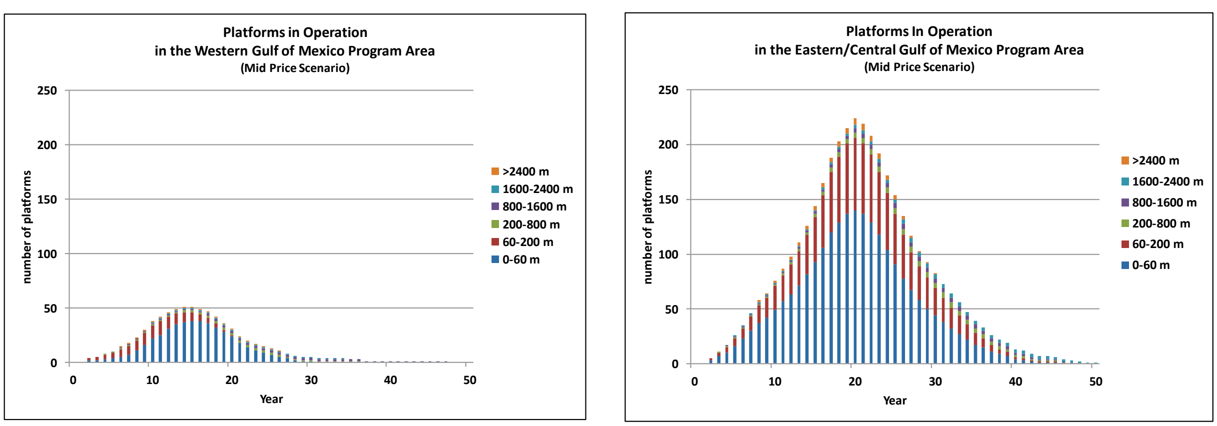


Figure 3.1-12. Platforms in Operation in the Gulf of Mexico Program Area, Mid-Price Scenario; Year 0 = 2017. Vertical Scale is Consistent Across Similar Figures to Illustrate the Relative Differences Within and Across Program Areas.

Figure 3.1-13 shows subsea systems in operation for the Central and Eastern Planning Areas and Western Planning Area in the mid-price scenario. Subsea structures would on be only installed and operated on the slope in water depths greater than 200 m (660 ft).

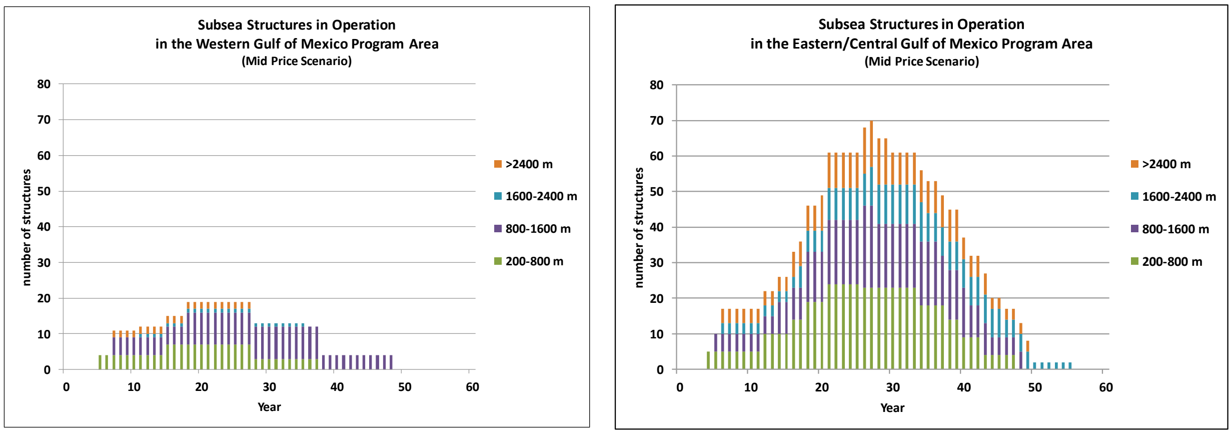


Figure 3.1-13. Distribution and Number of Subsea Structures in Operation in the Gulf of Mexico Program Area, Mid-Price Scenario; Year 0 = 2017.

The potential range in total and annual production is presented in **Table 3.1-4** and **Figure 3.1-9** (for the mid-price scenario).

Pipelines

The preferred method of transporting oil and gas from fixed or floating production structures in the Gulf of Mexico would be subsea pipelines to the nearest interconnect with existing offshore pipeline infrastructure or to a landfall location (**Tables 3.1-4** and **3.1-7**). Relatively few new pipeline landfalls are anticipated because of the extensive nature of the existing pipeline network in the Gulf of Mexico. **Figure 3.1-14** summarizes the line miles of pipeline to be installed under the Proposed Program for the mid-price scenario.

Table 3.1-7. Method of Oil Transportation in the Gulf of Mexico. Range Reflects Low to High Price Scenarios.

Method of Oil Transportation	Offshore Depth Ranges						Total Gulf of Mexico
	0 to 60 m (0 to 197 ft)	60 to 200 m (197 to 656 ft)	200 to 800 m (656 to 2,625 ft)	800 to 1,600 m (2,625 to 5,249 ft)	1,600 to 2,400 m (5,249 to 7,874 ft)	<2,400 m (<7,874 ft)	
Percent Piped	72 to 93.5	100	100	100	100 to 83.8	100 to 85.7	99.8 to 89.9
Percent Barged	28 to 6.5	0	0	0	0	0	0.2
Percent Tankered	0	0	0	0	0 to 16.2	0 to 14.3	0 to 9.9

Note: All natural gas is assumed to be transported by pipeline. Values of percent piped is presented according to the price range. The volume of oil transported by pipe decreases in a higher price scenario.

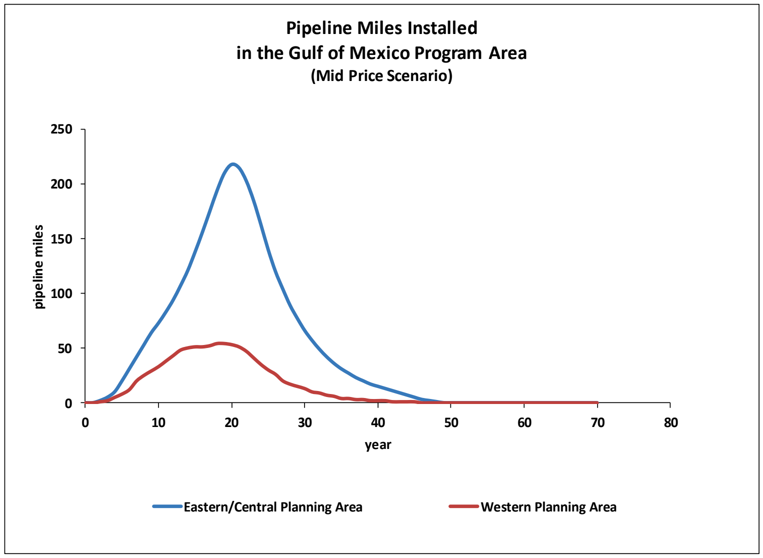


Figure 3.1-14. Pipeline Miles Installed in the Gulf of Mexico Program Area in the Mid-Price Scenario; Year 0 = 2017.

Decommissioning

After oil and gas resources are depleted and income from production no longer meets operating expenses, operators would begin to shut down their facilities. In a typical situation, wells will be permanently plugged with cement and wellhead equipment removed. Processing modules will be moved off the platforms. Subsea pipelines will be decommissioned by cleaning the pipelines, plugging pipelines at both ends, and removing them or leaving them buried beneath the seafloor, as permitted. Often, the platform will be disassembled and removed from the area and the seafloor site will be restored to some practicable pre-development condition. In the Gulf of Mexico, state-managed rigs-to-reef programs provide alternatives for in-water placement of suitably sized and cleaned platform components. **Table 3.1-8** summarizes the number of platforms removed with or without explosives in the Gulf of Mexico Planning Areas. Approximately 97 percent of removals occur on the Gulf of Mexico shelf in water depths less than 200 m (656 ft).

Table 3.1-8. Platforms in the Gulf of Mexico Program Area Removed With or Without the Use of Explosives. Range Reflects Low to High Price Scenarios.

Platforms Removed		
Eastern/Central Gulf of Mexico	With Explosives	Without Explosives
	45 to 850	30 to 360
Western Gulf of Mexico	With Explosives	Without Explosives
	10 to 100	4 to 45

3.1.2.3. Atlantic Program Area

One sale is scheduled to be held in 2021 in the Atlantic Program Area, including areas offshore the Commonwealth of Virginia and the states of North Carolina, South Carolina, and Georgia, with an 80-km (50-mi) no-leasing buffer from the coastline. There are no other moratoria currently affecting the Atlantic Program Area. **Table 3.1-9** provides an overview of exploration, development, and production activities that may occur in the Atlantic Program Area.

Table 3.1-9. E&D Scenario Summary for the Atlantic Program Area. Range Reflects Low to High Price Scenarios.

Scenario Element	Atlantic
Number of sales	1
Years of activity	<60
Oil (Bbbl)	0.3 to 0.7
Natural gas (tcf)	3.4 to 7.5
Exploration and delineation wells	30 to 70
Development and production wells	60 to 130
Platforms/structures	5 to 8
Subsea structures	10 to 20
Floating, production, storage, and offloading (FPSOs)	0 to 2
New pipeline miles	800 to 1,500
Vessel trips (thousands of round trips)	52 to 165
Helicopter operations (1,000 operations)	32 to 364
New pipeline landfalls	4 to 7
New onshore facilities[1]	
Support, transport, and crew facilities	0
Pipe coating facilities and pipeline shore facilities	0 to 1 each
Waste disposal	0 to 1
New natural gas processing and natural ga storage facilities	0 to 1 each
New Liquefied Natural Gas (LNG) facilities	0 to 1
Oil spill response and equipment staging facilities	0 to 1

[1] Existing coastal infrastructure in the Gulf of Mexico such as shipyards, platform fabrication yards, and supply bases may be used to mobilize equipment. Existing infrastructure in the Mid- and South Atlantic Region may be retrofitted as well (Dismukes, 2014; Commonwealth of Virginia, 2015).
Note: values have been rounded for presentation.
Bbbl = billion barrels; tcf = trillion cubic feet.

In comparison to the Gulf of Mexico Program Area, substantially less exploration, development, and production is anticipated for the Atlantic Program. Fewer than 200 wells would be drilled; only 8 platforms would be installed across a potentially large expanse more than 80 km (50 mi) from the coastline.

Exploration

Exploration activities would begin prior to the single lease sale scheduled for 2021 through geological and geophysical (G&G) survey activities. **Table 3.1-10** provides the projected level of G&G survey activity in the Atlantic Program Areas. Exploratory seismic survey activity is assumed to occur in advance of the Atlantic sale through the end of the program in 2022. HRG surveys generally occur before exploration drilling, development drilling, platform and pipeline installation, and decommissioning activities.

Table 3.1-10. Exploratory Seismic Survey Activities for Oil and Gas Exploration in the Atlantic Program Areas.

2D Surveys	2D Permits	3D Surveys (Lease Blocks)	3D Permits	Ancillary Permits
402,336 km (250,000 line mi)	16	2,500	5	30 to 70

Exploratory drilling in the Atlantic would begin as early as 2023 (**Figure 3.1-15**). It is anticipated that 5 to 10 exploration and appraisal wells would be drilled between 2023 and 2026 in shallow water (<200 m [656 ft] deep), and 30 to 60 additional wells would be drilled in deeper water along the shelf break and slope thereafter. **Figure 3.1-16** shows exploratory drilling activity in the Atlantic Program Area for the mid-price scenario.

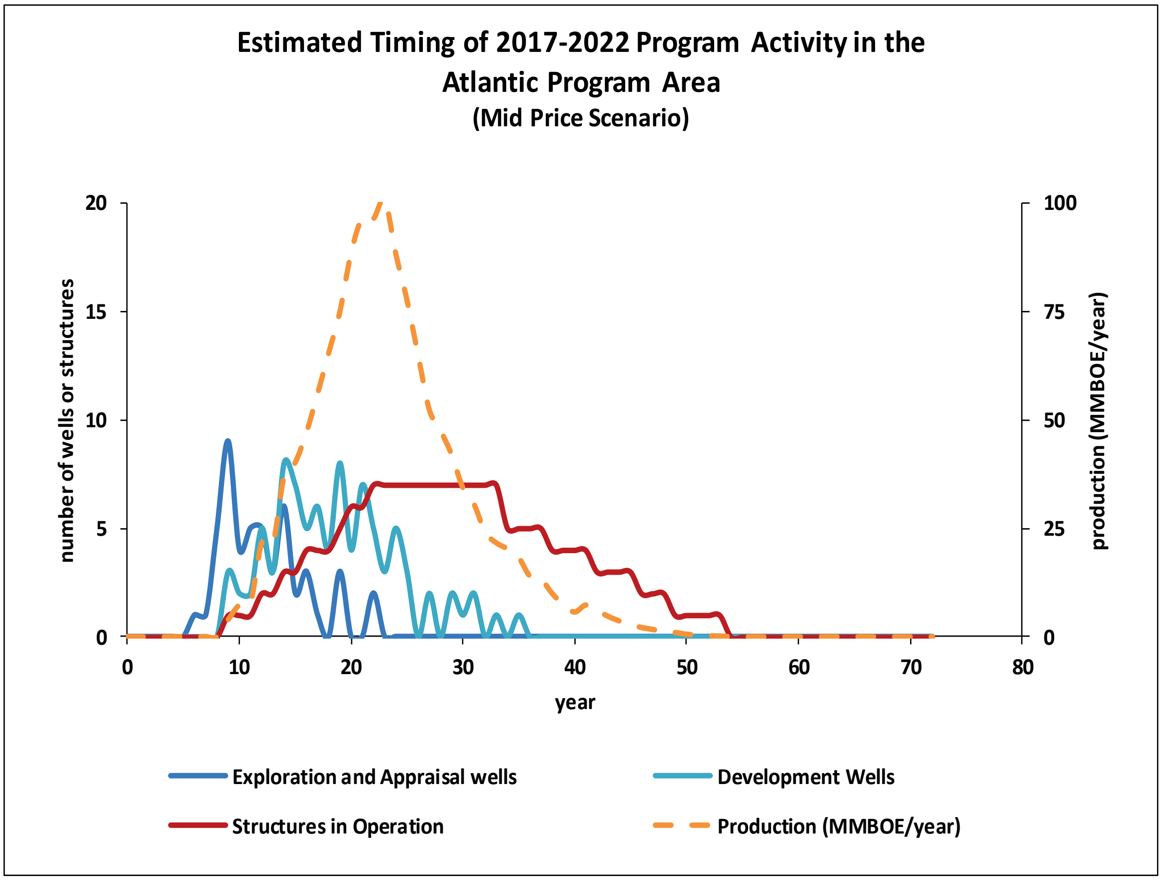


Figure 3.1-15. Timing and Magnitude of Exploration and Appraisal Wells, Development Wells, Structures in Operation, and Production in the Atlantic Program Area, Mid-Price Scenario. Development Wells may Include some Exploration Wells Re-Entered and Completed; Structures do not Include Subsea Structures; Year 0 = 2017.

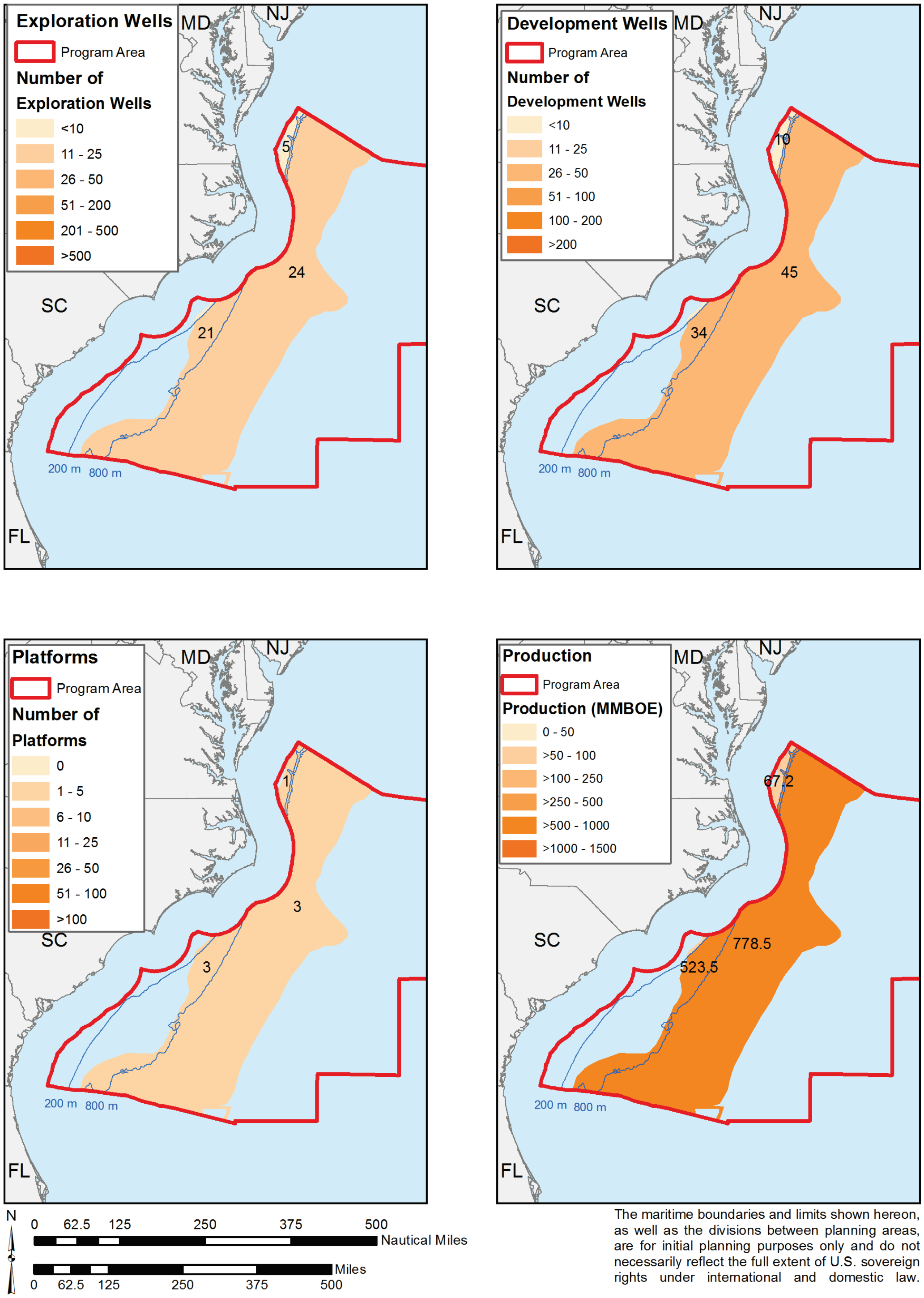


Figure 3.1-16. Distribution of OCS Exploration (*Top Left*: Exploration Wells), Development (*Top Right*: Development Wells), and Production (*Bottom Left*: Platforms, Excluding Subsea Structures; *Bottom Right*: Oil and Gas Production) in MMBOE by Depth Range in the Atlantic Program Area. Color Scale is Consistent Across Similar Figures to Illustrate the Relative Differences in Wells, Platforms, and Production Across Program Areas.

Development

Approximately 60 to 130 development and production wells would be drilled and completed following a single lease sale in the Atlantic Program Area. Most wells would be in moderate to deep water in the most prospective plays. Development wells are displayed by water depth range in **Figure 3.1-17**. The peak in development drilling and platform installation would lag behind the peak in exploration drilling by approximately 10 years (**Figure 3.1-15**).

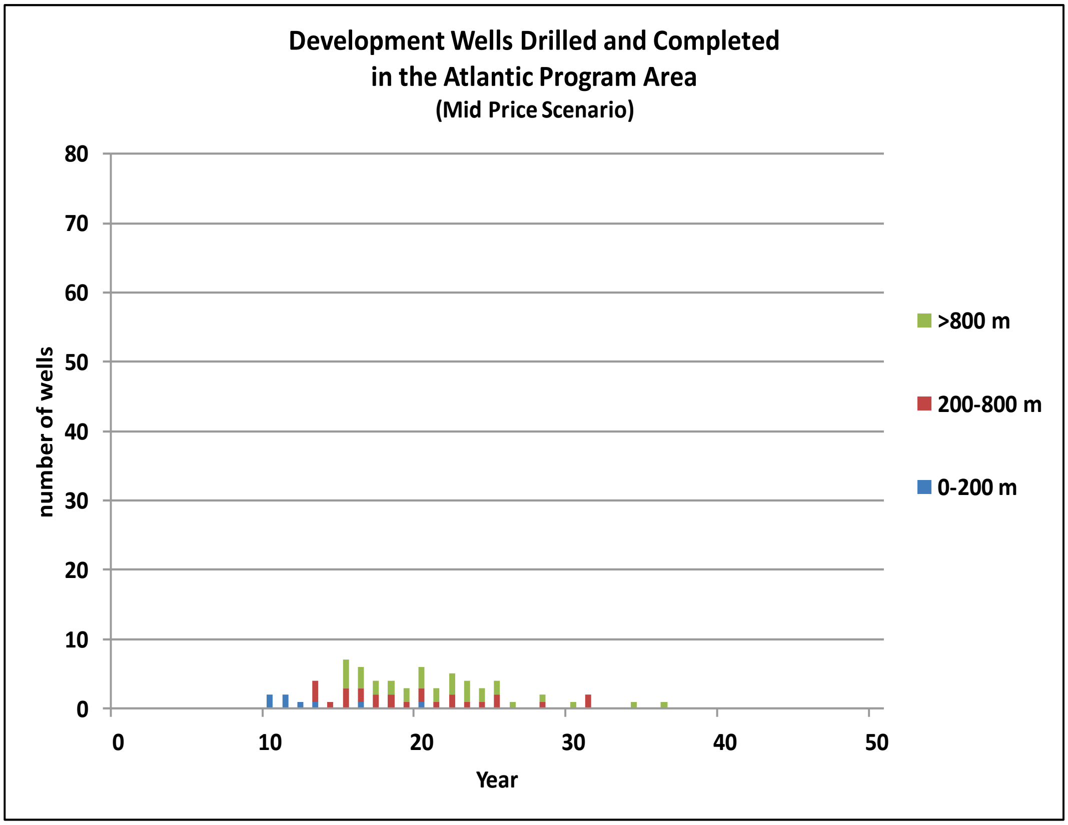


Figure 3.1-17. Distribution and Number of Development Wells Drilled and Completed in the Atlantic Program Area, Mid-Price Scenario; Year 0 = 2017. Vertical Scale is Consistent across Similar Figures to Illustrate the Relative Differences across Program Areas.

Production

Figure 3.1-18 depicts the estimated distribution and number of structures in operation in the Atlantic Program Area over the life of the Program for the mid-price scenario. Single well to multi-well structures would be installed and commissioned depending on the water depth. Tension leg platforms, spar buoys, or semisubmersible production structures are probable at depths of 201 to >800 m (659 to 2,625 ft). Subsea structures would only be installed and operated on the slope in water depths greater than 200 m (660 ft). Peak development drilling and platform installation would coincide approximately 15 years after the lease sale (**Figure 3.1-15**). One or two FPSOs may be necessary to produce and store product.

Oil and gas production in the Program Area would begin around 2025 and end almost 50 years later (**Figure 3.1-15**). It is anticipated that oil and gas production would increase gradually during the first 15 years, peaking around 2040, and decrease thereafter. The potential range in total and annual production is presented in **Table 3.1-9** and **Figures 3.1-15** and **3.1-18** (for the mid-price scenario).

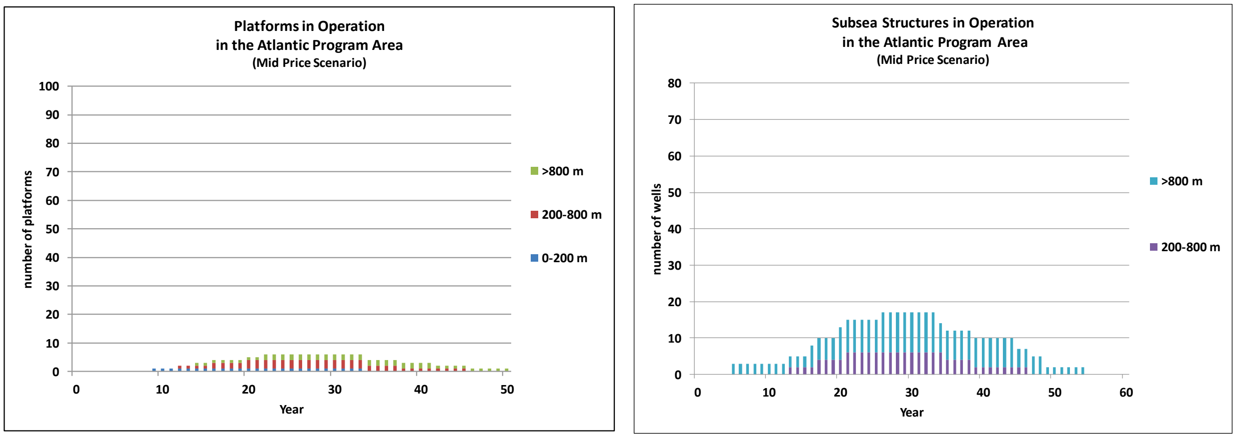


Figure 3.1-18. Distribution and Number of Platforms and Subsea Structures Completed in the Atlantic Program Area, Mid-Price Scenario; Year 0 = 2017. Vertical Scale is Similar across Similar Figures to Illustrate the Relative Differences Across Program Areas.

Pipelines

It is anticipated that transport of oil and gas from production structures in the Atlantic would be tankered (maximum of 30 percent in high-price scenario) or transported by pipeline (100 percent in low-price scenario and 68 percent in the high-price scenario) using subsea pipelines to the shore. The estimated range of pipeline miles to be installed (considering price cases) is approximately 1,287 to 2,414 km (800 to 1,500 mi). Four to seven landfall locations along the Atlantic coast may be necessary to transport product to processing facilities and markets.

Decommissioning

After oil and gas resources are depleted and income from production no longer meets operating expenses, the operator will begin to shut down and decommission the facilities, including platform and pipeline removal. All platforms anticipated to be installed in the Atlantic region are projected to be removed around 2070.

Coastal Infrastructure

Table 3.1-9 provides an estimate of potential coastal infrastructure that may be necessary to support exploration, development, and production of hydrocarbon resources in the Atlantic Program. Dismukes (2014) and Commonwealth of Virginia (2015) provide a complete discussion of infrastructure needs, considerations, and changes associated with an Atlantic OCS oil and gas industry.

3.2. ACCIDENTAL EVENTS

Impacts associated with accidental events are considered in terms of accidental events that occur with enough frequency that such events are statistically expected to occur and those statistically unexpected catastrophic discharge events (CDEs). Expected accidental events include spills expected to occur during routine operations (e.g., a diesel spill or oil spills of varying size from a platform, pipeline, or tanker). CDEs are rare, very low probability events arising from equipment failure such as a loss of well control or a blowout. Expected accidental events and CDEs were evaluated separately.

BOEM has estimated the source and number of accidental spills based on the estimated volume of oil production for each Program Area and the assumed mode of transportation (Anderson et al., 2012). Spills from platforms are assumed to occur within the lease sale areas. Spills from pipelines are assumed to occur within their respective routes from production platform to destination.

Estimates characterizing expected accidental events were developed for the Proposed Action and the cumulative scenario of OCS oil and gas activities in each OCS planning area (**Table 3.2-1**). Small spills (≥1 to <50 bbl; ≥50 to <1,000 bbl) and large spills (>1,000 bbl) from platforms and pipelines are considered.

Table 3.2-1. Expected Accidental Spills During the 2017-2022 Program. Range Reflects Low to High Price Scenarios.

Spill	Assumed Spill Volume (bbl)	Number of Spills[a]					
		Gulf of Mexico Program Areas		Arctic Program Areas		Cook Inlet	Atlantic Program Areas
		Western	Central/ Eastern	Beaufort Sea	Chukchi Sea		Mid- and South Atlantic
Large (bbl)	≥1,000						
Platform[b]	5,100	0 to 1	1 to 2	0 to 1	0 to 1	0 to 1	0-1
Pipeline[c]	1,720	0 to 1	2 to 5	0 to 4	0 to 3	0 to 1	0 to 1
Small (bbl)[d]	≥1 to <50	≥1 to <50	20 to 56	138 to 362	0 to 275	0 to 209	6 to 25
	≥50 to <1,000	4 to 10	23 to 62	0 to 47	0 to 36	1 to 4	4 to 10

[a] The assumed number of spills are estimated using the 1996 to 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 ≥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. For the 1996 to 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] During the period 1996 to 2010, two 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 between 1964 and 2010, is 7,000 bbl.

[c] During the period 1996 to 2010, seven 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] The number of spills <1,000 bbl is estimated using the total spill rate for pipeline and platform spills.

3.3. RISK OF A LOW-PROBABILITY CATASTROPHIC DISCHARGE EVENT

The term "catastrophic discharge event" (CDE) is a very large spill that is not expected to occur during the Program's activities and would be considered well outside the normal range of probability, despite the inherent risks of oil E&D-related activities. While unexpected, these spills may result from OCS exploration; development and production activities involving rigs, facilities, pipelines, tankers, and/or support vessels; and other causes (e.g., hurricane, human error, terrorism).

Incidents with the greatest potential for catastrophic consequences are likely to be losses of well control where primary and secondary barriers fail, wells do not bridge (bridging occurs when the wellbore collapses and seals the flow path), and discharge is of long duration and/or occurs in an environmentally sensitive area and or at a sensitive time. Recently implemented safeguards, including additional subsea blowout preventer (BOP) testing, required downhole mechanical barriers, well containment systems, and additional regulatory oversight make such an event less likely than in the past.

Although a CDE is not an expected outcome of the 2017-2022 Program, the consequences of a low-probability incident, if it were to occur, may be catastrophic. Past oil spills that are considered relevant include the *Exxon Valdez* oil spill in Prince William Sound in south-central Alaska (262,000 bbl) and the Ixtoc oil spill (3,500,000 bbl) in the Gulf of Mexico offshore Bahia de Campeche, Mexico, which were not expressly related to OCS activities, and the *Deepwater Horizon* event that occurred on the OCS in 2010 in the northern Gulf of Mexico (4,900,000 bbl) (McNutt et al., 2011).

A quantitative approach has been developed to demonstrate the relative unlikelihood of such low-probability spill incidents, wherein spill size is one of many factors that could determine the severity of effects (see 2012-2017 Final Programmatic EIS). BOEM defined a reasonable range of potentially catastrophic OCS spill sizes by applying extreme value statistics to historical OCS spill data (Ji et al., 2014). Extreme value statistical methods and complementary methods (Bercha Group, 2014) were then used to quantify the potential frequency of different size spills. It is important to note that the full range of spill sizes considered may not actually be possible in a given Program Area given the individual, undiscovered reservoir sizes or other geologic constraints in that Program Area.

Using the peer-reviewed methods described above, BOEM estimated (1) return levels (i.e., the spill size that occurs with a certain frequency, or alternatively, the spill size that is expected to be exceeded by the annual maximum in a particular year with a given probability); (2) return periods (i.e., the OCS-wide spill recurrence interval corresponding to certain sizes); and (3) a per-well probability that an OCS spill would exceed given sizes (**Table 3.3-1**). The estimated per-well frequency for a given spill size assumes a spill occurred following loss of well control. The per-well spill size frequency estimates consider OCS-wide loss of well control data from 1964 through 2014 and corresponding OCS-wide well exposure data (only original well boreholes and sidetracks are summed to determine well exposure; bypasses are excluded) (**Figure 3.3-1**).

Table 3.3-1. Annual Maximum OCS Spill Sizes (for all Ongoing OCS Activities and OCS Planning Areas Combined).

Spill Size (bbl) (rounded to nearest thousand)	Percent Spills Expected to be Less than or Equal to Given Spill Size	Return Period (years)	Frequency (per well)
150,000	97.4	39	0.0000564
500,000	98.8	86	0.0000422
1,000,000	99.3	139	0.0000357
2,000,000	99.6	229	0.0000302
5,000,000	99.8	451	0.0000242
10,000,000	99.87	770	0.0000205

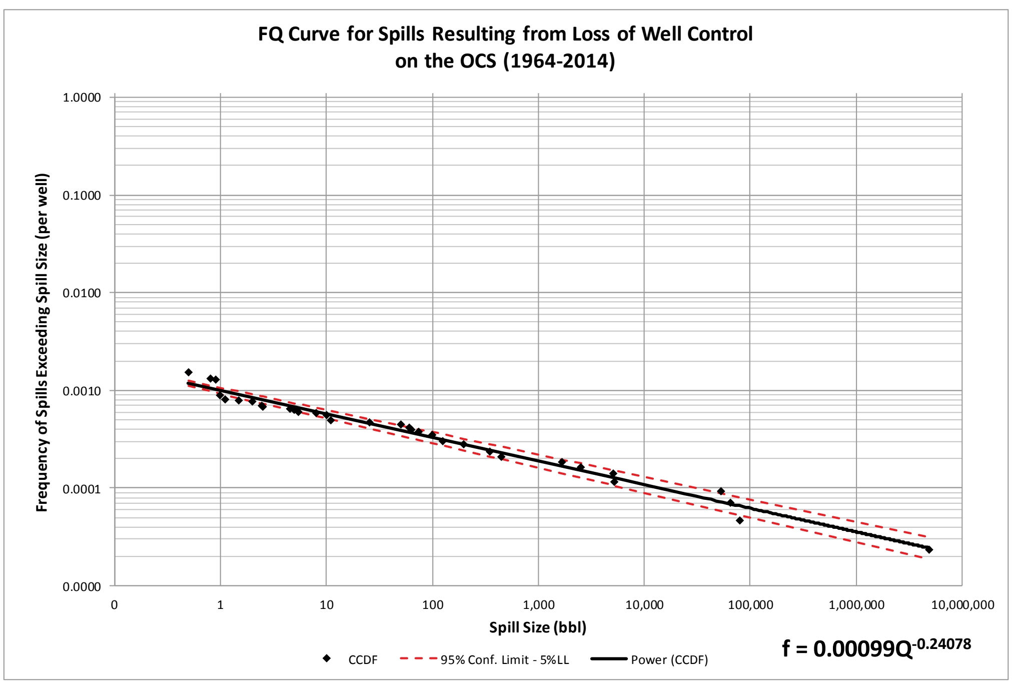


Figure 3.3-1. Frequency of Spills Resulting from Loss of Well Control on the OCS. The Variable f is Equal to a Per-Well Occurrence, whereas the Variable Q Refers to Spill Size. Note Log Scales.

Extreme value results show that 90 percent of "annual maximum" oil spills are expected to be approximately ≤16,000 bbl; 95 percent are expected to be approximately ≤50,000 bbl. Spill sizes corresponding to a range of larger sizes and statistically useful benchmarks were also considered.

Table 3.3-1 shows the return period and estimated frequency for sizes from 150,000 bbl to 10 million barrels (MMbbl). The return period estimated is independent of any Five-Year Program timing or activity level. Estimated return periods demonstrate that most very large spills are not expected to occur on a time frame relevant to the Proposed Action. The number of CDEs equal to or greater than a given size in a given Five-Year Program can also be estimated using the aggregate number of E&D wells expected to be drilled in that same Program. In combining the per-well spill frequency with estimates of the aggregate number of wells in the 2017-2022 Program, no spills ≥150,000 bbl are expected to occur despite the volume of program activities previously described.

3.4. ALTERNATIVE B: LEASING AND RESOURCE POTENTIAL CONSIDERATIONS

Alternative B describes several EIAs across the five Program Areas. Potentially excluding these areas from leasing may have a variable impact on leasing viability as well as levels of exploration, development, production, and decommissioning activities. **Tables 3.4-1** and **3.4-2** contrast the acreage of the EIAs with the acreage of the overall Program Area as well as the combined footprint of the all geologic plays within the respective Program Area. Geological plays are used to assess the potential for undiscovered oil and natural gas development in an OCS Planning Area. An individual play is identified and mapped based common geologic characteristics and a common history of hydrocarbon generation, migration, reservoir development, and entrapment. In many of the Planning Areas, geologic plays are often stacked in the vertical dimension.

Potential exclusions in the Beaufort Sea and Chukchi Sea Program Areas are likely to have the largest impact on activity levels given their relative size and location coincident with high hydrocarbon resource potential.

Table 3.4-1. Area Available for Leasing and Area of Combined Geologic Plays.

Program Area	Acreage of Program Area (including existing leases)	Acreage of all Geologic Plays
Beaufort Sea	64,768,658	11,445,107
Chukchi Sea	53,197,129	33,801,713
Cook Inlet	1,094,368	1,094,368
Gulf of Mexico	93,744,013	93,744,013
Atlantic	104,872,896	38,459,584

Table 3.4-2. Areas of EIAs Compared to Program Areas and Combined Footprint of Geologic Plays.

Program Area	EIA	Acreage of EIA	Percent of Program Area Acreage	Percent of Geologic Plays Acreage	No. of Geologic Plays Overlapping EIAs
Beaufort Sea	Kaktovik	484,436	0.8	4.2	4
	Camden Bay	127,657	0.2	1.1	5
	Cross Island	1,396,164	2.8	12.2	10
	Barrow Canyon	971,249	1.5	8.5	8
Chukchi Sea	Overlap of Walrus Foraging Area and Movement Corridor	5,180,862	9.7	15.3	15
	Walrus Foraging Area	4,936,975	9.3	14.6	15
	Walrus Movement Corridor	1,383,286	2.6	4.1	6
Cook Inlet	Beluga Whale Critical Habitat	17,520	1.6	1.6	4
Atlantic	Washington and Norfolk Canyons	36,454	0.03	0.09	1

3.5. IMPACT-PRODUCING FACTORS

Impact assessment considers impacting activities and pathways, known as IPFs, to determine the context and intensity of effects on environmental resources. At the Five-Year Program stage, it is not possible to perfectly identify the nature and scope of IPFs of future activities. Each phase of activity will have a set of IPFs (some unique to a particular phase) that may affect physical or environmental conditions and may affect one or more natural, cultural, or socioeconomic resources.

Table 3.5-1 outlines IPFs from initial exploration to decommissioning, differentiating between routine activities and accidental events. **Table 3.5-2** provides a general description of each IPF. **Table 3.5-3** presents a preliminary determination of the stressor-receptor relationship for oil and gas development activities considered within the current impact analysis, including routine activities and non-routine events.

Table 3.5-1. Summary of Impact-Producing Factors (IPFs) Associated with OCS Oil and Gas Activities.

Impact-Producing Factor	Exploration		Development	Production	Decommissioning
	Geophysical Survey	Exploration Drilling			
Routine Activities					
Noise	X	X	X	X	X
Seismic Noise	X	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 (Includes Explosives Use)	-	-	-	-	X
Traffic	X	X	X	X	X
Aircraft Traffic	-	X	X	X	X
Ship/Vessel Traffic	X	X	X	X	X
Routine Discharges	X	X	X	X	X
Sanitary Wastes	X	X	X	X	X
Gray Water, Misc. Discharges	X	X	X	X	X
Drilling Mud/Cuttings/Debris	-	X	X	-	X
Bottom/Land Disturbance	-	X	X	-	X
Drilling	-	X	X	-	-
Infrastructure Emplacement	-	-	X	-	-
Pipeline Trenching	-	-	X	-	-
Onshore Construction	-	-	X	-	-
Structure Removal	-	-	-	-	X
Air Emissions	X	X	X	X	X
Offshore	X	X	X	X	X
Onshore	-	-	X	X	X
Lighting	X	X	X	X	X
Offshore Facilities	X	X	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	-
Non-Routine Events					
Accidental Spills	X	X	X	X	X

"X" = the activity includes coincident IPFs; and "-" = the activity does not include coincident IPFs.

Table 3.5-2. General Description of Impact-Producing Factors (IPFs).

IPF and Specific Sources	General Description
Noise	
Geophysical Noise	The Exploration & Development (E&D) scenario considers two types of geophysical surveys: (1) marine seismic surveys, which generally cover a large area of leased and/or unleased acreage; and (2) geohazard surveys, which include side-scan sonar and shallow-penetrating reflection-seismic profiling conducted to detect archaeological resources or seafloor features that might be problematic for operations, such as drilling a well or installing a platform or pipeline on a more specific site. Geohazard surveys often are accompanied by geotechnical surveys, which involve sampling or measuring mechanical properties or stability of near-seafloor sediments. Sound source levels depend on equipment type and size. Airgun arrays may have source levels of 216 to 259 dB re 1 µPa-m, with frequencies <120 Hz. Other techniques (e.g., sparkers, boomers) are in the range of 212 to 221 dB re 1 µPa-m, with frequencies in the 800 to 1,200 Hz range (Richardson et al., 1995; National Oceanic and Atmospheric Administration [NOAA] and Marine Conservation Biology Institute (MCBI), 2000).
Ship Noise	Vessel noise is a combination of narrow-band (tonal) and broadband sound. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Sound source levels depend on vessel size. Small vessels (e.g., crew boats, tugs, self-propelled ships) have source levels of 145 to 170 dB re 1 µPa-m, with frequencies of 37 to 6,300 Hz. Larger vessels (e.g., commercial vessels, supertankers) have source levels of 169 to 198 dB re 1 µPa-m, with frequencies of 6.8 to 428 Hz (Richardson et al., 1995, Greene and Moore, 1995).
Aircraft Noise	Penetration of aircraft noise into the water is greatest directly below the aircraft; much of the sound is reflected and does not penetrate into the water at angles greater than 13° from vertical (Richardson et al., 1995). The duration of underwater sound from passing aircraft is much shorter in water than air; for example, a helicopter passing at an altitude of 152 m (500 ft) that is audible in air for 4 minutes may be detectable underwater for only 38 seconds at 3 m (10 ft) depth and for 11 seconds at 18 m (59 ft) depth (Richardson et al., 1995). Sound source levels of fixed-wing aircraft and helicopters are 156 to 175 dB re 1 µPa-m, with frequencies of 47 to 7,070 Hz.
Drilling Noise	Noise from drilling operations contains strong tonal components at low frequencies (<500 Hz), including infrasonic frequencies (Richardson et al., 1995). Machinery noise can be continuous or transient and can vary in intensity. Noise levels vary with the type of drilling rig and water depth. Drillships produce the highest levels of underwater noise because the hull containing the rig generators and drilling machinery is well coupled to the water. In addition, dynamically positioned drillships use thrusters to maintain position and are constantly emitting engine and propeller noise. Jack-up rigs are at the other end of the spectrum because they are supported by metal legs with only a small surface area in contact with the water, the drilling machinery is located on decks well above the water, and there is no propulsion noise. Semisubmersibles are intermediate in noise level because the machinery is located well above the water but the pontoons supporting the structure have a large surface area in contact with the water. Sound source levels vary depending on the drilling structure: drilling from islands and caissons generates sound source levels of 140 to 160 dB re 1 µPa-m, with frequencies of 20 to 1,000 Hz; drilling from bottom-founded platforms generates received sound levels of 119 to 127 dB re 1 µPa-m, with frequencies of 5 to 1,200 Hz; drilling from vessels generates sound source levels of 154 to 191 dB re 1 µPa-m, with frequencies of 10 to 10,000 Hz. (Greene and Moore, 1995; Richardson et al., 1995).
Production Noise	Production noise is generally low frequency and similar to drilling noise.
Trenching Noise	Pipeline trenching is conducted by using plow and jet burial and generates continuous, transient, and variable sound levels.
Offshore Construction	Construction noise is expected to be composed of vessel noise (e.g., support vessels, heavy lift vessels) and equipment noise. 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. Dredging sound source levels are 150 to 180 dB re 1 µPa-m with peak frequencies of 20 to 1,000 Hz; pile driving generates a sound source level of 228 dB re 1 µPa-m with a broadband frequency range, peaking in the 100 to 500 Hz range.
Onshore Construction	Onshore construction includes construction of new landfalls; possible new infrastructure; and expansion of existing ports, docks, and other infrastructure. Onshore construction may include the use of vehicles (e.g., trucks, earthmoving equipment) or vessels (e.g., dredges, pile driving equipment, barges).

Table 3.5-2. General Description of Impact-Producing Factors (IPFs) (Continued).

IPF and Specific Sources	General Description
Platform Removal (includes explosives use)	Explosive severance utilizes specially designed bulk or shaped charges with specific properties to produce enough stress upon detonation to completely sever the bottom-founded components of a platform. Explosive charges generally are placed inside the platform legs or conductors at a depth of 4.6 to 7.6 m (15 to 25 ft) below the seafloor. Platform removal using explosives generates sound source levels of 267 to 279 dB re 1 µPa-m; frequency estimates were not provided by BOEM.
Traffic	
Aircraft Traffic	All aircraft would be expected to follow U.S. Department of Transportation, Federal Aviation Administration (USDOT, FAA, 2004) guidance over land, which recommends a minimum altitude of 610 m (2,000 ft) when flying over noise sensitive areas such as national parks, wildlife refuges, and wilderness areas. When in transit offshore, helicopters generally maintain a minimum altitude of 213 m (700 ft). Guidelines and regulations have been implemented by NMFS (under the authority of the Marine Mammal Protection Act) that require operational altitudes of 305 m (1,000 ft) within 91 m (300 ft) of marine mammals (50 CFR Ch. II). During normal production operations, the frequency of helicopter flights offshore would remain the same (one to three per platform per day).
Ship/Vessel Traffic	Support-vessel traffic is estimated to consist of one to three trips per platform per week from the shore base. If barges are used to transport the drill cuttings and spent mud from production wells during drilling operations, a dedicated barge could make one to two trips per week to an onshore disposal facility.
Routine Discharges	
Sanitary Wastes	Sanitary waste consists of human body wastes from toilets and urinals. Sanitary waste is routinely treated by means of a marine sanitation device that produces an effluent with a maximum residual chlorine concentration of 1.0 mg/L and no visible floating solids or oil and grease. Wastewater treatment sludge is normally transported to shore for disposal at an approved facility.
Gray Water, Misc. Discharges	Miscellaneous discharges include deck drainage; desalination unit brine; and uncontaminated cooling water, bilge, fire, and ballast water. Domestic waste, or gray water, includes water from showers, sinks, laundries, galleys, safety showers, and eye wash stations. Aside from screening to remove solids, domestic waste does not require treatment before discharge. Food waste, a type of domestic waste, is routinely ground prior to discharge.
Produced Water	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 U.S. Environmental Protection Agency (USEPA) has set an effluent limitation of 29 mg/L for the oil content of produced waters (Minerals Management Service [MMS], 2007c).
Drilling Mud/Cuttings/Debris	
Exploratory and Development Drilling Muds and Cuttings	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 are recycled back down the well. The separated cuttings are, in most cases, discharged to the ocean. There are two classes of drilling muds used in the industry in the United States: water-based muds (WBMs) and synthetic-based muds (SBMs) (Neff, 2010). Several field studies have shown that the highest concentrations of cuttings are usually located in sediments within approximately 100 m (328 ft) of the platform. However, cuttings may be deposited 1 to 2 km (0.6 to 1.2 mi) from the discharge point. The potential impacts of accumulated drilling muds and cuttings are expected to be localized and short term.
Loss of Debris (all Phases)	Debris includes accidental loss of tools or equipment overboard, loss of trash and debris, and allowed components remaining on seafloor after decommissioning. In deep water, the probability that infrastructure will be left on the seafloor is likely higher.
Bottom/Land Disturbance	
Drilling	Physical disturbance of the seafloor will be limited to the proximal area where the well infrastructure and borehole penetrates the substrate and where mud and drill cuttings will be deposited.

Table 3.5-2. General Description of Impact-Producing Factors (IPFs) (Continued).

IPF and Specific Sources	General Description
Infrastructure Emplacement	Bottom disturbance from structure emplacement operations would disturb bottom habitat and may produce localized, temporary increases in suspended sediment. This would result in decreased water clarity and little reintroduction of pollutants. Structure emplacements can act as fish-attracting devices and result in the aggregation of migratory and reef fish species. The greatest potential physical disturbance is from anchor chains and cables; areal extent and severity of the impact are related to the size of the mooring anchor and the length of chain resting on the bottom.
Pipeline Trenching	Trenching for pipeline burial causes displacement or resuspension of seafloor sediments. 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. If anchors are used, the cable sweep inherent in the progression of the barge affects more area than any other seafloor disturbance.
Onshore Construction	Typical infrastructure (new or currently existing that may be expanded or retrofitted) that would support OCS activity and may affect biological, physical, and socioeconomic resources include the following: ▪ Ports and support facilities (repair and maintenance yards, crew services, support sectors); ▪ Construction facilities (platform fabrication yards, shipyards and shipbuilding yards, pipecoating facilities and yards); ▪ Transportation (offshore support vessels, tankers, pipelines, railroads, tank trucks, navigation channels); and ▪ Processing facilities (natural gas processing, natural gas storage, liquefied natural gas (LNG) facilities, refineries, petrochemical plants, waste management).
Structure Removal	The removal of offshore platforms by the use of explosives or by cutting the structure below the sediment line. Also includes the removal of pipelines, which causes seafloor disturbance and sediment displacement.
Air Emissions	
Offshore	Activities affecting air quality include vessel operations during geophysical 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 volatile organic compounds (VOCs) during transfers and spills.
Onshore	Activities affecting air quality onshore include emissions from new infrastructure constructed onshore and offshore activities that occur within 40 km (25 mi) of a state's boundary.
Lighting	
Offshore Facilities	Platform lighting, construction lighting, mobile offshore drilling unit (MODU) lighting, vessel lighting. Offshore facilities are routinely equipped with mandatory navigation lighting and special use lighting for work areas, outside passageways, machinery spaces, control stations, alleyways, stairways, and exits. Navigation lights are operated to ensure that the facility is visible to other vessels and aircraft. Special use lighting is intended to ensure the safety of vessel personnel. As a result, navigation lighting must be visible to specified distances, while special use lighting may be shielded or may employ alternative techniques to minimize projection into the environment (e.g., alteration of color; flashing).
Onshore Facilities	Lighting from onshore facilities, ports, construction facilities, transportation, and processing facilities.
Visible Infrastructure and Activities	
Offshore	Presence of platforms, vessels, MODUs, or flaring activities may contribute to visual or aesthetic experience. Lighting IPFs may also affect the nature of aesthetic or recreational experience.
Onshore	Onshore facilities, ports, construction facilities, transportation, and processing facilities.
Space-Use Conflicts	
Offshore Facilities	Military/NASA use, fishing, subsistence use, renewable energy (e.g., Wind Energy Areas), and LNG facilities.
Onshore Facilities	Onshore facilities, ports, construction facilities, transportation, and processing facilities.
Non-Routine Events	
Expected Accidental Events	Fuel, crude oil, or other spills resulting from accidents, weather events, and collisions.
Unexpected CDE	Well blowout. Low-probability, very large volume, longer-duration spills with the potential for catastrophic effects.

Table 3.5-3. Resources Potentially Affected by Impact-Producing Factors (IPFs).

Impact Producing Factor	Air Quality	Water Quality	Coastal and Estuarine Habitats	Marine Benthic Communities	Pelagic Communities	Marine Mammals	Sea Turtles	Marine and Coastal Birds	Fishes and Essential Fish Habitat (EFH)	Areas of Special Concern	Archaeological and Historical Resources	Population, Employment and Income	Land Use and Infrastructure	Commercial and Recreational Fisheries	Tourism and Recreation	Sociocultural Systems	Environmental Justice
Routine Project-Related Activities																	
Noise				●	●	●	●	●	●					●	●	●	●
Traffic			●		●	●	●	●						●	●	●	●
Routine Discharges		●	●	●	●	●	●	●	●							●	●
Drilling Muds/Cuttings/Debris		●	●	●	●	●	●	●	●		●			●		●	●
Bottom/Land Disturbance		●	●	●		●	●	●	●	1	●	2	●	●		●	●
Emissions	●			●		●									●	●	●
Lighting			●		●	●	●	●	●		●			●	●	●	●
Visible Infrastructure						●		●			●		●		●	●	●
Space-Use Conflicts													●	●		●	●
Non-Routine or Accidental Events																	
Oil Spills	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Other Spills or Discharges	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

[1]For Areas of Special Concern, the impacts will not be to the Area of Special Concern itself, but rather the resources present in the Area.
[2]The IPFs do not apply to population, employment, and income impacts, but the action itself is the impact to that resource.

3.6. CUMULATIVE ACTIVITIES SCENARIO

A cumulative impact "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 non-federal) or person undertakes such other actions" (40 CFR 1508.7). It is important to consider the lease sales that might be held under the Program in a broader context that accounts for the full range of actions and associated impacts taking place within each of the five Program Areas, currently and into the foreseeable future. Repeated actions, even minor ones, may produce significant impacts over time. Impacts in a programmatic NEPA review typically focus on environmental effects over a large geographic or time scale. Consequently, the depth and detail in a programmatic analysis reflects the major broad and general impacts that might result from making broad programmatic decisions (CEQ, 2014).

Many of the past, present, and reasonably foreseeable future actions and trends that would contribute to cumulative impacts under the Proposed Action alternatives also contribute to cumulative impacts under the No Action Alternative (Alternative C). Under Alternative C, there would be no OCS oil and gas lease sales conducted during the 2017-2022 Program and, as a result, energy would be obtained from other sources to replace the lost oil and gas production. Some of the lost OCS production would be replaced by tanker imports into existing terminals, but some would be made up by onshore production (transported via pipelines) and domestic production of oil and gas alternatives. Because the mix of non-OCS sources of energy and the locations of resource or energy development are unknown, but could occur throughout the U.S. or the world, both on land or at sea, setting the spatial boundaries for the No Action Alternative over the 40- to 70-year time frame of the cumulative impacts analysis is speculative. As a result, a separate treatment of the cumulative effects under the No Action Alternative is not considered here.

3.6.1. Methodology for Assessing Cumulative Impacts

The general approach for the cumulative impacts assessment follows the principles outlined by the CEQ (1997) and guidance developed by the U.S. Environmental Protection Agency (USEPA) (1999). It also considers the findings and recommendations of the NEPA task force and the CEQ as they pertain to programmatic assessments and environmental management systems (NEPA Task Force, 2003; CEQ, 2014).

The cumulative impacts assessment focuses on the resources, ecosystems, and human communities that may be affected by the incremental impacts associated with the PP (under any of the action alternatives), in combination with other past, present, and reasonably foreseeable future actions. 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).

3.6.2. Spatial and Temporal Boundaries for the Cumulative Impacts Assessment

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 PP and other non-Program actions, within and beyond the administrative planning area boundaries in which such activities are taking place. Marine regions are ecosystem-based regions defined according to the boundaries of large marine ecosystems (LMEs) developed by the National Oceanic and Atmospheric Administration (NOAA). The geographic scope of the cumulative analysis varies depending on the resources being evaluated and their geographic distribution.

Table 3.6-1 summarizes information pertinent to the regions of interest for the Gulf of Mexico, Cook Inlet, Arctic (Beaufort and Chukchi Seas), and Atlantic OCS Program Areas. The regions of interest presented in **Table 3.6-1** are relevant for the Proposed Action and other action alternatives because they span the broadest possible geographic areas of affected resources and the extent of the potential impacts.

Temporal Boundaries: The cumulative impacts assessment incorporates the sum of the effects of the PP in combination with other past, present, and future actions because 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 70 years from the time the Program takes effect in 2017. The time frame represents the temporal boundaries for all alternatives.

3.6.3. Past, Present, and Reasonably Foreseeable Future Actions

The following summarizes the E&D scenarios for the cumulative OCS activities for the Alaska (Arctic [Beaufort and Chukchi Seas] and Cook Inlet), Gulf of Mexico, and Atlantic over the next 40 to 70 years.

Table 3.6-1. Regions of Interest for the Cumulative Impacts Analysis.

Resource	Arctic Region	Cook Inlet	Gulf of Mexico	Atlantic Region
Water Quality	Coastal waters (bays); marine (state offshore and federal OCS) and deep waters in the Chukchi and Beaufort Seas	All waters of Cook Inlet	Coastal waters (bays and estuaries), marine waters (state offshore and federal OCS), and deep water (depths >305 m [1,000 ft])	Coastal waters (bays and estuaries), marine waters (state offshore and federal OCS), and deep water (depths >305 m [1,000 ft])
Air Quality	Shelf waters (marine). North Slope Borough	Kenai Peninsula, Alaska Peninsula, and Kodiak Island Boroughs	Northern GOM waters (marine). Coastal counties in Texas, Louisiana, Mississippi, Alabama, and Florida	Coastal habitats and offshore waters of the Mid- and South Atlantic Planning Areas
Coastal and Estuarine Habitats	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	Coastal and nearshore habitats within estuarine watersheds of the coastline and around bays, lagoons, and river mouths; includes beaches, marshes, tidal flats, scarps, river mouths/deltas, and marine algae	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, river mouths/deltas, and marine algae/*Sargassum*
Marine Benthic Habitats	Seafloor of the Beaufort/Chukchi Shelf Marine Ecoregion and the Arctic Slope and Arctic Plains Marine Ecoregions	Seafloor of the Alaska Fjordland Shelf Ecoregion; includes Kachemak Bay, Shelikof Strait, lower Cook Inlet, and Gulf of Alaska (oil spills)	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 OCS, slope/deep sea, and canyons; includes soft sediments, hard/live bottom, coral, chemosynthetic communities
Pelagic Habitats	Water column and water surface of the Beaufort/Chukchi Shelf Marine Ecoregion	Water column and water surface of the Cook Inlet and Shelikof Strait	Water column and water surface of the Mississippi and Texas Estuarine Areas	Water column and water surface of the shelf, slope, and canyon environments
Marine and Terrestrial Mammals (ESA- and non-ESA species)	Beaufort/Chukchi Shelf Level II Ecoregion, including the Chukchi Neritic and Beaufort Neritic Level III Ecoregions (marine) and coastal habitats of the Arctic region (terrestrial)	Cook Inlet Level III Coastal Region; Gulf of Alaska Level III Coastal Region (marine) and coastal habitats in the Cook Inlet Planning Area and nearby coastal habitats in the Gulf of Alaska	Northern GOM waters (marine) and coastal habitats of northern GOM waters (terrestrial)	Coastal habitats and offshore waters of the Mid- and South Atlantic Planning Areas
Marine and Terrestrial Reptiles (ESA- and non-ESA species)	N/A	N/A	Coastal habitats and offshore waters of the Eastern, Central, and Western Planning Areas	Coastal habitats and offshore waters of the Mid- and South Atlantic Planning Areas

Table 3.6-1. Regions of Interest for the Cumulative Impacts Analysis (Continued).

Resource	Arctic Region	Cook Inlet	Gulf of Mexico	Atlantic Region
Marine and Coastal Birds (ESA- and non-ESA species)	Beaufort and Chukchi Seas, including coastal habitats	Cook Inlet Planning Area, including coastal habitats (wetlands and bays) used by migratory species; includes mudflats, beaches, lagoons, and islands	Northern GOM coastline, including coastal habitats used by migratory species from northern latitudes; includes coastal wetlands and marshes, mud flats, and beaches. Trans-Gulf flyways.	Mid- and South Atlantic Planning Areas; numerous marine and coastal bird species present, including resident and migratory species utilizing estuarine and coastal habitat
Fish	Waters and seafloor of the Beaufort and Chukchi Seas and associated bays, estuaries, and rivers	Cook Inlet waters and seafloor and associated rivers and bays	Northern GOM waters and seafloor (continental shelf to abyssal plain) and associated rivers, bays, lakes, and estuaries	Waters and seafloor of the Mid- and South Atlantic, and associated nearshore coastal and intracoastal waterways
Essential Fish Habitat	Water and substrate of the Arctic Management Area	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 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 man-made structures identified by the GOM Fishery Management Council	Waters and substrate of the Mid- and South Atlantic managed by the Mid-Atlantic Fishery Management Council and the South Atlantic Fishery Management Council
Areas of Special Concern	Beaufort and Chukchi Seas Planning Areas, including adjacent onshore areas	Cook Inlet and Gulf of Alaska Planning Areas, including adjacent onshore areas	Eastern, Central, and Western Planning Areas, including adjacent onshore areas	Mid- and South Atlantic Planning Areas, including adjacent onshore areas
Archaeological and Historical Resources	Beaufort and Chukchi Seas Planning Areas, including adjacent onshore areas	Cook Inlet Planning Area, including adjacent onshore areas	Eastern, Central, and Western Planning Areas, including adjacent onshore areas (e.g., river channels, floodplains, terraces, levees)	Mid- and South Atlantic Planning Areas, including adjacent onshore areas

Table 3.6-1. Regions of Interest for the Cumulative Impacts Analysis (Continued).

Resource	Arctic Region	Cook Inlet	Gulf of Mexico	Atlantic Region
Population, Employment, and Income	North Slope and Northwest Arctic Boroughs	Anchorage municipality, Kenai Peninsula, Kodiak Island, and Matanuska-Susitna Boroughs	Relevant counties and Economic Impact Areas in Texas, Louisiana, Mississippi, Alabama, and Florida along the GOM coast	50 coastal counties inshore of the Mid-Atlantic Planning Area (North Carolina, Virginia) and 17 coastal counties inshore of the South Atlantic Planning Area
Land Use and Infrastructure	Land in the vicinity of the Beaufort and Chukchi Seas Planning Areas	Lands in the vicinity of the Cook Inlet Planning Area	Coastal counties along the northern GOM	Land in the vicinity of the Mid- and South Atlantic Planning Areas
Commercial and Recreational Fisheries	Arctic Management Area	Upper and Lower Cook Inlet Management Areas; Gulf of Alaska	GOM coastal states	Mid- and South Atlantic coastal states managed by the Mid-Atlantic Fishery Management Council and the South Atlantic Fishery Management Council
Tourism and Recreation	North Slope Borough (mainly Barrow and Deadhorse)	Cook Inlet area (including Anchorage), Kenai Peninsula, and Prince William Sound	Coasts of Florida, Alabama, Mississippi, Louisiana, and Texas	Mid- and South Atlantic coasts
Sociocultural Systems and Subsistence	North Slope and Northwest Arctic Boroughs	South-central Alaska (including Anchorage, Kenai, Soldotna, Nikiski, Port Lions, Nawlek, Port Graham, and coastal communities)	Coastal counties along the northern GOM	Coastal counties along the Mid- and South Atlantic coasts
Environmental Justice	North Slope and Northwest Arctic Boroughs	Anchorage municipality, Kenai Peninsula, Kodiak Island, and Matanuska-Susitna Boroughs	Relevant counties and Economic Impact Areas in Texas, Louisiana, Mississippi, Alabama, and Florida along the GOM coast	50 coastal counties inshore of the Mid-Atlantic Planning Area (North Carolina, Virginia) and 17 coastal counties inshore of the South Atlantic Planning Area
Climate Change	Coastal communities inshore of the Beaufort and Chukchi Sea Planning Areas	Coastal communities inshore of the Cook Inlet Planning Area	Coastal states, counties, and communities of the northern GOM	Coastal states, counties, and communities inshore of the Mid- and South Atlantic Planning Areas
Acoustic Environment (Noise)	Chukchi Sea and Beaufort Sea LMEs	Gulf of Alaska LME	GOM large marine ecosystem (LME)	Southern portion of the northeastern U.S. Continental Shelf LME; northern portion of the southeastern U.S. Continental Shelf LME

GOM = Gulf of Mexico; ESA = Endangered Species Act; LME = large marine ecosystem; N/A = not applicable; OCS = Outer Continental Shelf.

3.6.3.1. Cumulative Cases

Figures 3.6-1 through **3.6-6** depict the projected timing of cumulative OCS oil and gas activity levels in the Beaufort Sea, Chukchi Sea, Cook Inlet, Gulf of Mexico, and Atlantic, respectively, for a mid-price scenario. The structures in operation refer to all production structures that would be operating in a given planning area over the time frame specified. In all price scenarios, the Proposed Action only contributes a relative proportion towards the cumulative case, contributing least in the Gulf of Mexico where there are already high levels of activities. Different price scenarios may result in different magnitudes of activity and production; despite the influence of price, coherent trends persist. IPFs are similar to those described for the Proposed Action.

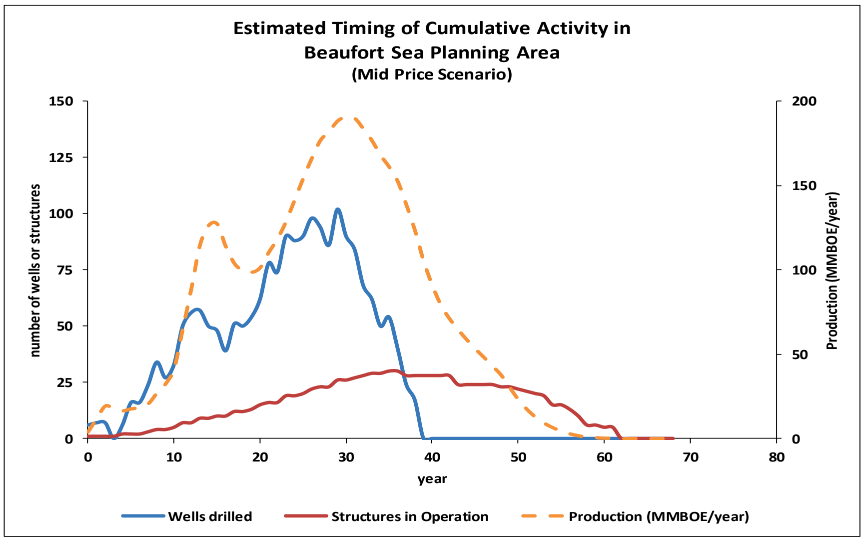


Figure 3.6-1. Cumulative E&D Activity in the Beaufort Sea Planning Area; Year 0 = 2017.

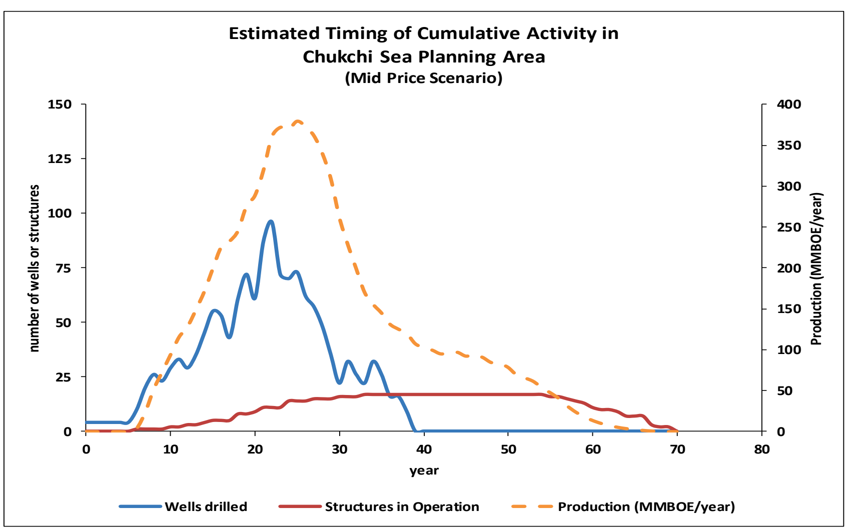


Figure 3.6-2. Cumulative E&D Activity in the Chukchi Sea Planning Area; Year 0 = 2017.

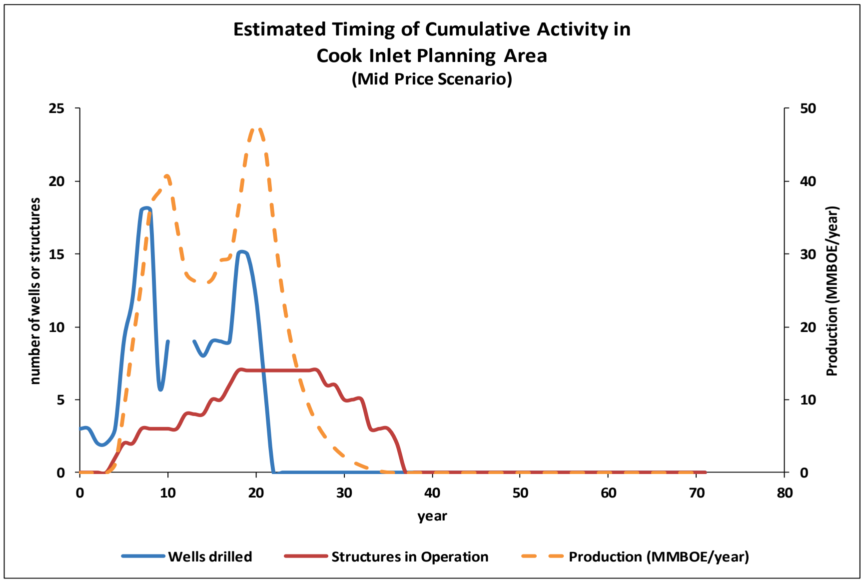


Figure 3.6-3. Cumulative E&D Activity in the Cook Inlet Planning Area; Year 0 = 2017.

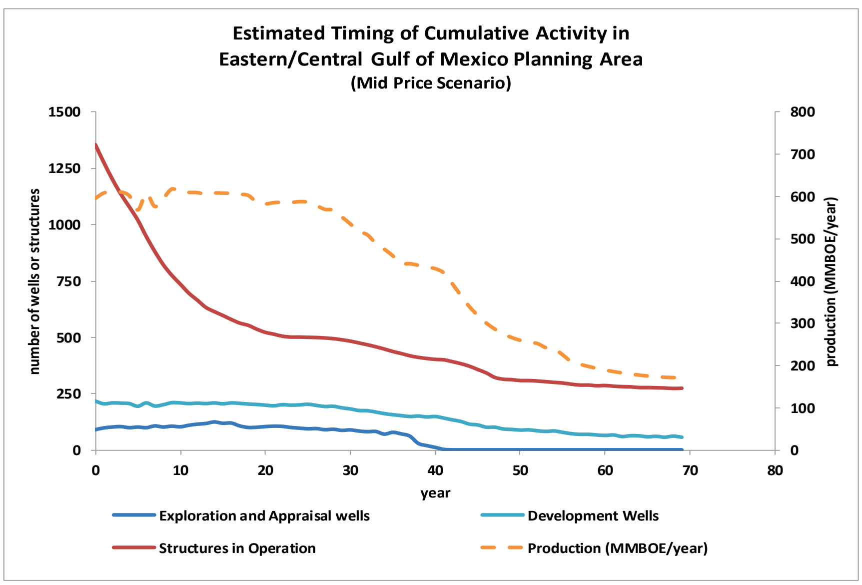


Figure 3.6-4. Cumulative E&D Activity in the Eastern/Central Planning Area. Structures do not Include Subsea Structures; Year 0 = 2017.

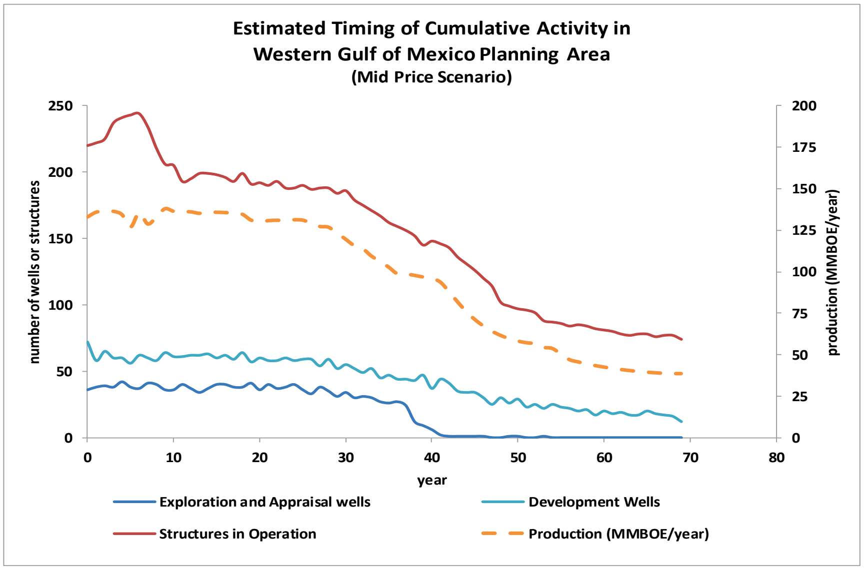


Figure 3.6-5. Cumulative E&D Activity in the Western Planning Area. Structures do not Include Subsea Structures; Year 0 = 2017.

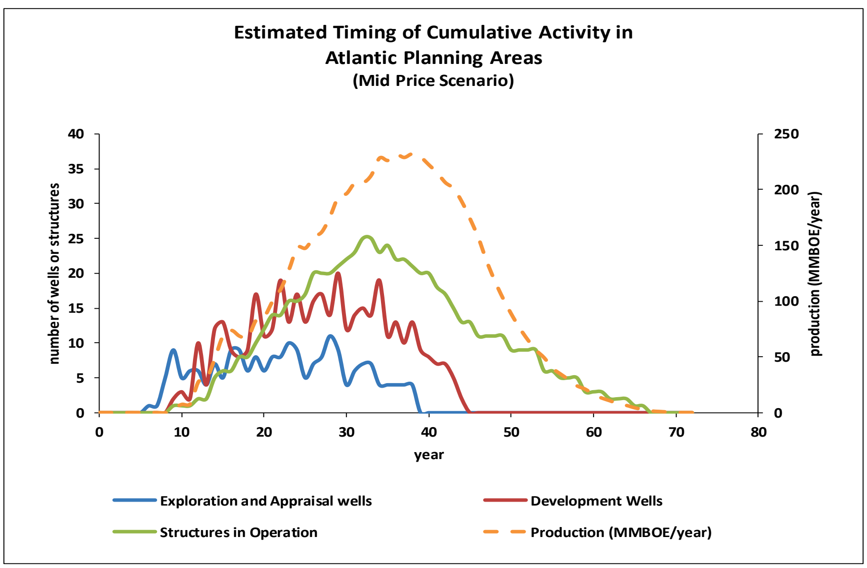


Figure 3.6-6. Cumulative E&D Activity in the Atlantic Planning Areas. Structures do not Include Subsea Structures; Year 0 = 2017.

Estimates of the assumed numbers of large and small expected oil spills that could result from all OCS activities over the 40- to 70-year time frame are presented in **Table 3.6-2**.

Table 3.6-2. Expected Accidental Spills in the Cumulative Case.

Spill	Assumed Spill Volume (bbl)	Number of Spills[a]					
		Gulf of Mexico Program Areas		Arctic Program Areas		Cook Inlet	Atlantic Program Areas
		Western	Central/ Eastern	Beaufort Sea	Chukchi Sea		Mid- and South Atlantic
Large (bbl)[b]	≥1,000						
Platform[c]	5,100	0 to 1	4 to 6	0 to 2	0 to 3	0 to 1	0 to 1
Pipeline[d]	1,720	2 to 4	12 to 20	0 to 6	0 to 10	0 to 1	2 to 3
Small (bbl)[e]	≥1 to <50	133 to 273	1,025 to 1,655	0 to 464	0 to 846	16 to 64	125 to 184
	≥50 to <1,000	23 to 47	177 to 285	0 to 80	0 to 146	3 to 11	22 to 32

[a] The assumed number of spills are estimated using the 1996 to 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 ≥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. For the 1996 to 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] During the period 1996 to 2010, two 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 between 1964 and 2010, is 7,000 bbl.
[c] During the period 1996 to 2010, seven 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] The number of spills <1,000 bbl is estimated using the total spill rate for pipeline and platform spills.

3.6.3.2. Non-OCS Program Actions and Trends

Other uses of the OCS include commercial fishing; state oil and gas activities; national defense activities; tourism and recreation; commercial shipping and transport; coastal recreation, including recreational fishing and diving; and subsistence use. This summary also provides information on the current status of BOEM's renewable energy leasing and non-energy marine minerals leasing. This section summarizes the information at the regional level, while highlighting important distinctions between the different planning areas in a region. Unless otherwise noted, the principal source of information on the economic and public uses of the OCS and the surrounding coastal region for the different planning areas is BOEM's report, "Economic Inventory of Environmental and Social Resources Potentially Impacted by a Catastrophic Discharge Event Within OCS Regions" (USDOI, BOEM, 2014a).

3.6.3.2.1. Alaska Region

The 15 planning areas in the Alaska OCS Region are grouped into three subregions: (1) the Arctic (Beaufort Sea, Chukchi Sea, and Hope Basin); (2) the Bering Shelf (Navarin Basin, North Aleutian Basin, St. George Basin, Norton Basin, St. Matthew-Hall, and Bowers Basin); and (3) the Pacific Margin (Cook Inlet, Gulf of Alaska, Shumagin, Kodiak, and Aleutian Arc).

3.6.3.2.1.1 Arctic Region

Table B-1 in **Appendix B** summarizes ongoing and reasonably foreseeable future actions and trends affecting resources and systems in the Arctic Region.

3.6.3.2.1.2 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 hydrocarbon 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, including roads, pipelines, power lines, production facilities, and transportation hubs. Due to the high cost of building infrastructure and the remoteness and harsh weather of the region, many Arctic fields remain undeveloped. For example, the USEIA estimates that of the 35.4 trillion cubic feet (tcf) of discovered natural gas resources in the Arctic, two-thirds is in the Prudhoe Bay Field but remains undeveloped due to a lack of transportation infrastructure (National Research Council [NRC], 2003; Budzik, 2009).

Currently, there are 35 producing oil fields and satellites on the North Slope and nearshore areas of the Beaufort Sea. Oil fields are distributed among the various unit pools: Bay (12), Duck Island (3), Northstar (1), Badami (1), Kuparak (5), Milne Point (3), Colville River (8), Ooogaruk (1), and Nakiatchuq (1) (National Energy Technology Laboratory [NETL], 2009). Industrial development centers on Prudhoe Bay and National Petroleum Reserve in Alaska; 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 (USDOI, BOEM, 2015d).

3.6.3.2.1.3 Arctic Other Uses

Commercial activity in the Arctic subregion is limited. There is oil and gas production in state waters adjacent to the Beaufort Sea Planning Area (USDOI, BOEM, 2015d).

Fishing activity is limited to subsistence and recreational fishing, as commercial fishing is prohibited in U.S. waters north of the Bering Strait. Among native communities (such as the Iñupiat along the Chukchi and Beaufort Seas), subsistence fishing and hunting activities have significant cultural value and provide a substantial portion of many communities' annual diets. Based on a survey commissioned by the Alaska Department of Administration, more than 25 percent of respondents living in the Alaskan Arctic rely on subsistence for at least half of their food supply. The harsh Arctic climate and the difficulty of physically accessing the area limit most recreational activity in the Arctic. Some recreational fishers are non-residents, who visit primarily in the summer, but Arctic oilfield workers account for most recreational fishing in the area.

The patterns and amount of vessel traffic in the Arctic are highly affected by seasonal variability and ice cover. There is limited infrastructure in the region, so transportation by water and, during the winter, via over-ice roads are important means of moving fuel and supplies for area residents. In addition to military activities in OCS waters, the U.S. Coast Guard conducts search and rescue missions and coordinates with the U.S. Navy to conduct ice thickness and acoustic surveys in the Arctic OCS.

3.6.3.2.2. Cook Inlet

Table B-2 in **Appendix B** summarizes ongoing and reasonably foreseeable future actions and trends affecting resources and systems in Cook Inlet.

3.6.3.2.2.1. Ongoing Oil and Gas Exploration, Development, and Production Activities and Existing Infrastructure

Oil and gas discoveries in the upper Cook Inlet cover an estimated 11,400 km^2 (4,400 mi^2), and extend from the Kachemak Bay area north to the Susitna River. The area includes fields in offshore Cook

Inlet, the west shore of Cook Inlet, and the western half of the Kenai Peninsula. As of 2009, approximately 1,300 MMbbl of oil and 7,800 billion cubic feet (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 approximately 34 MMbbl, with annual production projected to decline from 3.4 MMbbl in 2010 to approximately 0.52 MMbbl in 2034 (Alaska Department of Natural Resources [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 hectares (ha) (529,230 acres [ac]) onshore, and 182,321 ha (450,526 ac) offshore (ADNR, 2012b). Currently, there are 16 offshore production platforms in Cook Inlet, all of which are in state waters; 12 of the platforms are currently active. Crude oil production is handled through the Trading Bay Production Facility located on the west side of Cook Inlet, which pipes crude oil it receives to the Drift River Oil Terminal. Almost all 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 5 onshore and 14 offshore pipeline systems, totaling approximately 251 km (156 mi) of pipeline. Approximately 135 km (84 mi) of pipeline transport crude oil from offshore platforms to shore; onshore pipelines transport processed oil to the Drift River Oil Terminal on the west side of Cook Inlet or to the Tesoro Refinery in Nikiski on the east side. Offshore gas pipelines in the Trading Bay area are approximately 200 km (124 mi) in length; onshore pipelines on the Kenai Peninsula and on the west bank total approximately 322 km (200 mi) and 257 km (160 mi), respectively, in length, and some of these are double lines (USDOI, Minerals Management Service [MMS], 2003a).

3.6.3.2.2.2. Pacific Margin Other Uses

Commercial fishing, harvesting and processing seafood, tourism and recreation, and commercial shipping are all important industries in and adjacent to the Pacific Margin subregion. Commercial fishing as well as harvesting and processing seafood are particularly important industries along the Gulf of Alaska, Aleutian Arc, Kodiak, and Shumagin. While these are somewhat less important along Cook Inlet, they are still economically important.

Tourism is a critical component for the economies of Cook Inlet and the Gulf of Alaska, but is limited in and near the Kodiak, Shumagin, and Aleutian Arc Planning Areas. Visitor industry-related employment accounts for more than 10 percent of all employment in Juneau (Gulf of Alaska area) and approximately 20 percent of all sales tax revenue collected by the city.

Commercial shipping is also important in the Pacific Margin subregion. The Port of Valdez in the Gulf of Alaska is the largest Alaskan port and 1 of the 20 largest in the U.S. as defined by total traffic, largely due to oil shipments. The Port of Anchorage on the eastern end of Cook Inlet is essential for many Alaskans, as approximately 90 percent of all consumer goods provided to nearly 80 percent of Alaska's population move through the port. In addition, thousands of commercial vessels pass through the Gulf of Alaska, Kodiak, Shumagin, and the Aleutian Arc annually along the "Great Circle" shipping route from the Pacific Northwest to Asia. Oil and gas production in state waters adjacent to the Pacific Margin subregion is currently limited to the Cook Inlet Planning Area.

Important public uses in and along the Pacific Margin subregion include coastal recreation as well as recreational and subsistence fishing and hunting. Cook Inlet is a popular destination for outdoor recreational activities, particularly fishing, hiking, boating, hunting, and wildlife viewing. The majority of sportfishing in Alaska takes place along the south-central coast. Subsistence fishing and hunting is a critically important public use of coastal and marine resources across the five planning areas in the subregion. Communities engage in subsistence hunting and fishing for their economic, social, cultural, and spiritual value and to meet basic nutritional needs. While species of salmon are the primary subsistence source, halibut and shellfish, particularly crab, are important also.

Subsistence fishing and hunting make up a substantial portion of many communities' annual diets. For example, one-third of residents on the Kenai Peninsula and more than 15 percent in Anchorage (both of which are adjacent to Cook Inlet) report that they obtain 25 to 50 percent of their food supply from subsistence fishing and hunting.

3.6.3.2.3. Gulf of Mexico Region

Table B-3 in **Appendix B** summarizes ongoing and reasonably foreseeable future actions and trends affecting resources and systems in the Gulf of Mexico.

3.6.3.2.3.1. Ongoing Oil and Gas Exploration, Development, and Production

Oil and gas development is the main industrial activity in the Gulf of Mexico region, including the coastal waters of the Gulf of Mexico states and in Mexico's waters. Important IPFs associated with oil and gas development include subaerial and subsea noise and vibrations, platform lighting, engine emissions and fuel spills from marine vessels, oil spills from storage tanks and vessel casualties, 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 increasing turbidity and resuspended contaminants, extractive resource consumption, wildlife collisions with infrastructure and marine vessels, and collisions among marine vessels. 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, if present, cultural resources.

All the Gulf of Mexico states except Florida have active oil and natural gas programs in offshore state waters and on coastal lands. In 2009, oil and natural gas produced in Gulf of Mexico state waters totaled 503 MMbbl and 114 bcf, respectively (USEIA, 2010a,b). Offshore state oil and gas activity levels are highest in Texas and Louisiana, a long-established trend that likely will continue over the next 40 to 50 years.

3.6.3.2.3.2. Renewable Energy and Non-energy Marine Minerals

BOEM has not received nominations for renewable energy leasing in the Western, Central, or Eastern Planning Areas and is not aware of any specific plans or proposals to develop OCS renewable energy resources in any of these areas at this time. Therefore, it appears unlikely that commercial leasing for renewable energy resources will proceed in the 2017-2022 time frame. Noting that leases with discoveries of oil or gas can be held for as long as commercial production continues, any renewable energy leasing that may occur during the approximately 50-year lifespan of the producing leases issued during the 2017-2022 PP will need to be coordinated during the later stages of BOEM's oil and gas leasing process (e.g., lease sale, EP, and development and production plan stages).

BOEM has issued, or plans to issue, leases and agreements for sand and gravel projects along the Gulf of Mexico, specifically offshore the west coast of Florida, Mississippi, and Louisiana. The Gulf of Mexico Region Marine Minerals Program expects to be a substantial resource to the Gulf of Mexico coastal region as funds from the RESTORE Act are used for restoration projects by coastal states. Typically, the borrow areas are in 9 to 18 m (30 to 60 ft) of water in close proximity to the coast.

3.6.3.2.3.3. Military Uses

The U.S. Department of Defense (USDOD) conducts training, testing, and operations in offshore operating and warning areas, at undersea warfare training ranges, and in special use or restricted airspace on the OCS. These activities are critical to military readiness and national security. The U.S. Navy utilizes the airspace, sea surface, subsurface, and seafloor of the OCS for events ranging from instrument and equipment testing to live-fire exercises. The U.S. Air Force conducts flight training and systems testing over extensive areas on the OCS. The U.S. Marine Corps conducts amphibious warfare training extending from offshore waters to the beach and inland.

Some of the most extensive offshore areas used by the USDOD include Navy at-sea training areas. Training and testing may occur throughout the U.S. Gulf of Mexico OCS waters, but is concentrated in operating areas and testing ranges. These activities may vary, depending on where they occur (e.g., open water versus nearshore). Major testing and training areas in the Gulf of Mexico include the Gulf of Mexico Range Complex; the Naval Surface Warfare Center, Panama City Division; and the Key West Complex located off the southwestern tip of Florida.

The USDOD and USDOI will continue to coordinate extensively under the 1983 Memorandum of Agreement, which states that the two parties shall reach mutually acceptable solutions when the requirements for mineral E&D and defense-related activities conflict.

3.6.3.2.3.4. Other Uses

The most notable "other uses" in terms of economic contribution in the Gulf of Mexico are tourism and recreation (including recreational fishing), commercial fishing and harvesting seafood, and commercial shipping. Millions of individuals participate in a variety of recreational activities in the region's coastal environment each year, including recreational fishing, boating, beach visitation, wildlife viewing, and swimming. Texas, Louisiana, and Florida have significantly more coastline and more coastal population centers than do Alabama or Mississippi. However, while tourism and recreation contribute more to the gross domestic product (GDP) in states with more coastline and more coastal population centers, the tourism and recreation industries in Alabama and Mississippi still make up sizable portions of the states' GDPs and sizeable percentages of each state's total employment.

On an annual basis, coastal tourism and recreation industries contribute more than $1 billion in GDP along the Western and Central Planning Areas and more than $10 billion in GDP along the Eastern Planning Area. Commercial fishing and seafood industries also contribute billions to state GDP on an annual basis, most notably in and along the Eastern Planning Area, contributing more than $4 billion to Florida's GDP. The commercial fishery sector is largest in Louisiana, followed by Texas and Florida. However, Florida's commercial fishery sector does contribute most to the GDP because of its contributions further along the seafood supply chain (e.g., processors, retailers).

Commercial shipping also is economically important. As measured by the amount of cargo flowing through the ports on an annual basis, more than half of the 20 largest U.S. ports are along the Gulf Coast, mostly along the Central and Western Planning Areas. All five Gulf states have had some historical oil and gas exploration activity and, with the exception of Florida and Mississippi, currently produce oil and gas in state waters. While very little data exist to track its economic contribution, subsistence fishing and harvesting seafood also are an important public use of coastal and marine resources along the three Gulf of Mexico Planning Areas, particularly in rural communities. Traditional subsistence harvesting, including fishing and hunting, continues among some ethnic and low-income groups (Hemmerling and Colton, 2003) but also recreationally with higher-income groups.

3.6.3.2.4. Atlantic Region

Table B-4 in **Appendix B** summarizes ongoing and reasonably foreseeable future actions and trends affecting resources and systems in the Atlantic. In the U.S. Atlantic Region, there is currently no oil and gas production from state or OCS waters.

3.6.3.2.4.1. Renewable Energy and Non-Energy Marine Minerals

Renewable energy leases have been executed along the Atlantic coast, with site assessment and construction activities potentially occurring in the 2017-2022 time frame. BOEM is considering offering additional areas for lease and is processing unsolicited requests for research and limited leases and right-of-way grants.

BOEM has issued leases and agreements for sand and gravel projects along the Atlantic coast from New Jersey to Florida. Typically, the borrow areas are located in 9 to 18 m (30 to 60 ft) of water in close proximity to the coast. Recently, potential future use of OCS sand offshore New York and the New England states has become of interest.

3.6.3.2.4.2. Military and NASA Uses

Military training and testing occurs throughout U.S. Atlantic coast OCS waters, but is concentrated in Operating Areas (OPAREAs) and testing ranges. On the Atlantic coast, the major testing ranges include the Naval Undersea Warfare Center, Newport Division; Newport News, Virginia; and the Naval Surface Warfare Center, Panama City Division. In the Mid-Atlantic, range complexes include Virginia Capes, Marine Corps Air Station Cherry Point, Marine Corps Base Camp Lejeune (which includes ocean coastline amphibious landing training zones), and portions of Chesapeake Bay; in the South Atlantic, the Jacksonville (Florida) Range Complex.

The USDOD identified locations where there is potential space-use conflict between USDOD activities and offshore oil and gas development (**Figure 3.6-7**). Most of the potential conflicts are attributable to the frequent use of live munitions in support of fleet gunnery exercises, air-to-surface bombing, and anti-submarine warfare and test operations (USDOD, 2015).

In addition to military installations, there are several facilities along the U.S. Atlantic coast operated by the National Aeronautics and Space Administration (NASA) that incorporate marine components. Wallops Flight Facility on Wallops Island, Virginia is a key location for operational test, integration, and certification of NASA and commercial orbital launch technologies. The facility has an offshore launch hazard area in adjacent waters.

NASA has highlighted for these activities to impact operations at its Wallops Island Flight Facility using past missions and likely future missions (**Figures 3.6-8** and **3.6-9**). The USDOD indicated that it will conduct a comprehensive analysis of mission compatibility with offshore oil and gas development for the relevant planning areas included in any EP or Development and Production Plan.

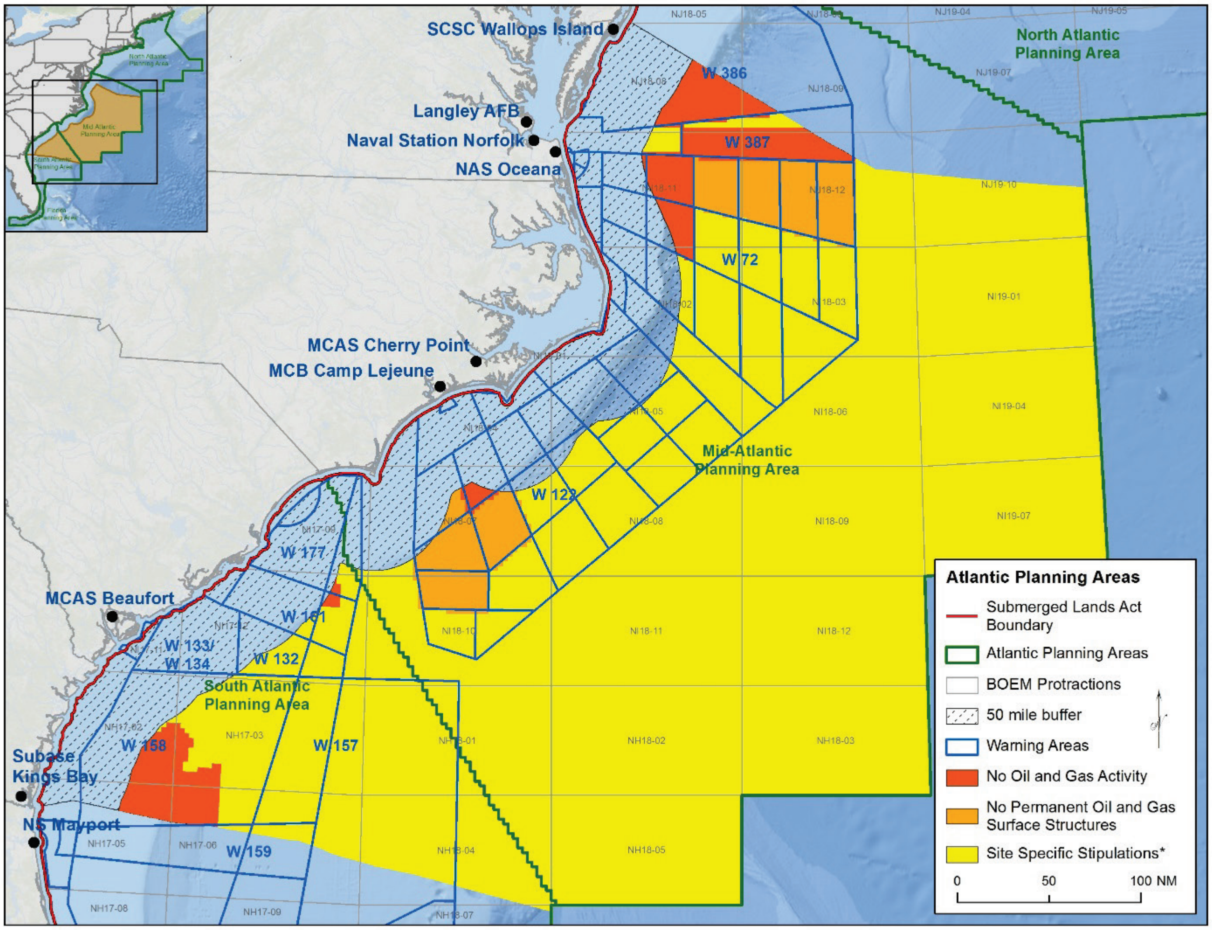


Figure 3.6-7. Potential Space-Use Conflicts Between USDOD Activities and Offshore Oil and Gas Activities (Data from: USDOD, 2015). Demonstrates the USDOD's Perspective on Where Oil and Gas Activities Should Occur to Minimize Conflicts with Defense Activities.

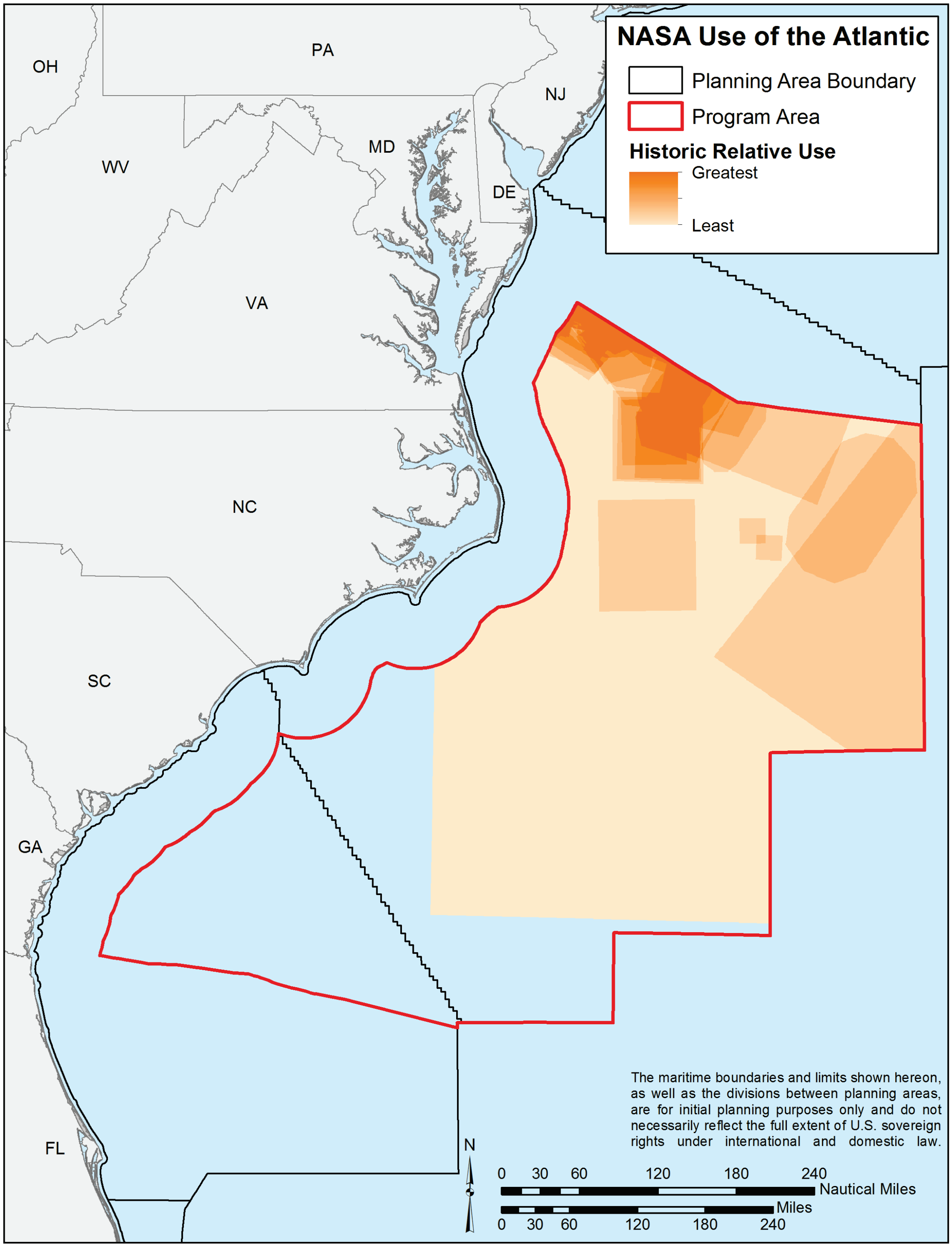


Figure 3.6-8. NASA's Assessment of Historic Use in the Atlantic Region (Data from: NASA, 2015).

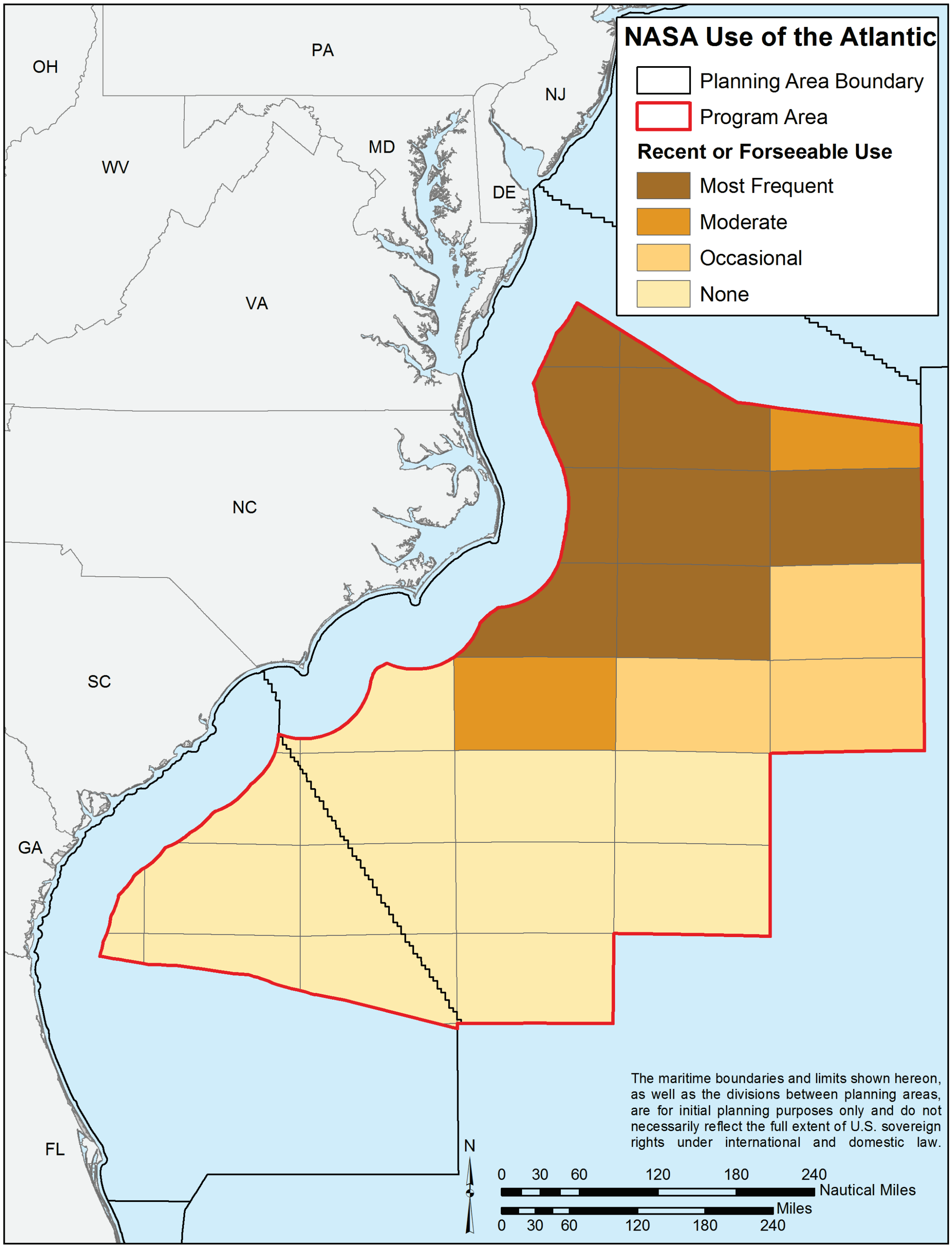


Figure 3.6-9. NASA's Assessment of Recent or Foreseeable Use in the Atlantic Region (Data from: NASA, 2015).

3.6.3.2.4.3. Other Uses

Commercial fishing, ocean-dependent tourism, and commercial shipping and transportation are important economic factors occurring along all the Atlantic Planning Areas. The North Atlantic supplies much of the fish and shellfish consumed in the U.S., with Massachusetts having the highest landings value (more than $2.5 billion), followed by New York (more than $1.7 billion). The economic impacts of commercial fishing along the entire Mid-Atlantic Planning Area total more than $1.5 billion of total value added to GDP; the industry is especially large in Virginia. Ocean-dependent tourism is also a significant economic use for the Mid-Atlantic, South Atlantic, and Straits of Florida Planning Areas, accounting for more than $6.5 billion, $4.4 billion, and $6 billion in value added, respectively, to adjacent coastal areas. Ocean-dependent tourism is particularly important for Maryland, Virginia, North Carolina, South Carolina, and Florida.

Ports located in the Mid-Atlantic Planning Area handle approximately 5 percent of total U.S. waterborne traffic, and Norfolk Harbor is 1 of the 20 largest ports in the U.S. While the South Atlantic Planning Area does not have as many adjacent ports as the other planning areas, three are in the top 40 ports in the U.S. in terms of traffic.

The Atlantic coastal region contains numerous national wildlife refuges (approximately 70), national parks, and national seashores as well as many state parks and recreational areas where the public engages in various recreational activities. Beach visitation, swimming, wildlife viewing, recreational boating, and fishing are the most popular activities across the Atlantic states. Recreational fishing expenditures resulted in total value added in the Mid-Atlantic economy of more than $2 billion, with North Carolina accounting for more than half; more than $1.3 billion in the South Atlantic economy, with east Florida accounting for the vast majority; and nearly $2 billion to the economies in the counties near the Straits of Florida Planning Area. Very little data exist on subsistence fishing and shellfish harvesting in and along the Atlantic Planning Areas, and what information is available is largely informal or speculative. It may be most prevalent in those areas designated as “fishing communities” by NOAA, due to their strong ties to commercial and recreational fishing. Overall, NOAA has identified 47 fishing communities near the South Atlantic Planning Area and 9 near the Straits of Florida Planning Area. According to NOAA’s profiles of fishing communities in the northeast, the limited information available on subsistence fishing and harvesting is for the urban communities and suggests a relative importance to immigrant populations in these areas.

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4. AFFECTED ENVIRONMENT AND IMPACT ASSESSMENT

4.1. INTRODUCTION

This Programmatic EIS evaluates the environmental consequences of a range of alternatives on the basis of Program Areas, including effects of 14 lease sales scheduled in 5 Program Areas under the Proposed Action (Alternative A). Alternative B, the Reduced Proposed Action, includes reductions in leasing compared to the Proposed Action through two approaches: (1) exclusion of certain Program Areas, and (2) exclusion or programmatic mitigation of EIAs within the Program Areas that may affect the size or location of leasing under the Proposed Action. Alternative A, Alternative B, and Alternative C are described in detail in **Chapter 2**.

This programmatic description of the affected environment assesses impacts on a regional scale for each alternative across the full range of potential effects in each of the five Program Areas. Some impacts involve features specific to particular Program Areas, and these are identified as warranted. However, most conclusions on impacts involve considerations that are common throughout a Program Area, and some conclusions on impacts cross all Program Areas. For this reason, the discussion of impacts for Alternative A in **Section 4.4.1** is not structured by Program Area. Furthermore, the discussion does not address specific OCS planning areas, which either encompass the entire Program Area (Chukchi Sea, Beaufort Sea, Cook Inlet) or are adjacent areas in the Gulf of Mexico Program Area (Western and Central Gulf of Mexico) or the Atlantic Program Area (Mid- and South Atlantic) because their separate consideration would not lead to different conclusions on impacts.

The exact context and intensity of impacts from future OCS oil and gas E&D activities cannot be identified without knowing specific location and design details. There are, however, general impacts typical of offshore oil and gas E&D that manifest regardless of where such activity occurs. For example, placement of a platform will disturb seafloor sediments and affect water quality in the vicinity of the platform regardless of location. Potential effects of platform emplacement, however, will differ between locations due to the nature of benthic communities present.

For each resource, IPFs identified in **Section 3.5** were carefully considered and refined to identify aspects specific to the environmental, sociocultural, and socioeconomic resources under evaluation. Analyses identified, as applicable, the sensitivities of each resource to further refine the relationship between impacting factors and the resource, establishing a clearer stressor-receptor relationship.

4.1.1. Impact Assessment Methodology

Impact analysis considers direct effects, indirect effects, and cumulative effects. Direct effects are those that may be caused by the Proposed Action and occur at the identical location and time of the action (40 CFR § 1508.8). Indirect effects are those that may be caused by the Proposed Action at a later time or farther removed from the location of the action, but still reasonably foreseeable (40 CFR § 1508.8). Cumulative effects are additive, interactive, or synergistic, and would result from incremental impact of the Proposed Action when compared or added to other past, present, and reasonable foreseeable future actions, regardless of what agency or person undertakes such other actions (40 CFR § 1508.7; CEQ, 1997a).

Based on scoping for this Programmatic EIS as well as a review of previous environmental analysis documents, BOEM has identified resources that may be impacted by activities associated with the 2017-2022 Program and the most likely IPFs (see **Section 3.5**). The CEQ has directed federal agencies to focus environmental analysis on what is significant and de-emphasize what is not. BOEM has undertaken a screening exercise to identify what stressor-receptor relationships may result in impacts and the level of those impacts (**Section 4.1.2**). **Appendix D** includes a structured presentation of each resource area, the IPFs that may impact each resource area, and a determination of the level of impact for each IPF. Impacts that are expected to be negligible or minor are disclosed and addressed in **Appendix D** in order to help focus the analysis in this chapter. Impacts that may rise to a moderate or major level are discussed in detail in in **Section 4.4**.

4.1.2. Impact Levels

Impact levels and associated terminology in this Programmatic EIS follow a prescribed set of impact definitions following a four-level classification scheme established by BOEM. This approach was used to characterize impacts that could result from routine operations and expected accidental events and spills during OCS oil and gas E&D. Although CDE-level accidents are not expected to occur under any of the alternatives, the Programmatic EIS discusses the types of effects that could arise if such an unexpected accident were to occur. The impact evaluation process considers potential impacts in terms of their temporal context (i.e., short- vs. long-term) and intensity (severity), guided by CEQ regulations implementing NEPA regarding the significance of impacts (40 CFR § 1508.27).

The following impact categories and definitions apply to ***biological***, ***physical***, and ***archaeological resources***. For most biota, determinations are based on population-level impacts rather than impacts on individuals. For species listed under the ESA, impact levels consider impacts on individuals, when appropriate, as well as populations. While archaeological and historic resources are valuable for providing insights into past cultures and cultural lifeways, they are physically present on or under the seafloor as well as on shore, and thus are affected in similar ways to biological and physical resources. Many shipwrecks also provide benefits to the marine ecosystem by providing stable structures for habitats in areas of the ocean that are devoid of such features. Impact levels and definitions include the following:

- **Negligible**: No measurable impact(s).

- **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, or there would be no loss of cultural information and a site will not require *in situ* stabilization.

- **Moderate**: Impacts on the affected resource are unavoidable. Viability or integrity 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, or some cultural information will be irretrievably lost requiring *in situ* stabilization, and limited data recovery may be necessary to preserve some cultural information.

- **Major**: Impacts on the affected resource are unavoidable. Viability or integrity of the affected resource may be threatened and some impacts may be irreversible. The affected resource would not recover fully even if proper mitigation is applied or remedial action is implemented once the impacting stressor is eliminated, or the resource will have been damaged to such an extent that most of the cultural information that may have been gathered from the resource will have been irretrievably lost. *In situ* stabilization will not be a viable mitigation, and data recovery would be necessary to preserve remaining cultural information.

The following impact categories and definitions apply to ***socioeconomic*** and ***societal*** issues, including population, employment, and income; land use and infrastructure; commercial and recreational fisheries; tourism and recreation; sociocultural systems; and environmental justice. Impact levels and definitions include the following:

- **Negligible**: No measurable impact(s).

- **Minor**: Adverse impacts on the affected activity, community, or 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 mitigation, return to a condition with no measurable 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 disruption due to impacts of the project, or once the impacting stressor is eliminated, the affected activity or community will return to a condition with measurable effects if proper remedial action is taken.

- **Major**: Impacts on the affected activity, community, or resource are unavoidable. Proper mitigation would reduce impacts substantially during the life of the project. For archaeological resources, all of the affected resource would be permanently damaged or destroyed. For other socioeconomic and cultural resources, impact 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 stressor is eliminated, the affected activity or community may retain measurable effects for a significant period of time or indefinitely, even is remedial action is taken.

4.2. ISSUES OF PROGRAMMATIC CONCERN

4.2.1. Climate Change

Climate change is the process of worldwide warming and related chemical and physical changes resulting from release of certain pollutants associated with human activities. Chief among drivers of climate change are increasing atmospheric concentrations of carbon dioxide (CO_2) and other greenhouse gases (GHGs), such as methane (CH_4), also known as natural gas, and nitrous oxide (N_2O); these influence positive radiative forcing and general climatic warming. Other climate forcers, such as black carbon, a specific kind of fine particulate matter ($PM_{2.5}$) also contribute to Earth's rising surface temperature. Climate change is expected to result in rising sea levels, leading to land submergence, as well as promoting reduction of sea ice areal extent and temporal duration, loss of permafrost, and increasingly extreme weather such as severe droughts, flooding, and stronger hurricanes.

The Proposed Action will increase global GHG emissions of CO_2 and N_2O, along with black carbon, as a result of the use of vessels, drilling equipment, and other activities that burn fossil fuels. CH_4, unlike other climate forcers, is not introduced through combustion of fossil fuels. Instead CH_4 is removed from the well and brought onto OCS facilities along with oil being produced. Operators have three different methods of handling natural gas removed from a well:

(1) Produce and sell the natural gas, provided there is a sufficient quantity, favorable market conditions, and infrastructure (e.g., natural gas pipelines) to justify production;
(2) Venting or deliberately releasing methane into the atmosphere; and
(3) Flaring, which is relatively rare on the OCS, involves burning methane, converting it to CO_2 and water, and in some cases, releasing N_2O and black carbon.

Methane is also released as a fugitive, so-called because it can escape unintentionally from leaks in equipment used by operators. BOEM is preparing a study to research the contribution of fugitives to overall emissions, including those contributing to climate change.

Because each GHG impacts the atmosphere at a different strength and for a different period of time, they typically are converted to what the strength would be if emissions were exclusively CO_2; this is referred to as the CO_2-equivelent or CO_2e. CH_4 and N_2O are much more effective climate forcers than CO_2; meaning one molecule of CH_4 or N_2O has a greater impact on climate change than one molecule of CO_2. However, CH_4 and N_2O are removed from the atmosphere through natural processes more efficiently than CO_2. Accounting for these factors, CO_2e conversion for CH_4 and N_2O are 25 and 298, respectively (USEPA, 2015). This means one molecule of CH_4 is estimated to have the same warming potential as 25 CO_2 molecules, and for N_2O, 298 CO_2 molecules. As black carbon is not a GHG and functions differently, it is not possible to convert it using the CO_2e method. However, because black carbon is a specific kind of $PM_{2.5}$, it is possible to use the $PM_{2.5}$ concentration to estimate the maximum amount of black carbon released.

As a result of exploration, development, and production of oil and gas on the OCS, the Proposed Action is expected to release GHGs and black carbon climate forcers from use of combustion engines in vessels, construction, drilling, and other equipment as well as through deliberate or accidental release of CH_4. Estimates of emissions from different climate forcers as a result of the Proposed Action, and of 40-year cumulative OCS emissions are in **Table 4.2.1-1**. Cumulative numbers include current operations, the Proposed Action, and expected future development beyond the Proposed Action.

Table 4.2.1-1. Climate Forcers' Estimated Emissions from the Proposed Action and 40-year Cumulative Emissions from OCS Activities in Thousands of Tons/Year and Based on the High Case E&D Scenario from the Offshore Economic Cost Model (USDOI, BOEM, 2015c).

Climate Forcer	Proposed Action		Cumulative	
	Total Emissions	CO_2e	Total Emissions	CO_2e
Western Gulf of Mexico				
CO_2	18,098.99	18,098.99	170,365.29	170,365.29
CH_4	34.16	854.00	395.90	9,897.50
N_2O	0.47	140.06	4.12	1,227.76
$PM_{2.5}$	7.12	N/A	53.10	N/A
CO_2e Total	--	19,093.05	--	172,580.55
Central and Eastern Gulf of Mexico				
CO_2	115,637.74	115,637.74	710,135.46	710,135.46
CH_4	155.00	3,875.00	2,139.24	53,481.00
N_2O	2.22	661.56	18.93	5,641.14
$PM_{2.5}$	39.17	N/A	236.42	N/A
CO_2e Total	--	120,174.30	--	769,257.60
Mid- and South Atlantic				
CO_2	18,668.41	18,668.41	51,412.22	51,412.22
CH_4	45.21	1,130.25	123.06	3,076.50
N_2O	0.49	146.02	1.38	411.24
$PM_{2.5}$	5.01	N/A	14.59	N/A
CO_2e Total	--	19,944.68	--	54,899.96
Beaufort Sea				
CO_2	32,456.31	32,456.31	53,985.52	53,985.52
CH_4	131.83	3,295.75	231.87	5,796.75
N_2O	0.89	265.22	1.54	458.92
$PM_{2.5}$	117.58	N/A	202.25	N/A
CO_2e Total	--	36,017.28	--	60,241.19

Table 4.2.1-1. Climate Forcers' Estimated Emissions From the Proposed Action and 40-year Cumulative Emissions from OCS Activities in Thousands of Tons/Year and Based on the High Case E&D Scenario From the Offshore Economic Cost Model (USDOI, BOEM, 2015c).

Climate Forcer	Proposed Action		Cumulative	
	Total Emissions	CO_2e	Total Emissions	CO_2e
Chukchi Sea				
CO_2	11,663.42	11,663.42	48,928.49	48,928.49
CH_4	47.08	1,177.00	195.79	4,894.75
N_2O	0.38	113.24	1.57	467.86
$PM_{2.5}$	33.03	N/A	202.25	N/A
CO_2e Total	--	12,953.66	--	54,291.10
Cook Inlet				
CO_2	3,699.04	3,699.04	10,187.04	10,187.04
CH_4	13.86	346.50	37.73	943.25
N_2O	0.11	32.78	0.31	92.38
$PM_{2.5}$	1.15	N/A	1.98	N/A
CO_2e Total	--	4,078.32	--	11,222.67

N/A = not applicable.

Tables 4.2.1-2 and **4.2.1-3**, respectively, compare emissions under the Proposed Action to those of the current program, and to those associated with current annual operations in the Gulf of Mexico. Compared to the current program, the Proposed Action would promote an overall increase in CO_2e. Most of the anticipated increase comes from work proposed in the Atlantic, and an expected increase in Arctic development.

Table 4.2.1-2. Estimated CO_2e Emissions from the Proposed Action Based on the High Case E&D Scenario from the Offshore Economic Cost Model (USDOI, BOEM, 2015c) and the 2012-2017 Program (USDOI, BOEM, 2012), with Emissions in Thousands of Tons/Year.

Region	2012-2017 Program (CO_2e)	2017-2022 Proposed Action (CO_2e)
Gulf of Mexico	132,828.51	139,267.35
Arctic (Chukchi and Beaufort Seas)	2,127.46	48,970.95
Cook Inlet	11,750.64	4,078.32
Mid- and South Atlantic	0	19,944.68
CO_2e Total	146,706.61	212,261.35

Table 4.2.1-3. Climate Forcers' Estimated Emissions from the Gulf of Mexico Proposed Action Based on the High Case E&D Scenario from the Offshore Economic Cost Model (USDOI, BOEM, 2015c) and the 2011 Gulfwide Emissions Inventory (USDOI, BOEM, 2014b), with Emissions in Thousands of Tons/Year.

Climate Forcer	GOADS 2011 Data	GOADS 2011 Data (CO_2e)	Gulf of Mexico Proposed Action	Gulf of Mexico Proposed Action (CO_2e)
CO_2	34,585.72	34,585.72	133,746.73	133,736.73
CH_4	273.38	6,834.60	189.16	4,729.00
N_2O	2.87	853.77	2.69	801.62
$PM_{2.5}$	14.62	N/A	46.29	N/A
CO_2e Total	--	42,274.09	--	139,267.35

GOADS = Gulfwide Offshore Activity Data System; N/A = not available.

There is evidence of climate change effects on resources in all three OCS regions included in the Proposed Action, although pace and consequences of change are most acute in the Arctic (International Panel on Climate Change [IPCC], 2014). Regardless of geographic location, climatic changes to the physical framework (e.g., sea level rise, shrinking ice caps), chemical framework (e.g., ocean acidification), and biological framework (e.g., changing habitats) of these areas may be affected by the Proposed Action; some examples include the following:

(1) Climate change is expected to increase the amount of vegetation, which releases volatile organic compounds (VOCs). VOCs interact with nitrogen oxides (NO_x) released from oil and gas operations to produce haze and ozone (O_3), degrading air quality. Increasing these compounds in the atmosphere will increase haze and ozone.
(2) Ocean acidification, a byproduct of increasing atmospheric CO_2 concentrations, threatens increased pressure on marine benthic and plankton communities, which also will be affected by other aspects of the Proposed Action.
(3) Rising sea levels and warmer ocean water will increase hurricane intensity and frequency, and hurricanes are expected to damage or reduce coastal and estuarine habitats.
(4) Melting sea ice is reducing polar bear habitat in the Chukchi and Beaufort Seas.
(5) Changing ocean and coastal environments have affected marine and coastal bird habitats.
(6) Shifting fisheries populations as a result of changing habitats are affecting commercial and recreational fishing.

Additional information on climate change can be found in **Appendix C**, Section 1.1.

4.2.2. Acoustic Environment and Marine Sound

4.2.2.1. Introduction

Once considered silent, the seas are now known to be alive with sounds. Some ocean sounds are the result of natural sources such as storms, earthquakes, waves, and marine animals that produce and use sound to communicate and discern their environment. Other sounds come from anthropogenic sources (those produced during human activities), such as vessels used by commercial fishers, and for transport of goods and services, or for exploration, construction and production of traditional (e.g., oil and gas) and renewable (e.g., wind and tidal power) energy sources, during exercises for military preparedness and national defense, dredging of offshore sand for beach and barrier island improvements (e.g., hurricane protection), seismic research for earthquake detection, and even recreational boating (e.g., nature tours, fishing trips, weekend boaters) (Richardson et al., 1995; Nowacek et al., 2007; Southall et al., 2007; Weilgart, 2007; Convention for the Protection of the Marine Environment of the North-East Atlantic [OSPAR], 2009).

As human presence in the offshore environment has grown, so have anthropogenic sound levels. Current science shows that some sounds may adversely impact marine life in certain situations while having no perceived effect in other settings. Some sounds can interrupt important biological behaviors (e.g., courtship, nursing, feeding, and migration) and mask communication between animals. In more extreme instances, exposures to high levels or extended periods of sound can impose physiological effects, including hearing loss and mortality. Research shows that the same level of sound may have different levels of impact on marine life depending on where in the ocean the sound occurs. In addition, individuals of the same species can react to sound differently in different situations.

Balancing human activities with protection of marine life can be challenging, especially for issues like marine sound that are characterized as highly technical and subject to scientific uncertainty about risks, and that garner significant attention from a wide variety of stakeholders. This section seeks to provide basic information on the physics of marine sound, types of sound sources expected under the

Proposed Action, what is known and unknown about effects of these sounds on marine life, and how BOEM approaches decision-making about marine sound issues.

Much of the following discussion of acoustic terminology, concepts, and application is based on Urick (1983), Richardson et al. (1995), and Au and Hastings (2008). Additional information on the acoustic environment can be found in **Appendix C**, Section 1.2.

4.2.2.2. Fundamentals of the Physics of Marine Sound (Acoustics)

Human activities addressed in this document can produce airborne and underwater acoustic signals, or noise, but only those that eventually enter the water will be addressed here. This includes noise that may be produced in air, but is transmitted into water by structures or vessels that are both in air and water, and by direct transmission into water through the air/water interface.

When discussing acoustics, often the terms sound, signal, and noise are used interchangeably. Technically, this is incorrect and the choice of terms may be confusing. Also, whether a particular sound is a noise or a signal is a matter of perspective. For example, the sound a dolphin produces is the sound signal he is interested in, and may help him localize his next meal. To the human sonar operator, however, that dolphin sound is unwanted noise that has to be ignored while looking for echoes from sonar signals. For this discussion, the term “sound” will be used to represent both signals and noises universally. The exception will be in instances where specific terminology (e.g., ambient noise) is associated with a particular quantity commonly used by acousticians.

4.2.2.3. Terminology and Basic Concepts

Sound is generally understood to be energy in the environment perceived by the sense of hearing. It consists of waves of energy that propagate or pass through the environment in the form of particle motions and vibrations. These waves transit through solids as well as gas and liquid fluids, but sound waves do not have the same appearance as physical waves, like one might see when a pebble is dropped into pond. Rather, these waves consist of compression (squeezing together) and rarefaction (spreading apart) of the ocean’s particles.

There are several parameters that are routinely used to characterize marine sounds, including the following:

- **Pressure Level** – Pressure level is a measure of the pressure existing in the ocean over the duration of the sound. Pressure is measured in micropascals (µPa), a unit of pressure in the International System of Units (SI). Additionally, because the range of perceptible pressures can vary over many orders of magnitude (i.e., many multiples of 10), a logarithmic scale (base 10) is normally used and reported in “dB” with a reference standard. In this way, the sound pressure level (SPL) is defined by SPL = $20 \log_{10} (P/P_0)$, where P is pressure in the ocean and P_0 is the reference pressure. SPL is annotated as a numerical value followed by “dB re 1 µPa.”

- **Frequency or Sound Spectra** – Because sound is the time-varying level of pressure, the rate at which it varies over time is the frequency of the sound. The frequency content of a sound can be a constant or pure tone (often called a continuous wave [CW]), a varying set of discrete frequency over time, or contain multiple frequencies simultaneously. The standard unit for frequency is hertz (Hz), or cycles per second.

- **Duration** – The length of the sound from start to finish is typically represented in time units like seconds or milliseconds (s or ms). Note this can be used to describe the actual signal produced by the source, or the signal at a point in the ocean after it has been smeared or spread during propagation.

- **Rise Time** – The length of time from the start of the signal to its highest pressure. The unit is typically ms or microseconds (µs).

- **Repetition Rate or Pulse Interval** – Repetition rate is the frequency of the transmission in units of the number of repetitions per unit time (e.g., three repetitions per minute), while pulse interval (the reciprocal of the repetition rate) is in time units. For the previous example, pulse interval is 20 seconds or 1/3rd of a minute.

There are other variations or clarifying parameters with sound characteristics, including the following:

- **Sound Exposure Level (SEL)** – An SEL is a measure of acoustic energy in a sound. Effectively, it is the integration of the energy associated with the pressure over the duration of the sound. Like SPLs, SELs have a wide range of values, so they also use a logarithmic scale, but the reference value is a standard energy unit. They are written as a numerical value followed by the unit “dB re 1 µPa^2-s.”

- **Source Level Values** – Source levels can be measured at many ranges. For powerful sources such as airguns, this can be accomplished most easily hundreds of meters from the source, to avoid receivers from overshooting maximum levels they are calibrated to receive. Later, they are scaled back to a source with a 1-m (3-ft) radius. For clarity and to prevent errors, when this scaling is performed, it is a common practice to add “at 1 m” to the sources description. Thus, the unit for a source level is typically “dB re 1 µPa at 1 m.”

- **Peak, Zero-to-Peak, Peak-to-Peak, and RMS Qualifiers** – Historically, different acousticians have used different measuring equipment and terminology for their specific tasks. For example, acousticians evaluating explosive or airgun data typically measured positive and negative pressures, and reported them as “peak-to-peak” pressures, while acousticians in other communities used “zero-to-peak” or “root-mean-squared (rms)” terminology. For clarity, the type of SPL used will be designated using these qualifiers.

4.2.2.4. Description of Sources Associated with Proposed Action

Several sound-producing activities would occur under the Proposed Action that could impact marine life. These potential impacts are shown as broad categories in **Figure 4.2.2-1**. Examples of the sources and their descriptions are in **Section 3.5**.

Vessel activity and seismic surveys likely would be the most prevalent sound-producing activities associated with the Proposed Action. Vessel noise is a combination of narrow-band (tonal) sounds, usually in frequency bands <500 Hz, and some broadband sound. Primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the vessel’s wake (Richardson et al., 1995). Large vessels produce sounds; vessels that use dynamic positioning (DP) for station keeping employ thrusters to maintain position and produce higher sound levels. Representative source levels for DP vessels range from 184 to 190 dB re 1 µPa at 1 m, with a primary amplitude frequency <600 Hz (Blackwell and Greene, 2003; Kyhn et al., 2011; McKenna et al., 2012). Ice breakers are a sound source in the Arctic. They may escort vessels or manage ice near drill rigs during some months. Active ice breaking in moderate to heavy ice is among the loudest industry activities in the Arctic. As an example, when compared with open-water transit, the U.S. Coast Guard (USCG) icebreaker *Healy’s* noise signature increased approximately 10 dB between 20 Hz and 2 kilohertz (kHz) when breaking ice. Highest noise levels resulted while the ship was engaged in backing-and-ramming maneuvers, owing to cavitation when operating the propellers astern or in opposing directions. In frequency bands centered near 10, 50, and 100 Hz, source levels reached 190 to 200 dB re 1 µPa at 1 m (full octave band) during icebreaking operations (Roth et al., 2013).

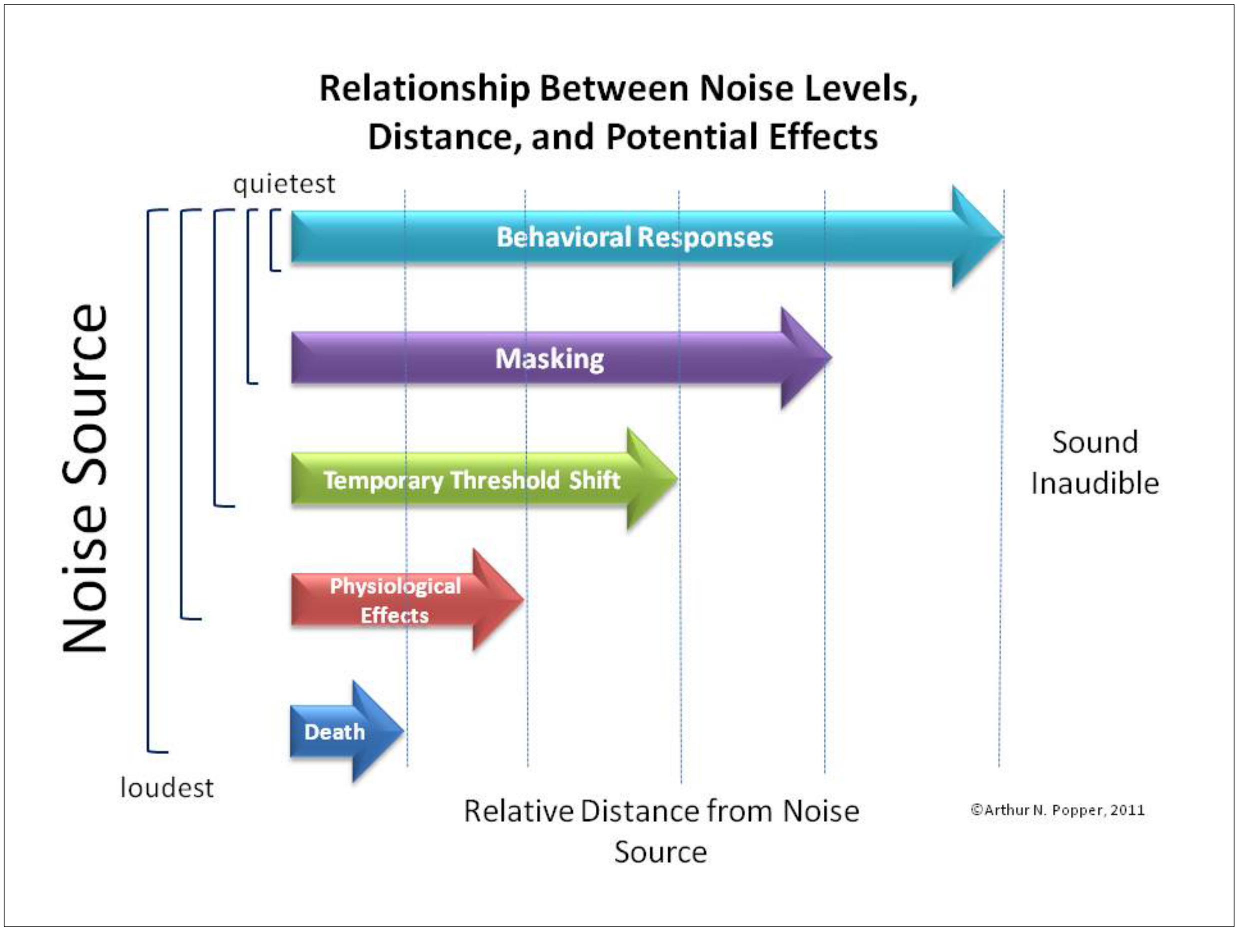


Figure 4.2.2-1. Relationship Among Sound Levels and Potential Effects on Animals.

Airguns are used for deep-penetration seafloor surveys during oil and gas exploration. An airgun is a stainless steel cylinder filled with high-pressure air. An acoustic signal is generated when air is released nearly instantaneously into the surrounding water. During seismic surveys, seismic pulses are emitted at intervals of 5 to 30 seconds, and occasionally at shorter or longer intervals. Although airguns have a frequency range from approximately 10 to 2,000 Hz, most acoustic energy is radiated at frequencies <500 Hz. Amplitude of the acoustic impulse emitted from the source is equal in all directions, but airgun arrays do possess some directionality due to different phase delays between airguns in different positions within an array. Broadband rms source levels for airgun arrays typically range between 190 and 270 dB re 1 µPa at 1 m (Department of Energy and Climate Change [DECC], 2011).

In addition to these sources, there are multiple emerging technologies that may come to fruition during the course of activities considered under the Proposed Action: (1) new airgun designs that better control the frequency content of the signal, reducing much of the unwanted higher frequencies that occur in the current signals (Norton, 2015); and (2) development of new marine vibrators, currently underway. Additionally, sound attenuation technologies such as the AdBm Corporation (2014) noise abatement technology, currently being tested, might be usefully incorporated into various sources.

4.2.2.5. Characterization of Acoustic Sources

Acoustic sources can be described by their sound characteristics. For the regulatory process, they are generally divided into two categories: (1) impulsive (e.g., lightning strikes, explosives, airguns, and impact pile drivers), and (2) non-impulsive (e.g., sonars, and vibratory pile drivers) (U.S. Department of Commerce [USDOC], NMFS, 2015). Currently, there is no universally accepted definition for what constitutes an impulsive sound, but they are generally understood to be powerful sounds with relatively short durations, broadband frequency content, and rapid rise times to peak levels. In general, these sound characteristics have been observed to be more physiologically damaging to marine mammals than non-impulse sounds with equivalent pressures and energies (Southall et al., 2007), and therefore are examined with a different and more protective set of acoustic threshold criteria.

Configuration of an acoustic source also directly affects how that source will transfer energy into the marine environment. Impulsive and non-impulsive sound sources also can be characterized as controlled or non-controlled. Sound produced by controlled anthropogenic sources (e.g., hydrophones, airguns, and speakers) take their basic sound-producing characteristics from these individual components, but beam patterns (e.g., large-scale 3D patterns of projected acoustic energy) are restrained by configuration of the source array itself. (The equivalent in the visual environment is that a lightbulb defines the color and brightness of the light produced, but reflectors and lenses in a flashlight determine how the light is broadcast outward.) Under a controlled source, adjustments to timing and amplitudes of the signal produced by each individual source-element can refine and steer the beam pattern within the constraint dictated by the array configuration. Another type of source, called non-controlled (e.g., radiation pattern of sound from a driven pile as the shock wave travels down its length), also may exhibit some beam-forming and steering, but most unintended sound sources (e.g., cavitation and vessel thrusters) radiate in an approximately omnidirectional fashion.

One final consideration, especially for controlled anthropogenic sources, is the difference between point and distributed sources. Some sources that are physically smaller (i.e., completely contained within a sphere with a 1-m [3-ft] diameter) can be considered point sources. However, most other sources (e.g., an airgun array, which may be tens of meters in width and length) are distributed sources. For a distributed source, a receiver must be some distance away from the source in order to perceive it acoustically as a single, or point, source. (Closer to the source, a receiver gathers many signals from all separate components of the source. The receiver then is considered in the "near-field.") Once a receiver is beyond this range, and can interpret the signal as a point source, it is considered in the source's "far-field." This problem is visually analogous to viewing an illuminated 100-story building at night and attempting to characterize the lighting intensity around it. One would need to be miles away from that building to see it as a single light source. Anywhere closer, and individual floors could be seen, and how they are perceived would strongly influence the level of light received. If the observer was only 10 m (32.8 ft) from the ground floor, higher floors would be partially seen and the overall light being produced by such a structure could be greatly underestimated.

This distinction between near-field and far-field is a particularly important one for distributed sources such as airgun arrays. This is because the most severe potential impacts to animals generally occur near the source and a correct understanding and assessment of these impacts requires a correct understanding of the sound field in the near-field. If a receiver (i.e., animal) is in the near-field of an airgun array then it will receive energy from all individual sources (e.g., individual airguns) in that array (just as the observer of the building would receive some light from the many floors in the above example). But the closest individual source (i.e., floor for the building example) will tend to be the dominant source, with other individual sources in the array making smaller contributions to the overall received sound level. Because these additional contributions will be delayed in time (due to the physical geometry and the time differences required for sound travel from individual sources to the receiver), and may not be in phase (i.e., peak pressures may not arrive simultaneously or "in-phase"), these contributions will seldom sum to the maximum energy of the overall signal, and may actually result in diminishing some of the signal. In this way, near-field sound of the real array will always be less than that modeled for a theoretical point source. In effect, estimating the near-field sound field around an assumed point source is conservative because it will always be greater than the actual values in the near-field.

4.2.2.6. Propagation

Once a sound source is characterized (i.e., sound levels at very close proximity to the source are understood), the next step is to consider how acoustic energy emitted from the source propagates (or spreads). How sound from a particular source propagates is a function of the characteristics of the source, and properties of the medium through which it travels (in this case, water). There are four basic physical processes that affect sound propagation:

- **Spreading** – The average energy on the surface of an acoustic wavefront decreases as the wavefront expands over time. Essentially, as the range from the source increases, the same amount of energy is being spread out over an ever-increasing surface area. When the wavefront looks like an expanding sphere, the spreading is assumed to be "spherical" and transmission loss (TL) decreases as predicted by the equation: $TL = 20 \log_{10}(r)$, where r is the radius of the modeled sphere. Spherical spread occurs to approximately 1,000 m (3,280 ft) from a sound source in deep water and to a radius approximately equal to the depth of the water in shallow water. Once an expanding sphere reaches and begins to interact with the ocean surface and bottom boundaries, the expanding wavefront more closely resembles a cylinder. At that time, spreading is classified as "cylindrical," and TL follows the relationship: $TL = 10 \log_{10}(r)$, where r is now the radius of the cylinder.

- **Absorption** – Loss of acoustic energy to heat energy as sound propagates through the ocean. Rate of this energy loss is related directly to the distance sound has traveled, and its frequency: absorption increases with distance and frequency.

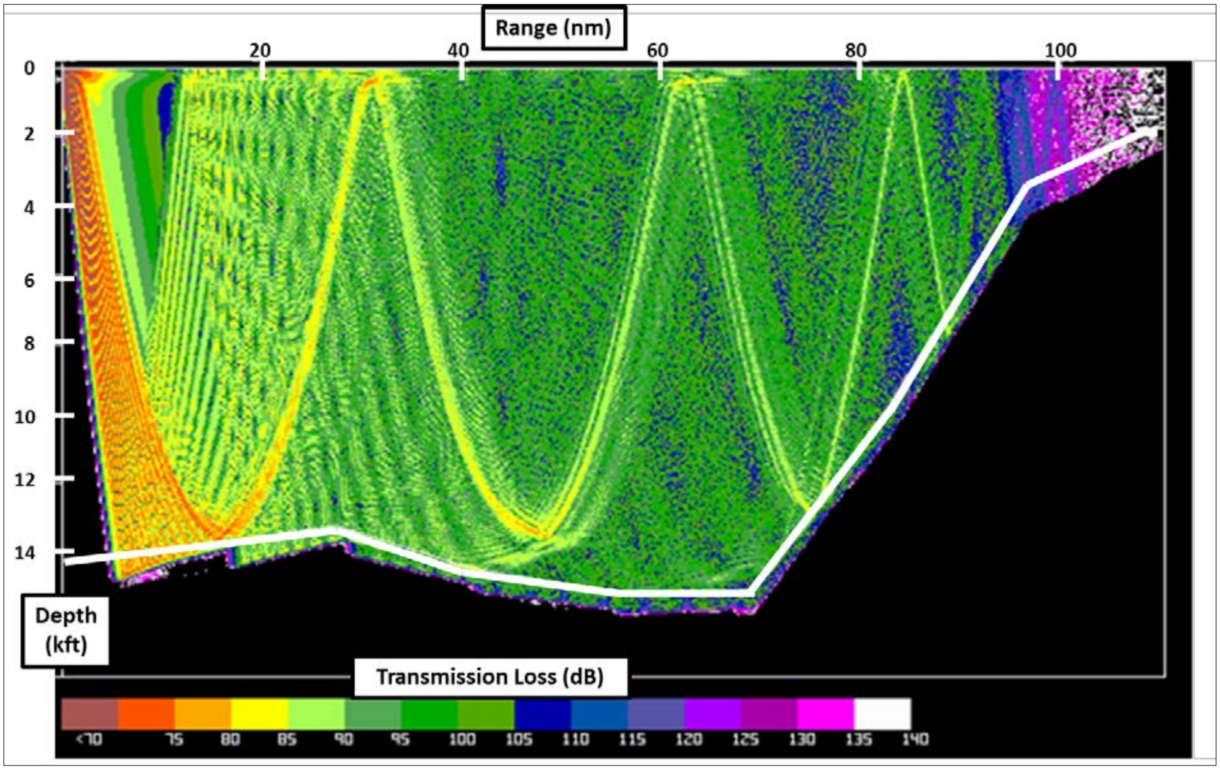
- **Refraction** – Bending of a sound wave as it changes speed in the ocean. Sound speed changes in water as a function of variations in temperature, salinity, and hydrostatic pressure. Sound velocity also can change horizontally in the ocean due to the presence of different water masses, currents, and eddies. For example, the Gulf Stream is usually much warmer than waters that it is passing through, and sound speed in the Gulf Stream varies accordingly. Sound will bend towards areas promoting lower sound speeds.

- **Reflection** – Sound is deflected off the interface between two media having differing sound speed properties. This happens at the air/sea and water/sediment interfaces of the ocean. It also can occur when discrete objects (like air bubbles or fish air bladders) occur in the water column or the biota inhabiting the water column.

Given these variables, predicting the exact propagation of sound in the oceans is nearly impossible, without detailed knowledge of the acoustic environment parameters (i.e., all local conditions that influence acoustic propagation and ambient noise conditions). However, the acoustic community has worked for many decades to understand and quantify these parameters. Today, many important parameters required to predict propagation have been identified, and mapped well enough to support representative propagation modeling in most U.S. waters. However, care should always be exercised in propagation modeling given the possibility of unusual conditions (e.g., significant weather events, river runoff, variable currents, or eddy conditions), and the expected variability of certain parameters (e.g., variability in individual sound velocity profiles [SVP] and multiple SVPs in the propagation area, bathymetry, bottom roughness, or wave heights). The following describe the most common propagation modes in U.S. waters, and their distributions:

- **Shallow Water Propagation** – There are two definitions of shallow water commonly used. The first is bathymetrically shallow water, which is used to refer to water <200 m (656 ft) deep (i.e., the continental shelf). The second is “acoustically” shallow water where sound propagation is characterized by numerous surface and bottom interactions. Although these two definitions do not generally and perfectly coincide, most of the U.S. continental shelf is acoustically shallow water. Most of the shelf regions, therefore, exhibit TL approximations that are somewhere between spherical and cylindrical spread, with a nominal TL value governed by the equation: $TL = 17\log_{10}$ (range). Note that even though many Arctic areas are shallower than 200 m (656 ft), sound propagation for the region is discussed separately later.

- **Convergence Zone Propagation** – Convergence Zone (CZ) propagation exists in deeper water. This occurs where some part of a wavefront (e.g., typically that portion of transmitted beams within approximately 5° of the horizontal plane) is initially refracted downward as it propagates outward from the source and then, refracted back towards the surface (due to the higher sound speeds deep in the water column) before it can interact with the seafloor. The range from the source where this sound returns to the surface is 56 to 65 km (30 to 35 nautical miles [nmi]) away. The near-surface ring around the source where this occurs is called the CZ annulus and the TL to these areas can be 20 to 30 dB less than that outside the annulus. Also, the captured wavefront can continue to produce additional annuli at multiples of the range of the first CZ (i.e., if the first CZ is at 60 km [32 nmi], the second will occur at approximately 120 km [65 nmi], the third at 180 km [97 nmi], and so on). **Figure 4.2.2-2** presents a representative Parabolic Equation (PE) Propagation Model field plot of a section of the ocean with CZ propagation. Here, the source is very shallow (approximately 76 m [250 ft] deep), and on the far left of the figure. As the signal propagates to the right from the source, initially (i.e., for ranges between 0 to 56 km [0 to 30 nmi]) the water is not quite deep enough to support CZ propagation and some bottom interaction (reflection) occurs. Between 56 and 138 km (30 and 75 nmi), the water deepens and a true CZ propagation path is evident. Then for ranges >138 km (75 nmi), the continental slope appears, and transmission becomes increasingly interactive with the seafloor, and attenuates more quickly.



nm = nautical miles; kft = thousands of feet; dB = decibels.

Figure 4.2.2-2. Convergence Zone.

- **Bottom Interactive Propagation** – In most areas where water is not deep enough to support CZ propagation or the source is not in a duct or a deep sound channel (explained below), most of the sound eventually will interact with the seafloor. A combination of the seafloor's slope, depth, and composition as well as the characteristics of the source (e.g., beam patterns, frequencies) will determine how and how much of the sound energy will be scattered, reflected, or penetrate into the seafloor. Generally, seafloor interactions, especially repeated interactions, are significant contributors to the attenuation of propagated sound. There is no easy or general rule of thumb to predict these interactions because each depends on the specific conditions present.

- **Surface or Near-Surface Duct Propagation** – In the near-surface or "mixed layer," wind and wave action serve as the mechanism that drives the heating or cooling of the water by the atmosphere. Seasonal cooling can drive near-surface sound speed to be less than that directly below it. This process can create a condition known as a surface duct in which sound can be trapped by reflections off the ocean's surface and refracted upward before sound can leave the duct. Strength of the duct is strongly frequency dependent (i.e., depending on depth and strength of the duct, only frequencies above a critical value will be trapped), and that sound will exhibit cylindrical spreading loss.

- **Deep Sound Channel** – Deep sound channels exist where minimum sound speed in the water column occurs deep enough that much of the sound transmitted from a source near that depth will be refracted before it can interact with the ocean's surface or bottom. The minimum sound speed can vary from approximately 1,300 m (4,265 ft) deep in the mid-latitudes to near the surface in the Arctic. Minimum sound speed depth serves as the channel's axis; that is, the depth that wavefronts are constantly refracting toward. Sound trapped in this way can propagate long distances within a channel, governed by cylindrical spreading and the absorption losses for its frequency. Deep sound channels exist in most intermediate and deep waters.

- **Arctic Propagation** – Arctic sound propagation acts like that of a surface duct, except that in Arctic, propagation in the duct typically goes all the way to the seafloor. In this condition, sound is constantly trying to refract upward where it reflects off the surface. An additional complication in the Arctic is the potential presence of sea ice. Complexity of the ice and water interface and how to model it acoustically remains a challenge.

In Atlantic, Pacific, and Gulf of Mexico waters, propagation modes will progress from shallow to bottom interactive to CZ (if there is sufficient water depth to support CZ propagation) as a source progresses from shore to sea (i.e., shallow to very deep water). Some care must be exercised in predicting propagation because the extent of the sound field around a source may transit across several different propagation modes or various azimuthal directions may have different propagations modes from the "pure" and isolated modes described previously. Also, as a source transits farther north, the deep sound channel rises in the water column and affects the CZ propagation mode in deep waters. Sound in Arctic waters propagates as described earlier.

4.2.2.7. Ambient Noise

Common usage of the term "ambient noise" is generally understood to consist of any noise, natural or anthropogenic, that might be heard in the ocean. This is the widest definition of the term, and difficult to use effectively in acoustic analyses. This differs from the traditional technical definition of the term which includes all of the sound that a hydrophone receiver (an electromechanical source that observes sound underwater) would observe minus any internal electrical or mounting "self noise" (i.e., noise produced by the presence of the hydrophone, like cable strumming, which did not exist in the ocean itself when the hydrophone was absent), and minus all anthropogenic noises, except for the ubiquitous distant shipping noise. Discrete anthropogenic sources typically are excluded from this traditional definition because of their strong local influence and variability, which are difficult to characterize or use in receiver system performance analyses. When they are known and can be adequately characterized, they are normally included in a second or refined iteration of these analyses.

This bifurcation is evident in **Figure 4.2.2-3**, where the more traditional definition and sources are captured in standard Wenz curves (portion (c)), while discrete anthropogenic sources are presented in portion (b). For ease of comparison, portion (a) presents marine mammal hearing frequency bands, as defined in NMFS (2015). Some care is needed when comparing these three portions of the figure because each represents a different parameter (e.g., hearing range/sensitivity, source level at 1 m [3 ft], and spectral noise level), but this arrangement allows a rapid comparison of where these characteristics occur as a function of their frequencies.

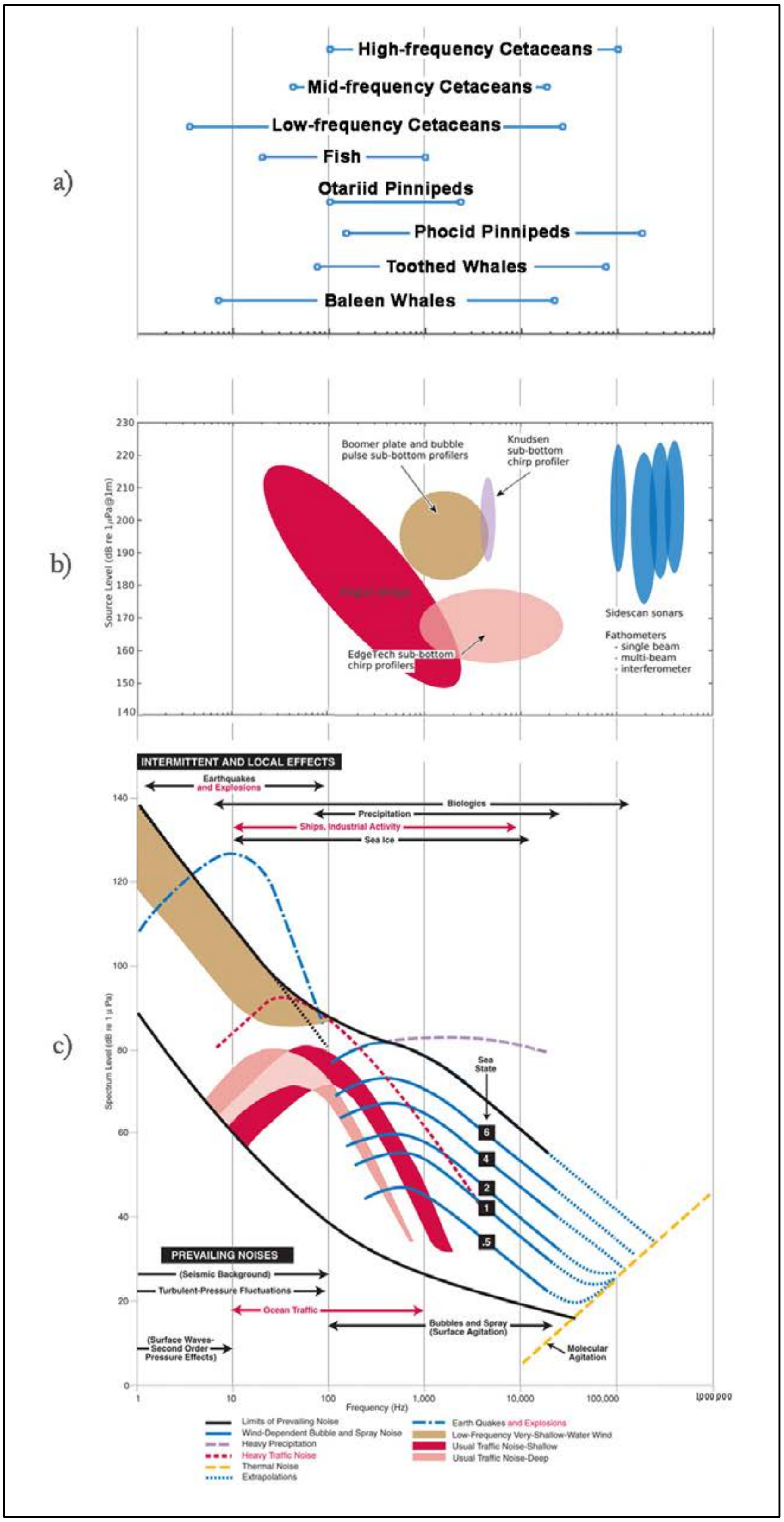


Figure 4.2.2-3. Ambient Noise, Anthropogenic Source, and Marine Mammal Hearing Spectra.

4.2.2.8. Reverberation

Reverberation is another standard acoustic analysis term with a precise meaning and definition that is not always used accurately in the policy realm. Standard technical usage of the term revolves around the scattering of sound from an acoustic source from numerous scatterers throughout the water column and at the ocean's surface and bottom. The combined return from these scatterers is called reverberation. It is most often used for monostatic sources (e.g., the source system's transmitters and receivers are collocated or nearly so), and reverberation can interfere with echoes received by the system. The level of reverberation is directly related to the source level (i.e., if the source level is increased by a set level, the reverberation also rises by that level), much like automobile headlights in a fog, and the reverberation decreases as a function of time. This differs from some policy uses of the term, where it may be used to describe persistence of a source's signal, through multipaths, that cause some persistence of a signal to remain in the effected sound field after the main pulse has passed. Both cases are caused by similar physical processes, but how they are applied in analyses is different. This document will not use the term beyond its standard acoustic analysis meaning.

4.2.2.9. Marine Animals as Receivers

When acting as acoustic receivers, marine animals exhibit many of the same characteristics of sound sources, including: (1) a range of perceived acoustic levels (i.e., how loud or quiet they are); (2) a frequency spectrum sensitivity; (3) beam patterns of an animal's sensors; and (4) signal durations an animal can detect (including how the animal processes the signal). These acoustic sensor characteristics, along with cues and clues created by the sounds propagating in the environment and ambient noise conditions, determine how successful and useful the animal's hearing will be.

Thus far, this section has discussed sounds that would be "heard" by a receiver, just as sound is heard by the human ear. However, there is another mechanism for sensing sound (or particle vibration) other than detecting the associated pressure. It involves using sensors that respond directly to motion of the water particles themselves. Humans exhibit this same capacity, demonstrated when we "feel" rather than hear a sound if the sound is strong enough, like when we are near a speaker. Sensing through the motion of water particles is one of the principle methodologies utilized by fish to perceive their environment. Because particle velocity is directly related to acoustic pressure and this pressure rapidly decreases as sound propagates away from the source, particle motion also rapidly decreases with distance from a source. Currently, impacts from particle motion (if any) are being studied.

4.2.2.10. Challenges and Issues in Modeling

There are numerous issues that affect the ability to accurately model and predict potential impacts of marine sound on marine life: (1) variability and uncertainty in most parameters (inputs) used in the modeling process; (2) broad temporal and spatial areas that need to be examined; (3) development of new thresholds and analytical techniques; (4) continuous updating of databases used for modeling (including acoustic parameters like sediment conditions or weather and marine mammal densities); and (5) the need to address new technology and system developments or field techniques that may be employed by system operators in the field. The general approach to addressing these challenges is use of constantly improving, more sophisticated modeling techniques, along with utilization of conservative assumptions throughout the modeling process where uncertainty exists. Current state-of-the-art approaches include (1) sensitivity analyses; (2) complex area acoustic characterizations; (3) statistical and numerical analytical techniques; and (4) ongoing scientific studies and investigations to improve understanding of the base science (e.g., source characteristics, parameter databases, animal hearing) and complex interactions (e.g., animal behavioral studies, population based effects, etc.). Although modeling approaches have progressed, much more is needed to improve their accuracy, especially as it relates to predicting effects to marine life.

4.2.2.11. Potential Biological Impacts

Many species of marine animals produce and use sound to communicate as well as to orient, locate, and capture prey, and to detect and avoid predators (Payne and Webb, 1971; Richardson et al., 1995; Hastings et al., 1996; Hastings and Popper, 2005; Southall et al., 2007). When anthropogenic noise occurs within animals' hearing ranges and is at a high enough intensity, research has shown that exposures can produce no perceived impact or can lead to adverse physical and psychological effects. Possible adverse effects include (1) mortality; (2) permanent or temporary hearing loss and physiological stress responses; (3) masking of important sound signals; (4) behavioral responses such as fright, avoidance, and changes in physical or vocal behavior; and (5) indirectly altering prey availability (Nowacek et al., 2007; Southall et al., 2007; Clark et al., 2009; Casper et al., 2012a,b). There is no set pattern to when one or another potential impact will occur. Furthermore, responses of marine animals to acoustic stimuli vary widely, depending on the species, the individual, hearing ability, context of animal activities at the time of ensonification (e.g., feeding, spawning, migrating, calving), properties of the stimuli, and prior exposure of the animals (Nowacek et al., 2007; Southall et al., 2007; Normandeau Associates, 2012).

Although uncertainty still remains, considerably more information is known about marine mammal hearing and potential susceptibility to impacts from noise. Good sources of information on marine mammal hearing can be found in Southall et al. (2007) and Appendix H of BOEM (2014). In general, mysticetes (baleen whales) such as the blue whale may be more susceptible to sounds generated from the Proposed Action given overlap in the frequency of these noises with mysticete hearing (Southall et al., 2007; Di Iorio and Clark, 2010; Risch et al., 2012). Less is known about sea turtle and fish hearing or impacts to individual fish and catch rates (Popper et al., 2007; Halvorsen et al., 2011, 2012; Normandeau Associates, 2012; USDOI, BOEM, 2014c). Very little is known about whether and how invertebrate species may hear and if other aspects of sound, such as particle motion, may be of concern (Pye and Watson, 2004; Lovell et al., 2005, 2006; Mooney et al., 2010, 2012; Normandeau Associates, 2012; USDOI, BOEM, 2014c).

It is generally believed that the greatest potential for impact of sound on marine life is through behavioral changes and auditory masking. Of the sound sources under the Proposed Action, seismic surveys, decommissioning using explosives, drilling, and associated vessels are believed to have the greater potential for effects. Behavioral responses to acoustic stimuli have been observed in some instances in relation to these sound sources, but not always. Auditory masking is considered the obscuring of sounds of interest (e.g., whale communications) by other, stronger sounds, often at similar frequencies. Masking is not solely dependent on distance from source but also on cumulative sources as well as population density and distribution (Clark et al., 2009; Hatch et al., 2012). In reviewing available scientific information, the extent for the potential of masking and, if it occurs, the degree of effect remains unclear. It is also unclear whether masking is an issue for fish, sea turtles, and invertebrates (Normandeau Associates, 2012; USDOI, BOEM, 2014).

The larger question, as it relates to impacts to behavior and masking, is if and when these effects reach biologically significant levels. Determining where the potential exists for biological significance has been the focus of numerous studies, some funded by BOEM, but is still largely unknown.

4.2.2.12. Proposed and Historic Mitigation Techniques

Appendix G contains a discussion of mitigation measures in place to protect against impacts of noise from the Proposed Action, particularly seismic surveys using airguns and decommissioning operations using explosives. Although these measures are not assumed to be 100 percent effective, they are expected to substantially reduce the risk of hearing loss or injury to marine mammals. They are considered less effective for protecting against masking or behavioral disruption given that mitigation efforts are focused on smaller spatial scales as compared to the larger spatial scope where these effects may occur. Limitations to the effectiveness of mitigation measures are due to a variety of factors, including physical conditions; presence of animals at the surface; difficulty in species identification; vocalization of animals;

lack of knowledge regarding sound produced by some species; and regular masking by vessel noise of lower frequency vocalizations, such as those produced by mysticetes. Although these mitigations are largely aimed at reducing effects to marine mammals, they incidentally afford some level of protection to other species (e.g., sea turtles, fish, invertebrates) in the same areas as marine mammals when mitigation efforts are applied.

4.2.2.13. Summary and Discussion of Applying Knowledge of Acoustics to Decision

Overall, there is potential for impacts to marine animals from noise associated with certain activities under the Proposed Action, primarily in the form of masking and behavioral disruption. Given scientific uncertainty surrounding potential effects from sound sources under the Proposed Action, and whether they may rise to the level of biological significance, it is assumed that impacts can range from negligible to major in nature. Responses of marine animals in any given situation vary widely, depending on the species, the individual, hearing ability, context of their activities at the time of ensonification, properties of the stimuli, and prior exposure of the animals.

Fully predicting impacts from marine sound and the degree of any effect is impossible at the programmatic scale being considered under the Proposed Action. As discussed in **Section 1.4**, in conducting this analysis, the Programmatic EIS examines existing scientific evidence relevant to evaluating reasonably foreseeable significant adverse impacts of oil and gas E&D activities on the human environment. BOEM has identified impacts from sound (including impacts from particle motion) as an area of incomplete or unavailable information. Subject matter experts that prepared the Programmatic EIS diligently searched for pertinent information, and BOEM's evaluation of such impacts is based on research methods and theory generally accepted in the scientific community. BOEM's subject matter experts acquired and used previously developed and newly available scientifically credible information and, where gaps remained, exercised their best professional judgment to extrapolate baseline conditions and impact analyses using accepted methodologies based on credible information. For purposes of this Programmatic EIS, all impacts reasonably foreseeable at later stages of the oil and gas development process have been considered, and the characterization of impact magnitude and duration is supported by scientific evidence. BOEM's assessment of impacts is not based on conjecture, media reports, or public perception; it is based on research methods, theory, and modeling applications generally accepted by the scientific community.

BOEM utilizes the best available scientifically credible information in its tiered decision-making process and any new data on the impacts of noise would be incorporated as they are made available. At the programmatic stage, incomplete and unavailable information does not affect the ability of the decision-maker to make an informed choice. Subsequent approvals of more site- or region-specific analyses that may result from implementation of the Proposed Action consider the most recent science available at the time of the decision as well as additional mitigation measures (and their efficacy) to limit the potential for masking or behavioral disruption (e.g., time-area closures, limiting activities in space and time). It is also crucial to continue efforts to lessen the scientific gap between what is known and unknown about marine animal hearing, and potential effects from sounds associated with this Proposed Action. BOEM has played a key role in improving this scientific understanding to date (see http://www.boem.gov/Fact-Sheet-on-Sound-Studies/) and remains steadfastly committed to funding and supporting science needed to better understand anthropogenic sounds and their impacts on marine life. BOEM also is dedicated to using adaptive management for this complicated issue so that approaches evolve as understanding expands and the science matures.

4.3. AFFECTED ENVIRONMENT

4.3.1. Air Quality

The Clean Air Act (CAA) requires the USEPA to establish National Ambient Air Quality Standards (NAAQS) (**Appendix C**, Section 2) for criteria pollutants to provide protection from adverse effects of poor air quality on human health and public welfare. These pollutants are:

- Nitrogen dioxide (NO_2);
- Carbon monoxide (CO);
- Sulfur dioxide (SO_2);
- Ozone (O_3);
- Particulate matter (PM), course (PM_{10}) and fine ($PM_{2.5}$); and
- Lead (Pb).

The CAA established two types of air quality standards under the NAAQS. Primary standards set limits to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility and harm to animals, crops, vegetation, and buildings. Primary and secondary NAAQS are identical for four of the six criteria pollutants (NO_2, PM, O_3, and Pb). The secondary NAAQS is less strict than the primary standards for SO_2, and there is no secondary NAAQS for CO.

When an area does not meet the NAAQS for one or more criteria pollutants, the USEPA designates the location as a nonattainment area. The CAA sets forth the regulatory process to be applied to an area in order for it to comply with the NAAQS within a specified time frame that varies by the type of pollutant and severity. Some areas near the Program Areas were in nonattainment for O_3, SO_2, and $PM_{2.5}$ (**Figures 4.3.1-1** and **4.3.1-2**) (USEPA, 2015a) . The atmosphere above the OCS is unclassified. The USEPA defines unclassified as "any area that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for the pollutant" (USEPA, 2015b).

In addition to the air quality standards, the USEPA splits the country into Class I and Class II Areas (**Appendix C**, Section 2). Class I Areas are defined in the CAA as federally owned land for which air quality-related values are highly prized and no diminution of air quality, including visibility, can be tolerated (USEPA, 2015c). Incremental increases in NAAQS criteria are more strictly regulated for Class I Areas compared to the remainder of the country, known as Class II Areas. There are several Class I Areas close to the OCS, five of which could be impacted by oil and gas development. The USEPA recommends BOEM notify the Federal Land Manager when a proposed source would be located within 100 km (62 mi) of a Class I Area because proposed sources may have an effect within this distance. In general, Federal Land Managers request notification of any large facility up to 300 km (186 mi) from a Class I Area. All five Class I Areas within 100 km (62 mi) of the Program Area are managed by the U.S. Fish and Wildlife Service (USFWS). The NPS and USFWS have identified several Sensitive Class II Areas that do not receive the same protections as Class I Areas, but still receive more scrutiny than other Class II areas. Six of these Sensitive Class II Areas falls within 100 km (62 mi) of regions that would be impacted by the Proposed Action. See **Figures 4.3.1-1**, **4.3.1-2**, and **4.3.1-3** for the relevant Class I and Sensitive Class II Areas.

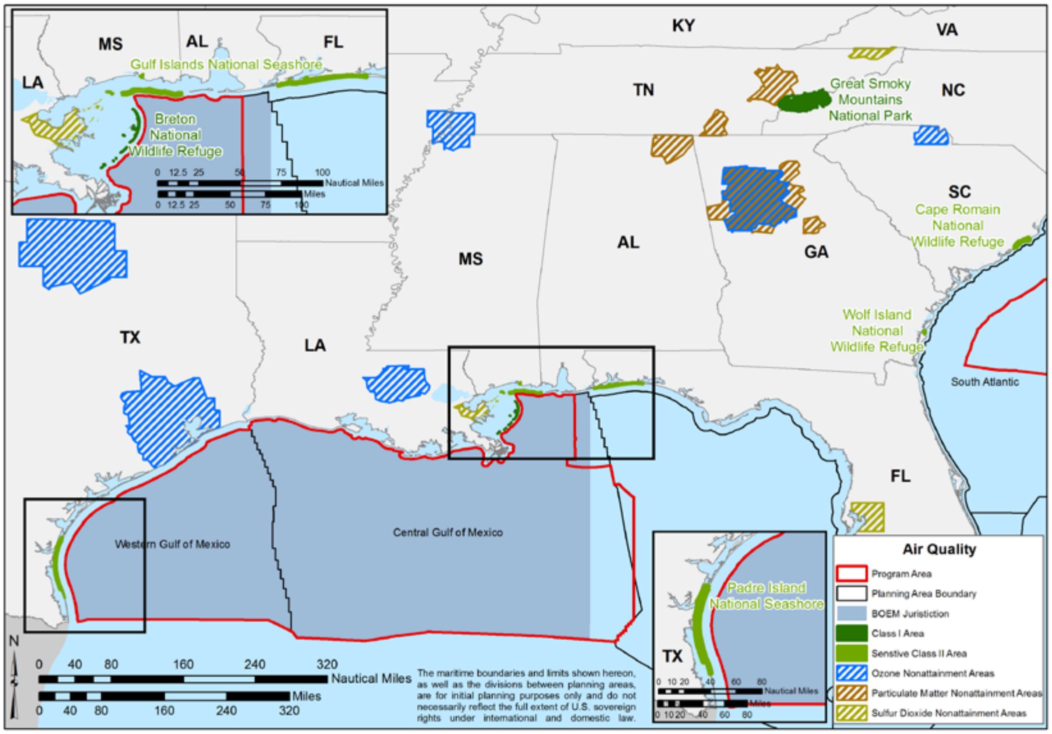


Figure 4.3.1-1. BOEM Air Quality Jurisdiction in Gulf of Mexico and Nonattainment, Class I and Sensitive Class II Areas Near the Program Area.

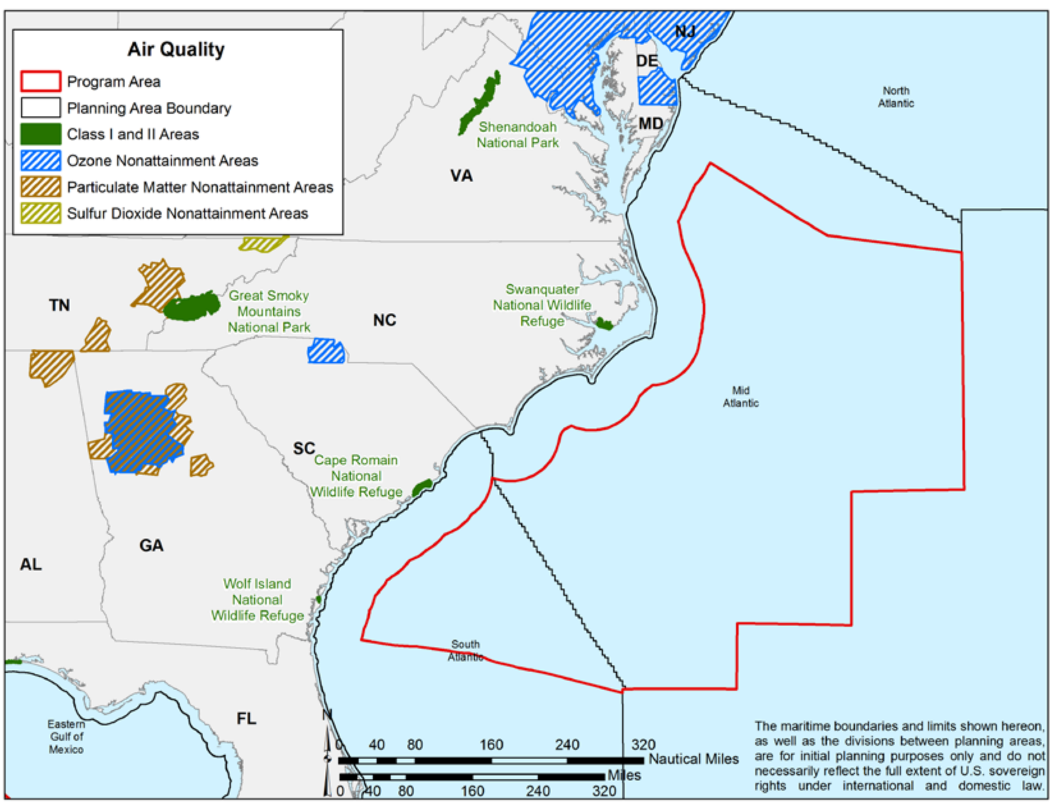


Figure 4.3.1-2. Nonattainment and Class I and Sensitive Class II Areas Near the Atlantic Program Area.

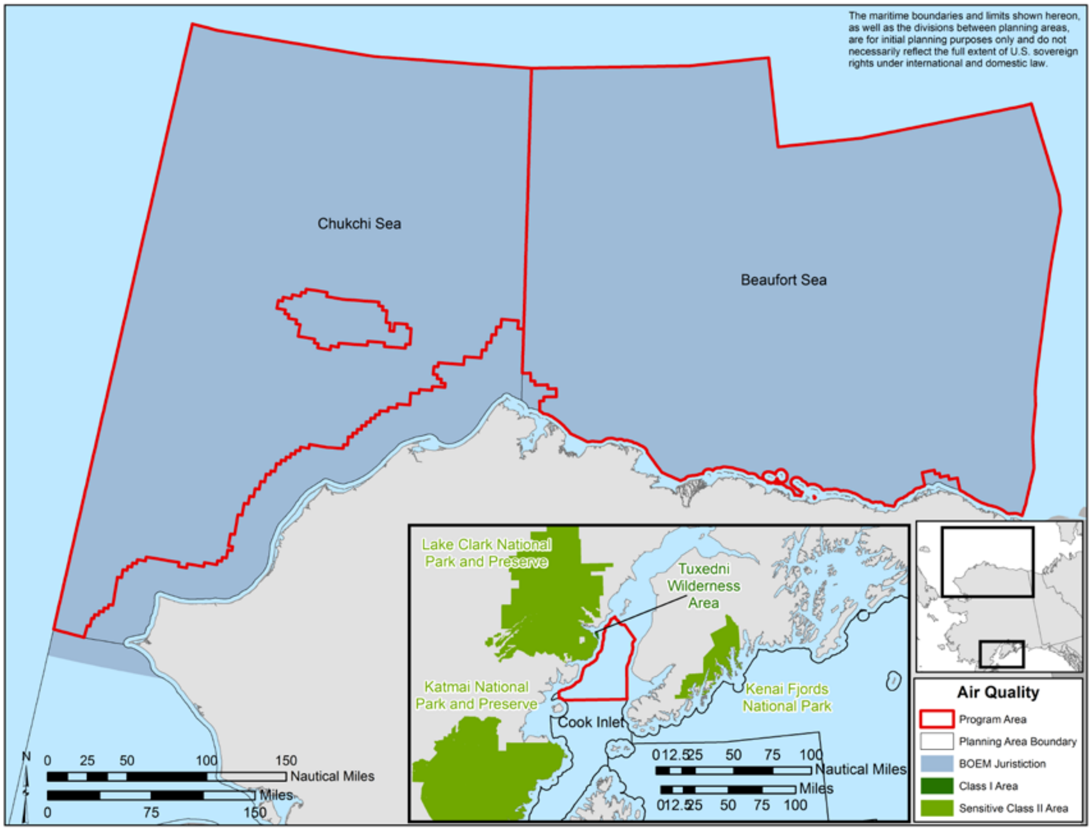


Figure 4.3.1-3. BOEM Air Quality Jurisdiction in Alaskan Waters, and Class I and Sensitive Class II Areas Near the Program Area.

In the Gulf of Mexico west of 87.5° W, off the coasts of Texas, Louisiana, Mississippi, and Alabama as well as offshore the North Slope Borough (NSB), Alaska, OCS air emissions are regulated by BOEM under 30 CFR part 550, Sections 302-304. Lease-specific plans submitted for exploration or development activities must include emissions information for BOEM review. If the emissions exceed certain thresholds, which are determined by distance from shore, a modeling analysis is required to assess air quality impacts to onshore areas. Should modeled concentrations exceed certain significance levels in an attainment area, control technology is required at the facility. If the affected area is classified as nonattainment, mitigation is required for each nonattainment pollutant to ensure no net increase in the nonattainment pollutant's concentration. Onshore concentrations also are subject to the USDOI maximum allowable increases above a baseline level. The Beaufort Sea, Chukchi Sea, Western Gulf of Mexico, and most of the Central Gulf of Mexico Planning Areas fall under BOEM jurisdiction.

The rest of the OCS as directed in Section 328 of the CAA, falls under the USEPA's jurisdiction, which regulates air emissions under 40 CFR part 55. Facilities located within 40 km (25 mi) of a state's seaward boundary are subject to the air regulations of the corresponding onshore area and would include state and local requirements for emission controls, emission limitations, offsets, permitting, monitoring, testing, and modeling. For facilities located beyond 40 km (25 mi) of a state's seaward boundary, only federal air regulations apply, including Prevention of Significant Deterioration (PSD) regulations, Title V permits, and new source emissions standards. PSD regulations apply to sources with the potential to emit more than 100 or 250 tons per year of a criteria pollutant or precursor, depending on the source type. Title V permits are required for sources emitting >100 tons per year of any regulated pollutant.

4.3.2. Water Quality

Water quality is a term used to describe the condition or environmental health of a water body or resource, reflecting its particular biological, chemical, and physical characteristics and the ability of the waterbody to maintain the ecosystems it supports and influences. It is an important measure for ecological and human health.

Water quality is evaluated by measuring factors that are considered important to the health of an ecosystem. Primary factors influencing coastal and marine environments are temperature, salinity, dissolved oxygen, chlorophyll content, nutrients, potential of hydrogen (pH), oxidation reduction potential (Eh), pathogens, transparency (i.e., water clarity, turbidity, or suspended matter), and contaminant concentrations (heavy metals and hydrocarbons). Moreover, concentrations of trace constituents such as metals and organic compounds also can affect water quality. The 2012 USEPA National Coastal Condition Report (USEPA, 2012) categorizes coastal waters of the U.S. based on an evaluation of five indices: water quality, sediment quality, benthic, coastal habitat, and fish tissue contaminants.

4.3.2.1. Beaufort and Chukchi Sea Program Areas

Water quality in the Beaufort and Chukchi Seas varies naturally throughout the year. This variation is related to seasonal biological activity and naturally occurring processes such as seasonal plankton blooms, hydrocarbon seeps, seasonal changes in turbidity due to terrestrial runoff and storms, localized upwelling of cold water, and formation of surface ice. Rivers and streams that flow into the Beaufort Sea contribute substantial freshwater to the marine system, which affects salinity, temperature, and other aspects of water quality such as productivity, particularly within a band of water that runs along the seacoast. McClelland et al. (2014) found that annual river discharge to the Alaskan Beaufort Sea is strongly dominated by runoff during the spring melt, which contributes nitrogen that influences productivity along the Alaskan Beaufort Sea coast.

Overall, the rivers that flow into the Chukchi and Beaufort Seas are relatively unpolluted by anthropogenic sources (Alaska Department of Environmental Conservation [ADEC], 2013). Studies in the region have shown that the flow and the concentration of constituents such as suspended sediment, dissolved chemicals, and landborne contaminants carried by rivers vary seasonally and generally are higher in the spring melt (Alkrie and Trefry, 2006; Townsend-Small et al., 2006).

In both seas, water quality is relatively pristine because there is limited municipal and industrial activity along the coast. Most detectable pollutants occur at very low levels in Arctic waters and sediments, and therefore do not pose an ecological risk to marine organisms (USDOI, MMS, 2003). Degradation of water quality, where it occurs in the Arctic, is largely related to aerosol deposition and localized anthropogenic pollution from mining activities, urban runoff/development, and seafood processing (ADEC, 2013). Water quality is also affected by erosion of organic material along the shorelines. The Chukchi Sea has a high-energy shore that contributes to erosion and flooding during fall and spring storms, and periods of ice movement (USDOI, BOEM, 2015d). Water quality is altered by sea ice cover as well. During fall, the formation of sea ice reduces shoreline erosion and storm wave action. In addition, lower temperatures reduce river discharges. All of these factors result in low turbidity levels during the winter (USDOI, BOEM, 2015d).

Studies by Naidu et al. (2001), Trefry et al. (2004, 2012, 2014), Neff (2010), MMS (2010), Cai et al. (2011), and BOEM (2015d) have examined hydrocarbon and trace metal concentrations in the water and sediments of the Beaufort and Chukchi Seas, finding concentrations at natural background values except in areas around drilling sites.

4.3.2.2. Cook Inlet Program Area

Cook Inlet watershed contains approximately two-thirds of Alaska's population and provides the potential for non-point source pollution runoff. Additional influences on water quality include onshore and offshore oil and gas exploration and production (Nuka Research and Planning Group, LLC., n.d.), municipal discharges including fecal pathogens (Norman et al., 2013), mining wastes, vessel traffic, fish-processing discharges, and numerous smaller industries (USDOI, BOEM, 2012). Point source pollution is rapidly diluted by the energetic tidal currents in the Cook Inlet; it is estimated that 90 percent of the water in the Cook Inlet is flushed every 10 months (USDOI, MMS, 2003).

ADEC (2013) rated the overall condition of south-central Alaska's coastal waters (water quality, sediment quality, and fish tissue contaminants indices) as good. Glass et al. (2004) reported that water quality in the Cook Inlet Basin was good, but that quality was affected by natural geologic and climatic features, including the presence or absence of glaciers as well as human activities.

Studies by Boehm et al. (2001), Saupe et al. (2005), Driskell and Payne (2011), and Trefry et al. (2012)have examined hydrocarbon and trace metal concentrations in the water and sediments of Cook Inlet and determined that there does not appear to be any identifiable enrichment of hydrocarbon or metals contaminants from anthropogenic activities, including oil and gas production in upper Cook Inlet, with no detectable enrichment from oil and gas activities.

4.3.2.3. Gulf of Mexico Program Area

Gulf of Mexico coastal waters include all bays and estuaries from the Rio Grande River to Florida Bay. Water quality in the Gulf of Mexico has two primary influences: (1) configuration of the basin, which controls the influx of water from the Caribbean Sea and the output of water through the Straits of Florida; and (2) runoff from the land masses, which controls the quantity of freshwater input into the Gulf of Mexico from the estuarine and fluvial drainage areas. Coastal water quality also is affected by the loss of wetlands, water temperature, total dissolved solids (salinity), suspended solids (turbidity), nutrients, and anthropogenic inputs via runoff, terrestrial point source discharges, and atmospheric deposition. The USEPA (2012) National Coastal Condition Report rates the overall condition of coastal waters within the Gulf Coast as fair. With increasing distance from shore, oceanic circulation patterns play an increasingly large role in dispersing and diluting anthropogenic contaminants and determining water quality.

Water quality on the continental shelf west of the Mississippi River is predominantly influenced by the input of sediment, nutrients, and pollutants from the Mississippi and Atchafalaya Rivers (USDOI, BOEM, 2012b). There is a surface turbidity layer associated with the freshwater plume from the two rivers. During summer months, shelf stratification results in a large hypoxic zone (having a low concentration of dissolved oxygen on the Louisiana-Texas shelf in bottom waters (Turner et al., 2005). Hypoxia therefore is a widespread seasonal phenomenon on the continental shelf of the northern Gulf of Mexico (**Appendix C**; Figure 3.2-3) (Rabalais et al., 2002; Turner et al., 2005, 2012; Obenour et al., 2013). The hypoxic zone is influenced by the timing of the Mississippi and Atchafalaya River discharge; formation of the zone is attributed to nutrient influxes and shelf stratification, and the zone persists until wind-driven circulation mixes the water column.

Turner et al. (2003) found trace organic pollutants, including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and trace inorganic metals, in shelf sediments offshore Louisiana that were attributed to river discharge. Additional input of hydrocarbons associated with natural seeps and oil and gas activity of the region were found farther offshore (Turner et al., 2003). Discharges of drilling wastes, produced water, and other industrial wastewater streams from offshore oil and gas platforms in the area also contribute to the water quality of the region.

Water quality on the continental shelf east of the Mississippi River is influenced by river discharge, coastal runoff, and the Loop Current and its associated eddies. The Loop Current and its associated eddies intrude on the shelf at irregular intervals and mix the water column. Warm-core eddies bring clear, low-nutrient water onto the shelf and entrain and transport high-turbidity shelf waters farther offshore into deeper waters while cold-core eddies introduce nutrient-rich waters onto the shelf through upwelling. Waters in the area generally are turbid from the input of fine sediments discharged from the Mississippi River, but water clarity improves closer to Florida, and out of the influence of riverine outflow.

Studies have analyzed water, sediments, and biota for hydrocarbons in the Mississippi, Alabama, and Florida area (Dames & Moore, Inc., 1979; Brooks and Giammona, 1991). Results indicated the area showed only minor influence of anthropogenic and petrogenic hydrocarbons from river sources and natural seeps. Analysis of trace metals indicated no contamination sources.

Water quality of the deep Gulf of Mexico may be closely tied to sediment quality, and the two can affect each other. Limited information is available with respect to the deepwater environment. Few studies analyzing sedimentary concentrations of trace metals and hydrocarbons have been conducted, and water column measurements have been primarily limited to oxygen, salinity, temperature, and nutrients (Trefry, 1981; Gallaway, 1988; Continental Shelf Associates, Inc., 2006; Rowe and Kennicutt, 2009). Two studies (Continental Shelf Associates, Inc., 2006; Rowe and Kennicutt, 2009) measured concentrations of organics, metals, and nutrients in sediments in the deepwater zone and found elevated concentrations near exploratory drilling sites. Resuspension of sediments through dredging, trawling, or storm events could impact deepwater water quality, but these events are infrequent. Deep water and sediment quality are most directly impacted by the large number of natural hydrocarbon seeps on the continental slope, which have been estimated to input anywhere from 1 to 1.4 MMbbl of oil per year into the Gulf of Mexico (Kvenvolden and Cooper, 2003; NRC, 2003a).

Storm events have had a substantial impact on the quality of coastal waters in the Program Area. Hurricanes Katrina and Rita impacted water quality in the Gulf of Mexico by damaging pipelines, refineries, manufacturing and storage facilities, sewage treatment facilities, and other infrastructure, resulting in hundreds of minor pollution reports, and millions of gallons of spilled oil (Pine, 2006; USDOI, MMS, 2006).

Deepwater Horizon

The *Deepwater Horizon* explosion, oil spill, and response event had an impact on the coastal and marine water quality of the Gulf of Mexico. The explosion and resultant spill released an estimated 4.93 MMbbl of oil (Operational Science Advisory Team [OSAT], 2010) and a range between 200,000 and 500,000 tons of hydrocarbon gases (predominantly methane) (Joye et al., 2011a; Reddy et al., 2012) into the Gulf of Mexico. In addition, estimates of dispersants applied to the spill have ranged from 1.8 to 2.2 million gallons (combined for surface and depth) (OSAT, 2010; National Commission, 2011; Allan et al., 2012; Joung and Shiller, 2013; Paul et al., 2013; Spier et al., 2013). The Federal Interagency Solutions Group Oil Budget Calculator (2010) and the National Incident Command (NIC) (Lubchenco et al., 2010) estimated the fate of the oil, and determined that 26 percent of spilled oil 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 (**Appendix C**; Figure 3.2-1).

Valentine et al. (2010) reported that after the spill, gases such as methane, ethane, propane, and butane were driving rapid respiration by bacteria. However, the extent to which the bacteria consumed these gases is under dispute (Joye et al., 2011b; Kessler et al., 2011b). Fate of the remaining oil from the spill is still being studied, but work by Valentine et al. (2014) identified a fallout plume of hydrocarbons on the seafloor over an area of 3,200 km^2 (1,236 mi^2) around the wellsite. Valentine et al. (2014) suggested that the oil was initially suspended in deep waters around the wellsite and then settled to the underlying seafloor. Similarly, Chanton et al. (2015) estimated that 3.0 to 4.9 percent of the oil spilled was deposited in a 2.4×10^{10} m^2 (2.6×10^{11} ft^2) region surrounding the wellhead.

Kujawinski et al. (2011) investigated the fate of the chemical dispersants injected at depth and found that dispersant ingredients were concentrated in hydrocarbon plumes at 1,000 to 1,200 m (3,281 to 3,937 ft) depths up to 300 km (186 mi) from the wellsite, and that the dispersants underwent slow rates of biodegradation. In addition, White et al. (2014) indicated that under certain conditions (formation of oil and dispersant soaked sand patties), dispersants can persist for up to 4 years in the environment. DeLeo et al. (2015) provided direct evidence for the toxicity of dispersant on deepwater corals and indicated that dispersant addition during the cleanup efforts following the *Deepwater Horizon* event may have caused more damage to coldwater corals than the initial release of oil into the deep sea.

Following the spill, multiple additional studies evaluated concentrations of oil and dispersant-related chemicals in water and sediment samples collected regionally throughout the Gulf of Mexico; these studies are summarized in **Appendix C**, Section 3 (Camilli et al., 2010; Diercks et al., 2010; OSAT, 2010; Boehm et al., 2011; Allan et al., 2012; Joung and Shiller, 2013; Paul et al., 2013; Sammarco et al., 2013; Spier et al., 2013).

4.3.2.4. Atlantic Program Area

Atlantic coastal waters include all bays and estuaries from Delaware Bay to approximately Cape Canaveral, Florida. Marine waters include state offshore waters and federal OCS waters extending from outside the barrier islands to the Exclusive Economic Zone (EEZ). Water quality in coastal waters of the Atlantic is controlled primarily by terrestrial runoff, terrestrial point source discharges, and atmospheric deposition. Near cities and populated areas, coastal water quality is influenced by non-point pollution sources, including urban runoff containing oil, greases, and nutrients; domestic and sanitary wastes; and large expanses of agricultural land in which fertilizers and biocides are applied.

The Atlantic coast is divided into two regions in the USEPA National Coastal Condition Report (USEPA, 2012): the Northeast Coast covering the coastal and estuarine waters of Maine through Virginia, and the Southeast Coast covering the coastal and estuarine waters from North Carolina to Florida. However, the Atlantic Program Area includes only the area from the Delaware-Maryland border south to the Georgia-Florida border.

Overall condition of the Northeast and Southeast Coasts is rated as fair (USEPA, 2012). Sediment quality poses a risk to coastal water quality because contaminants in sediments may be resuspended into the water by anthropogenic activities, storms, or other events. Sediment quality along 76 percent of the Northeast Coast was characterized by low levels of chemical contamination, an absence of acute toxicity, and moderate to low levels of total organic carbon (TOC). Plumes from two prominent estuaries along the Northeast Coast, Chesapeake and Delaware Bays, have a substantial effect on coastal water quality. Extensive watersheds funnel nutrients, sediment, and organic material into secluded, poorly flushed estuaries that are much more susceptible to eutrophication, the pattern of which also closely reflects the distribution of population density (USEPA, 2012).

Marine water quality in the Atlantic Planning Areas is expected to be generally good to excellent, with minimal water column stratification. Additionally, observations of high water clarity, dissolved oxygen concentrations at or near saturation, and low concentrations of suspended matter and trace metal and hydrocarbon contaminants have historically indicated good water quality in the region (USEPA, 1998). Concentrations of suspended matter (turbidity) typically have been low in Mid-Atlantic marine waters, generally <1 mg/L (Louis Berger Group, Inc., 1999).

Trace metal and hydrocarbon concentrations in sediments also have been studied (Lee, 1979; Smith et al., 1979; Windom and Betzer, 1979; USDOI, MMS, 1992; USDOC, NOAA, 2012; Michel et al., 2013). Results indicated trace metal concentrations in shelf waters were within the range of observed oceanic concentrations and not indicative of significant contamination. Results showed that concentrations generally were higher closer to shore, suggesting a potential link to anthropogenic sources.

4.3.3. Marine Benthic Communities

4.3.3.1. Beaufort and Chukchi Sea Program Area

Shallow continental shelves of the U.S. Chukchi Sea and Beaufort Sea are among the largest in the world (Grebmeier et al., 2006). These seas have some of the highest primary productivity found in the Arctic regions due to advective processes, which drive warm, nutrient-rich Pacific Ocean waters northward to meet deep Arctic Ocean water upwelling from abyssal depths in the Chukchi and Beaufort Seas (Codispoti et al., 2005). The Chukchi and Beaufort Seas are also strongly influenced by organic nutrients from freshwater discharges of numerous coastal rivers (Dunton et al., 2006). Most of the North Slope seafloor 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 seafloor 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 (Barnes, 1999).

High primary productivity of the Chukchi and Beaufort Sea Program Area fuels high benthic faunal mass (Grebmeier and Dunton, 2000; Dunton et al., 2005), composed of a diverse array of invertebrates, primarily cnidarians, echinoderms, mollusks, polychaetes, copepods, and amphipods (Darnis et al., 2008). Gouging of the seafloor by ice keels creates a habitat for opportunistic infauna (e.g., *Macoma* spp., *Mya truncata*, amphipods, other small invertebrates) (Conlan and Kvitek, 2005) that are fed on by seabirds, fishes, walrus, and other marine mammals (Bogoslovskaya et al., 1981; Bluhm and Gradinger, 2008). Common fish in areas of soft sediment include Arctic cod (*Boreogadus saida*), Pacific herring (*Clupea pallasii*), sculpins, and pollock (*Gadus chalcogramma*) (North Pacific Fishery Management Council [NPFMC], 2009).

Hard bottom seafloor habitat also is present, primarily in the form of cobblestone and boulders distributed sporadically along the inner Beaufort and Chukchi shelves and in Barrow Canyon (USDOI, 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 (USDOI, MMS, 2003b). Boulder Patch in Stefansson Sound is biologically rich and complex relative to the rest of the OCS seafloor; total biomass of organisms is approximately an order of magnitude higher than for most of the OCS seafloor (Dunton and Schonberg, 2000). Hard bottom habitats in the Beaufort and Chukchi Seas shelves typically are dominated by kelp beds (communities dominated by the large kelp *Laminaria solidungula*). These unique biological communities exist on bottom substrates dominated by cobblestone or rock that support highly diverse and abundant epifaunal communities dominated in numbers by amphipods, polychaetes, cumaceans, sponges, corals (including the soft coral *Geremisa rubiformis*), and sponges (Dunton and Schonberg, 2000). Kelp communities spread very slowly, taking almost a decade to recolonize denuded boulders (Martin and Gallaway, 1994).

4.3.3.2. Cook Inlet Program Area

Intertidal and shallow subtidal habitats of lower Cook Inlet support infaunal and epifaunal organisms as well as floral communities. Western lower Cook Inlet is influenced by seasonal ice cover while eastern lower Cook Inlet remains ice free. These physical differences create somewhat distinct benthic communities. Seafloor substrate types include rock, sand, silt, and shell debris.

The floral community of southeastern Cook Inlet is dominated by various species of brown algae in the rocky intertidal zones and by kelps in the subtidal areas to a depth of approximately 20 m (66 ft) (Lees et al., 1986). Dominant faunal species include echinoderms (sea urchins and sea stars), mollusks (clams, chitons), crustaceans (crabs), fish, gastropods, polychaetes, bryozoans, and sponges. Southwestern intertidal zones of Cook Inlet are dominated by *Fucus* (a brown algae) and red algae. Kelps are also present, but at shallow subtidal depths (<5 m [16.5 ft]). Fauna in this zone of winter ice are smaller and less diverse compared to the shallow areas of southeastern Cook Inlet. In deeper waters beyond the kelp beds the dominant fauna include suspension feeders (e.g., barnacles, bryozoans, social ascidians, polychaetes) and predator/scavengers (e.g., sea stars, snails, crabs). In non-rock substrate areas (mud and sand), the invertebrate community is dominated by polychaetes, amphipods, clams, and crabs (USDOI, MMS, 1996).

4.3.3.3. Gulf of Mexico Program Area

Marine benthic communities of the northern Gulf of Mexico inhabit continental shelf and slope/deepsea environments, including soft sediments, hard bottom areas, deepwater coral areas, pinnacles (including warm-water coral reefs), artificial reefs, and chemosynthetic communities. The continental shelf, present in all three Gulf of Mexico Planning Areas, extends from the coastline to water depths of approximately 200 m (660 ft). The continental slope is a complex transitional zone that includes varying ranges of productivity and faunal assemblages.

The seafloor of the Gulf of Mexico is composed primarily of muddy and sandy sediments. Faunal assemblages of the continental slope and abyssal zone are described in BOEM's Multisale EIS for the Program Area (USDOI, BOEM, 2012) as follows:

- Shelf-Slope Transition Zone (150 to 450 m [492 to 1,476 ft]): A highly productive zone that is dominated by demersal fishes, asteroids, gastropods, and polychaetes.
- Archibenthal Zone Horizon A (475 to 740 m [1,558 to 2,428 ft]): Sea cucumbers become more abundant in this zone, and demersal fishes become less abundant. Gastropods and polychaetes are also numerous.
- Archibenthal Zone Horizon B (775 to 950 m [2,543 to 3,117 ft]): Demersal fishes, asteroids, and echinoids are found in large numbers. Gastropods and polychaetes are also common.
- Upper Abyssal Zone (1,000 to 2,000 m [3,281 to 6,562 ft]): This zone has fewer fishes than shallower depths. The number and types of invertebrate species increase, especially sea cucumbers and galatheid crabs.
- Mesoabyssal Zone (2,300 to 3,000 m [7,546 to 9,843 ft]): Few fish species are found in this deepwater zone. Echinoderms dominate the fauna.
- Lower Abyssal Zone (3,200 to 3,800 m [10,499 to 12,468 ft]): The large asteroid *Dytaster insignis* is the dominant megafaunal species.

Hard bottom communities, though far less common than soft bottom environments, are scattered across the Gulf of Mexico. Gulf of Mexico hard bottom communities include shallow corals, deepwater corals, pinnacles, topographic features, artificial reefs, and chemosynthetic communities.

Deepwater coral habitats are known to exist throughout the Gulf of Mexico. In order to help identify potential areas where chemosynthetic communities and deepwater coral habitats may exist, BOEM has examined decades of industry-collected seismic data to identify areas of anomalously high reflectivity that may indicate hard bottom areas. As of 2012, the database included >28,000 areas of anomalously high reflectivity that indicate possible hard bottom where deepwater reefs or chemosynthetic communities could exist (Shedd et al., 2012). Colonies of the deepwater *Lophelia pertusa* coral have been found as deep as 3,000 m (9,842 ft) (USDOI, BOEM, 2012, 2013a). Other high density coral habitats also have been described on deeper areas of the slope with one notable example of *Madrepora* at a depth of 1,440 m (4,593 ft) (Brooks et al., 2012). These findings suggest that hard bottom areas throughout the entire Gulf of Mexico Program Area could harbor deepwater coral communities.

A total of seven species of coral are classified as threatened in the Atlantic/Caribbean region (which includes the Gulf of Mexico): elkhorn coral (*Acropora palmata*), staghorn coral (*A. cervicornis*), pillar coral (*Dendrogyra cylindrus*), lobed star coral (*Orbicella* [previously *Montastraea*] *annularis*), mountainous star coral (*O. faveolata*), boulder star coral (*O. franksi*), and rough cactus coral (*Mycetophyllia ferox*). Four of the threatened coral species (elkhorn, lobed star, mountainous star, and boulder star) were documented on the Flower Garden Banks (USDOC, NOAA, 2013a,b) and on the 18 Fathom and Bright Bank reefs in the northwestern Gulf of Mexico (Rezak et al., 1983, 1990). Two very small elkhorn coral colonies also were documented at the West and East Flower Garden Banks in 2003 and 2005, respectively (Zimmer et al., 2006).

Pinnacles are hard bottom features with vertical extensions up to 15 m (49 ft) above the seafloor. Pinnacles, which consist of rock outcrops heavily encrusted with sessile invertebrates and harboring subtropical and tropical fishes, are known to exist in at least 47 OCS lease blocks, encompassing >2,652 km^2 (1,024 mi^2) of the northeastern Central Planning Area (**Figure 4.3.3-1**). Relatively steep sides and tops of the pinnacles provide prime hard bottom habitat for coralline algae, sponges, octocorals (sea fans and sea whips), crinoids (sea lilies), bryozoans, and demersal fishes. The biological diversity of the fauna on the pinnacles has been found to be directly related to the height of the pinnacle feature (Gittings et al., 1992b; Thompson et al., 1999). Biological diversity also increases with greater distance from the Mississippi River Delta as water turbidity decreases (Gittings et al., 1992b).

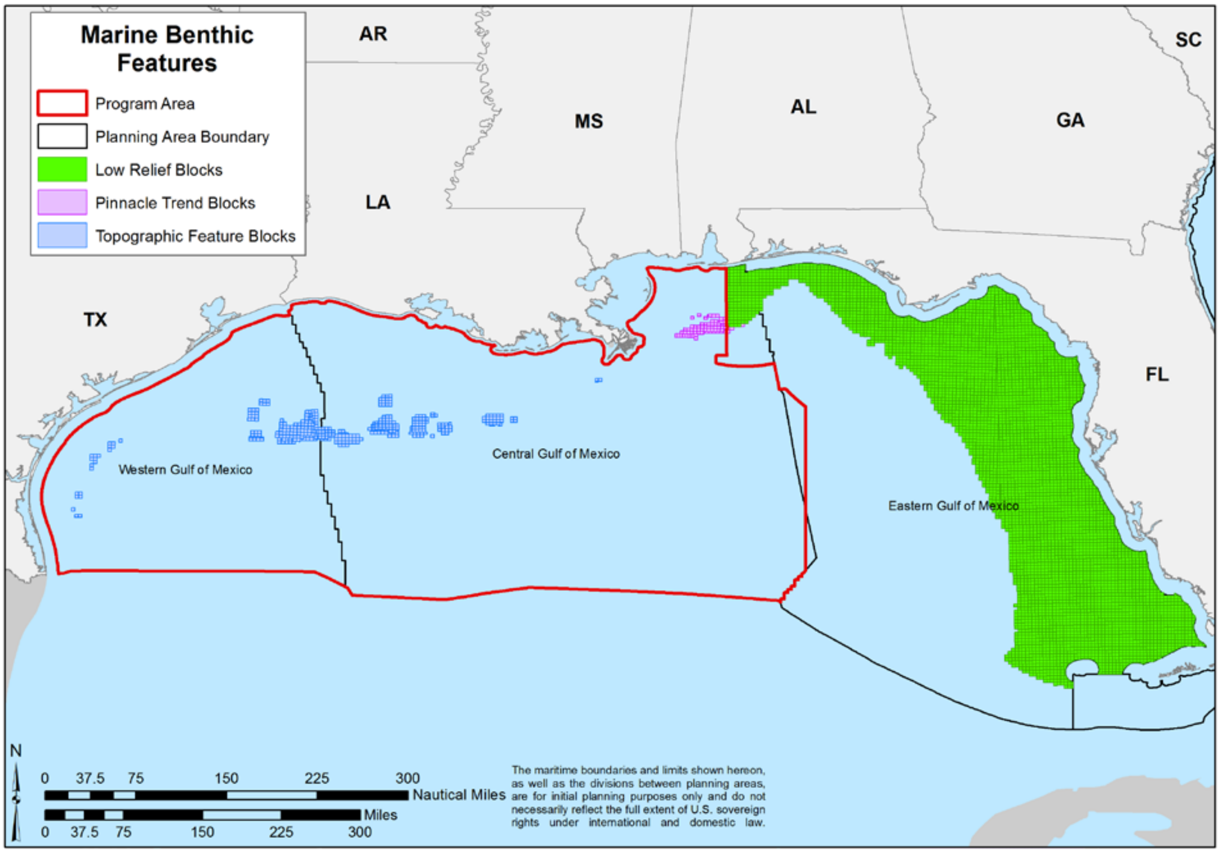


Figure 4.3.3-1. Lease Blocks Subject to the Stipulations for Topographic Features, Live Bottom Pinnacle Trend, and Live Bottom Low Relief. Gulf of Mexico Live Bottoms are not Limited to These Areas.

The term “topographic features” refers to submerged banks in the Gulf of Mexico that are protected from oil and gas activities as described in Notice to Lessee and Operators (NTL) 2009-G39: “isolated areas of moderate to high relief that provide habitat for hard bottom communities of high biomass and diversity and large numbers of plant and animal species, and support, either as shelter or food, large numbers of commercially and recreationally important fisheries.” These banks are located in the Western (21 banks) and Central (16 banks) Planning Areas, and include the Flower Garden Banks, which are also hermatypic coral reefs. BOEM has mandated “No-Activity Zones” around major topographic features in the Gulf of Mexico (see USDOI, MMS, 2008) to protect these submerged banks from anchoring and other disturbances that may occur during oil and gas exploration and production activities. Topographic features in the Gulf of Mexico include shelf-edged banks (e.g., East and West Flower Garden Banks), mid-shelf banks (e.g., Stetson Bank and Sonnier Bank), and the South Texas banks.

Flower Garden Banks National Marine Sanctuary (East and West Flower Garden Banks and Stetson Bank) was withdrawn from leasing in 1998 (**Section 4.3.10**). NOAA is in the process of considering whether to expand the sanctuary boundaries. BOEM is a cooperating agency on the EIS that identifies sanctuary expansion alternatives.

Artificial reefs created by decommissioned Gulf of Mexico oil and gas platforms and sunken vessels can provide suitable substrate for supporting vibrant live bottom communities (South Atlantic Fishery

Management Council [SAFMC], 2009) and associated fish assemblages. As of September 2012, approximately 420 platforms, or 10 percent of all platforms removed in the Gulf of Mexico, had been converted into artificial reefs (USDOI, BSEE, 2015) many through the USDOI Rigs-to-Reef policy implemented by BSEE and BOEM's predecessor, MMS in the 1980s. Platforms are prepared for decommissioning and can be toppled in place, partially removed near the surface, or towed to existing reef sites with proper permits obtained by the state from the U.S. Army Corps of Engineers (USACE) and in accordance with applicable guidelines to ensure navigational safety, infrastructure security, and environmental protection.

At least 330 deepwater benthic communities have been found in the Gulf of Mexico that constitute a combination of chemosynthetic and coral assemblages (USDOI, BOEM, 2015f). Chemosynthetic organisms are unique in that they use a carbon source other than the photosynthesis-based food webs that support all other life on earth. Chemosynthetic bacteria have the ability to oxidize the chemicals present in seafloor vents, including oil, methane, hydrogen sulfide, hydrogen gas, or ammonia) into organic molecules used to produce biomass (often sugars). Growth rates of many organisms in these communities are extremely slow, averaging approximately 2.5 millimeters (mm) per year for tubeworms of the genus *Lamellibrachia* (Fisher, 1995). However, mytilid mussels have been found to reach reproductive age relatively quickly, with growth rates slowing in adulthood (Fisher, 1995). These factors lead to long-lived individuals and communities; Powell (1995) estimated that some clam and mussel communities at chemosynthetic sites have been present in the same location for between 500 and 4,000 years. Individual tubeworms can be >400 years old.

4.3.3.4. Atlantic Program Area

The Atlantic Program Area straddles two ecoregions: the Mid-Atlantic Bight (MAB), which extends from Cape Cod to Cape Hatteras, and the South Atlantic Bight (SAB), which extends from Cape Hatteras to Cape Canaveral. Some general characteristics of the benthic communities in the portions of these two ecoregions that lie within the Program Area are discussed here. Following is a description of the more sensitive benthic communities in the Atlantic Program Area, including live/hard bottom areas, canyons, deepwater coral, and chemosynthetic habitats. **Figure 4.3.3-2** shows the location of the major submarine canyons on the U.S. Atlantic OCS.

The MAB portion of the Program Area is colonized by silt-clay fauna dominated by deposit-feeding polychaetes, bivalves, and echinoderms (Boesch, 1979). The shelf break is a transitional zone from the sandy sediments on the shelf to the finer, silt- and clay-dominated sediments on the slope. Polychaetes, brittle stars, galatheid crabs, and tubeworms colonize the muddy sediments of the shelf break (Boesch, 1979). Hard bottom habitats are sparsely distributed over the MAB shelf and are composed of bare rock, gravel, shell hash, and artificial reefs (Steimle and Zetlin, 2000). Man-made reefs include shipwrecks, which constitute one of the most abundant types of man-made reef habitat in the MAB (Steimle and Zetlin, 2000). Coarser surficial sediments often are found on ridges and shoals, while generally finer sediments with higher organic carbon content are found in swales, along with greater biomass and species diversity (Boesch, 1979). Polychaetes, bivalves, and amphipods are common in sand habitats of the continental shelf (Schaffner and Boesch, 1982; Brooks et al., 2006). Large burrowers and surface tube dwellers are found in the fine, stable sediments of swales. Within the soft sediment matrix found in the MAB, natural and man-made reef habitats occur in estuaries, along the coast, across the continental shelf, and in deeper waters.

Soft bottom habitats in the SAB portion of the Program Area are primarily sandy habitats of varying grain size. Hard bottom habitats are interspersed throughout the SAB and range from areas of flat hard bottom with a sand veneer sparsely colonized by sponges and soft corals to dense coral thickets on shelf-edge fossil Pleistocene coral substrate (Parker et al., 1983; Van Dolah et al., 1994; Schobernd and Sedberry, 2009). The nearshore area of the SAB is a relatively narrow band approximately 20 km (12 mi) wide that receives the outfall of terrigenous sediment and organic and inorganic nutrients, resulting in relatively high silt/clay fractions and nutrient conditions favorable to biological activity (Tenore, 1979).

The shallow, wide shelf of the SAB is characterized by a sandy bottom interspersed with isolated areas of live bottom of varying relief.

Live bottom habitats occur widely on the Atlantic continental shelf, particularly in the SAB. These rock outcrops typically are heavily encrusted with sessile invertebrates such as sponges and sea fans. Large sponges and corals are important components of these habitats because they enhance structural complexity of the environment, contribute shelter and hiding places attractive to fishes, and provide microhabitats for invertebrates that are a food source for reef and pelagic fish (Fraser and Sedberry, 2008). Nearshore hard bottom habitats primarily consist of low relief rock outcrops, often referred to as sponge-coral habitats, colonized by decapods, mollusks, polychaetes, sponges, octocorals, ascidians, echinoderms, bryozoans, and algae (Continental Shelf Associates Inc., 1979; Wenner et al., 1983). Locations of hard bottom and "probable" hard bottom habitat in the region have been mapped and are available on the SAFMC map server on their Digital Dashboard (http://ocean.floridamarine.org/safmc_dashboard/). Parker et al. (1983) estimated that 14 percent of the SAB shelf area between 27 and 101 m (89 and 331 ft) is hard bottom habitat.

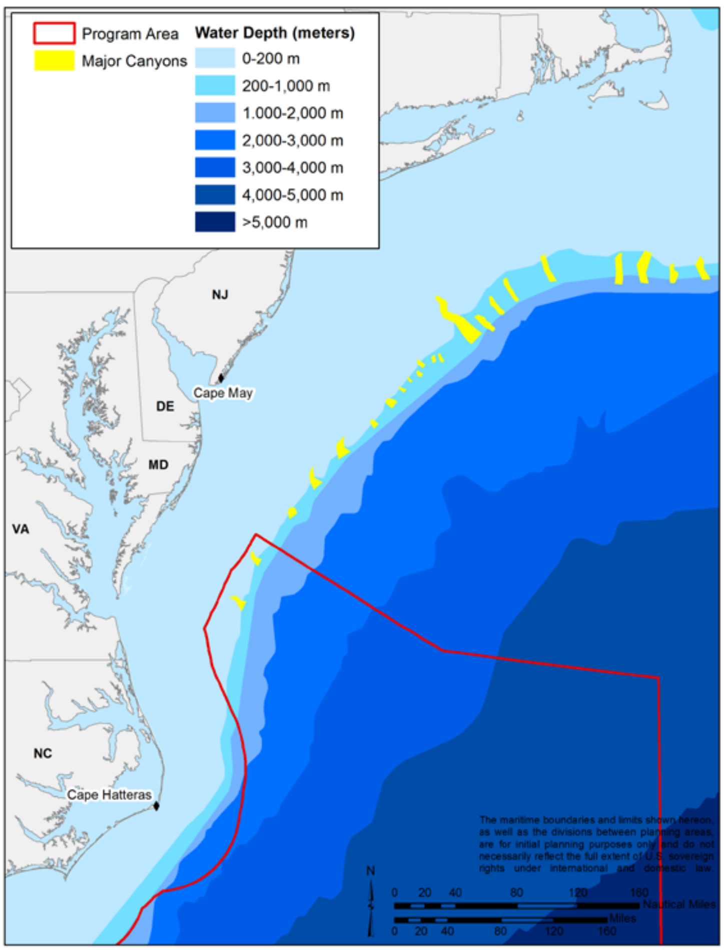


Figure 4.3.3-2. Major Submarine Canyons on the U.S. Atlantic OCS.

In deeper water, limited areas of hard bottom habitats are associated with canyon walls in the MAB, and with deepwater coral bioherms along the Blake Plateau in the SAB. Locations of canyons and some hard bottom features are well known (e.g., Gray's Reef). In other areas, deepwater corals are generally known to be present but the precise distribution of coral sites may not yet be well documented. Deepwater corals have been documented in the SAB (Reed and Ross, 2005; Reed et al., 2006; Ross, 2006). Several features have been mapped, including *Lophelia* coral mounds on the Blake Plateau and the *Oculina* Bank offshore of the Atlantic coast of central Florida. *Lophelia* reefs off North Carolina also have a well-developed and abundant invertebrate fauna. In addition, one chemosynthetic community site has been reported on the Blake Ridge (Van Dover et al., 2003).

The two Fishery Management Councils in this area, the SAFMC and Mid-Atlantic Fishery Management Council (MAFMC), have given various designations to particular geographic features with known or suspected concentrations of deepwater benthic communities, including HAPCs such as the Cape Lookout and Cape Fear HAPCs off North Carolina, Deepwater Coral HAPCs, and the MAFMC's proposed broad and discrete coral zones around certain submarine canyons (http://www.mafmc.org/actions/msb/am16). NOAA and the councils place certain restrictions on fishing gear or practices in some of these areas to protect communities from physical damage by fishing gear such as trawls.

Submarine canyons are important features of the MAB shelf edge and slope. There are two major canyons in the Atlantic Program Area (Washington and Norfolk) and several minor canyons (Warr, Accomac, Hull, Keller, Hatteras, and Pamlico). These features are regarded as hot spots of biodiversity, hosting many different species of coral; numerous fish species; several squid and octopus species; and various sea stars, sea urchins, and sea cucumbers. The canyons generally are characterized by downslope areas of soft sediment leading up to steep walls with abundant biological communities under overhangs. Atlantic canyons are especially important habitats for deepwater coral species that have been found in nearly every canyon that has been investigated (Packer et al., 2007; Brooke and Ross, 2014; National Resources Defense Council [NRDC], 2014). Dense, localized patches of solitary stony corals and massive colonies of gorgonians are documented in Baltimore and Norfolk Canyons (Packer et al., 2007) as well as the structure-forming species *Lophelia pertusa* (Brooke and Ross, 2014).

A chemosynthetic community associated with a methane hydrate site has been identified on the Blake Ridge (Van Dover et al., 2003). The SAFMC has designated this area as the Blake Ridge Diapir Deepwater Coral HAPC. A line of approximately 20 salt diapirs begins near the intersection of the Blake Ridge with the Carolina Rise, and extends northward on the eastern side of the Carolina Trough. Although only one site has been documented in this area to date, it is likely that others are present. BOEM is currently investigating these features.

In addition to natural hard bottom habitats, artificial reefs provide suitable substrate for the proliferation of live bottom communities (SAFMC, 2009). Artificial habitats are an integral part of the coastal and shelf ecosystem in the region, and they support a diverse and special biological community (Steimle and Zetlin, 2000).

4.3.4. Coastal and Estuarine Habitats

Coastal and estuarine habitats are discussed in detail in **Appendix C**, Section 4. The type of coastal and estuarine habitat usually is determined by the local geology and climate. Habitats associated with estuaries include salt and brackish marshes, bays, lagoons, mangrove forests, mud flats, tidal rivers and deltas, rocky intertidal shores, reefs, submerged aquatic vegetation, barrier islands, and beaches.

4.3.4.1. Beaufort and Chukchi Sea Program Areas

Arctic coastal habitats are greatly influenced by a short growing season, extremely cold winters, and the dynamics of sea ice. In the Arctic, wet tundra and moist tundra dominate the Alaska Coastal Plain (ACP). Wet tundra is a saturated or inundated wetland in wetter environments such as drained lake basins and poorly drained river terraces, while moist tundra is a saturated wetland in broad expanses of tundra above shallow water tables; both have similar emergent and scrub-shrub vegetation (USACE, 2012). Moist and wet tundra are composed of wetlands and marshes over permafrost soils (Wahrhaftig, 1965; Walker et al., 1980; Walker, 1983). Coastal and nearshore habitats along the shorelines of the Beaufort and Chukchi Seas include barrier islands and beaches, wetlands, tidal flats, and seagrasses. These habitats occur within estuarine watersheds in and around bays, lagoons, and river mouths where marine and freshwaters intermix (Wilkinson et al., 2009). Sea ice is more extensive and lasts longer in the Beaufort Sea than in the Chukchi Sea (Hopcroft et al., 2008; Forbes, 2011). The Arctic coastline is highly disturbed due to the movement of sea ice that is frequently pushed onshore, scouring and scraping the coastline (Forbes, 2011). Coastal habitats of the Beaufort and Chukchi Seas, as described by the National Environmental Sensitivity Index (ESI) Shoreline data, are featured in **Figure 4.3.4-1**.

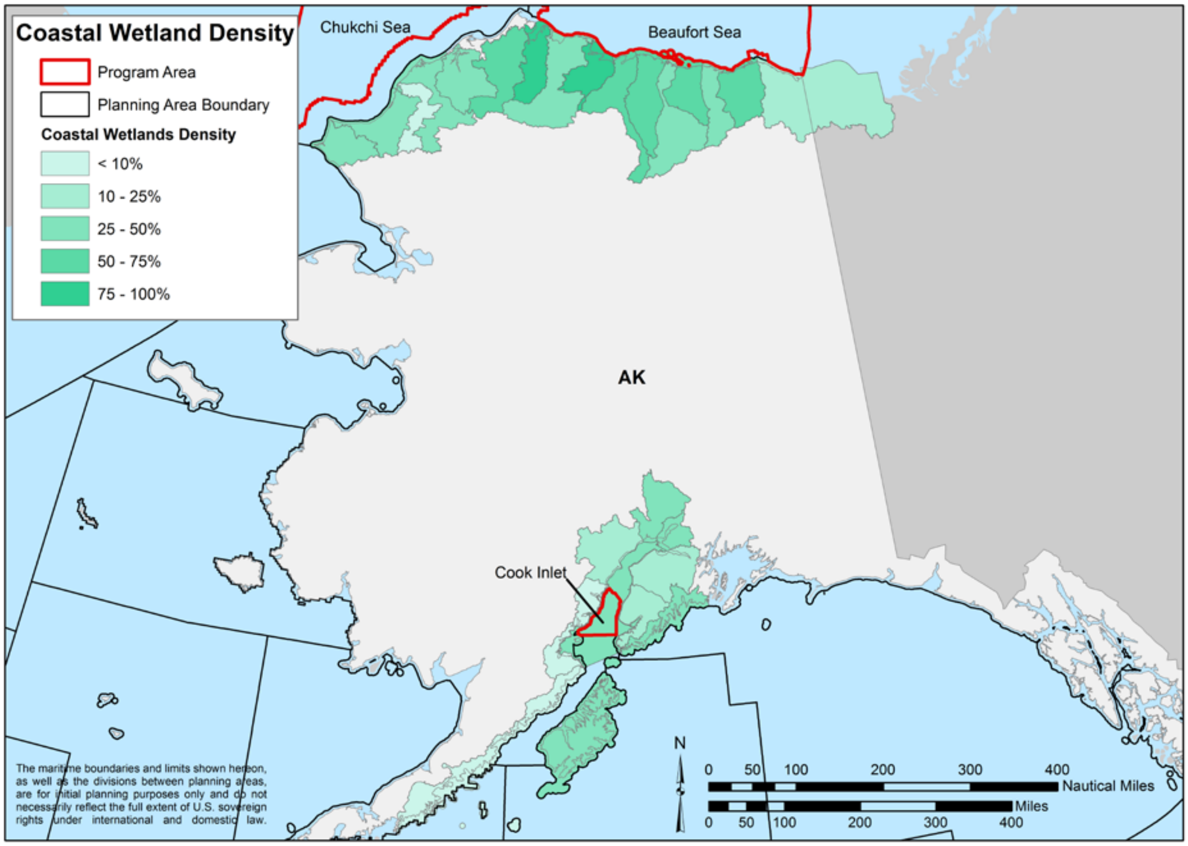


Figure 4.3.4-1. Coastal Wetland Density in the Coastal Watersheds of the Arctic Program Areas.

4.3.4.2. Cook Inlet Program Area

Physiography of this region includes rocky coastlines and numerous fjords, islands, and embayments (Wilkinson et al., 2009). Large salt marshes and mud flats are dominant coastal features along Cook Inlet, particularly along the western shore, although sand and gravel beaches and rocky shores are quite common at more exposed locations also (Lees and Driskell, 2004). Coastal habitats of Cook Inlet, as described by the National ESI Shoreline data, are featured in **Figure 4.3.4-1**.

4.3.4.3. Gulf of Mexico Program Area

The Gulf of Mexico OCS has a highly developed oil and gas infrastructure that will likely continue for the foreseeable future. Coastal habitats are associated with a nearly continuous estuarine ecosystem that extends across the coast of the northern Gulf of Mexico. These habitats occur within shallow estuarine watersheds and offshore, to depths of up to 30 m (98 ft) (Fonseca et al., 2008). For the purposes of this analysis, 5.5 km (3 nmi) offshore is considered the boundary between "coastal" and "offshore."

More than 60 percent of U.S. drainage, including outlets from 33 major river systems and 207 estuaries, flows into the Gulf of Mexico (Morang et al., 2012). Three major estuarine and fluvial drainage areas (Texas, Mississippi River, and northeast Gulf Coast) have a large influence on coastal and estuarine habitats in the northern Gulf of Mexico (**Appendix C**, Figure 3.2-2). Coastal and estuarine habitats provide important nursery and adult habitat for numerous species of fish and invertebrates (**Appendix C**, Section 8), while seagrass habitats provide foraging habitat for sea turtles (**Appendix C**, Section 6), and marine mammals (manatees). Protection and conservation of numerous coastal and estuarine habitats are achieved through management and protected designations, as described in **Appendix C**, Section 9.

Seagrasses

Seagrasses are a common and vital component of the Gulf of Mexico coastal ecology and economy (Carter et al., 2011; Yarbro and Carlson, 2011) (**Appendix C**, Figure 4.2-1). Seagrasses provide a variety of ecological services, including sustenance through food webs and habitat for marine life (fisheries in particular) as well as providing important nursery habitat for numerous commercially important fish and invertebrate species (**Appendix C**, Section 8). Seagrasses are also important economically (Bell, 1993; Dawes et al., 2004).

Wetlands

Wetlands are low-lying habitats where water accumulates long enough to affect the condition of the soil or substrate and promote the growth of wet-tolerant plants (LaSalle, 1998). From a regulatory standpoint, a wetland is defined as: "Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (USEPA: 40 CFR 230.3; USACE: 33 CFR 328.3).

The most common coastal wetlands in the Gulf of Mexico include saltwater marshes, saltwater mangrove swamps, and non-vegetated areas such as sand bars, mud flats, and shoals (Gulf Restoration Network, 2004; Dahl and Stedman, 2013). Wetlands occur along all coastal areas of the Gulf of Mexico, with the highest density occurring in Louisiana in the Central Planning Area and in south Florida in the Eastern Planning Area (**Figure 4.3.4-2**).

Coastal wetlands in the northern Gulf of Mexico are characterized by flat topography and are associated with several barrier islands, bays, peninsulas, lagoons, and estuaries (Handley et al., 2012). Brackish marshes dominate estuaries of the Central Planning Area and are the most extensive and productive in Louisiana. Louisiana has lost approximately 4,877 km^2 (1,883 mi^2) of land since the 1930s with a current loss rate of 42.9 km^2/yr (16.57 mi^2/yr) (Couvillion et al., 2011). The most extensive coastal wetland areas in Mississippi are associated with the deltas of the Pearl River and Pascagoula River. 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). Along Florida's Gulf coast, coastal emergent wetlands make up a large component of the coastline and are most prevalent around the central panhandle, the Big Bend region, and southern Florida near Collier County and the Ten Thousand Island region (Stedman and Dahl, 2008). The Big Bend region of Florida is dramatically different than the rest of Florida's sandy coasts, instead dominated by a marshland made up of black needle rush (*Juncus roemerianus*), with shell and sand beaches (Florida Department of Environmental Protection [FDEP], 2010; USDOI, BOEM, 2013).

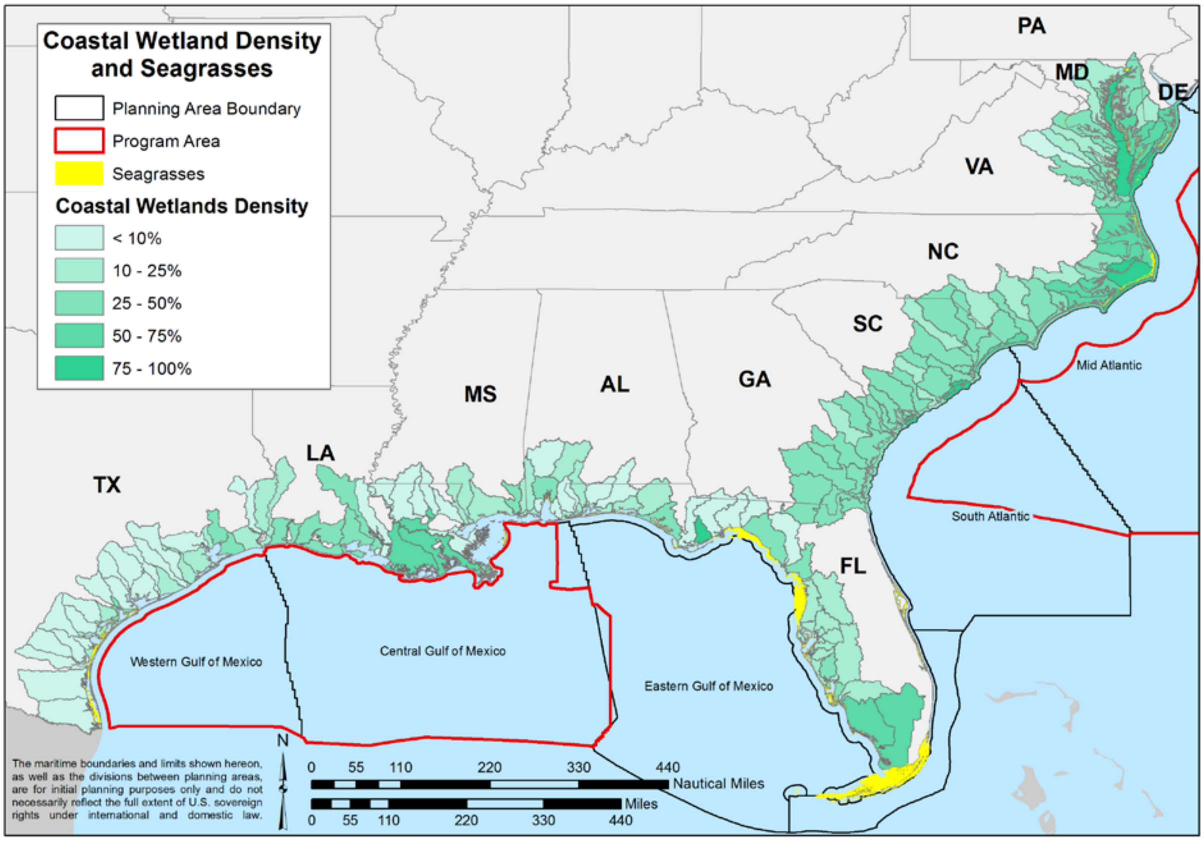


Figure 4.3.4-2. Coastal Wetland Density in the Coastal Watersheds of the Gulf of Mexico and Atlantic Program Areas. Seagrass Data from: NOAA's Ocean Service, Office for Coastal Management, March 2015.

Coastal Barrier Islands and Beaches

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, a distance of approximately 2,623 km (1,631 mi) (National Atlas, 2013). Coastal barrier islands are important resources that protect the mainland by reducing wave action that may cause shoreline deterioration. Barrier islands are composed largely of sand or other unconsolidated soils and usually run parallel to shore (Zhang and Leatherman, 2011). Barrier islands are present on more than half of the U.S. coastline that extends along the Gulf of Mexico, from the Mexican border to southern Florida (LaRoe, 1976; USDOI, BOEM, 2015f). The importance of barrier islands and beaches is recognized by two national seashores (Padre Island in Texas, and Gulf Islands in Mississippi and Florida), and several National Wildlife Refuges (NWRs) along the coast of the northern Gulf of Mexico (e.g., Breton NWR in Louisiana).

Barrier islands serve as critical stopover areas for numerous migrating birds (**Section 4.3.8**), especially along the northern Gulf of Mexico. Barrier islands also provide habitat for sand-dwelling crustaceans (e.g., mole crabs, ghost shrimp, clams) (Britton and Morton, 1989) and burrowing small mammals (e.g., mice, rabbits). In addition, barrier island beaches provide important nesting habitat for sea turtles (**Section 4.3.7**).

Wave, wind, and tidal energy are environmental conditions that shape barrier islands, including their respective shorelines and sand dunes, to create a dynamic system (Zhang and Leatherman, 2011). Most of the geographic changes experienced by barrier islands are due to storms, subsidence, deltaic influence, longshore drift, or anthropogenic stressors (USDOI, BOEM, 2012a). Most of the barrier islands in the Gulf of Mexico are migrating laterally and retreating landward to some extent (USDOI, BOEM, 2012a; Khalil et al., 2013), although some of the beaches on the west coast of Florida are stable or slowly accreting due to low wave energy and frequent renourishment projects (Morton et al., 2005).

Major barrier islands in the Western Planning Area generally are narrow, low relief, and sediment starved (Paine et al., 2014). In far eastern Texas and western Louisiana, the coastline is dominated by expansive marshlands with inland lakes left by erosion during the last glaciations (USDOI, BOEM, 2012a). This stretch, east to Atchafalaya Bay, Louisiana, is primarily marshland with no barrier islands and beaches. In the Central Planning Area, barrier islands and beaches generally are eroding (McBride et al., 1992; Otvos and Carter, 2008; Byrnes et al., 2013; Khalil et al., 2013). Barrier islands off the coast of Louisiana are highly influenced by the Mississippi River Delta (Coastal Protection and Restoration Authority [CPRA], 2014). Major barrier islands of Mississippi and Alabama are eroding rapidly (Morton, 2007). Florida's barrier island beaches are of low to moderate energy, with low relief and small dunes composed mostly of quartz sand (Godfrey, 1976). Most of the barrier island beaches in this region are wider and more stable than the eroding barrier islands of Mississippi, Alabama, and Texas (Hine et al., 2001; Otvos and Carter, 2008).

4.3.4.4. Atlantic Program Area

Coastal habitats that are present along the shoreline in associated states include barrier islands, beaches, tidal flats, rocky shores, tidal rivers, wetlands and marshes, and submerged aquatic vegetation. Use of these habitats by birds, wildlife, fish, and other marine life is discussed in other sections of this Programmatic EIS, as applicable. Non-intertidal and deepwater habitats such as reefs are also discussed in other sections of the Programmatic EIS.

The Atlantic coast from the Maryland-Virginia border to Georgia is characterized by a nearly continuous line of barrier islands, beaches, and sand spits with a few large embayments. Extensive tidal marshes typically exist behind the barrier islands (USDOC, NOAA and Association of State Floodplain Managers [ASFPM], 2007). Seagrasses are reported to occur in patches along the entire Atlantic coast of the U.S. with the exception of South Carolina and Georgia. There are very few rocky or armored shorelines along the Atlantic coast.

Barrier islands located along the Atlantic coast provide natural habitat for plants and animals as well as serving as a recreational destination for locals and tourists. Barrier islands also protect the mainland from wave and current action, particularly during major storms and hurricanes. Beaches are prevalent along the Atlantic coast, occurring along the mainland and on barrier islands and sea islands. These beaches consist primarily of sand or gravel. Beaches provide vital habitats for migratory birds using the Atlantic Flyway (flyways are well-described routes between wintering grounds and summer nesting grounds), nesting habitat to loggerhead turtles, and haul-out locations for seals. Beaches also provide habitat for shellfish and other burrowing organisms. Various beach grasses and dune vegetation provide shade, cover, food, and nesting habitat for animals.

Tidal flats occur sporadically in the intertidal zone along the Atlantic coastline. They are typically composed of muddy (silt and clay) substrates in the Mid-Atlantic Planning Area, and mud or sand in the South Atlantic Planning Area, and have little to no vegetation. Surficial sediments in tidal flats support microscopic plants and burrowing animals as well as an abundant variety of benthic invertebrates, fish, and birds (Strange et al., 2008; USDOC, National Ocean Service [NOS], 2012).

Estuaries, tidal rivers, and stream habitats along the Atlantic coast are dynamic environments with freshwater and marine components that support a wide variety of aquatic, estuarine, and marine communities, including habitat and nursery areas for juvenile fish, shellfish, birds, and other wildlife.

Wetland habitats also occur extensively throughout the Atlantic Program Area **(Figure 4.3.4-2)**. Those considered in this Programmatic EIS are limited to salt and brackish water marshes. Freshwater and forested wetlands occur in this region, but they are located outside of the area to be evaluated in this Programmatic EIS and are not described.

Salt and brackish water marshes are very productive ecosystems and are a primary source of organic matter and nutrients that form the base of estuarine food web (Keyes, 2004; Strange et al., 2008). They serve important functions, including acting as a buffer against storm damage, floods, waves, and sea level rise; acting as a nursery for fish and shellfish by providing food, shelter, and spawning habitat; providing nesting and foraging habitat for birds and wildlife (including migratory birds); improving water quality by filtering pollutants and nutrients from terrestrial runoff; stabilizing shorelines and minimizing upland erosion; and supporting recreational uses such as tourism, hunting, and fishing (USEPA, 2012).

In Virginia and North Carolina, 63 percent of the shoreline is mapped as salt and brackish water wetlands and marshes; 80 percent of the shoreline in South Carolina and Georgia is mapped as such (see National ESI Shoreline maps in **Appendix C**, Figures 4.3-1a,b). These marshes occur along protected shorelines and on the edge of estuaries, including the inland side of barrier islands. Brackish to freshwater marshes extend inland along estuaries where rivers meet the ocean. Seagrasses are reported to occur along the entire Atlantic coast of the U.S. with the exception of South Carolina and Georgia (Deaton et al., 2010). Seagrasses occur on the sound (landward) side of many of the barrier islands and in estuaries in Virginia and North Carolina. They typically occur as patchy or continuous beds in shallow, subtidal, or intertidal unconsolidated sediments in areas with good water clarity. They form highly productive ecosystems that provide water filtration, shoreline erosion protection, and nursery habitat for many fish and shellfish species. In this region, common seagrass species include eelgrass (*Zostera marina*), widgeongrass (*Ruppia maritimia*), and shoalweed (*Halodule wrightii*).

4.3.5. Pelagic Communities

4.3.5.1. Beaufort and Chukchi Sea Program Areas

The Beaufort and Chukchi Seas are characterized by distinct hydrographic and productivity regimes. Both waterbodies experience extreme and lengthy seasonal changes in light conditions, low temperatures, and ice cover. The Chukchi Sea is less productive, although the benthic community of the Chukchi is considered more diverse with higher faunal densities than the Beaufort Sea. In 2014, the average concentration of chlorophyll *a* ranged between 199 and 254 mg/m^3 in the Chukchi Sea and between 206 and 254 mg/m^3 in the Beaufort Sea.

The water column surface in the Chukchi and Beaufort Seas consists of ice-free open water and high-productivity areas of open water surrounded by sea ice (polynyas). Phytoplankton productivity is highest in the summer when temperatures are highest, ice cover is lowest, and when nutrient concentrations and solar irradiance are most conducive to productivity (Hopcroft et al., 2008). In general, the Chukchi Sea exhibits strong benthic-pelagic coupling, with high fluxes of phytoplankton and organic matter from open-water areas (including polynyas) to the sediment. Production also may be advected to deep waters of the Canada Basin (Cooper et al., 2002; Bates et al., 2005).

In the Beaufort Sea, dominant phytoplankton include Arctic Micromonas, *Chaetoceros* spp., Chrysophyceae, Pelagophyceae, and *Chrysochromulina* spp. (Lovejoy and Potvin, 2011; Balzano et al., 2012). Similar species were observed in the Chukchi Sea in addition to *Thalassiosira* sp. and *Phaeocystis* sp. (Hill et al., 2005). Questal et al. (2013) found significant seasonal and interannual variability in the zooplankton community in the Chukchi Sea. Generally, the communities were numerically dominated by copepods (*Pseudocalanus* spp., *Acartia* spp., *Calanus glacialis*, and *Oithona similis*); larvaceans (*Fritillaria borealis* and *Oikopleura vanhoeffeni*); and planktonic stages of bivalves, barnacles, and polychaetes. Biomass was dominated by *C. glacialis* and the chaetognath, *Parasagitta elegans* (Questal et al., 2013). Two Arctic cephalopods are known to have circumpolar distributions: the pelagic squid *Gonatus fabriccii* and the octopus *Cirroteuthis muelleri* (Nesis, 2001).

Sea ice exists for variable periods in the colder months of the year near the coastline and perennially closer to the shelf edge and basin (Gradinger, 2009). Arctic sea ice provides a unique and ecologically important habitat for a wide variety of microorganisms (Brown et al., 2011). For example, massive phytoplankton blooms consisting of *Chaetoceros* spp., *Thalassiosira* spp., and *Fragilariopsis* spp. have been noted under Chukchi Sea ice (Arrigo et al., 2012). Phytoplankton growing on the underside of sea ice can be a primary source of productivity in northern areas of the shelf that have permanent ice cover, and sea ice algal productivity and biomass can exceed that of the water column during the spring (Gradinger, 2009). Diatoms are highly abundant in under-sea ice communities, but there is also a diverse mixture of bacteria, protozoans, rotifers, turbellarians, polychaete larvae, amphipods, copepods, and nematodes (Horner et al., 1992; Gradinger and Bluhm, 2004; Poulin et al., 2011). Sea ice also supports the early life stages of fishes (especially Arctic cod) and benthic invertebrates by providing temporary habitat (particularly nearshore sea ice) and by exporting seasonal pulses of organic matter to the seafloor (Gradinger and Bluhm, 2005; Bluhm and Gradinger, 2008). Sea ice is responsible for strong ice-edge phytoplankton blooms, which occur as melting sea ice releases organic matter and freshwater, creating a stratified upper water column with high nutrient concentrations (Hopcroft et al., 2008; Mundy et al., 2009).

4.3.5.2. Cook Inlet Program Area

Cook Inlet pelagic waters are influenced by riverine and marine inputs, resulting in salinity gradients and horizontal mixing near the inlet. In Cook Inlet, sea ice forms in October to November and melts in March to April (USDOI, MMS, 2003). In 2014, the average concentration of chlorophyll *a* ranged between 164.4 and 201.6 mg/m^3 in the Cook Inlet Planning Area. Cook Inlet's pelagic habitat is highly productive in the summer, and phytoplankton blooms peak in the spring as the water column stratifies and light levels increase (USDOI, MMS, 1996, 2003). Tidal fluxes and currents resuspend nutrients, allowing productivity to remain high in the summer. Speckman et al. (2005) concluded that the abundance and distribution of chlorophyll and thus both zooplankton and forage fish in Cook Inlet were affected more by spatial variability in its physical oceanography than by interannual variability.

4.3.5.3. Gulf of Mexico Program Area

In general, primary productivity within the Gulf of Mexico is highest in the mixing region of the Mississippi River outflow (Karnauskas et al., 2013) because it provides large seasonal inputs of freshwater as well as inorganic and organic nutrients. Extra nutrients help increase primary productivity (phytoplankton growth) (Fennel et al., 2011), which supports a high biomass of fishes (Wawrik and Paul, 2004). The river plume contributes to the productivity of the surface and the total water column. Non-plume phytoplankton community constituents include *Prochlorococcus*, *Synechococcus*, and diatoms (Wawrik and Paul, 2004). In Gulf of Mexico oceanic waters, there are temporary high productivity areas generated by upwelling zones where deepwater containing nutrients flows up the slope into the photic zone. Productivity in the Gulf of Mexico is limited by nutrients. In 2014, the average concentration of chlorophyll *a* was 254 mg/m^3 in the Gulf of Mexico Planning Areas.

SEAMAP data indicate that total zooplankton abundance varies yearly and fluctuates with no obvious trend. Factors that influence zooplankton include hypoxia, which decreases their concentration (Kimmel et al., 2010), and the Loop Current and its eddies, which transport them and influence zooplankton concentrations (i.e., concentrations within the Loop Current's frontal zone may be higher than within the main body of the current) (Lindo-Atichati et al., 2012). The *Deepwater Horizon* oil spill had a negative effect on pelagic microbial communities, including phytoplankton and zooplankton, by initially decreasing diversity that returned to normal approximately 4 to 5 months later (Yang et al., 2014).

The life history of *Sargassum* in the Gulf of Mexico is part of a larger cycle that includes the mid-Atlantic Ocean and the Caribbean Sea (Frazier et al., 2015). This cycle begins in the Sargasso Sea (North Atlantic) where *Sargassum* remains year-round. However, winds and currents move some of this *Sargassum* south into the Caribbean Sea and eventually into the Gulf of Mexico via the Yucatan Channel. Once in the Gulf of Mexico, it moves into the western area where it uses nutrient inputs from coastal rivers, including the Mississippi River, for growth. As *Sargassum* abundance increases, plants will continue to travel east during the summer months; however, a large quantity of plants will travel in to the nearshore where they will be deposited on coastal beaches. *Sargassum* deposition on Gulf Coast beaches is important because *Sargassum* facilitates dune stabilization and provides a pathway for nutrient and energy transfer from the marine environment to the terrestrial environment (Webster and Linton, 2013). Eventually the plants moving east will be incorporated into the Gulf Stream where they return to the Sargasso Sea. Throughout this cycle, plants will continue to grow, die, and reproduce. When a plant dies, it can sink to the seafloor, transporting nutrients and resources with it (Parr, 1939; Coston-Clements et al., 1991; Wei et al., 2012). Although the cycle continues year-round, the rapid growth of *Sargassum* populations in the western Gulf of Mexico typically occurs during the spring/summer (Gower et al., 2006; Gower and King, 2008, 2011). Estimates suggest that between 0.6 and 6 million metric tons of *Sargassum* are present annually in the Gulf of Mexico, with an additional 100 million metric tons exported to the Atlantic basin (Gower and King, 2008, 2011; Gower et al., 2013). The spatial expanse of this life history facilitates the rapid recovery from episodic environmental perturbations because of the remote probability that any single event could impact the entire spatial distribution.

Sargassum mats provide substrate, a food source, and protection from predation for a wide spectrum of fauna, including ichthyoplankton and sea turtles (Dooley, 1972; Cassaza and Ross, 2008). *Sargassum* was designated critical habitat for hatchling loggerhead turtles in July 2014 (79 *Federal Register* [FR] 39856), in offshore waters of the Gulf of Mexico and Atlantic (**Section 4.3.7.3**; **Figure 4.3.7-1**).

4.3.5.4. Atlantic Program Area

Information regarding the primary productivity of the Mid-Atlantic shelf can be found in Balcom et al. (2011). Some of the factors that impact primary productivity in the Atlantic are temperature, precipitation, concentrations of nutrients and nitrogen limitations, and seasonality (Paerl et al., 1999; Willey et al., 1999; Redalje et al., 2002). In 2014, the average concentration of chlorophyll *a* ranged between 51.9 and 125.4 mg/m^3 in the Mid- and South Atlantic.

Phytoplankton community composition in the Atlantic varies significantly between different water masses and is impacted by wind and shelf circulation processes (Lohrenz et al., 2003). Effects of ocean currents on ichthyoplankton have been studied along the southern and Mid-Atlantic states. The Charleston Gyre is correlated with enhanced primary and secondary productivity. Chlorophyll *a* concentrations and zooplankton densities are higher in the Charleston Gyre, providing additional food sources; it also may act as spawning habitat (Govoni and Hare, 2001; Govoni et al., 2011, 2013). Ichthyoplankton community composition includes larvae of commercially and recreationally important estuarine-dependent species.

In addition to plankton, non-planktonic pelagic organisms include fishes and invertebrates. Federally managed fishes and invertebrates are discussed in **Section 4.3.9.4**. Common pelagic invertebrates include cephalopods (longfin [*Loligo pealei*], arrow [*Doryteuthis plei*], and shortfin squid [*Illex illecebrosus*]) (Herke and Foltz, 2002). These species are an important food source for a wide range of species, including cetaceans.

Sargassum from the Gulf of Mexico is advected during fall and winter into the Atlantic Ocean by the Loop Current and Gulf Stream (Gower and King, 2011). It is estimated that >1 million tons of *Sargassum* are transported to the Atlantic basin (Gower and King, 2008, 2011; Gower et al., 2013). Distribution and quantity along the U.S. Atlantic coast varies (Cassaza and Ross, 2008). *Sargassum* circulates from south of the Florida Keys as far north as Maryland (Dooley, 1972; SAFMC, 2002). Four species of sea turtles are associated with *Sargassum*, and this habitat was designated critical habitat for hatchling loggerhead turtles in July 2014 (79 FR 39856); the critical habitat includes offshore waters of the Mid- and South Atlantic Planning Areas (**Section 4.3.7.4**; **Figure 4.3.7-1**).

4.3.6. Marine Mammals

The status, general ecology, general distribution, migratory movements, and abundance of marine mammals are discussed in greater detail in **Appendix C**, Section 5. Many marine mammal species are known to make wide-ranging movements and may not be present in a Program Area year-round; time periods of vulnerability vary. For example, gray whales are present in the Alaska Program Areas during the summer but migrate south along the U.S. West Coast to breeding grounds in Mexico. In the Atlantic Program Area, there are species such as the North Atlantic right whale (*Eubalaena glacialis*; NARW) that make well-documented migrations between foraging grounds well north of the Program Area to breeding and calving grounds south of the Program Area. However, not all individuals undertake this migration, and individuals may be vulnerable to impacts from oil and gas activities on both their southbound and northbound migrations, or year-round if they remain in the Program Area. The majority of species in the Gulf of Mexico Program Area are considered distinct populations and do not undertake migrations.

4.3.6.1. Beaufort and Chukchi Sea Program Areas

Fifteen species of marine mammals may occur within the Chukchi and Beaufort Sea Program Areas. These include 5 species of baleen whale, 4 species of toothed whales and dolphins), 5 species of pinnipeds, and the polar bear (*Ursus maritimus*). The bowhead whale (*Balaena mysticetus*), fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), bearded seal (*Erignathus barbatus*), ringed seal (*Pusa hispida*), and polar bear are federally listed as endangered or threatened species under the ESA. The Pacific walrus (*Odobenus rosmarus divergens*) is a candidate species for ESA listing.

4.3.6.2. Cook Inlet Program Area

Thirteen species of marine mammals may occur within the Cook Inlet Program Area: three species of baleen whale, six species of toothed whales and dolphins, two species of seals, and the northern sea otter (*Enhydra lutris kenyoni*). The humpback whale, Cook Inlet DPS of beluga whale, Southwest Alaska DPS of northern sea otter, and the Western DPS of Steller sea lion (*Eumetopias jubatus*) are listed as threatened or endangered under the ESA.

4.3.6.3. Gulf of Mexico Program Area

Twenty-three species of marine mammals may occur within the northern Gulf of Mexico: a baleen whale (the Bryde's whale [*Balaenoptera brydei*]), 21 species of toothed whales and dolphins, and the West Indian manatee (*Trichechus manatus*). The sperm whale (*Physeter macrocephalus*) and manatee are listed as endangered under the ESA. There is designated critical habitat for the manatee in the Gulf of Mexico along the coast of Florida.

4.3.6.4. Atlantic Program Area

There are 39 species of marine mammals that may occur within the northwestern Atlantic Ocean, including the Atlantic Program Area: 7 species of baleen whale, 27 species of toothed whales and dolphins, 4 species of seals, and the West Indian manatee. The sei whale (*Balaenoptera borealis*), blue whale (*Balaenoptera musculus*), fin whale, NARW, humpback whale, sperm whale, and the Florida subspecies of the West Indian manatee (*T. m. latirostris*) are federally listed as endangered species under the ESA. There is designated critical habitat for the manatee along the coast of Florida south of the Atlantic Program Area. There is designated critical habitat for the NARW in the waters adjacent to the Atlantic Program Area (**Figure 4.3.6-1**).

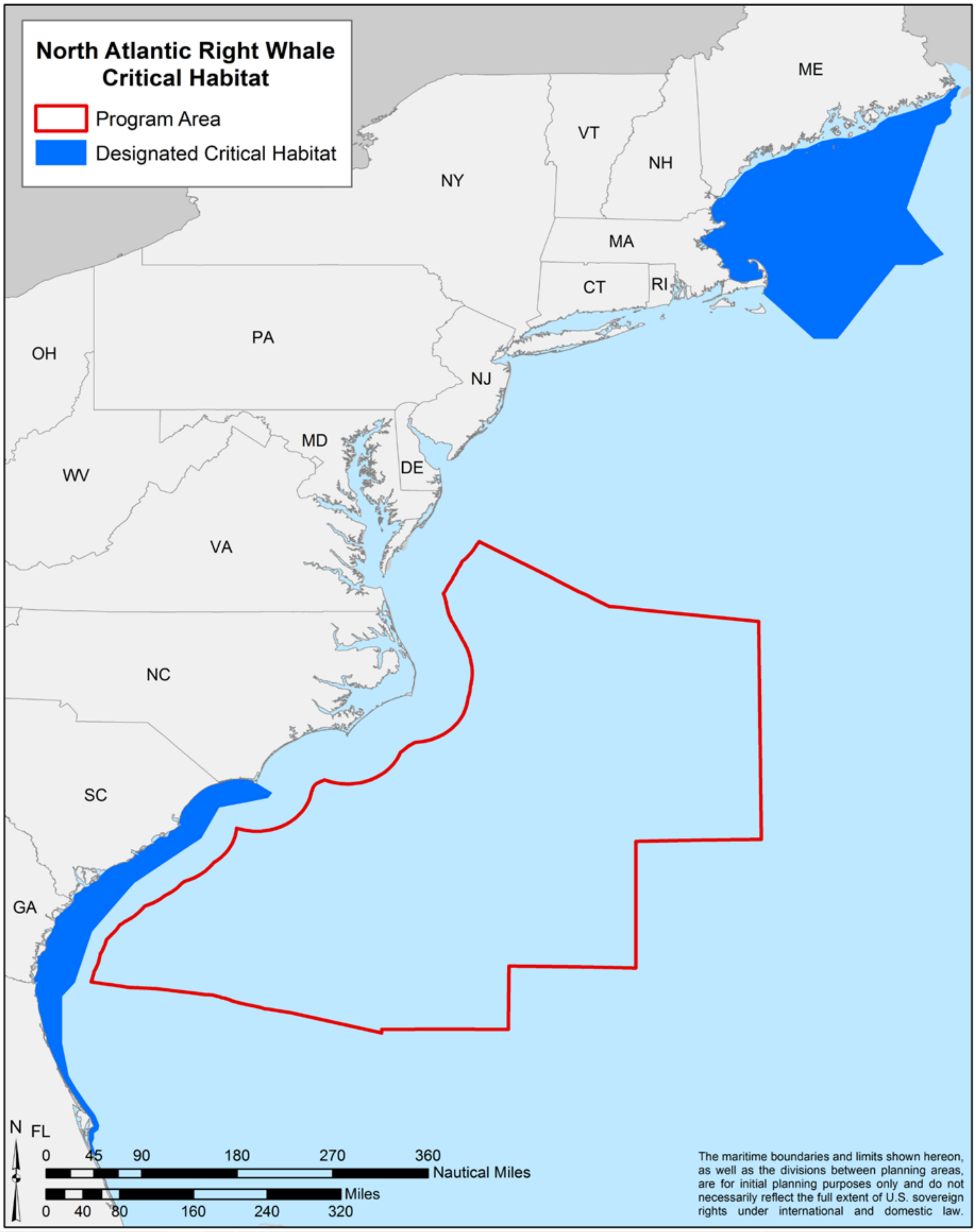


Figure 4.3.6-1. Locations of Designated Critical Habitat for the North Atlantic Right Whale.

4.3.7. Sea Turtles

The status, general ecology, and general distribution of sea turtles are discussed in greater detail in **Appendix C**, Section 6.

4.3.7.1. Beaufort and Chukchi Sea Program Areas

Beaufort and Chukchi Sea Program Areas are outside the distribution range for all sea turtle species.

4.3.7.2. Cook Inlet Program Area

The Cook Inlet Program Area is generally outside the distribution range for all sea turtle species. However, sea turtles are occasional visitors to Alaska's Gulf Coast waters and are considered a natural part of the state's marine ecosystem. Between 1960 and 2007, there were 19 reports of leatherback turtles (*Dermochelys coriacea*), the world's largest sea turtle. There have been 15 reports of green turtles (*Chelonia mydas*). There also have been three reports of olive ridley turtles (*Lepidochelys olivacea*) (Hoge and Rabe, 2008). BOEM does not consult on sea turtles for activities in Alaska.

4.3.7.3. Gulf of Mexico Program Area

Five species of sea turtle may occur within the northern Gulf of Mexico, including the Gulf of Mexico Program Area. These include representatives of two taxonomic families: Cheloniidae (loggerhead, green, hawksbill [*Eretmochelys imbricata*], and Kemp's ridley [*Lepidochelys kempii*]) and Dermochelyidae (leatherback) (USDOC, NMFS, 2015). **Table 4.3.7-1** provides a list of these species, along with their status, life stage, nesting locations, and ESA critical habitats within the Gulf of Mexico Program Area. Critical habitat within and adjacent to the Program Area is shown in **Figure 4.3.7-1**.

Table 4.3.7-1. Sea Turtles Occurring in the Gulf of Mexico Program Area.

Scientific Name	Common Name	Status[1]	Life Stage	States with Nesting Reported Adjacent to Program Area	ESA-Designated Critical Habitat Within and/or Adjacent to Program Area
Caretta caretta	Loggerhead turtle	T[2]	All	TX, LA, MS, AL, FL	Nesting[5], *Sargassum*, Nearshore Reproductive Breeding, Migratory
Chelonia mydas	Green turtle	E, T[3]	All	--[4]	--
Eretmochelys imbricata	Hawksbill turtle	E	All	--[4]	--
Lepidochelys kempii	Kemp's ridley turtle	E	All	TX, MS, AL, FL	--[6]
Dermochelys coriacea	Leatherback turtle	E	All	--[4]	--

[1] Status: E = endangered; T = threatened.
[2] The Northwest Atlantic Ocean distinct population segment (DPS) of the loggerhead turtle is currently classified as threatened (76 FR 58868).
[3] The green turtle is threatened, except for the Florida breeding population, which is endangered (USDOC, NMFS, 2015).
[4] Though green, hawksbill, and leatherback turtles have been documented to nest on rare occasions on Gulf coast beaches, only loggerhead and Kemp's ridley are considered routine nesters.
[5] Within the Gulf of Mexico, terrestrial critical habitat units have been designated for the Northern Gulf of Mexico, Dry Tortugas, and Peninsular Florida Recovery units of the Northwest Atlantic loggerhead turtle DPS along portions of the Mississippi, Alabama, and the west coast of Florida shorelines and the Dry Tortugas (**Figure 4.3.7-1**).
[6] On February 17, 2010, the USFWS and NMFS were jointly petitioned to designate critical habitat for Kemp's ridley turtles for nesting beaches along the Texas coast and marine habitats in the Gulf of Mexico and Atlantic Ocean (http://www.nmfs.noaa.gov/pr/pdfs/petitions/kempsridley_criticalhabitat_feb2010.pdf).

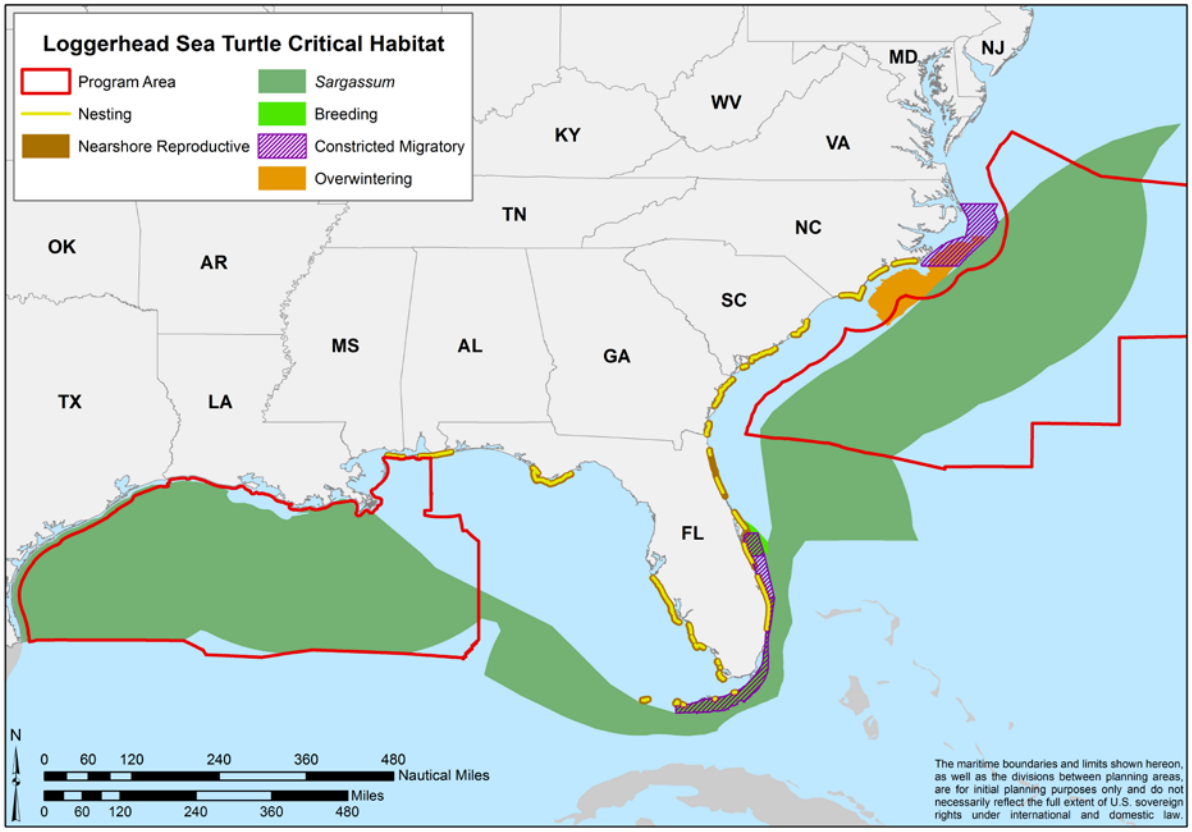


Figure 4.3.7-1. Locations of Designated Marine and Terrestrial Critical Habitat for Loggerhead Turtles in the Atlantic and Gulf of Mexico Program Areas.

The loggerhead turtle is the most common sea turtle species within the Gulf of Mexico Program Area. It is a circumglobal species that is found from tropical to temperate regions. In the Gulf of Mexico, loggerhead turtles nest primarily in southwest Florida with minimal nesting outside of this area westward to Texas. There are designated critical habitats for the Northwest Atlantic Ocean DPS of loggerhead turtle (78 FR 18000), including nesting beaches, coastal areas, and offshore areas of the Gulf of Mexico. Located within or adjacent to the Program Area, these include designated critical habitat units for nesting, nearshore reproductive, breeding, migratory, and *Sargassum* (hatchling developmental) habitats (**Figure 4.3.7-1**).

Green turtles are found throughout the Gulf of Mexico but do not frequently nest on Gulf of Mexico beaches (USDOC, NMFS and USDOI, USFWS, 2007a, 2011). Satellite tagging data indicate that, similar to other sea turtles, green turtles display highly migratory behavior, making vast seasonal coastal and annual transoceanic migrations (Godley et al., 2003, 2008, 2010). Based on satellite tagging research by Hart and Fujisaki (2010), green turtles display daily and seasonal movement patterns associated with foraging strategies. Small juveniles often were found within regions of optimal foraging habitat (e.g., sources of marine algae) suggesting that juvenile greens may be found at higher abundance in various shallow-water inshore areas in the Program Area where macroalgae (seagrass) is reported.

The hawksbill turtle is a circumtropical species distributed mainly in waters between latitudes 30° N and 30° S. Though they regularly occur in the Gulf of Mexico, nesting is rarely reported (USDOC, NMFS and USDOI, USFWS, 2007b, 2013, and 2015). Hawksbill turtles display highly migratory behavior; satellite-tagging data demonstrate short and long migrations from nesting to foraging grounds (USDOC, NMFS and USDOI, USFWS, 2007b; Blumenthal et al., 2009).

The Kemp's ridley turtle is found throughout the Gulf of Mexico (USDOC, NMFS et al., 2010). Survey data from the Gulf of Mexico suggest that Kemp's ridley turtles occur mainly in waters over the continental shelf. The primary habitat for adult Kemp's ridley turtles is within nearshore waters <37 m (121 ft) deep; however, it is not uncommon for adults to swim farther from shore where waters are deeper (USDOC, NMFS and USDOI, USFWS, 2015). Shallow coastal habitats serve as foraging grounds throughout the year, although there is evidence for seasonal offshore movements in response to low water temperatures in the winter (Bjorndal, 1997). Key foraging areas within the Program Area include Sabine Pass, Texas; Caillou Bay and Calcasieu Pass, Louisiana; Big Gulley, Alabama; Cedar Keys, Florida; Ten Thousand Islands, Florida; and Ship Shoal, Louisiana (USDOC, NMFS and USDOI, USFWS, 2007b; Hart et al., 2013, 2014). Similar to other sea turtles, Kemp's ridley turtles display some seasonal and coastal migratory behavior; satellite-tagging data indicate that they transit between nearshore and offshore waters (within 80.5 km [50 mi] of the shore) from spring/summer to fall/winter, which coincides with seasonal water temperature changes (USDOC, NMFS et al., 2010).

The leatherback turtle is found within the Gulf of Mexico and is the most abundant turtle in waters over the northern Gulf of Mexico continental slope (Mullin and Hoggard, 2000; USDOC, NMFS and USDOI, USFWS, 2015), but nesting on Gulf of Mexico beaches is rare. Leatherback turtles appear to use continental shelf and slope waters in the Gulf of Mexico (Fritts et al., 1983a,b; Collard, 1990; Davis and Fargion, 1996). GulfCet I and II surveys suggest that the region from Mississippi Canyon to DeSoto Canyon, especially near the shelf edge, appears to be an important habitat for leatherback turtles (Mullin and Hoggard, 2000).

4.3.7.4. Atlantic Program Area

Five species of sea turtles may occur within the Atlantic Program Area, including representatives of two taxonomic families: Cheloniidae (loggerhead, green, hawksbill, and Kemp's ridley) and Dermochelyidae (leatherback) (USDOC, NMFS, 2015). **Table 4.3.7-2** provides a list of these species, along with their status, occurrence, life stage, nesting locations, and ESA critical habitats within the Atlantic Program Area. Critical habitat within and adjacent to the Atlantic Program Area is shown in **Figure 4.3.7-1**.

Table 4.3.7-2. Sea Turtles Occurring in the Atlantic Program Area.

Scientific Name	Common Name	Status[1]	Life Stage	States with Nesting Reported Adjacent to Program Areas	ESA-Designated Critical Habitat Within and/or Adjacent to Program Areas
Caretta caretta	Loggerhead turtle	T[2]	All	VA, NC, SC, GA, FL	Nesting, Nearshore Reproductive, Breeding, Migratory, Wintering, and *Sargassum*
Chelonia mydas	Green turtle	E, T[3]	All	NC, SC, GA, FL	--[4]
Eretmochelys imbricata	Hawksbill turtle	E	All	--	--[4]
Lepidochelys kempii	Kemp's ridley turtle	E	All	NC, SC, FL	--[5]
Dermochelys coriacea	Leatherback turtle	E	All	NC, SC, GA, FL	--[4]

[1]Status: E = endangered; T = threatened.
[2]The Northwest Atlantic Ocean DPS of the loggerhead turtle is currently classified as threatened (76 FR 58868; USDOC, NMFS, 2011h).
[3]The green turtle is currently threatened, except for the Florida breeding population, which is endangered (USDOC, NMFS, 2011).
[4]Designated critical habitat is not located within the vicinity of the Program Area.
[5]On February 17, 2010, the USFWS and NMFS were jointly petitioned to designate critical habitat for Kemp's ridley turtles for nesting beaches along the Texas coast and marine habitats in the Gulf of Mexico and Atlantic Ocean (http://www.nmfs.noaa.gov/pr/pdfs/petitions/kempsridley_criticalhabitat_feb2010.pdf).

The loggerhead turtle is the most common sea turtle species within the Atlantic Program Area. Loggerhead turtles, like other sea turtles, are highly migratory, making various seasonal and annual migrations (Godley et al., 2003). The southeast U.S. coast is among the most important areas in the world for loggerhead nesting. Approximately 80 percent of loggerhead nesting in this region occurs in six Florida counties: Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward (USDOC, NMFS and USDOI, USFWS, 2008), and extends as far north as Virginia. Loggerhead sea turtles occur year-round in ocean waters off North Carolina, South Carolina, Georgia, and Florida. As coastal water temperatures warm in the spring, loggerhead turtles begin to migrate to inshore waters of the southeast U.S. (e.g., Pamlico and Core Sounds) and also move up the U.S. Atlantic coast (Epperly et al., 1995a,b,c; Braun-McNeill and Epperly, 2004), occurring in Virginia foraging areas as early as April/May and on the most northern foraging grounds in the Gulf of Maine in June (Shoop and Kenney, 1992). The trend is reversed in the fall as water temperatures cool. The large majority leave the Gulf of Maine by mid-September, but some sea turtles may remain in Mid-Atlantic and northeast areas until late fall. By December, loggerhead turtles have migrated from inshore and more northern coastal waters to waters offshore North Carolina, particularly off Cape Hatteras, and waters farther south where the influence of the Gulf Stream provides temperatures favorable to sea turtles (Shoop and Kenney, 1992; Epperly et al., 1995b). Features off North Carolina serve to concentrate juvenile and adult loggerhead turtles, especially those foraging in northern latitudes. Terrestrial and neritic critical habitat designations for loggerhead turtles were finalized on July 10, 2014 (**Figure 4.3.7-1**). Critical habitat designations within or adjacent to the Atlantic Program Area include nesting, nearshore reproductive, breeding, migratory, wintering, and S*argassum* habitats.

The green turtle is a circumglobal species found in the Mediterranean Sea and the Pacific, Indian, and Atlantic Oceans (USDOC, NMFS and USDOI, USFWS, 1991, 2007a). Satellite tagging data indicate that, similar to other sea turtles, green turtles display highly migratory behavior, making vast seasonal coastal and annual transoceanic migrations (Godley et al., 2003, 2008, 2010). In the western North Atlantic, green turtles can be found from Florida to Massachusetts on coastal beaches during the nesting season, and at other times feeding or swimming in nearshore or offshore waters (USDOC, NMFS and USDOI, USFWS, 2007a). Green turtles are vulnerable to cold temperatures, so in many locations within the Atlantic Program Area they are found only seasonally (Foley et al., 2007).

The hawksbill turtle is a circumtropical species limited to waters between latitudes 30° N and 30° S (USDOC, NMFS and USDOI, USFWS, 2007b). Hawksbill turtles display highly migratory behavior; with satellite tagging data demonstrating that these sea turtles display short and long migrations from nesting to foraging grounds (USDOC, NMFS and USDOI, USFWS, 2007b; Blumenthal et al., 2009). In the western North Atlantic, hawksbill turtles can be found from Florida to Massachusetts, but they are rarely reported north of Florida. They have a restricted distribution and range given their preferred habitat for foraging is coral reefs, which are found in near coastal areas to the south of the Atlantic Program Area.

Kemp's ridley turtles are occasionally sighted along the Atlantic coast from Florida to New England (USDOC, NMFS et al., 2010). Similar to other sea turtles, Kemp's ridley turtles display some seasonal and coastal migratory behavior; satellite-tagging data indicate that they transit between nearshore and offshore waters (within 80.5 km [50 mi] of the coastline) from spring/summer to fall/winter, which coincides with seasonal water temperature changes (USDOC, NMFS et al., 2010). The MAB is an important foraging area for juvenile Kemp's ridley turtles during spring through fall. Wintering habitats for Kemp's ridley turtles in the northwestern Atlantic include shelf habitats off Florida and waters south of Cape Hatteras, North Carolina (Gitschlag, 1996).

Leatherback turtles are found throughout the Atlantic Program Area, depending on the season. Along the Atlantic coast, the principal nesting beaches for leatherback turtles are in Florida, although they also have been documented nesting in Georgia, South Carolina, and North Carolina (South Carolina Department of Natural Resource [SCDNR], 2005). In April through June, leatherback turtles are found off South Carolina when cannonball jellyfish (*Stomolophus meleagris*) are abundant, and again in October and November during their fall migration (SCDNR, 2005).

4.3.8. Marine and Coastal Birds

Status, general ecology, general distribution, migratory movements, and abundance of birds are discussed in greater detail in **Appendix C**, Section 7. Avian species within a family share common physical and behavioral characteristics. Because of these commonalities, birds are presented in this document in terms of ecological groups rather than individual species. Common behavioral characteristics within these ecological groups also result in similar potential impacts.

Time periods of vulnerability vary across species and families. Some species may be resident year-round within a single Program Area, such as the brown pelican (*Pelecanus occidentalis*) in the Gulf of Mexico. Other species may migrate through one or more Program Areas over the course of the year, typically by following the Pacific Flyway from Alaska down the west coast, the Atlantic Flyway down the Atlantic coast, or either the Mississippi or Central Flyway. Western sandpipers (*Calidris mauri*), semipalmated sandpipers (*Calidris pusilla*) and dunlin (*Calidris alpina*) are all examples of species that nest in Alaska (and other places) and migrate through or to the Gulf of Mexico in fall/winter. Some other species may be resident for only part of a year in only one of the Program Areas, such as the Arctic tern (*Sterna paradisaea*), which nests in Alaska in summer then migrates to the southern hemisphere for the rest of the year. Arctic terns nesting in other parts of the Arctic may migrate using the Atlantic Flyway, and so pass over or through the Atlantic Program Area.

4.3.8.1. Beaufort and Chukchi Sea Program Areas

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. Few species are present in winter (i.e., snowy owls[*Bubo scandiacus*], ravens, ptarmigans), but multiple species arrive early in the spring, following ice leads that provide access to open water. A total of 45 marine species breed in the Alaskan Arctic. The majority of marine and coastal avian species found in the Arctic are waterfowl, seabirds, and shorebirds. Most nest in coastal tundra and near tundra ponds, although in some locations seabirds occur in large nesting colonies, notably at Cape Lisbourne in the Chukchi Sea and on barrier islands in the Beaufort Sea. A few species of passerines (i.e., buntings, longspurs, warblers and wagtails) regularly occur in coastal and offshore areas during migration and are common breeders along the coastal plain (USDOI, USFWS, 2010). Several areas within the Beaufort and Chukchi Seas have been recognized as Important Bird Areas (IBAs) of global significance by the National Audubon Society.

Sigler et al. (2011) analyzed seabird distribution at sea and found that the north Bering Sea and Chukchi Sea birds form a distinctly separate group from the Beaufort Sea birds. The north Bering-Chukchi region was dominated by planktivorous birds (*Aethia* spp. auklets in the north Bering Sea and *Puffinus* spp. shearwaters in the Chukchi Sea), whereas the Beaufort seabirds were primarily piscivorous, and circumpolar in distribution. Two ESA listed species, spectacled eiders (*Somateria fischeri*) and Steller's eiders (*Polysticta stelleri*), breed in the Arctic, and Ledyard Bay in the Chukchi Sea has been designated critical habitat for spectacled eiders.

4.3.8.2. Cook Inlet Program Area

Marine and coastal habitats of Cook Inlet host a large number of bird species. At least 237 avian species have been recorded in the Kodiak Island Archipelago on the eastern margin of Cook Inlet (MacIntosh, 2009). Birds traveling to and from breeding areas in interior Alaska, the North Slope, and west coast areas of Alaska use Cook Inlet during migration. Annual use patterns of Cook Inlet are characterized by the sudden and rapid arrival of very large numbers of birds in spring, typically in early May, followed by an abrupt departure in mid- to late May. As many as 175,000 shorebirds (primarily Western Sandpipers) regularly occur in Cook Inlet during spring migration (Gill and Tibbitts, 1999). Although fewer species and lower abundances of birds are present in the winter, habitats in Cook Inlet still support significant populations of overwintering birds, notably waterfowl, seabirds, and, most conspicuously, virtually the entire population of the nominate race of rock sandpiper

(*Calidris ptilocnemis*) (Agler et al., 1995; Larned and Zwiefelhofer, 2001; Gill et al., 2002; USDOI, USFWS, 2013).

Marine and coastal birds occurring within and adjacent to the Cook Inlet Planning Area encompass dozens of species that fall into at least 11 orders of seabirds, waterfowl, shorebirds, wading birds, and raptors. Coastal wetlands and bays along Cook Inlet provide important staging habitats for migratory birds, with large seasonal aggregations of waterfowl and shorebirds. Large numbers of seabirds and some waterfowl and shorebirds remain in Cook Inlet and its adjacent coastal areas to breed. Seabird nesting colonies are prominent on multiple small offshore islands and on steep coastal slopes (USDOC, NOAA, 2002).

Numerous IBAs of global significance have been identified by the National Audubon Society within Cook Inlet. Of the sites identified or recognized as IBAs in the Cook Inlet area, Kachemak Bay also has received recognition as a Site of International Importance by the Western Hemisphere Shorebird Reserve Network (WHSRN) as it hosts >100,000 shorebirds on an annual basis (Matz, 2014).

4.3.8.3. Gulf of Mexico Program Area

The northern Gulf of Mexico supports a diverse avifauna and includes a variety of coastal habitats that are important to the ecology of coastal and marine bird species. A broad range of habitats are used at different life and migratory stages. Open-water areas offshore are used for foraging and resting, while nesting occurs in estuarine and marsh habitats as well as beach and dune habitats. Some species (clapper rail[*Rallus crepitans*] and seaside sparrow [*Ammodramus maritimus*]) may spend their lives in small areas in coastal marshes for all their life stages. The northern Gulf of Mexico is also home to many important bird colonies.

The northern Gulf of Mexico is a vitally important migration route and provides important wintering habitat for some bird species. Parts of the Central, Mississippi, and Atlantic Flyways are used by hundreds of millions of migratory birds that converge on diverse coastal and terrestrial habitats along the northern Gulf Coast, where some stay while other continue on to another migratory destination. Birds may continue their migration along the northern Gulf Coast, follow the Mexico-Texas coastline, or cross the Gulf of Mexico between Mexico's Yucatan Peninsula and the Texas coast. For many species such as the white pelican (*Pelecanus erythrorhynchos*), common loon (*Gavia immer*), and a variety of waterfowl and shorebirds, the coastal areas in the northern Gulf of Mexico provide important wintering habitat. Portions of the shoreline in the northern Gulf of Mexico have been designated as critical habitat for wintering threatened and endangered piping plovers (*Charadrius melodus*).

Six distinct taxonomic and ecological groups could be affected by OCS oil and gas activities: passerines, raptors, seabirds, waterfowl, shorebirds, and wetland birds. Seabirds, waterfowl, shorebirds, and wetland birds depend on marine and coastal habitats (such as beaches, mud flats, salt marshes, coastal wetlands, and embayments), and these birds have the greatest potential for being impacted by OCS-related oil and gas development activities.

Listed under the ESA are seven species of marine and coastal birds present within the northern Gulf of Mexico. Five are found in habitats within the Western and Central Planning Areas where they could be affected by OCS oil and gas activities (Mississippi sandhill crane [*Grus canadensis pulla*], piping plover, red knot [*Calidris canutus*], whooping crane [*Grus americana*] and wood stork [*Mycteria americana*]). Two species are exclusive to Florida (Eastern Planning Area), in areas where they could be affected by a catastrophic oil spill but not by normal OCS oil and gas operations (Cape Sable seaside sparrow [*Ammodramus maritimus mirabilis*] and roseate tern [*Sterna dougallii*]).

4.3.8.4. Atlantic Program Area

The Atlantic Planning Areas and adjacent shorelines support a diversity of avifauna and include a variety of coastal habitats that are important to the ecology of coastal and marine bird species for breeding, foraging, and wintering. Within the Atlantic Planning Areas, there are resident and migratory species of marine and coastal birds, encompassing 30 taxonomic families and 14 orders. Coastal and marine birds most likely to be impacted by OCS activities are seabirds (gulls and terns, cormorants, frigatebirds, gannets, boobies, tropicbirds, cormorants, petrels, storm-petrels, and shearwaters), waterfowl (loons, grebes, sea ducks), shorebirds (sandpipers, plovers, oystercatchers, and stilts), and wetland birds (egrets, herons, storks, ibises, spoonbills, cranes, and rails). There are five ESA-listed marine and coastal bird species in the Atlantic Region: the Bermuda petrel (*Pterodroma cahow*), piping plover, red knot, roseate tern, and wood stork.

Many species of migrant marine and coastal birds (as well as terrestrial birds) use the Atlantic Flyway, a migratory route that extends from the offshore waters of the Atlantic Coast west to the Allegheny Mountains, and then continues across the prairie provinces of Canada and the Northwest Territories to the Arctic coast of Alaska. The coastal route of this flyway originates in the eastern Arctic islands and the coast of Greenland, and generally follows the shoreline along the Atlantic Coast (http://www.birdnature.com/flyways.html) (Brown et al., 2001; Morrison et al., 2001). Disturbance along the shoreline where the migrating birds forage can cause additional energy requirements for migrating birds (Helmers, 1992). There is an additional route termed the North Atlantic or Shorebird Route that is exclusively oceanic and passes directly over the Atlantic Ocean from Labrador and Nova Scotia to the Lesser Antilles, continuing on to South America (Rappole, 1995). This route is followed by thousands of birds, including some shorebirds that nest on the Arctic tundra, fly across Canada to the Atlantic coast, and follow this oceanic course to South America (http://www.birdnature.com/flyways.html) (Morrison et al., 2001).

4.3.9. Fish and Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (FCMA) (16 U.S.C. § 1801-1882) established regional Fishery Management Councils (FMCs) and mandated that Fishery Management Plans (FMPs) be developed to responsibly manage exploited fish and invertebrate species in U.S. waters. When Congress reauthorized the FCMA in 1996 as the Sustainable Fisheries Act (SFA), several reforms and changes were made. Among the changes, NMFS was required to designate and conserve EFH for species managed under existing FMPs. EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity” (16 U.S.C. § 1801[10]). NMFS published the final rule implementing the EFH provisions of the SFA (50 CFR part 600) on January 17, 2002. The rule included guidance to regional FMCs for identifying and defining EFH, clarified the intent of key terms, and required that federal agencies consult with NMFS when planning or authorizing activities that may adversely affect EFH. BOEM consults with NMFS regarding such activities and implements measures to avoid, minimize, or mitigate impacts to EFH when appropriate.

The broad definition of EFH is useful for drawing management attention to the potential effects of human activities on coastal and marine environments. The additional designation of HAPC is used by NMFS and the regional FMCs to increase focus on specific areas for purposes of research and conservation efforts, but does not confer specific protections or restrictions. HAPC designation and review processes vary by region, and discrete areas or habitat types may be selected for very different reasons. However, HAPCs also may serve as a mechanism for highlighting certain areas for greater scrutiny during the consultation process and for specific impact analyses. A complete description of the affected environment for fishes and EFH is provided in **Appendix C**, Section 8.9.

Many fish species are known to make wide-ranging seasonal movements and may not be present in an individual Program Area year-round. For example, bluefin tuna (*Thunnus thynnus*) are present during the summer in the Atlantic Program Area but migrate east and south depending on population. Other highly migratory species, such as the great white shark (*Carcharodon carcharias*), make large-scale migrations with no known correlation to seasonal changes. In the Gulf of Mexico Program Area, species such as the hammerhead shark (*Sphyrna* spp.) and whale shark (*Rhincodon typus*) can be exposed to impacts from oil and gas development in the program area and in waters of adjacent nations.

4.3.9.1. Beaufort and Chukchi Sea Program Area

BOEM divides the Beaufort and Chukchi Seas into two planning areas. Fish resources in both are managed under two FMPs: the Arctic Management Area (NPFMC, 2009) and the Salmon Fisheries in the EEZ off Alaska (NPFMC, 2009; USDOC, NMFS and Alaska Department of Fish and Game [ADFG], 2012). The Arctic FMP encompasses all marine waters in the U.S. EEZ within the Chukchi and Beaufort Seas. The western boundary is demarcated by the 1990 U.S./Russia maritime boundary line, and the eastern limit is the U.S./Canada maritime boundary bisecting the Beaufort Sea (NPFMC, 2009). Both FMPs and descriptions of the boundaries can be found on the NPFMC website (http://www.npfmc.org/). The Arctic FMP governs commercial fishing for all stocks of finfish and shellfish in federal waters except for Pacific salmon (*Oncorhynchus* spp.) and Pacific halibut (*Hippoglossus stenolepis*). These species are managed under the Salmon FMP and the International Pacific Halibut Commission, respectively (NPFMC and USDOC, NMFS, 1990).

Commercial fishing is not permitted in federal waters of the Beaufort and Chukchi Seas, but fishery species are present in these waters and EFH has been designated for several fishes and one species of crab (**Figure 4.3.9-1**) (NPFMC, 2009). According to the Arctic FMC and NMFS, there has been no new information indicating that commercial fisheries could be supported in the Arctic Ocean and no reason to initiate a planning process for commercial fishery development (NPFMC, 2009). EFH is described for Arctic cod (*Boreogadus saida*), saffron cod (*Eleginus gracilis*), and snow crab (*Chionoecetes opilio*) in the Arctic FMP (NPFMC, 2009), and for chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), pink (*O. gorbuscha*), sockeye (*O. nerka*), and chum (*O. keta*) salmon in the Salmon Fisheries FMP (NPFMC, 2012). There are no ESA-listed fish or shellfish species in the Arctic Program Areas.

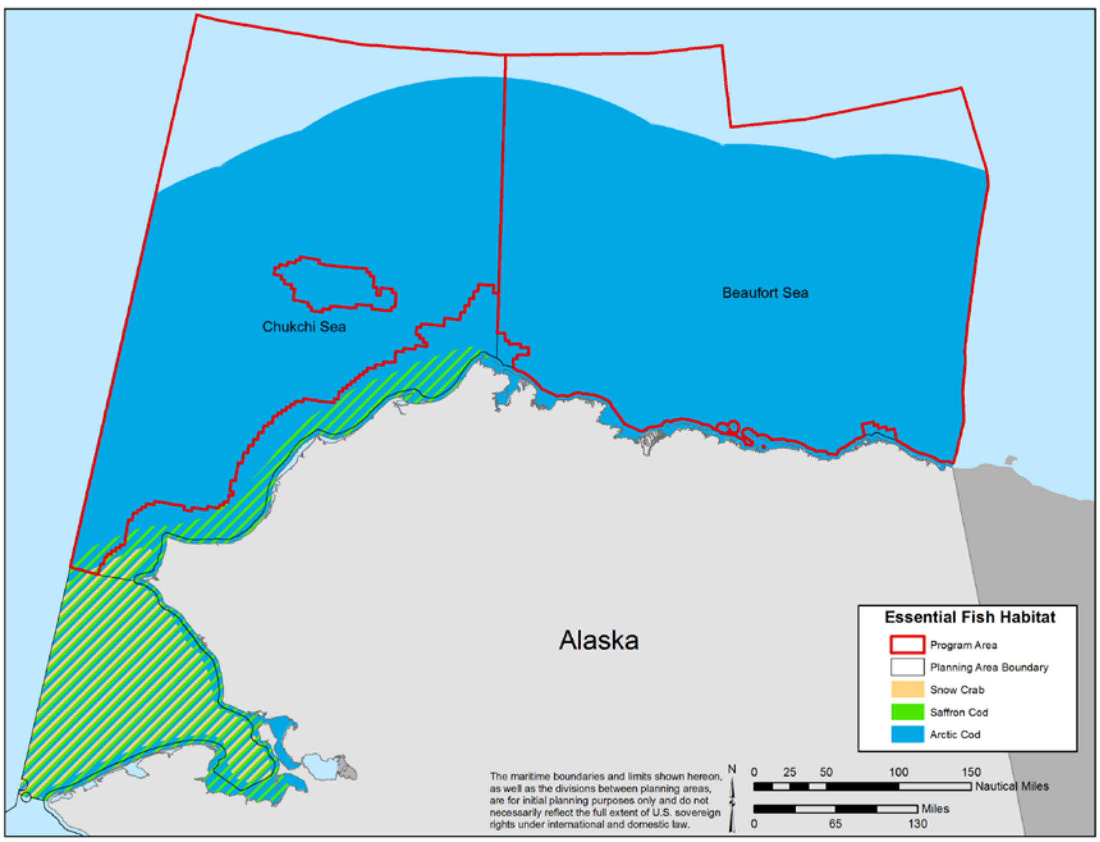


Figure 4.3.9-1. Distribution of Essential Fish Habitat (EFH) in and Around the Arctic Program Areas.

Based on the distribution of adult and juvenile saffron cod, EFH includes coastal waters and nearshore bays of the Chukchi Sea; Arctic cod EFH encompasses most pelagic and epipelagic waters in the Arctic Planning Areas (NPFMC, 2009). A small portion of saffron cod EFH overlaps with the Chukchi Sea Planning Area in the southwest; the remaining saffron cod EFH in the Arctic falls within a Presidential withdrawal. NPFMC determined there was insufficient information to designate EFH for early life stages of these species (NPFMC, 2009). Designated adult and juvenile snow crab EFH includes muddy bottom habitats of the inner and middle continental shelf (0 to 100 m [0 to 328 ft] depth) south of Cape Lisburne, Alaska. A very small area of snow crab EFH extends into the southwest portion of the Chukchi Sea Planning Area (NPFMC, 2009). EFH for the five species of Pacific salmon in the Beaufort and Chukchi Program Areas, as described in the Salmon FMP, includes all marine waters within the EEZ off the coast of Alaska (NPFMC, 2012).

4.3.9.2. Cook Inlet Program Area

The Program Area (**Figure 4.3.9-2**) includes the upper boundaries of Cook Inlet, Alaska. Stock Assessment and Fishery Evaluation Reports that support the FMPs and fishing regulations within Cook Inlet are available on the NMFS Alaska Fisheries Science Center website. FMPs applicable to Cook Inlet include the Gulf of Alaska (GOA) Groundfish FMP, Scallop FMP, and Salmon FMP.

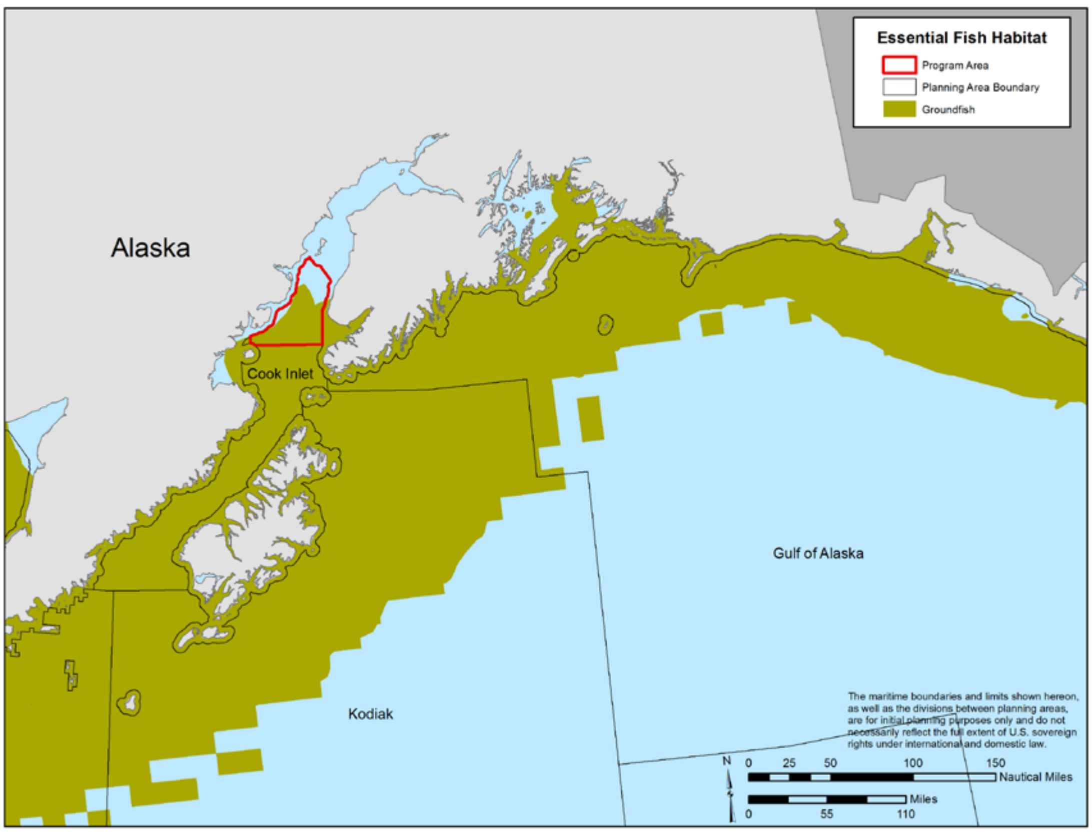


Figure 4.3.9-2. Distribution of Groundfish EFH in and Around the Cook Inlet Program Area.

The GOA Groundfish FMP covers all commercial finfish except salmon (*Oncorhynchus* spp.), Pacific halibut, and Pacific herring (*Clupea pallasii*). Species taken within the groundfish fishery are categorized as target species and ecosystem components by the NPFMC (2015). Target species are those that support single species or mixed species fisheries, are commercially important, and for which there is sufficient information available to manage each species based on its own biological merits. Ecosystem components include two elements: prohibited species and forage fish. Prohibited species must be avoided by fishers targeting groundfish and, if caught, must immediately be released to minimize injury. Forage fish are those species that are a critical food source for marine mammals, seabirds, and other fishes.

Species groups managed under the GOA Groundfish FMP are listed in **Appendix C**; Table 8.1-2. Life stage-specific EFH has been designated for managed species whenever sufficient data were available; EFH was not designated for sharks, octopus, or forage fish due to insufficient information (NPFMC, 2015). Descriptions of groundfish habitats are provided in the 2015 GOA Groundfish FMP. Most marine habitats within the Cook Inlet Program Area have been identified as EFH (**Figure 4.3.9-2**). Within Cook Inlet, non-pelagic trawling is prohibited to reduce crab bycatch and assist in the rebuilding of crab stocks (**Appendix C**; Figure 8.1-3) (NPFMC, 2015).

Weathervane scallops (*Patinopecten caurinus*) are widely distributed from California to the Bering Sea, inhabiting waters ranging in depth from the intertidal to approximately 300 m (985 ft). EFH has been designated only for late juvenile and adult life stages, and includes clay, mud, sand, and gravel substrates to a depth of 200 m (656 ft) (NPFMC, 2014). A small portion of the designated EFH lies within the Cook Inlet Program Area. Most, if not all, weathervane scallop EFH in the Cook Inlet Program Area and GOA coincides with areas also designated as groundfish EFH. Pacific salmon EFH, as described in the Salmon FMP, includes all marine waters within the EEZ off the coast of Alaska (NPFMC, 2012).

There are no HAPCs identified within Cook Inlet (NPFMC, 2015). The Alaska Seamount Habitat Protection Areas and GOA Coral Protection Areas are the closest designated HAPCs within Alaskan EEZ, and are located approximately 416 km (225 nmi) from the entrance of Cook Inlet. There are no listed species in the Cook Inlet Program Area.

4.3.9.3. Gulf of Mexico Program Area

More than 150 rivers empty out of North America into the Gulf of Mexico, delivering freshwater and sediment into coastal waters (Gore, 1992). These mixing zones are areas of high productivity, especially in waters on the continental shelf that are heavily influenced by the Mississippi and Atchafalaya Rivers. The Loop Current and its associated eddies create a dynamic zone, with strong divergences and convergences that concentrate and transport plankton, including eggs and larvae of coastal and oceanic species.

Fishery resources within the Program Area include 182 species managed under 7 FMPs. Species are grouped as follows: reef fish (31), coastal migratory pelagic fish (3), red drum (1), shrimp (4), spiny lobster (1), and corals (142). Migratory pelagic fish species are jointly managed by the Gulf of Mexico Fishery Management Council (GMFMC) and the SAFMC. In addition to these FMPs, 39 highly migratory species (HMS) (i.e., tunas, billfishes, sharks, and swordfish) occurring in the Gulf of Mexico are managed by the HMS Management Unit, Office of Sustainable Fisheries, NMFS. EFH for managed fisheries is described in the respective FMPs, but collectively encompass the entire EEZ of the Gulf of Mexico.

Designated HAPCs include the East and West Flower Garden Banks, Stetson Bank, Rankin Bank, Bright Bank, 29 Fathom Bank, 28 Fathom Bank, MacNeil Bank, Geyer Bank, McGrail Bank, Sonnier Banks, Alderdice Bank, and Jakkula Bank; in Florida, they are Madison-Swanson, Steamboat Lumps, Florida Middle Grounds, Pulley Ridge, and Tortugas Ecological Reserve.

The Proposed Action area includes critical habitat for three endangered fish species managed by NMFS and the USFWS under the ESA. Smalltooth sawfish (*Pristis pectinata*) and largetooth sawfish (*Pristis pristis*) of the Family Pristidae are members of the cartilaginous class of fishes (Chondrichthyes). Gulf sturgeon (*Acipenser oxyrinchus desotoi*) is a member of Family Acipenseridae of the ray-finned fishes (Class Actinopterygii).

4.3.9.4 Atlantic Program Area

The Atlantic Program Area (**Figure 2.1-3**) covers a broad geographic and bathymetric region that supports diverse assemblages of fish and invertebrate resources. NMFS is responsible for managing the fisheries with advice from four regional FMCs. Primary responsibility for developing recommendations lies with the SAFMC and the MAFMC. Both councils have developed joint FMPs to manage fishery resources shared with the neighboring GMFMC and New England Fishery Management Council (NEFMC), respectively. In addition to the FMPs prepared by these councils, HMS are managed by the HMS Management Unit, Office of Sustainable Fisheries, NMFS. Although fishery management units differ in the various regions, Atlantic species may be generally grouped as: bivalves, shrimps, crabs, *Sargassum*, squids, reef fishes, coastal pelagic fishes, and HMS. These groupings encompass a range of habitat preferences best addressed through detailed regional and site-specific analyses.

As with the other Program Areas, the combined EFH designated for fishery species broadly overlaps the EEZ. Within the designated EFH, HAPCs are also identified. HAPCs in the Atlantic Program Area include many coastal habitats (e.g., seagrass habitat and coastal inlets); state-designated nursery grounds; nearshore hard bottom areas; medium- to high-profile offshore hard bottoms; localities of known or likely periodic spawning aggregations; pelagic and benthic *Sargassum*; all hermatypic coral habitats and reefs; and council-designated Artificial Reef Special Management Zones (SAFMC, 1998). Specific areas include The Point, Georgetown Hole, Hoyt Hills, Cape Fear *Lophelia* Banks, and Blake Ridge Diapir (SAFMC, 1998). The majority of SAFMC-designated HAPCs do not fall within the Program Area; MAFMC and NMFS have not designated HAPCs.

Two listed species occur within the Mid-Atlantic and South Atlantic Planning Areas, the shortnose sturgeon (*Acipenser brevirostrum*) and Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Both species ranges are throughout the Atlantic basin extending from the St. Johns River, Florida to Hamilton Inlet, Labrador.

4.3.10. Areas of Special Concern

Areas of Special Concern are essentially analogous to marine protected areas and include federally managed areas (e.g., Marine Protected Areas [MPAs], National Marine Sanctuaries [NMSs], National Parks, NWRs), and areas that have been given special designations by federal and state agencies (e.g., National Estuarine Research Reserves [NERRs], national estuary program sites, and state-designated MPAs). MPAs are designed to achieve a variety of goals generally falling within six categories: conservation of biodiversity and habitat, fishery management, research and education, enhancement of recreation and tourism, maintenance of marine ecosystems, and protection of cultural heritage. MPAs are created by a specific federal, state, or tribal entity, which receives its authority from a statute or treaty; MPAs are not the same as the EIAs discussed in this document, although there may be some overlap. Because MPAs focus specifically on the protection of habitat and specific biological and cultural resources while providing appropriate and compatible recreational opportunities, the impacts to these categories will be discussed in their respective sections. This fulfills the requirement that each "federal agency whose actions affect the natural or cultural resources that are protected by an MPA shall identify such actions. To the extent permitted by law and to the maximum extent practicable, each federal agency, in taking such actions, shall avoid harm to the natural and cultural resources that are protected by an MPA. In implementing this section, each federal agency shall refer to the MPAs identified under subsection 4(d) of this order [i.e., the National System of MPAs]" (Executive Order [E.O.] 13158 Section 5).

Areas of Special Concern are discussed in detail in **Appendix C**, Section 9, and shown by region in **Figures 4.3.10-1** through **4.3.10-3**. Tables provided in **Appendix C**, Section 9 refer to the identification of MPAs within the scope of potential impacts from the Proposed Action, whether they are listed as a member of the National System of MPAs, or an EIA overlaps an MPA. Where appropriate, the respective sections discuss where pertinent analysis is carried out relevant to the Proposed Actions' effects on the natural or cultural resources protected by an MPA.

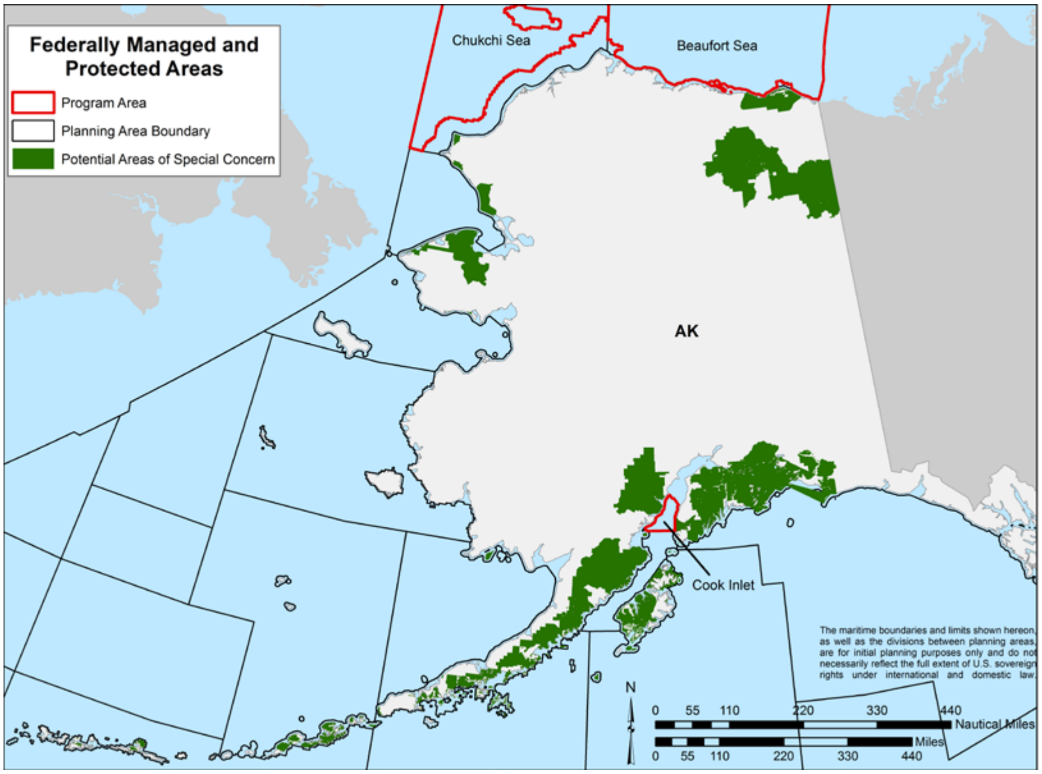


Figure 4.3.10-1. Federally Managed and Protected Areas in Alaska.

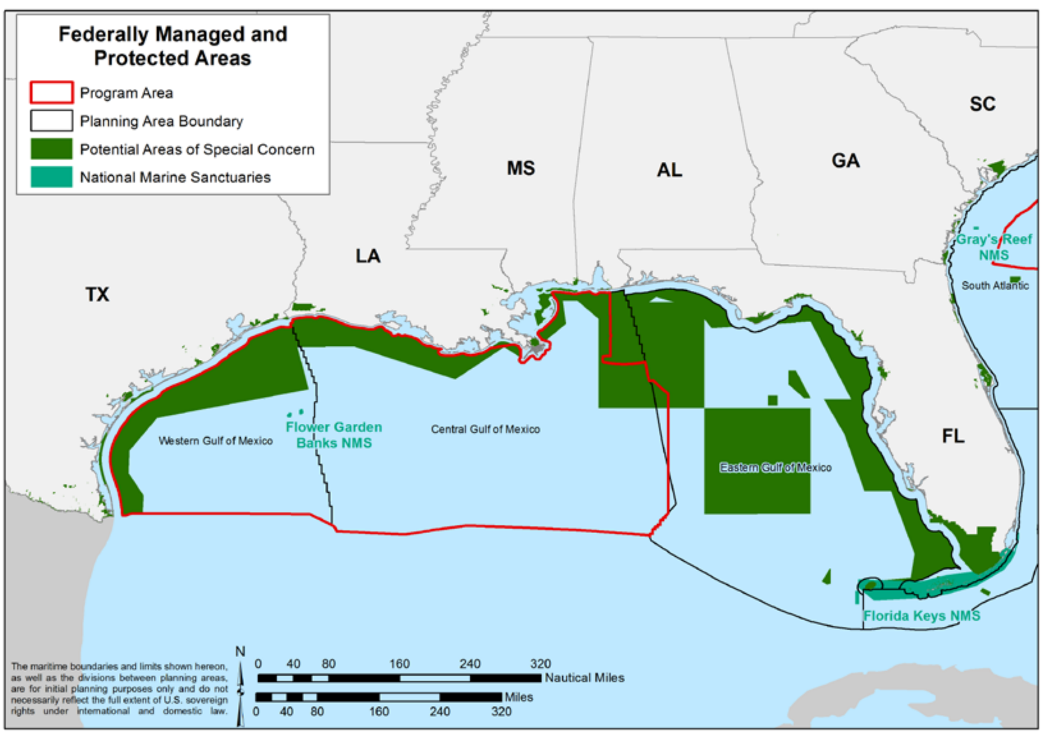


Figure 4.3.10-2. Federally Managed and Protected Areas in the Gulf of Mexico.

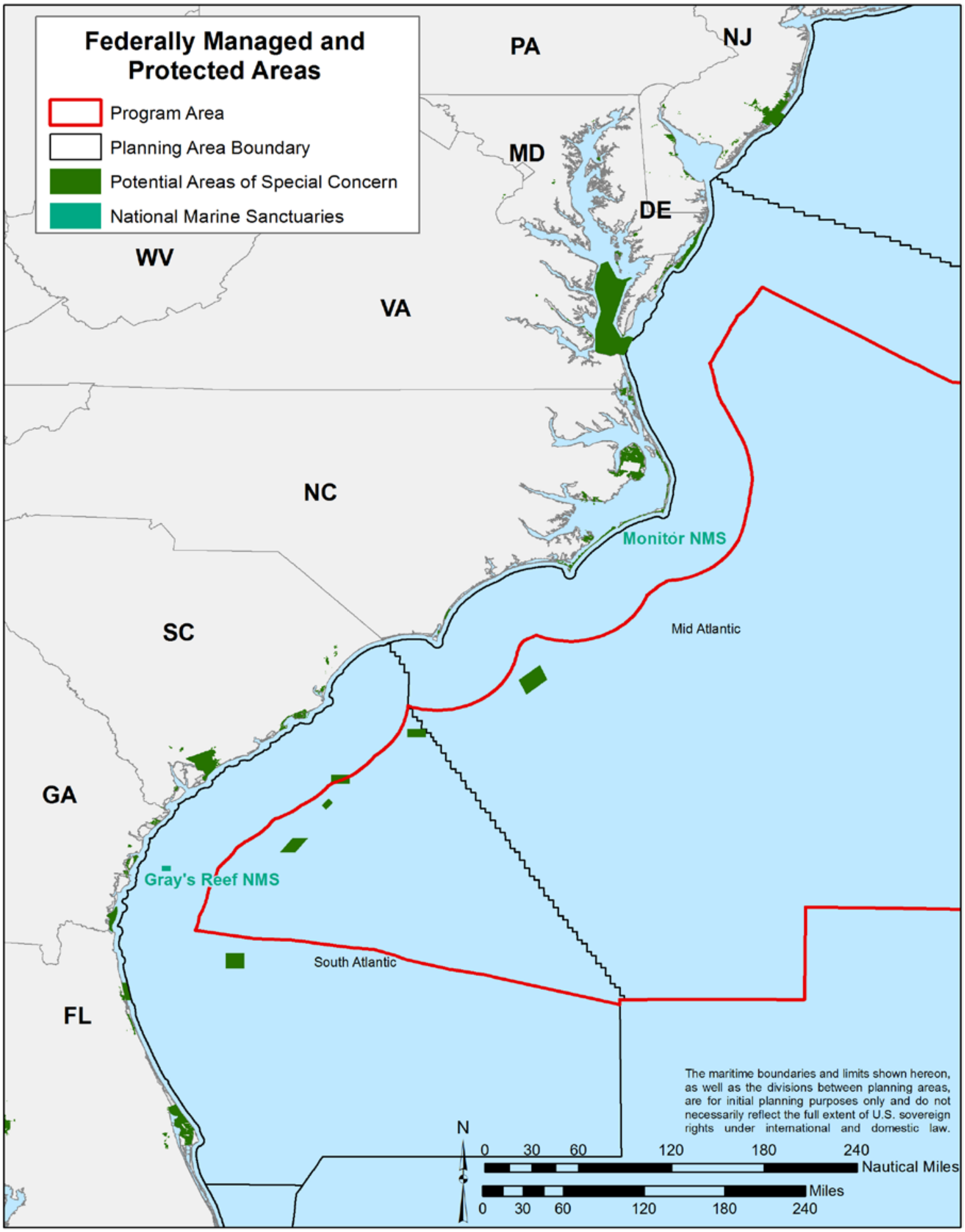


Figure 4.3.10-3. Federally Managed and Protected Areas in the Atlantic.

NMSs were withdrawn for an indefinite period of time from consideration for oil and gas leasing by Executive Order, first in 1998, with continuation in 2008. These areas are identified in **Figures 4.3.10-1** through **4.3.10-3**.

4.3.11. Archaeological and Historical Resources

Archaeological resources are defined as any material remains of human life or activities that are at least 50 years of age and are of archaeological interest (30 CFR 550.105). By the careful scientific study of archaeological sites, features, and artifacts, archaeologists are able to extract information capable of providing an increased understanding of cultural information such as past human behavior, cultural adaptation, and related topics. Significant archaeological resources are those that meet the criteria of significance and integrity for eligibility on the National Register of Historic Places (National Register), as defined in 36 CFR 60.4. Historical resources are a broader category that may include archaeological resources (if they pertain to the post-contact period), but for this analysis, are generally considered built structures or landscapes that meet the requirements of significance and integrity for eligibility on the National Register. Detailed information for archaeological and historic resources is provided in **Appendix C**, Section 10.

BOEM has funded multiple studies in the Gulf of Mexico, Atlantic, Pacific, Arctic, and Cook Inlet Planning Areas to assess the potential for these cultural resources based on archaeological, geological, and historical research. BOEM maintains regional databases of reported shipwreck losses as well as those resources found through oil and gas industry- and BOEM-funded surveys. The majority of offshore archaeological resources within the planning areas are shipwrecks; onshore archaeological resources include pre- and post-contact sites (pre- and post-contact sites for this discussion refer to periods before or after nonindigenous contact was first made with the peoples inhabiting the North American continent).

Based on BOEM's analysis and more than 30 years of experience managing impacts to archaeological resources on the OCS, there are thousands of shipwrecks that are located on or under the seafloor of the OCS. Because of the mobility of watercraft, combined with the unknown nature of how most were lost (e.g., fire, storm, war), it is impossible to reliably predict where a shipwreck might be located on the OCS. At the programmatic level, analysis of impacts to archaeological and historical resources will not assist the decision-maker in making a reasoned decision among the alternatives. BOEM is unable to assess where an archaeological or historic resource is located on the OCS prior to conducting site-specific archaeological surveys; therefore, environmental analysis of impacts to archaeological and historical resources from oil and gas activities is premature at the planning level (programmatic and leasing phases). This analysis will be carried out at the project level (exploration, development and production, and decommissioning phases).

The remaining discussion of the affected environment in this section will describe, in a general manner, the nature of expected archaeological and historical resources, without distinction for planning area or regional differences. Archaeological resources on the OCS mostly comprise post-contact shipwrecks. For example, in the last 7 years, oil and gas surveys in the Gulf of Mexico, covering 737 whole or partial lease blocks, have located more than 2,500 potential shipwreck sites based on magnetic or acoustic signatures within survey data; 68 have been confirmed. Proper study and analysis of shipwreck sites on the OCS can provide unique insights into local, regional, national, and global cultural patterns, in addition to enhancing understanding of our shared past, that may not have survived in written or oral tradition. Several significant shipwreck sites located in recent years include casualties from the U-boat campaign during WWII (both German and Allied vessels), and early 19th century armed sailing vessels that carried a mixed cargo of weapons and wares from the Yucatan peninsula.

There is also the potential in certain offshore areas for the preservation of pre-contact archaeological sites; such sites would have been located in terrestrial areas exposed during the last ice age or glacial maximum, when sea level was as much as 120 m (394 ft) lower than it is today; these areas were subsequently submerged during sea level rise as the glaciers melted and retreated. Fishers have periodically found pieces of extinct North American megafauna and stone tools entangled in their nets and other gear, but associated archaeological sites are extremely difficult to find, even using current state-of-the art survey technologies. BOEM currently is funding several studies to advance the scientific methods needed to locate submerged and buried pre-contact archaeological sites. BOEM's survey guidelines continue to be informed by current scientific standards, that, when used appropriately, can be used to locate certain relict landforms that might have survived sealevel rise over the last 19,000 years, and were formerly suitable for human habitation.

An important point of consideration when discussing archaeological resources, especially those in a submerged and underwater marine environment, is that these resources are remnants or vestiges of past cultural activity. All archaeological sites go through taphonomic (site formation) processes, where each site is impacted by anthropogenic and/or natural forces until it comes into an equilibrium with its environment (**Figure 4.3.11-1**). Once equilibrium is reached, deterioration slows and sites can be preserved for hundreds and, in rare cases, thousands of years.

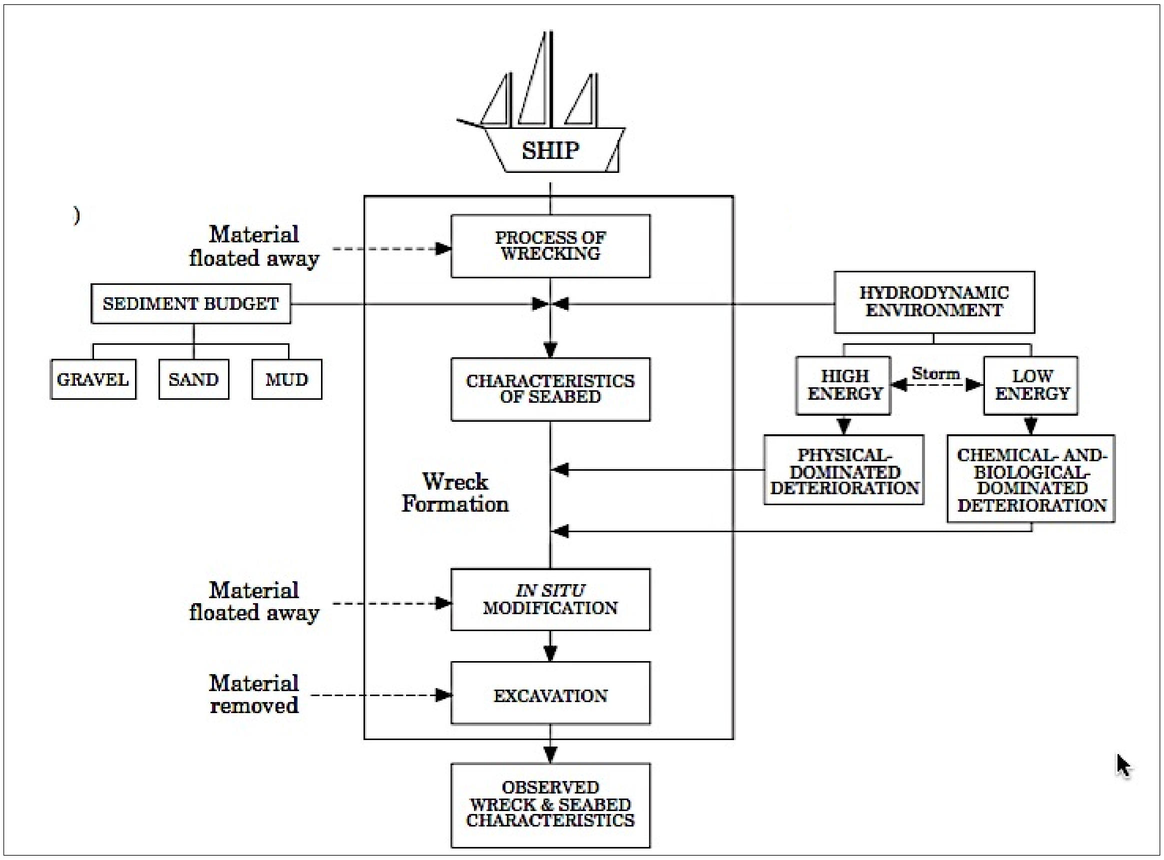


Figure 4.3.11-1. Site Formation Processes for a Shipwreck (Ward et al., 1999).

Significance of these resources does not lie in their integrity of preservation, but in the cultural data that can be extracted through the use of archaeological methods and analyses; any disturbance of these sites can result in the irretrievable loss of data, and changes to the equilibrium of a site could result in long-term changes to the site's integrity.

Onshore archaeological and historic resources occur adjacent to all of the Program Areas. These resources are under the jurisdiction of state or federal land management agencies and include pre- and post-contact archaeological sites as well as historical built structures, and districts that are eligible for listing on the National Register. Some examples of these types of resources are lighthouses, coastal fortifications, stone formations, fish weirs, houses, and other built structures that have viewsheds or other associations with the sea.

4.3.12. Population, Employment, and Income

Table 4.3.12-1 presents data from Woods and Poole Economics, Inc. (2015) regarding the total projected population, employment, and associated labor income in 2015 for the states that would be most impacted by offshore oil and gas activities. In the Gulf of Mexico, Texas and Florida have the largest overall economies, followed by Louisiana, Alabama, and Mississippi. Most Atlantic states (including Pennsylvania, Georgia, and North Carolina) have high levels of population, employment, and labor income[1]. Alaska is more sparsely populated and supports lower overall employment and labor income than states in other regions. Additional information regarding the affected Program Areas is discussed in the individual Program Area sections as well as in **Appendix C**, Section 11.

Table 4.3.12-1. Projected 2015 Population, Employment, and Income.

States	Population	Employment	Labor Income ($ thousands)
Alaska	751,202	476,579	29,233,310
Gulf of Mexico			
Texas	27,248,258	16,155,163	876,375,805
Florida	20,061,019	10,962,178	480,580,846
Alabama	4,891,849	2,617,784	115,565,858
Louisiana	4,684,193	2,711,651	130,849,456
Mississippi	3,027,545	1,580,515	64,070,075
Atlantic			
Pennsylvania	12,850,286	7,506,036	401,752,242
Georgia	10,227,011	5,694,742	273,623,900
North Carolina	10,092,539	5,646,851	268,581,289
New Jersey	8,976,940	5,235,585	321,349,753
Virginia	8,447,176	5,074,828	282,020,631
Maryland	6,028,489	3,585,733	206,911,746
South Carolina	4,876,893	2,582,008	112,407,845
Delaware	943,375	560,874	31,281,454

From: Woods and Poole Economics, Inc. (2015).

4.3.12.1. Beaufort and Chukchi Sea Program Areas

The NSB is adjacent to the Beaufort and Chukchi Sea Program Areas. It had an estimated 9,703 residents[2], representing <1 percent of Alaska's total population, in 2014. The majority of its residents are Alaska Natives, mostly Iñupiat. The borough's population grew at an average annual rate of approximately 0.7 percent, a little lower than the state's growth rate of 0.9 percent, from 2010 to 2014 (U.S. Census Bureau, 2015). As of 2010, approximately 75 percent of employed residents worked for the NSB and other government entities, native corporations, and similar organizations. A large percentage of the labor force is unemployed, under-employed, or "discouraged" — not actively seeking employment (NSB, 2011). North Slope oil field workers usually are scheduled for week-on-week-off or longer

[1] Although not adjacent to the Atlantic Program Area, Pennsylvania, Delaware, and New Jersey are included in this analysis because of potential effects on the human environment in those states. Refineries in these states along the Delaware River are the closest refineries capable of using a range of crude oils as feedstock and, therefore, could be the recipients of any oil produced on the Atlantic OCS. In addition, Pennsylvania has a developed an onshore oil and gas industry that could expand to provide workers, goods, and services for OCS operations.

[2] For consistency, the description of the affected environment for Alaska uses U.S. Census Bureau population statistics. The North Slope Borough's Economic Profile and Census Report (2010) shows a total borough population of 7,998.

on-off-duty rotations. The vast majority of these workers commute from outside the area, and are housed in worker enclaves located onshore, on drilling ships, or on offshore production facilities while on duty. A large proportion of these workers live in south-central Alaska in the Kenai Peninsula Borough (KPB), the Municipality of Anchorage (MoA), or the Matanuska-Susitna (Mat-Su) Borough.

4.3.12.2. Cook Inlet Program Area

Cook Inlet is adjacent to or near south-central Alaska, which contains the most heavily populated communities in the state and historically has supplied workers for oil and gas activities in Cook Inlet state waters. Therefore, much of any employment resulting from new Cook Inlet activities is likely to be among residents of that nearby area. South-central Alaska grew at an average annual rate of 1.5 percent between 2000 and 2009 with an estimated annual rate of growth slightly >1.1 percent between 2010 and 2014, to an estimated 456,369 individuals, or approximately 60 percent of Alaska's total population. Within the region, recent annual population growth has been higher in the Mat-Su Borough located north of the Cook Inlet Program Area, with annual growth of 2.4 percent (10 percent total) between 2010 and 2014, although growth has slowed from >4 percent per year over the previous two decades (U.S. Census Bureau, 2015).

4.3.12.3. Gulf of Mexico Program Area

Table 4.3.12-2 presents data from Woods and Poole Economics, Inc. (2015), regarding the total projected population, employment, and associated labor income in 2015 for the Gulf coastal regions of each state; these Gulf coastal regions correspond to the 133 near-coastal counties and parishes in the BOEM-defined Gulf of Mexico Economic Impact Area. The Gulf coastal zone supports high levels of population, employment, and labor income in many areas, such as near Houston (Texas), New Orleans (Louisiana), and Tampa (Florida).

Table 4.3.12-2. Projected 2015 Population, Employment, and Labor Income in Gulf Coastal Regions.

States	Population	Employment	Labor Income ($ thousands)
Coastal Texas	9,399,497	5,378,314	328,994,955
Coastal Florida	8,748,653	4,448,697	187,122,278
Coastal Louisiana	3,466,529	2,069,738	103,307,467
Coastal Alabama	736,626	389,937	15,735,439
Coastal Mississippi	511,176	252,391	10,818,240

From: Woods and Poole Economics, Inc. (2015).

The Gulf of Mexico has an extensive existing offshore oil and gas industry. While this industry receives economic contributions from many areas, the largest concentrations of offshore oil and gas companies and supporting activities are near Houston, Texas and in coastal Louisiana. Quest Offshore Resources Inc. (2011) provides more information regarding the Gulf of Mexico offshore oil and gas industry. For example, this report estimates that the Gulf of Mexico offshore oil and gas industry supported 215,400 jobs and yielded $21.8 billion in GDP in the five Gulf states in 2009. The Gulf of Mexico also supports large tourism, fishing, and marine transportation industries.

4.3.12.4. Atlantic Program Area

As shown in **Table 4.3.12-1**, the Atlantic states generally support high levels of population, employment, and income. Among the many major population and employment centers along the Atlantic coast or major waterways are Camden (New Jersey), Baltimore (Maryland), Philadelphia (Pennsylvania), Wilmington (Delaware), Washington D.C., Norfolk/Virginia Beach (Virginia), Wilmington (North Carolina), Charleston (South Carolina), Savannah (Georgia), and Jacksonville (Florida). Atlantic coastal areas support many industries, including tourism, fishing, and shipping. No offshore oil and gas development or production currently occurs in the Atlantic. In addition, most Atlantic states (except Pennsylvania) do not have expansive upstream onshore oil and gas industries. However, the diverse economies in the Atlantic region should help support potential offshore oil and gas development. Dismukes (2014) provides more information regarding the potential for existing Atlantic infrastructure to support the various facets of offshore oil and gas activities. **Section 4.3.13.4** also presents information regarding the existing Atlantic oil and gas infrastructure. The USEIA (2015) provides more information regarding each Atlantic state's energy supply and demand.

4.3.13. Land Use and Infrastructure

4.3.13.1. Beaufort and Chukchi Sea Program Areas

The Beaufort and Chukchi Seas are located in the U.S. Arctic region and are characterized by extreme remoteness, long Arctic winters, and very low population densities. Only the Beaufort Sea Program Area has a well-developed oil and gas industry infrastructure from operations onshore and in state waters.

Land use in the Beaufort and Chukchi Program Areas consists primarily of subsistence use activities and oil and gas activities around Prudhoe Bay. Various federal agencies oversee large amounts of land in the U.S. Arctic, including the Arctic NWR, Gates of the Arctic National Park, and the National Petroleum Reserve in Alaska. These areas are described in **Appendix C**, Section 9. Less than 1 percent of charted navigationally significant Arctic waters have been surveyed with modern technology to determine depth and depict hazards to navigation.

Oil and Gas Infrastructure

Oil and gas infrastructure occurs intermittently along the Arctic coast from the northeast corner of the National Petroleum Reserve in Alaska 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.

There are no harbors of refuge or deepwater port facilities in the Arctic and virtually no aids to navigation. The amount of available infrastructure in the Beaufort and Chukchi Sea Program Areas is minimal, with a majority of the limited infrastructure and transportation systems located closer to the Beaufort Sea Program Area. There is potential for operations in the Beaufort Sea Program Area to tap into the existing network of onshore oil and gas infrastructure, and the transportation system for oil based out of Prudhoe Bay. This network reaches almost as far east as the Arctic NWR western border and almost as far west as the eastern border of the National Petroleum Reserve in Alaska. Potentially, existing support facilities such as airfields, docks, storage, and processing facilities could be shared. These facilities would likely need to be retrofitted or expanded to support future leasing. Oil and gas infrastructure is discussed further in **Appendix C**, Section 12.

Other Uses

BOEM has not received nominations for renewable energy or marine mineral leasing in any of the Arctic Program Areas and does not does not expect that commercial leasing for renewable energy resources will occur in the 2017-2022 time frame.

The Beaufort Sea and Chukchi Sea Program Areas are fully within the Arctic boundary as defined by the U.S. Arctic Research and Policy Act, a boundary recognized by the U.S. Department of Defense (USDOD). There are also four active U.S. Air Force radar sites located on the coast bordering the Beaufort Sea and Chukchi Sea Program Areas. Access to each is only for personnel on official business and with approval of the Commander of the U.S. Air Force's 611th Air Support Group (USDOI, BOEM, 2012). More information on other uses of the Beaufort and Chukchi Sea Program Area can be found in

Appendix C, Section 9. Since 2012, the USCG has conducted operations and training exercises in the Arctic during the summer through a series of Operation Arctic Shield deployments in preparation for the anticipated increase of maritime activities in western Alaska and the Bering Strait. These deployments involve deployment of aircraft, boats, and personnel to locations that serve as temporary bases for sea and air support during the seasonal surge in Arctic activities.

4.3.13.2. Cook Inlet Program Area

Cook Inlet, located in south-central Alaska, is nearly 290 km (180 mi) long, and covers approximately 100,000 km^2 (38,610 mi^2). The area extends from the GOA at the inlet's southernmost border to its northernmost reaches where the inlet narrows and bifurcates into two bodies of water, the Turnagain and Knik Arms. The city of Anchorage is the cultural and business hub of Alaska and is located between these two arms of Cook Inlet. Land use in the Cook Inlet Program Area is diverse and includes a wide range of business and business support services for a variety of industries, including the well-developed oil and gas industries associated with state lands and waters. The Cook Inlet region also provides important transportation services, and established hubs for air, rail, road, and marine transport throughout the region and Alaska. Lands in the vicinity of the Cook Inlet Program Area feature large National Parks, NWRs, and a National Forest, notably including the Lake Clark National Park and Preserve (NPP), the Katmai NPP, the Kenai Fjords NP, the Kenai NWR, the Kodiak NWR, and the Chugach National Forest. These areas are described in **Appendix C**, Section 9.

Oil and Gas Infrastructure

The Cook Inlet Program Area and surrounding lands have multiple important port facilities to support oil and gas activities, including Anchorage, Nikiski, and Homer. The port of Anchorage receives goods that support 75 percent of the population and all five of the state's military bases. The port also supports the staging and fabrication of modules used in the North Slope oil and gas industry, and has a cargo facility that is served by a railroad connecting it to Alaska's interior and the port at Seward. The Cook Inlet and Kenai Peninsula area have an extensive road network to support oil and gas activities and are served by the Ted Stevens Anchorage International Airport in Anchorage as well as numerous smaller airfields and facilities. The more remote western side of Cook Inlet is not connected to the road system and is home to the village of Tyonek, several commercial set-net fish sites, and several oil camps.

Oil and gas are produced onshore and offshore on state lands in the region; however, there are currently no active federal leases in Cook Inlet. On state lands north of the Cook Inlet Program Area, there are 16 active offshore production platforms, with 28 producing oil and gas fields in Cook Inlet offshore waters, and on the Kenai Peninsula. Existing offshore and onshore crude oil production is handled through the Trading Bay production facility with nearly all of the oil going to Tesoro's Refinery located near Kenai. Crude oil is received through the Port of Nikiski Terminal Wharf, which also is used to send out refined products. There are onshore treatment facilities along the shores of the upper Cook Inlet, and hundreds of miles of undersea and onshore oil and gas pipelines. Further discussion of oil and gas infrastructure in the Cook Inlet Program Area can be found in **Appendix C**, Section 12.

Other Uses

Anchorage is home to two military bases and the hub of the state's overall road network. The Cook Inlet Program Area and surrounding lands have a large USDOD presence located at the northern end of the Cook Inlet. The Joint Base Elmendorf-Richardson, adjacent to Anchorage, encompasses 33,993 ha (84,000 ac) and includes more than $11 billion of infrastructure to support the 5,500 USDOD personnel living or working on base. More information on military uses in the Cook Inlet can be found in **Appendix C**, Section 12.

4.3.13.3. Gulf of Mexico Program Area

The Gulf of Mexico Program Area is composed of the Western, Central, and a portion of the Eastern Planning Area not subject to Congressional Moratorium. The combined planning areas adjoin five coastal states (Texas, Louisiana, Mississippi, Alabama, and Florida), and span approximately 2,623 km (1,630 mi) of coastline. Land use within the states is a heterogeneous mix of urban areas, manufacturing, marine, shipping, agricultural, oil and gas activities, recreational areas, and tourist attractions. Due to the abundance of urban areas, high population density around coastal areas, and wide variety of land use, the Gulf of Mexico is one of the most mature yet complex areas for oil and gas development.

The Gulf of Mexico Program Area contains a mix of bays, estuaries, wetlands, barrier islands, and beaches. As described in **Sections 4.3.4** and **4.3.15**, these areas are known to provide significant environmental and economic value to the region, supporting fishing, shrimping, and other recreational and tourism activities. Along the Gulf of Mexico coast are numerous state parks and beaches as well as units of the NPS and USFWS. Notable features in the area include Padre Island National Seashore, the Atchafalaya Basin, the Mississippi River Delta, Gulf Islands National Seashore, Mobile Bay, and Everglades NP.

All states in the Gulf of Mexico Program Area participate in the Coastal Zone Management (CZM) Program and have taken various approaches to managing their coastal lands. The CZM Program is a voluntary partnership between the Federal Government and the U.S. coastal and Great Lakes states and territories 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.

Oil and Gas Infrastructure

Oil and gas development and production play an important role in determining land uses in many communities surrounding the Gulf of Mexico. The use of oil and gas infrastructure 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 of remote deepwater facilities and servicing them require deeper ports than needed for nearshore operations. There are several ports with deepwater access along the Gulf of Mexico coast that provide substantial logistical support to the oil and gas industry: Port Fourchon, the Port of Morgan City, and the Port of Iberia, all in Louisiana, and the Port of Galveston in Texas.

Other existing OCS-related infrastructure in the region includes the following, many of which are shown on **Figures 4.3.13-1** and **4.3.13-2**:

- *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 also can 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 offshore activities. This includes repair and maintenance yards, supply bases, crew services, and heliports.
- *Pipelines*. Infrastructure used to transport oil and gas from offshore facilities to onshore processing sites, and ultimately to end users.
- *Pipe Coating Plants and 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 it into 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 use oil and natural gas intensively, 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.

More information on infrastructure supporting offshore oil and gas activities can be found in **Appendix C**, Section 12 and Dismukes (2011).

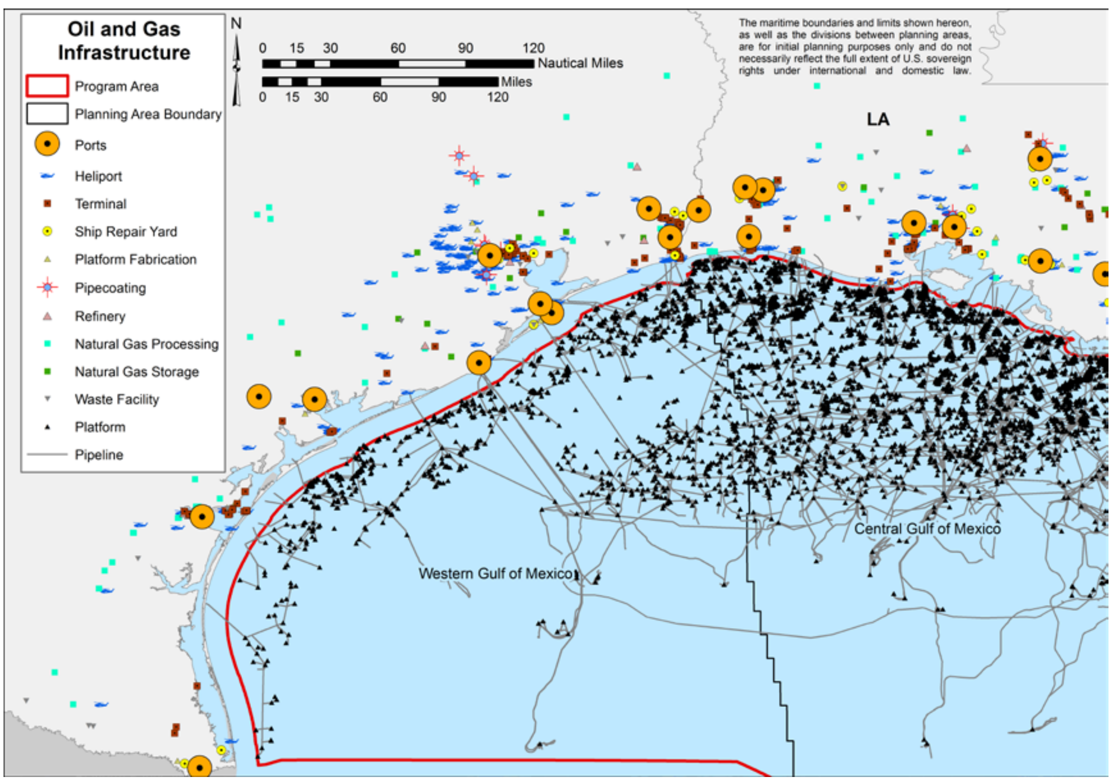


Figure 4.3.13-1. Western Gulf of Mexico Oil and Gas Infrastructure.

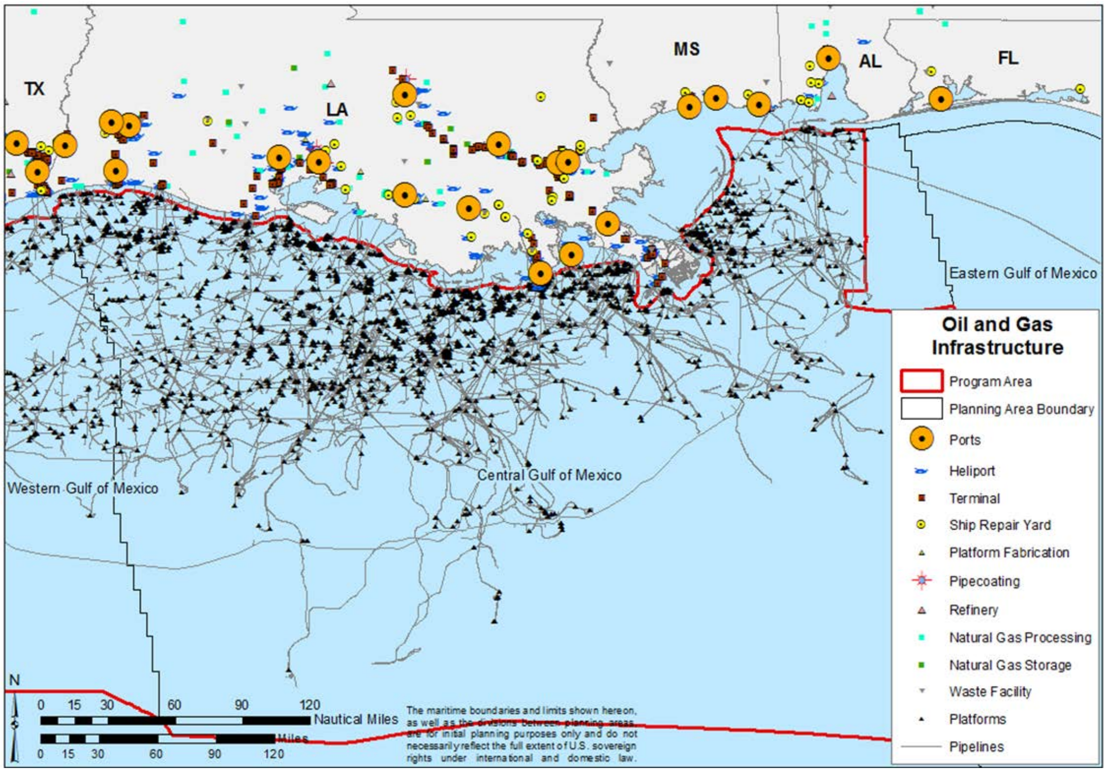


Figure 4.3.13-2. Central Gulf of Mexico Oil and Gas Infrastructure.

Other Uses

Military uses, Areas of Special Concern, dredged material disposal sites, and non-energy marine minerals development areas are prevalent in the Gulf of Mexico, and these are discussed in more detail in **Chapter 3** and **Appendix C**, Section 12. BOEM has not received nominations for renewable wind energy leasing in the Gulf of Mexico Program Area and is not aware of any specific plans or proposals to develop OCS renewable energy resources in federal waters there at this time. BOEM has issued leases and agreements for OCS sediment for coastal restoration projects along the Gulf of Mexico, specifically offshore the coasts of Louisiana, Mississippi, and Florida. Typically, the borrow areas are in waters <27 m (90 ft) deep and are in close proximity to the coast.

The Gulf of Mexico region has a large USDOD presence with multiple Navy and Air Force facilities located along the coastal zone. USDOD activities in the Gulf of Mexico range from flight training to amphibious warfare training, and occur year-round both offshore and onshore. These activities are discussed in relation to OCS leasing in the *DoD Mission Compatibility Planning Assessment: BOEM 2017-2022 Outer Continental Shelf (OCS) Oil and Gas Leasing Draft Proposed Program* (USDOD, 2015) and in **Chapter 3**.

4.3.13.4. Atlantic Program Area

The Atlantic Program Area encompasses portions of the Mid- and South Atlantic Planning Areas. There are four coastal states within the Atlantic Program Area covering approximately 1,127 km (700 mi) of coastline. These states include Virginia, North Carolina, South Carolina, and Georgia. Land use is a heterogeneous mix of urban, manufacturing, marine, shipping, and agricultural activities, recreational areas, and tourist attractions. Two of the nation's largest ports (Norfolk, Virginia and Savannah, Georgia) are within the Atlantic Program Area (Wilson and Fischetti, 2010; USACE, 2012).

The Atlantic Program Area contains a mix of bays, estuaries, wetlands, barrier islands, and beaches of great environmental and economic value as described in **Sections 4.3.4** and **4.3.15**. Along the Atlantic Program Area are numerous state parks and beaches as well as NPs, National Seashores, and NWRs. These areas also support fishing and shrimping, and are very popular for recreation and tourism. Further discussion of these areas can be found in **Appendix C**, Section 4.

As with the Gulf of Mexico Program Area, all of the states in the Atlantic Program Areas participate in the national CZM Program, and have taken various approaches to managing their coastal lands. These states have authority over submerged lands to approximately 3 nmi from the coast.

Oil and Gas Infrastructure

A total of 10 federal lease sales have been held in the Atlantic region, most recently in 1983. Leases have not occurred since the mid-1990s and, as a result, there is currently no drilling or production on the U.S. Atlantic OCS. Given the lack of oil and gas activity in the Atlantic, few facilities with capacities for offshore oil and gas development have been identified. However, there are several facilities that currently are being used for onshore oil and gas production that could be retrofitted or expanded to temporarily meet offshore needs.

Currently identified Atlantic infrastructure is shown in **Figure 4.3.13-3**. Some these facilities already may have the ability to support offshore oil and gas activities, or could be retrofitted and expanded in the future to meet regional needs. The list of OCS-related infrastructure that may be needed to meet oil and gas needs in the region that is provided in **Section 4.3.13.3** for the Gulf of Mexico also applies for the Atlantic Program Area.

More information on infrastructure supporting offshore oil and gas activities can be found in **Appendix C**, Section 12 and in *Onshore Oil and Gas Infrastructure to Support Development in the Mid-Atlantic OCS Region* (Dismukes, 2014).

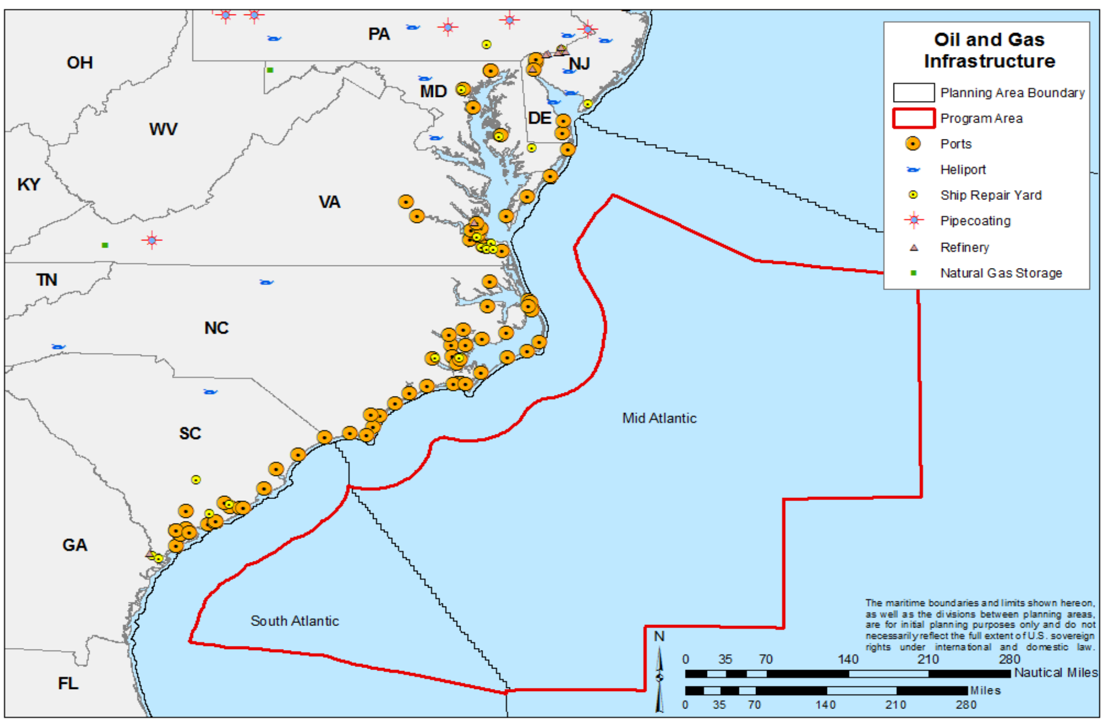


Figure 4.3.13-3. Atlantic Oil and Gas Infrastructure.

Other Uses

Military uses, Areas of Special Concern, dredged material disposal areas, renewable energy development areas, and NASA-identified operational areas are prevalent in the Atlantic. These areas are discussed in more detail in **Chapter 3** and **Appendix C**, Section 12. BOEM has issued renewable (wind) energy leases along the Atlantic coast in Massachusetts, Rhode Island, Delaware, Maryland, and Virginia. A lease sale for areas offshore New Jersey was held in November, 2015. In addition, Wind Energy Areas (WEAs) have been identified in North Carolina to aid in planning for potential leasing activity. BOEM is also in the planning phase for potential leasing offshore New York and South Carolina. The state with executed leases in closest proximity to the Atlantic Program Area is Virginia; site assessment and construction activities on these leases may occur in the 2017-2022 time frame. BOEM also has issued leases and agreements for OCS sand for coastal restoration projects along the Atlantic coast from New Jersey to Florida. Typically, the borrow areas are located in water depths <27 m (90 ft) and are in close proximity to the coast.

In addition, the Atlantic has a large USDOD presence with multiple Navy and Air Force facilities located along the Atlantic coastal zone. As in the Gulf of Mexico, the USDOD uses portions of the Atlantic Program Area for activities ranging from various air-to-air, air-to-surface, and surface-to-surface naval fleet, submarine, and antisubmarine training as well as Air Force exercises. Portions of the area are further defined as danger zones, which can be closed or subject to limited public access during intermittent periods. These activities are discussed in **Chapter 3** and **Appendix C**, Section 12.

NASA operates one facility in the Atlantic Program Area at Wallops Island, Virginia. Operations from the Wallops Flight Facility (WFF) include rocket testing, whereby designated downrange danger zones and patterns for debris from field tests coincide with BOEM's Atlantic Program Area. Since 2006, launches from WFF have grown in number and importance to U.S. space and national defense priorities and programs. Other NASA activities are further discussed in **Chapter 3** and **Appendix C**, Section 12.

4.3.14. Commercial and Recreational Fisheries

In areas of dense fishing effort, or where gear is spread over a large area, commercial fishing has the potential to cause semi-permanent standoff-distance conflicts on the OCS. Marine standoff-distance conflicts are already an issue between many competing fisheries in some portions of each Program Area (e.g., pelagic longline fisheries; deepwater crab fisheries). On a space-use basis, commercial fishing can occur anywhere in favored areas where it is not temporarily or permanently excluded (i.e., in areas where there are no surface or bottom obstructions). Virtually all commercial trawl fishing is performed in water depths <200 m (656 ft). Commercial and recreational fishing within the Program Areas is discussed in detail in **Appendix C**, Section 13.

4.3.14.1. Beaufort and Chukchi Sea Program Areas

Although some commercially valuable species' ranges extend into the Chukchi and Beaufort Seas, no commercial fishing is currently permitted within this Program Area. Recreational fishing may occasionally occur in federal waters of the Beaufort and Chukchi Sea Program Areas (NPFMC, 2009); however, no landings data are currently available. Subsistence fishing is important to communities bordering the Program Area, but it is believed that the majority of these activities occur in state waters; no landings data are currently available.

4.3.14.2. Cook Inlet Program Area

Of the three Alaska Planning Areas (Cook Inlet, Chukchi Sea, and Beaufort Sea), Cook Inlet is the only one with appreciable commercial or recreational fisheries. The planning area is within lower Cook Inlet. Lower Cook Inlet fisheries target the five Pacific salmon (pink, sockeye, chum, coho, and chinook); groundfishes, including Pacific cod, sablefish, halibut, and lingcod; and pelagic shelf rockfish (primarily black rockfish). Other groundfishes harvested as bycatch to other directed groundfish and halibut fisheries include walleye pollock, skate, and several rockfish species. Mollusk and shellfish species commercially harvested in the lower Cook Inlet Area are octopus, which may be retained as bycatch to other directed fisheries, and razor clams.

Salmon are harvested commercially with purse seines and set gillnets. Groundfish are caught with hooks and lines, jigs, and pots. Sablefish and some Pacific cod are caught with longlines. Fisheries in the Cook Inlet area are managed by the ADFG (in state waters 4.8 km [3 mi] from shore), or by the NPFMC (in federal waters >4.8 km [3 mi] from shore).

Recreational fishing in the Cook Inlet Planning Area consists predominantly of hook and line fishing for halibut and the five salmon species.

4.3.14.3. Gulf of Mexico Program Area

Commercial fishing in the Gulf of Mexico Program Area supports some of the most productive and valuable fisheries in the U.S., and is described in detail in **Appendix C**, Section 13. Key fisheries target shrimp, oysters, blue crab, menhaden, snappers, groupers, tunas, and swordfish. The most important fisheries (and recovery gear) are shrimps (bottom trawl); menhaden (purse net); red snapper, Spanish mackerel, king mackerel, and cobia (hook and line); groupers and tilefishes (bottom longline); and tunas, swordfish, and sharks (pelagic longline). Species occurring in federal waters are managed by the GMFMC (shrimps, snappers, groupers, mackerels); HMS Division of the Office of Sustainable Fisheries (tunas, swordfish, sharks); and the Gulf States Marine Fisheries Commission (menhaden).

Recreational fishing extends from the shoreline to blue offshore waters beyond the shelf break. Most recreational fishing practiced by private vessels is concentrated nearshore (<4.8 km [3 mi] from shore); recreational fishing is exclusively undertaken from privately owned or charter/party/rental boats (generally ≤20 m [66 ft] long). Recreational anglers seek red drum, black drum, Atlantic croaker, seatrouts, mackerels, tunas, snappers, sheepshead, and jacks. Additional details regarding recreational fisheries are discussed in **Appendix C**, Section 13. A very small portion of the Gulf of Mexico OCS surface area now includes many structures and other obstructions that can cause potential spatial conflict commercial fishing operations. A very small fraction of total OCS area in the Program Area is now unavailable for trawl or longline fishing, and the introduction of surface and bottom obstructions from oil and gas-related activities and associated structures would not impact >1 percent of the available surface or bottom area in the Program Area in water <200 m (656 ft) deep.

4.3.14.4. Atlantic Program Area

Commercial fisheries in the Atlantic Program Area that occur seaward of the 80.5-km (50-mi) boundary include hook and line fishing for oceanic pelagic fishes (tunas, billfishes, and sharks); pelagic longlining for sharks, swordfish, and tunas; bottom longlining for tilefish and groupers; bottom trawling for royal red shrimp (South Atlantic) and flounder (Mid-Atlantic); and bottom fishing for wreckfish (South Atlantic). Bottom longlining for tilefish occurs in the vicinity of Norfolk Canyon north, an area north of the Atlantic Program Area. Surface longlining and trolling by commercial fishers occurs within the Mid-Atlantic Planning Area near and just seaward of the 80.5-km (50-mi) boundary. The primary fishing area for wreckfish in the Atlantic Program Area is on the Blake Plateau, usually in the vicinity of the Charleston Bump.

Most recreational fishing in the Mid-Atlantic Planning Area also takes place inshore of the 80.5-km (50-mi) boundary. Recreational fishers with vessels capable of making trips to and from the planning area boundaries seek tuna, marlin, wahoo, and dolphinfish. Various recreational fishing tournaments occur from May through September, and venture beyond the 80.5-km (50-mi) coastal buffer.

Fisheries in federal waters of the Atlantic Region are managed by the MAFMC (north of North Carolina), the SAFMC (south of North Carolina), joint FMPs with the NEFMC, and the HMS Division of the Office of Sustainable Fisheries (tunas, sharks, and billfishes).

4.3.15. Tourism and Recreation

4.3.15.1. Beaufort and Chukchi Program Areas

Tourism and recreational activities on the North Slope of Alaska include hunting, hiking, kayaking, and rafting in the numerous parks, preserves, and refuges adjacent to the Beaufort and Chukchi Sea Program Areas (**Figure 4.3.10-1**), such as Gates of the Arctic NPP, the Arctic NWR, and Kobuk Valley NP. Gates of the Arctic NPP and the Arctic NWR are accessible to communities within the NSB and the Northwest Arctic Borough (NWAB). With sea ice extent retreating, cruise ships are venturing farther north, and tourism opportunities are increasing. Cruise ships occasionally are witnessed by coastal communities as they transit through the Beaufort and Chukchi Seas during open ice season, and more cruise liners are scheduling trans-Arctic expeditions in waters off the coast of Alaska. Further opening of the Northwest Passage in Canada is facilitating increased cruise interests. Anticipated cruise ship routes through the Chukchi and Beaufort Sea Planning Areas and the Northwest Passage are shown in **Figure 4.3.15-1**.

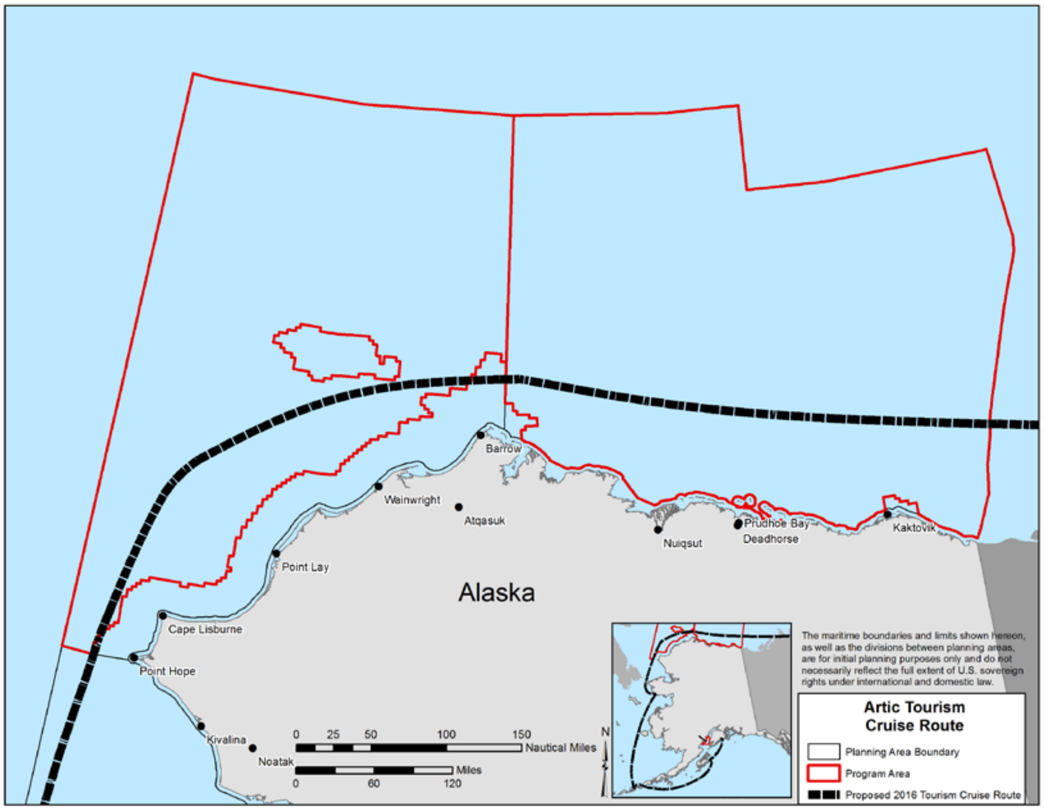


Figure 4.3.15-1. Proposed Route for Cruise Ships Through the Beaufort and Chukchi Sea Planning Areas.

Tourism opportunities in the NSB usually operate out of Barrow or Deadhorse. Travel to these areas is primarily by air, although personal vehicles and occasional bus tours arrive in Deadhorse via the Dalton Highway that runs between Deadhorse and Fairbanks. Barrow offers cultural and educational opportunities at the Iñupiat Heritage Center, which houses native artifacts and promotes local arts and crafts. Larger communities and centers such as Barrow and Deadhorse (as well as Kotzebue located in the NWAB) have increased temporary lodging options through hotels and bed and breakfasts, which facilitate tourism opportunities. Many communities located more in the interior of the NSB do not have large-scale or commercial lodging options that would facilitate growth of a tourism industry.

Kotzebue is the second largest community north of the Arctic Circle. Most visitors typically access this area via air travel as there are no highways or roads connecting Kotzebue to the remainder of Alaska. This makes Kotzebue a main airport transportation hub for travel to and within the NWAB. The Bering Land Bridge National Preserve is located in Shishmaref, just southeast across Kotzebue Sound, and is well known for its archaeological sites and geological features (Nuttall, 2012). Area hot springs are also becoming a popular destination for tourists (NPS, 2015).

Tourism and recreational opportunities within the Alaskan Arctic are limited and do not contribute substantively to the NSB's or NWAB's revenue streams. Employment opportunities fluctuate seasonally, providing an estimated 767 to 1,039 jobs during the peak season. From October 2013 through September 2014, tourism or visitor spending within the Arctic regions accounted for $25 million.

While opening of the Arctic and growing public interest in the Arctic environment has the potential to expand tourism and recreational-based opportunities within the NSB and NWAB, the remoteness, limited access, lack of automobile access and lodgings, relatively short open-water season (approximately 4 months, though weather dependent), and extreme weather all present challenges to growth of a tourism industry within Arctic Alaska.

4.3.15.2. Cook Inlet

In and around the Cook Inlet Program Area, there are abundant recreational opportunities, including hunting, fishing, hiking, cruising, boating, wildlife viewing, and sightseeing. Tour ships based out of the contiguous U.S. and Canada regularly traverse southeast Alaska as well as transiting within Cook Inlet. The Alaska Marine Highway Ferry System is used by numerous independent travelers to access the region. Marine vessels used for tourism include cruise ships, ferries, and tour boats. Cook Inlet has less cruise ship activity than southeast Alaska and Prince William Sound; however, cruise ships do dock at the Port of Anchorage weekly during the tourist season, which generally runs from May through September. Anchorage and the Port of Anchorage are located to the north, and outside of the Cook Inlet Program Area. However, vessel traffic with an Anchorage or Port of Anchorage destination must transit through the Program Area (**Figure 4.3.15-2**). The Port of Anchorage (2015) is currently expanding, in part to accommodate increased cruise ship interest. Growth of between 6 and 18 cruise ship visits annually for the next 10 years is projected (Port of Anchorage, 2015).

Cook Inlet Planning Area is home to several NPPs, including Kenai Fjords NP, Lake Clark NPP, Katmai NPP, and Aniakchak National Monument and Preserve (**Appendix C**, Figure 9.1-2).

Most of south-central Alaska's recreational fishing activity is based in the Cook Inlet area. Popular recreational and subsistence fishing locations include the Kenai, Kasilof, Ninilchik, and Susitna Rivers. Little Suisitna River and Deep Creek are also popular with recreational fishers, and these areas contribute greatly to the local economy. Cook Inlet is home to all five Pacific salmon species, and the open fishing season generally runs from May through September, depending on species and regulation. Cook Inlet also is the site of recreational fishing seasons for different groundfish and shellfish. The abundant presence of wildlife has prompted development of many wildlife viewing recreational activities, especially for bears on the western side of Cook Inlet and in the Cook Inlet Program Area, in addition to an active hunting industry. From October 2013 to September 2014, fishing and game licenses and tags contributed $18.1 million in revenue to the State of Alaska. Sea kayaking and charter boats are popular summer tourist activities for scenic and wildlife (e.g., beluga whale) tours. Beluga whale sightings occur along Anchorage's coastal trail. Beluga Point Turn-Out along the Seward Highway and Turnagain Arm are popular tour bus stops for beluga whale watching opportunities. Winter recreational activities include snowmachining (also known as snowmobiling), skiing, and ice fishing.

Seasonal fluctuations occur within the recreation and tourism employment sectors, and the summer months of May to September are the peak tourism season. Cruise ship travel in Alaska generally begins in May and runs through the middle of September, directly and indirectly impacting regional employment in the tourism sector.

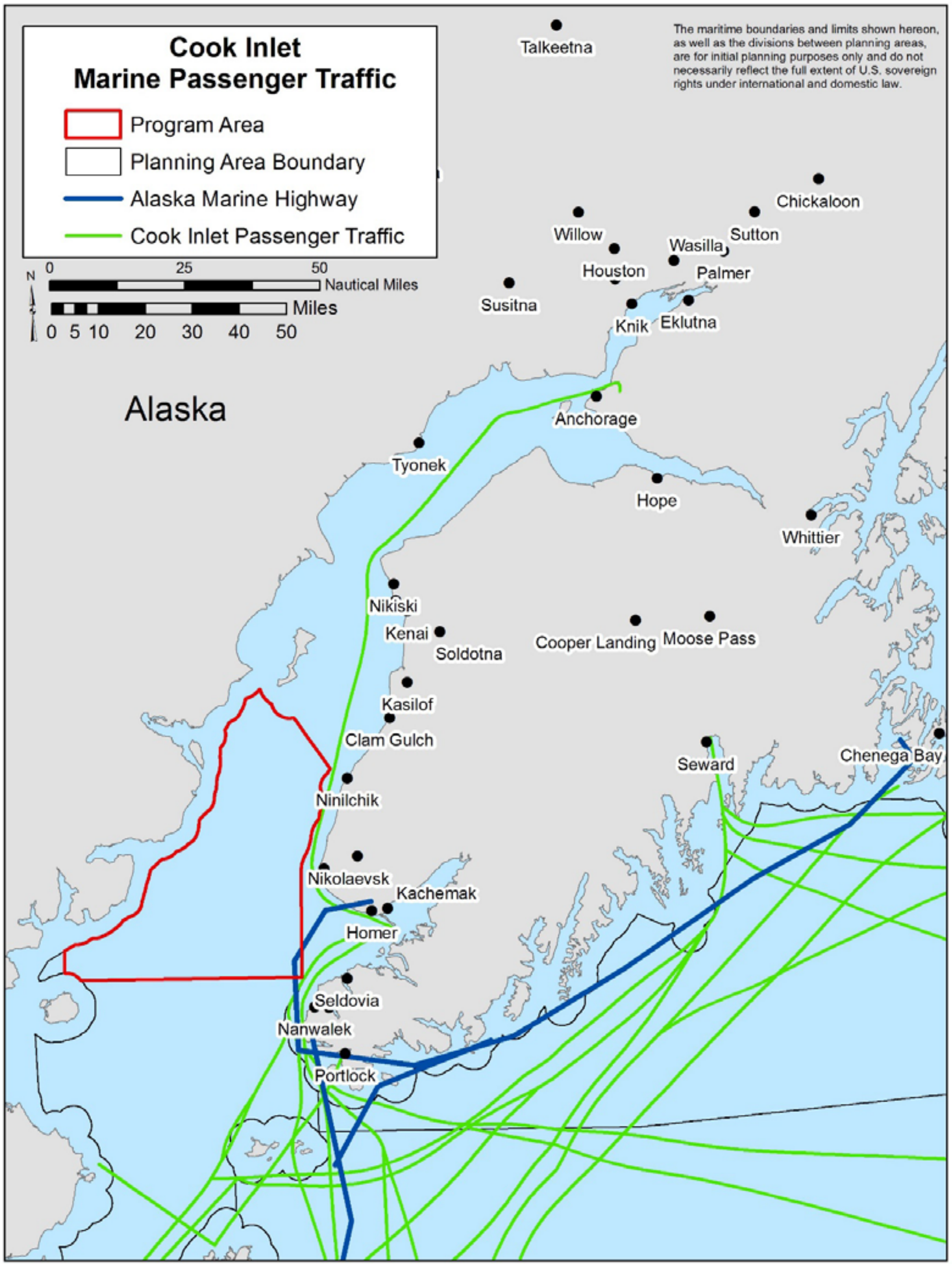


Figure 4.3.15-2. Cook Inlet Passenger Traffic.

Recreation and tourism are major sources of employment in the Cook Inlet region. In 2013, the recreational and tourism industry employed an estimated 21,302 people. The MoA accounts for 78.4 percent of tourism-related employment in the Cook Inlet region.

Unlike tourism and recreational activities in the Alaskan Arctic, south-central Alaska is a popular destination for tourism and recreation for visitors and residents of Alaska, especially for recreational fishing, given the abundance of salmon, trout, and groundfish in the area. According to a 2015 report completed by the McDowell Group for the Alaska Department of Commerce, an estimated 44 percent ($798 million) of the visitor spending within the State of Alaska (2013 to 2014) is focused within south-central Alaska (inclusive of the MoA, the Mat-Su Borough, and the KPB). During the same time, approximately 19,200 people in south-central Alaska were employed in the tourism and recreational industries in seasonal or long-term opportunities, accounting for a labor income of $604 million (McDowell Group, 2015). Within south-central Alaska, the visitor industry contributed $2.06 billion to the local economy, resulting in a labor impact of $604 million (McDowell Group, 2015).

4.3.15.3. Gulf of Mexico Program Area

The Gulf of Mexico is a popular destination for domestic and foreign tourists. The mild climate and coastal waters provide numerous recreational and tourism opportunities. Beach-going, recreational fishing, boating and diving, nature watching, and other water-based activities are primary among tourist activities.

The entire Gulf of Mexico Program Area has 1,385.6 km (861 miles) of coastline, with 244 public beaches. In a typical year, beaches in Texas alone accommodate nearly 3.9 million visitors, while beaches in Louisiana, Mississippi, and Alabama see nearly 2.8 million visitors during tourist season (USEPA, n.d.; USDOC, NOAA, 2008). In addition to beaches, visitors have access to several national, state, and local parks and wildlife refuges (**Appendix C**, Figure 9.2-1) as well as public and private boat docks and marinas, boat launches, and equipment rental and tour boat companies.

Tourism is critical to the regional economies of the Gulf of Mexico. In 2013, >375,000 workers were employed in the travel and tourism industry in the coastal counties adjacent to the Program Area. During the same time, total industry spending in those coastal counties was approximately $25.1 billion, including $13.2 billion in wages and salaries (U.S. Census Bureau, 2013; U.S. Travel Association, 2013). See **Section 4.3.12** for more information about regional economic statistics.

Deepwater Horizon **Explosion, Oil Spill, and Response**

The *Deepwater Horizon* explosion, oil spill, and response that began on April 20, 2010 impacted the tourism industry in the Gulf of Mexico. Real and perceived impacts of the *Deepwater Horizon* explosion, oil spill, and response on recreational resources curtailed tourism spending immediately after the incident. Tourists' concerns that the *Deepwater Horizon* explosion, oil spill, and response had impacted water quality, the shoreline, and seafood quality led to a high rate of leisure trip cancellations between April and December 2010 (Oxford Economics, 2010).

Influx of media, relief workers, and government officials to the region during response and cleanup phase helped offset some, but not all, of the economic activity lost through the reduction in leisure travel (Oxford Economics, 2010). Charter boat operations, restaurants, and attractions were especially affected. Casinos, on the other hand, were minimally impacted (Eastern Research Group, Inc., 2014).

Because most economic data are released after a time lag, and given restrictions placed on disclosure of data specific to the *Deepwater Horizon* event from litigation, limited information is available to estimate long-term impacts of the accident to the tourism industry. Additionally, the *Deepwater Horizon* explosion, oil spill, response, and the national economic recession made analysis of economic impacts of the oil spill to specific industries such as tourism more complex. BOEM currently has several completed and ongoing studies designed to estimate the long-term impacts of the *Deepwater Horizon* explosion, oil spill, and response on tourism in the Gulf of Mexico.

4.3.15.4. Atlantic Program Area

Tourists are attracted to the mid- and south Atlantic coasts by a diverse range of marine and coastal habitats, including sandy beaches and barrier islands, estuarine bays and sounds, inland waterbodies, maritime forests, and marshlands. There are five national seashores along the coast, occupying a combined area of >80,128 ha (198,000 ac): Assateague Island in Maryland and Virginia, Cape Hatteras and Cape Lookout in North Carolina, and Cumberland Island in Georgia (**Appendix C**, Figure 9.3-1). Covering 16,077 ha (39,726 ac), Assateague Island National Seashore straddles Maryland and Virginia and is known for its wild horses. The 12,282 ha (30,350 ac) Cape Hatteras National Seashore is best known for the Bodie Island and Cape Hatteras lighthouses. Cape Lookout National Seashore, covering 11,430 ha (28,243 ac), comprises three Outer Bank islands and is known for its wild horses. Cumberland Island, which covers 14,737 ha (36,415 ac) of the southernmost barrier island in Georgia, has a rich history extending from the Timucua Indians to the Thomas Carnegie family.

Barrier island systems along the mid- and south Atlantic coasts consist of sandy strands that provide recreational beaches open to the Atlantic Ocean, with protected lagoons and marshlands between the barrier island and the mainland. Sandy beaches are popular destinations for swimming, sunbathing, and surfing. Lagoons provide a low-energy environment for fishing, kayaking, boating, and viewing wildlife. Fishing piers and boat landings are located on both the lagoon and beach sides of the barrier systems. Public beach facilities typically are located on the ocean side of a barrier island. Golf courses are popular, especially along the southeast Atlantic coast, and are typically located on the mainland, although some are located on barrier islands (e.g., Hilton Head, South Carolina).

Natural harbors and bays of varying sizes are located adjacent to the Atlantic Program Area. These serve as centers of recreational boating and fishing and support activities in the coastal, nearshore, and offshore areas. Boat-based activities include fishing, diving, sailing, and sightseeing. Diving is most popular at the many shipwrecks and artificial reefs in nearshore and, to a lesser extent, offshore waters. Natural hard bottom areas such as Gray's Reef NMS offshore Georgia are also a destination for divers. Types of recreational activities that occur in the Atlantic Program Area are listed in **Table 4.3.15-1**.

Table 4.3.15-1. Types of Recreational Activities by Location in the Atlantic Program Area.

Location	Recreational Activities
Offshore waters (depths >30 m)	• Fishing • Diving (very limited; e.g., Monitor NMS) • Wildlife viewing (e.g., whale watching, pelagic birdwatching)
Nearshore waters (depths <30 m)	• Fishing • Boating • Diving (artificial reefs and wrecks; Gray's Reef NMS) • Wildlife viewing (e.g., whale watching, pelagic birdwatching)
Beaches	• Swimming, snorkeling, surfing • Sunbathing • Fishing • Boating • Wildlife viewing • Camping (e.g., state parks and national seashores)
Lagoons and embayments	• Swimming • Fishing • Boating • Wildlife viewing • Camping
Other coastal areas	• Sightseeing • Golf • Bicycling • Hiking • Hunting

4.3.16. Sociocultural Systems

4.3.16.1. Beaufort and Chukchi Sea Program Areas

Residents of the communities bordering the Arctic Planning Areas are primarily Iñupiat. They live in a mixed subsistence-cash economy. The Iñupiat view subsistence foods as essential for their physical health and spiritual well-being (USDOI, BOEM, 2015d). Subsistence hunting for marine mammals, particularly bowhead and beluga whales and walrus, is central to their culture. Marine mammal hunters are from the communities of Kaktovik, Nuiqsut, Barrow, Point Lay, Wainwright, Point Hope, and Kotzebue. Seal and seal oil are important parts of the diet, providing a significant source of calories.

Whaling is a very strenuous activity. Subsistence hunting for marine mammals tends to focus in areas located within 40 km (25 mi) of shore. Village whaling occurs in the spring and fall, based on ice and weather conditions and variations in whale migration patterns. **Figure 4.3.16-1** shows bowhead whale migration and the location of the communities.

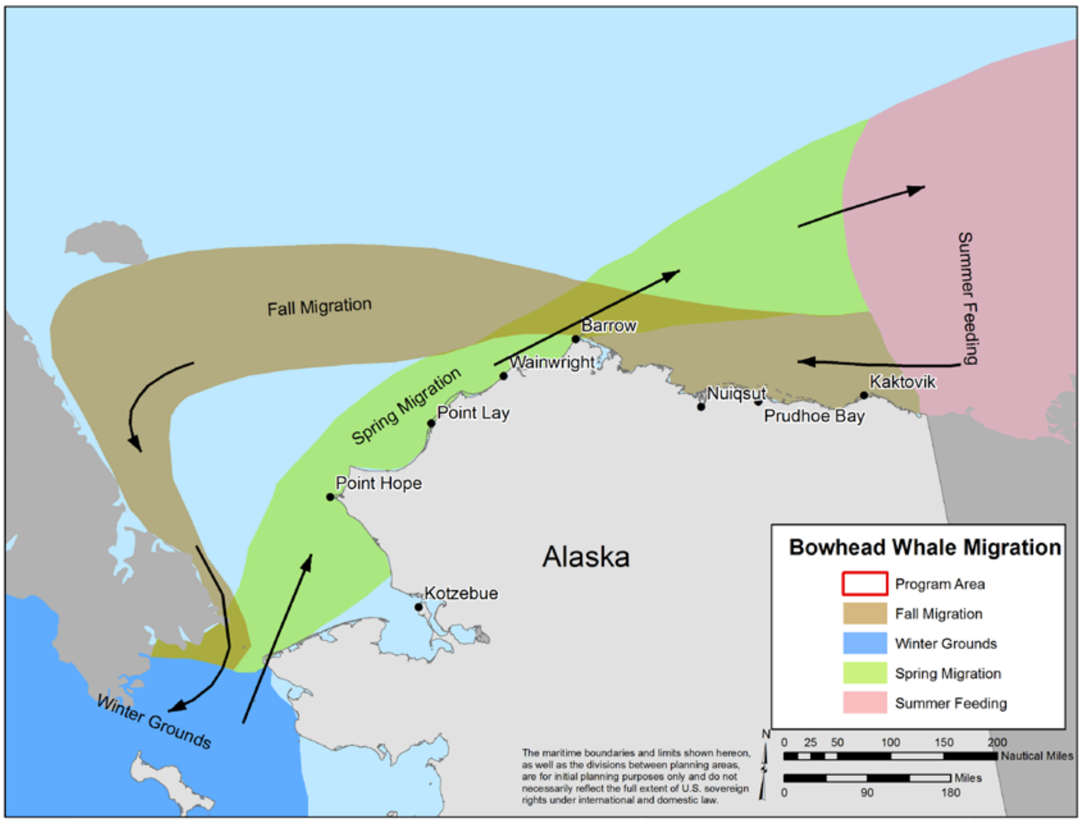


Figure 4.3.16-1. Bowhead Whale Migration and Locations of North Slope communities.

Whaling is accomplished by crews of 10 to 15 whalers. In the spring, whales migrate through leads in the ice and whalers prefer to use traditional walrus skin boats so they can move quietly through ice leads, avoiding unnecessary noise. In the fall, when open water prevails, and whalers use more durable wood, aluminum, and fiberglass boats. This is because of the harsher fall weather conditions with rougher seas and floating ice, which demands a greater speed to find and pursue whales in more open water. Confronting potentially extreme weather and rough seas in a small vessel is very demanding physically; going offshore as far as 80 km (50 mi) demonstrates the capability of the whaling crews. Harvested bowhead whales range in size from 9 to 15 m (30 to 50 ft) long, and weighing between 30 to

50 tons. Once the whale is captured, the crews must drag it through the water back to their community. This is the final test of their strength on the water (Galginaitis, 2009).

Males make up nearly all of the whaling crews. In recent years, more women have begun to participate in whaling crews. However, traditionally, the role of women has been to prepare walrus hides for skin boats as well as anoraks, caribou skin pants, and the like for the whaling crews. Children start to learn the roles of their parent near the age of 14.

Villages share extensively with other communities. Cultural values reflect the Iñupiat traditional emphasis on maintaining a close relationship with natural resources and other members of their communities, with particular focus on kinship, maintenance of the community, cooperation, and sharing. Subsistence is a central activity that embodies these values, with bowhead whale hunting the paramount subsistence activity (Shell, 2015).

The 2010 populations were: Barrow, 4,970; Kaktovik, 310; Nuiqsut, 420; Point Hope, 830; Point Lay, 270; and Wainwright, 550 (Wilson and Fischetti, 2010). These villages are not connected to the road system in Alaska. Travelers must fly to them from the nearest communities on the road system, such as Fairbanks. In Kaktovik and Nuiqsut, >85 percent of the population self-identifies as American Indian/Alaska Native.

4.3.16.2. Cook Inlet Program Area

The area directly west of the Program Area is not populated, but does have snow-capped mountains and the rugged country of Lake Clark NPP. People living in or touring on the eastern side of the inlet have views of snow-capped mountains to the west. People in these communities also can see oil and gas platforms on the western side of the inlet in state waters. The eastern side of the inlet has a road extending from Kenai to Homer. That road leads north to Anchorage, and the rest of the state's road system. Population of the communities on the road system on the eastern side of Cook Inlet is 7,100 (Kenai), 5,000 (Homer), and 800 (Ninilchik) (Wilson and Fischetti, 2010). These communities contain more than 95 percent of the population from Kenai to Homer. In 2010, the population of Anchorage was 293,000. See **Section 4.3.17** for the percent of Alaska Natives.

The Ninilchik Village Tribe Report, using 2013 data from the State of Alaska and the federal fisheries, shows that just under 3.6 million sockeye salmon were harvested in the Cook Inlet area, with subsistence fishers taking just 1,515 individuals, or 0.04 percent. The same data show that subsistence fishers took 0.0 percent of the more than 20,000 chinook salmon harvested by sport, commercial, personal, and educational user groups (www.ninilchik.gov).

Subsistence activities in the Cook Inlet region include fishing for salmon, trout, halibut, and shrimp. Common marine subsistence sources include the Stellar sea lion, northern sea otter, harbor seal, and all five species of salmon, along with a variety of other non-salmon fish (USDOI, MMS, 2003). The ADFG (2012) estimated that Anchorage residents harvested >5 million pounds of wild food through various subsistence activities; this includes marine and onshore harvest. The KPB along the southeastern coast of Cook Inlet has direct access to the Cook Inlet Program Area, and many communities are active commercial and recreational fishers. The five species of salmon and halibut are most sought after of all recreational species. The endangered species designation of the beluga whale has put this whale off limits to all subsistence activities in Cook Inlet since 2006.

4.3.16.3. Gulf of Mexico Program Area

The Western Planning Area is home to the Texas Coastal Bend (two counties shoreward of the Gulf of Mexico) and has a total population of 7.18 million. Houston has the highest concentration of this population, with approximately 2.1 million residents (Wilson and Fischetti, 2010); in contrast, there are stretches of the coast with very sparse population. The Coastal Bend encompasses 13 bays. The culture of the population is rural, urban, and suburban, with a mix of mainly Hispanic and Anglo traditions. However, part of this culture involves African American and Asian/Pacific Islander cultural traditions as well. The population in rural and suburban areas of the Coastal Bend is predominantly white. All of these groups have access to recreational fishing in coastal waters, and beach recreation, especially on barrier islands.

The Louisiana, Mississippi, and Alabama Gulf coastal areas adjacent to the Central and Eastern Planning Areas are known for their recreational fishing. Tourists enjoy beach activities and recreational fishing on the Alabama coast, staying in the many high-rise condos to the east of Mobile Bay. Tourism and recreation is a major industrial sector, contributing to the local economy in dollars spent for hotels, restaurants, and beach- and fishing-oriented retail products. These are the most important sociocultural aspects of Gulf states needed for analysis of potential impacts of OCS activities.

Several groups living in the Louisiana Gulf coast are central to the culture of the region and rely on fisheries and related marine resources. Cajuns recreationally harvest fish and shellfish from the bayous (Henry and Bankston, 2002). The United Houma Nation and the Chittimacha Tribe in southeast Louisiana depend on subsistence diets, recovering foods from coastal areas (Brightman, 2004; Campisi, 2004). Vietnamese fishers, who fish in the near offshore, retain up to 25 percent of their catch for family and barter use (Alexander-Bloch, 2010).

The oil and gas industry is a part of the culture of the Gulf of Mexico also. For example, Port Fourchon has historically been a land base for offshore oil support services as well as a land base for the Louisiana Offshore Oil Port (LOOP). The overwhelming majority (>95 percent) of tonnage handled at the LOOP is oil and gas related (www.portfourchon.com).

4.3.16.4. Atlantic Program Area

The Atlantic coast adjacent to the Atlantic Program Area has a mixture of highly developed urban areas, recreational areas, and undeveloped rural lands. The north Virginia coast is home to vital estuaries, small towns, hotels, and recreational fishing. On its southern border with North Carolina is Norfolk, a city whose population in 2010 was 243,000 (Wilson and Fischetti, 2010). The region's cargo ports support the largest economic sector in Hampton Roads and Norfolk. Headquartered in Norfolk, the Virginia Port Authority (VPA) is a Commonwealth of Virginia-owned entity that, in turn, owns and operates three major port facilities in Hampton Roads for break-bulk and container type cargo. In Norfolk, Norfolk International Terminals (NIT) represents one of those three facilities, and is home to the world's largest and fastest container cranes. Together, the three terminals of the VPA handled more than 2 million 20-ft equivalent units and 475,000 tons of breakbulk cargo in 2006, making it the second busiest port on the Atlantic coast of North America by total cargo volume, after the Port of New York and New Jersey. The area is on the Interstate Highway System and has railroad access connecting the ports to inland areas where goods moving in and out of the ports are consumed.

The Outer Banks of North Carolina is a collection of narrow barrier islands with many hotels and beach houses. The Outer Banks spans all of Dare County and has a population of 33,920 as of 2010 (Wilson and Fischetti, 2010). Tourism, beach activities, and recreational fishing dominate the economy.

From the coast of southern North Carolina to northern Florida, runs the Gullah Geechee Cultural Heritage Corridor, designated by Congress in 2006 (www.Corridor.org). The Gullah Geechee are linked to Sierra Leone, as their ancestors were brought forcefully to America during the slave trade. They have retained many aspects of their original African heritage due to geographic barriers of the coastal landscape, a long period of isolation in these coastal rural areas, and the strong sense of place and family. The Gullah Geechee reside mostly in the Sea Islands of South Carolina (Gullah) and Georgia (Geechee) (Transatlantic, 2015). Marquetta Goodwine is the Chieftess of the Gullah Geechee Nation. Speaking for her culture, she says, "Fishing is the heart of the Gullah Geechee people" (Ellis et al., 2014).

The coastal area adjacent to the South Atlantic Program Area is home to Charleston, South Carolina. The population of Charleston in 2010 was 123,110 (Wilson and Fischetti, 2010). The Port of Charleston, owned and operated by the South Carolina Ports Authority, is one of the largest ports in the U.S.; it consists of five terminals, and a sixth will open in 2018. Port activity at the two terminals located in the city of Charleston is one of the city's leading sources of revenue, behind tourism. Today, the Port of Charleston has the deepest port in the southeast region.

4.3.17. Environmental Justice (Executive Order 12898)

The fundamental tenet of environmental justice is fair treatment and meaningful involvement of all people in the environmental decision-making process, particularly minority, low-income, and indigenous populations. Environmental justice requires the same degree of environmental quality and protection from health hazards and equal access to the decision-making process in all communities.

E.O. 12898 (59 FR 7629; February 11, 1994), establishes federal agency responsibilities for environmental justice:

> 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 Mariana Islands. Section 1-101.

In 1997, the CEQ (1997b) issued guidance for implementing E.O. 12898 under NEPA (Guidance). Among other things, the Guidance provides the following definitions for several key terms used in the executive order –

> **Low-income population**: Low-income populations in an affected area should be identified with the annual statistical poverty thresholds from the Bureau of the Census' Current Population Reports, Series P-60 on Income and Poverty. In identifying low-income populations, agencies may consider as a community either a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect.

> **Minority**: Individual(s) who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic.

> **Minority population**: Minority populations should be identified where either: (a) the minority population of the affected area exceeds 50 percent or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis. In identifying minority communities, agencies may consider as a community either a group of individuals living in geographic proximity to one another, or a geographically dispersed/transient set of individuals (such as migrant workers or Native American), where either type of group experiences common conditions of environmental exposure or effect. The selection of the appropriate unit of geographic analysis may be a governing body's jurisdiction, a neighborhood, census tract, or other similar unit that is to be chosen so as to not artificially dilute or inflate the affected minority population. A minority population also exists if there is more than one minority group present and the minority percentage, as calculated by aggregating all minority persons, meets one of the above-stated thresholds.

Disproportionately high and adverse human health effects: When determining whether human health effects are disproportionately high and adverse, agencies are to consider the following three factors to the extent practicable:

(a) Whether the health effects, which may be measured in risks and rates, are significant (as employed by NEPA), or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death;

(b) Whether the risk or rate of hazard exposure by a minority population, low-income population, or Indian Tribe to an environmental hazard is significant (as employed by NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group; and

(c) Whether health effects occur in a minority population, low-income population, or Indian Tribe affected by cumulative or multiple adverse exposures from environmental hazards.

Disproportionately high and adverse environmental effects: When determining whether environmental effects are disproportionately high and adverse, agencies are to consider the following three factors to the extent practicable:

(a) Whether there is or will be an impact on the natural or physical environment that significantly (as employed by NEPA) and adversely affects a minority population, low-income population, or Indian Tribe. Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural or physical environment;

(b) Whether environmental effects are significant (as employed by NEPA) and are or may be having an adverse impact on minority populations, low income populations, or Indian Tribes that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group; and

(c) Whether the environmental effects occur or would occur in a minority population, low-income population, or Indian Tribe affected by cumulative or multiple adverse exposures from environmental hazards.

This Programmatic EIS has a three-part analytical methodology: (1) describing the geographic distribution of low-income and minority populations in each Program Area; (2) assessing whether oil and gas activities at any stage of development would produce reasonably foreseeable impacts that are high and adverse in those areas; and (3) if impacts are high and adverse, determining whether the impacts would disproportionately affect minority and low-income populations. The geographic distribution of minority and low-income groups is based on demographic data from the 2013 American Community Survey (ACS) conducted by the U.S. Census Bureau. Data were collected at the "shoreline" county level for all coastal shoreline counties. Tables in **Appendix C**, Section 15, list the percentage of people living below the poverty by state and county in planning areas. Note that the poverty thresholds take into account family size and age of individuals in the family. In 2014, for example, the poverty line for a family of five with three children below the age of 18 was $28,252 whereas, the threshold was $12,071 for a single adult (Census Poverty, 2014).

4.3.17.1. Beaufort and Chukchi Sea Program Areas

The Beaufort Sea Planning Area is seaward of the Iñupiat Native Villages of Kaktovik and Nuiqsut, and reaches just east of the Native Village of Barrow. Native Villages are the tribal entity within the geographic place (e.g., town, city). For a detailed reference to the sociocultural environment (most notably subsistence harvest activities) of this area, see **Section 4.3.16**.

Factors that can affect these communities are their vulnerability to storms and storm surge, shoreline change (erosion and accretion), cost of living, and distant proximity to hospitals, grocery stores, and modern conveniences. Because these villages are so remote, the cost of living and scarcity of food sources are high. Healthcare, treatment, and emergency care requires plane travel to metropolitan areas.

Social vulnerabilities can make it more difficult for communities to recover after a disaster: "…evidence indicates that the poor are more vulnerable at all stages—before, during, and after—of a catastrophic event. The findings are similar for racial and ethnic minorities; children, elders, or disabled people…" (Flanagan, 2011).

Figure 4.3.17-1 shows the percent below the poverty level for coastal states adjacent to the Program Areas. Macartney, et al. (2013) estimated that in the previous 12 months in the City of Kaktovik, 17.4 percent of the population lived below the poverty level. This is 7.1 percent higher than the average for the NSB, and 2.0 percent higher than the national average of 15.4 percent. In the city of Nuiqsut, 3.7 percent of the population lived below the poverty level. This is 6.6 percent lower than the average for the NSB and 11.7 percent lower than the national average (Macartney et al., 2013).

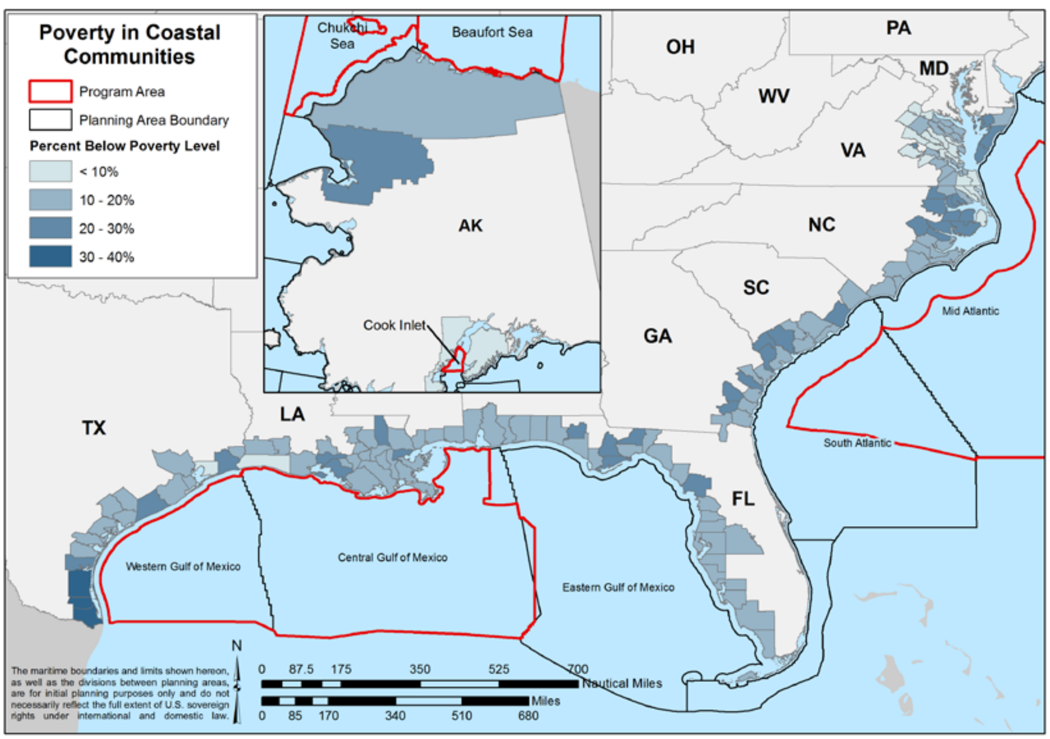


Figure 4.3.17-1. Percent of Population Below Poverty Line in Coastal Communities.

Minority data were analyzed using the USEPA mapping application EJSCREEN, which uses 2010 census data to display communities that may be more vulnerable than others to disasters or negative impacts. In the city of Kaktovik, 88.7 percent of the population identifies themselves as American

Indian/Alaska Native. In the city of Nuiqsut, 87.1 percent of the population identifies themselves as American Indian/Alaska Native (Wilson and Fischetti, 2010).

The Chukchi Sea Planning Area is seaward of the Iñupiat Native Villages of Barrow, Wainwright, Point Lay, and Point Hope. For a detailed reference to the sociocultural environment (most notably subsistence harvest activities) of this area, see **Section 4.3.16**.

Figure 4.3.17-1 shows the percent below the poverty level for coastal states adjacent to the Program Areas. Macartney et al. (2013) estimated that in the past 12 months in Barrow, 12.0 percent of the population lives below the poverty level. This is 1.7 percent higher than the average for the NSB and 3.4 percent lower than the national average. In the city of Wainwright, 16.9 percent of the population lives below the poverty level. This is 4.6 percent higher than the average for the NSB and 1.5 percent higher than the national average. In the village of Point Lay, 13.2 percent of the population lives below the poverty level. This is 2.9 percent higher than the average for the NSB and 2.2 percent lower than the national average. In the village of Point Hope, 9.7 percent of the population lives below the poverty level. This is 0.6 percent lower than the average for the NSB and 5.7 percent lower than the national average. **Table 4.3.17-1** shows the percentage and of the population by gender that is below the poverty level (Macartney et al., 2013).

Table 4.3.17-1. Percentage of Female and Males Living Below the Poverty Level, Within Each Jurisdiction (Macartney et al., 2013).

Highlighted Jurisdictions	Percentage of Population-Alaska Native	
	% Living Below Poverty Female	% Living Below Poverty Male
Kaktovik	22.2	14.2
Barrow	13.2	10.9
Wainwright	16.7	17.0
Point Lay	21.4	7.5
Point Hope	11.7	7.9

Climate change is occurring much more rapidly in the Arctic than in the rest of the world. The annual temperatures in Alaska have increased by 3.6°F, and winter temperatures have increased by 5°F since the 1950s (Arctic Council, 2004). Evidence of climate change exists in and around Kaktovik, including failed ice cellars, shallower lakes, and areas where the ground has collapsed. These conditions have been attributed to thawing permafrost from higher temperatures. Failure of ice cellars from rising temperatures and increased flooding is resulting in a lack of enough places for safe handling and storing of subsistence harvest materials. In addition, climate change has other impacts that will affect Kaktovik: a later freeze up has been associated with increased erosion from coastal storms; ocean acidification is occurring faster in Arctic waters than in other areas; reduced sea ice cover is affecting ice-dependent species such as ice seals and polar bears; thawing permafrost releases methane gas which in turn speeds up climate change; general drying trends could lead to more tundra wildfires; vegetation composition is changing with more brush cover than in the past; changing climate impacts the distribution and numbers of fish and wildlife which in turn impacts subsistence hunting, fishing and gathering (NSB, 2005). (Kaktovik Comprehensive Plan).

"…participation in traditional subsistence activities is a vital part of maintaining cultural integrity on the North Slope. The Native Village of Barrow and the NSB both organize subsistence classes and community events such as traditional whaling feasts that celebrate subsistence as a source of cultural pride." (NSB DHSS 2012, 90).

Barrow is unique amongst the NSB communities in that it is more culturally and ethnically diverse, but also is considered the transportation hub and seat of the local governments.

> *"…Barrow is truly unlike other communities. Its remote location makes access and transportation logistically difficult and expensive. It is considered to be one of the coldest and driest places in the United States, with an annual average temperature of*

about 12 degrees Fahrenheit (°F) and less than five inches of annual precipitation. Barrow is also the borough seat of government where diverse issues converge, among them Native Iñupiat subsistence rights, oil and gas development activity and study of climate change in the Arctic" (Barrow Comprehensive Plan, 2014).

One factor that makes these coastal communities even more vulnerable to the elements is shoreline change, which has been cause for certain communities to abandon previous settlements and move their villages more inland.

"Erosion of the shoreline of the Chukchi Sea has been taking place in Wainwright for over four decades. Public testimony in Wainwright indicated that some houses in the community have been moved as many as three times since 1965 to avoid Chukchi Sea erosion of the coastal bluffs. Some from Wainwright said that they believe coastal erosion accelerated when the beach in front of Wainwright was mined for gravel in 1967. The disappearance of ice cellars next to the coast as well as the loss of high coast bluffs were also reported by residents" (Wainwright Comprehensive Plan, 2014).

4.3.17.2. Cook Inlet Program Area

Cook Inlet is home to the majority of Alaska's population and intersects the Kenai Peninsula Borough. Onshore of the Cook Inlet Planning Area is the Native Village of Nanwalek, the Native Village of Port Graham, the Kenaitze Indian Tribe, the Ninilchik Village Tribe, the Eklutna Native Village, the Village of Salamatof, the Seldovia Village, and the Native Village of Tyonek, which are all distinct, minority communities.

Subsistence fisheries, be it a cultural tradition, a means of nutritional sustenance, or a combination of these, is central to the culture of Cook Inlet, and is allowed for all residents of the state. 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 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 4.3.16**.

Figure 4.3.17-1 shows the percent of the population below the poverty level for coastal states adjacent to the Program Areas. In the KPB, 8.6 percent of the population lives below the poverty level. This is 1.3 percent lower than the average for the State of Alaska and 5.5 percent lower than the national average of 15.4 percent. Approximately 11 percent of all residents of the KPB identify as a minority. Estimates in the past 12 months in the KPB show that 8.9 percent of the population that lives below the poverty level were female, and 8.3 percent were male. **Table 4.3.17-2** shows the percentage of the population by gender that is below the poverty level (Macartney et al., 2013).

Table 4.3.17-2. Percentage of Female and Males Living Below the Poverty Level, Within Each Jurisdiction (Macartney et al., 2013).

Highlighted Jurisdictions	% Total Population Living Below Poverty	% of the Total Population-Female Living Below Poverty	% of the Total Population-Male Living Below Poverty
Kenai Peninsula Borough	**8.6**	**8.9**	**8.3**
Cohoe	16.1	15.8	16.4
Ninilchik	16.9	18.0	15.9
Tyonek	21.7	23.3	20.0
Beluga	40.0	0.0	66.7

Several thousand Alaskans participate in subsistence fishing and processing, and it is an important element of Alaska's social and cultural heritage.. Subsistence fishing and hunting are important parts of the economies of rural Alaskan communities, providing food, clothing, and employment. Subsistence food sources contribute approximately 39 percent of the caloric requirements of the rural population (ADFG, 2014). Approximately 2.5 percent of daily caloric requirements of urban populations is met through subsistence activities (ADFG, 2014).

Although it is difficult to establish the economic importance of subsistence harvests because the consumption and exchange of subsistence products typically do not occur in the marketplace, estimates of their importance have been made based on the dollar value of replacing such products in the commercial market. Using a replacement value of $4 per pound, the replacement value of subsistence harvests in rural Arctic Alaska is estimated to be $44 million annually; at $8 per pound, the replacement value is estimated at $88 million. In Alaska as a whole, the replacement value of subsistence products is estimated to be $201 million annually (ADFG, 2014).

4.3.17.3. Gulf of Mexico Program Area

The Western Gulf of Mexico Planning Area is seaward of coastal counties off Texas. For a detailed reference to the sociocultural environment of this area, see **Section 4.3.16.**

Minority data were analyzed using the USEPA mapping application EJSCREEN, which uses 2010 census data to display communities that may be more vulnerable than others to disasters or negative impacts. Nueces County, home to Corpus Christi, is in the 79th percentile in the nation for minority populations. This county is also home to a distinct community, a state-recognized tribe, the Lipan Apache Tribe. In the top percentiles in the state for minority populations also are Kleberg, Kenedy, Willacy, and Cameron Counties.

Figure 4.3.17-1 shows the percent of the population below the poverty level for coastal states adjacent to the Program Areas. In Cameron and Kenedy Counties, the percentage of the population living below the poverty level is 34.8 percent and 32.8 percent, respectively. In Willacy County, 40 percent of the population lives below the poverty level. This is 22.4 percent higher than the average for the State of Texas and 24.6 percent higher than the national average of 15.4 percent. **Table 4.3.17-3** shows the percentage of the total population, and of females and males living below the poverty level within the highlighted counties (Macartney et al., 2013).

Table 4.3.17-3. The Percentage of Female and Males Living Below the Poverty Level Within the Highlighted Counties (Macartney et al., 2013).

Highlighted Jurisdictions	% Total Population Living Below Poverty	% of the Total Population-Female Living Below Poverty	% of the Total Population-Male Living Below Poverty
Cameron, Texas	34.8	36.7	32.7
Kenedy, Texas	32.8	36.7	28.8
Willacy, Texas	40.0	41.9	38.0

The Central Gulf of Mexico Planning Area is seaward of coastal counties off Louisiana, Mississippi, Alabama, and a small portion of Florida. For a detailed reference to the sociocultural environment of this area, see **Section 4.3.16**.

On the coast of Louisiana, there is one federally recognized tribe, the Chitimacha Tribe of Louisiana, and three state-recognized tribes, the Biloxi-Chitimacha Confederation of Muskogee, the Pointe-Au-Chien Indian Tribe, and the United Houma Nation, all residing in Lafourche, Terrebonne, and Jefferson Parishes. These tribes are especially vulnerable to impacts from shoreline erosion and saltwater intrusion due to their location on the coast. Additional geographic vulnerabilities for this area are storms and storm surge as well as shoreline erosion and accretion.

Table 4.3.17-4 shows the percentage of the total population, and of females and males living below the poverty level, within the highlighted jurisdictions (Macartney et al., 2013). Orleans Parish has a poverty rate that is 8.2 percent higher than the average for the State of Louisiana and 11.9 percent higher than the nation average. In Harrison County, Mississippi, the poverty rate is 2.8 percent lower than the average for the State of Mississippi and 4.5 percent higher than the national average. In Mobile County, Alabama, the poverty rate is 1.2 percent higher than the average for the State of Alabama and 4.4 percent higher than the national average. Plaquemines Parish, the parish that reaches farthest into the Gulf of Mexico, is in the 90th percentile in the nation for minority populations. For further county comparisons, see **Appendix C**, Section 15.

Table 4.3.17-4. Percentage of Female and Males Living Below the Poverty Level, Within the Highlighted Areas (Macartney et al., 2013).

Highlighted Jurisdictions	% Total Population Living Below Poverty	% of the Total Population-Female Living Below Poverty	% of the Total Population-Male Living Below Poverty
Orleans Parish, Louisiana	27.3	29.5	25.0
Harrison County, Mississippi	19.9	21.6	18.2
Mobile County, Alabama	19.8	21.8	17.6

4.3.17.4 Atlantic Program Area

In the Atlantic Program Areas (from North Carolina through Georgia) (**Figure 4.3.17-1**), the Gullah and Geechee people of the Gullah/Geechee Cultural Heritage Corridor have a rich cultural and spiritual connection to their coastal waters. Gullah and Geechee communities subsist on fish and other coastal resources that compose staples of the Gullah/Geechee diet, culture, and economy.

The Mid-Atlantic Planning Area is seaward of coastal counties off Virginia and North Carolina. For a detailed reference to the sociocultural environment of this area, see **Section 4.3.16**.

Table 4.3.17-5 shows the percentage of the total population, and of females and males living below the poverty level, within the highlighted jurisdictions (Macartney et al., 2013). Richmond City has a poverty rate that is 14.3 percent higher than the average for the State of Virginia and 10.2 percent higher than the national average. In Chowan County, North Carolina, the poverty rate is 11.5 percent higher than the average for the State of North Carolina and 13.6 percent higher than the national average. In Jasper County, South Carolina, the poverty rate is 5.6 percent higher than the average for the State of South Carolina and 8.3 percent higher than the national average. In Charlton County, Georgia, the poverty rate is 1.5 percent higher than the average for the State of Georgia and 4.3 percent higher than the national average. For further county comparisons, see **Appendix C**, Section 15.

Table 4.3.17-5. Percentage of Female and Males Living Below the Poverty Level, Within the Highlighted Areas (Macartney el al., 2013).

Highlighted Jurisdictions	% Total Population Living Below Poverty	% of the Total Population Female Living Below Poverty	% of the Total Population Male Living Below Poverty
Richmond, Virginia	25.6	28.0	23.0
Chowan County, North Carolina	29.0	30.1	27.8
Jasper County, South Carolina	23.7	24.5	22.9
Charlton County, Georgia	19.7	19.0	20.3

Virginia is home to one federally recognized tribe in the affected area, the Pamunkey Indian Tribe, located in King William County, as well as 10 state tribes: the Patawomeck Tribe, Nottoway Tribe, Cheroenhaka Tribe, Nansemond Tribe, Rappahannock Tribe, Mattaponi Tribe, Upper Mattaponi Tribe, Eastern Chickahominy Tribe, Monacan Indian Tribe, and Chickahominy Indian Tribe. North Carolina is home to one state-recognized tribe in the affected area, the Meherrin Nation, located in Hertford County.

Minority data were analyzed using the USEPA mapping application EJSCREEN. Bertie County, just south of the Meherrin Nation is in the 94th percentile in the nation for minority populations.

The South Atlantic Planning Area is seaward of coastal counties off of South Carolina and Georgia. For a detailed reference to the sociocultural environment of this area, see **Section 4.3.16**. In Jasper County, South Carolina, 23.7 percent of the population lives below the poverty level. This is 5.6 percent higher than the average for the State of South Carolina and 8.3 percent higher than the national average.

South Carolina is home to six state tribes in the affected area: the Waccamaw Indian People of Aynor, Pee Dee Indian Tribe of South Carolina, Chicora Indian Tribe of South Carolina, Santee Indian Organization, Winyah Indian People, and Yamassee Indian Tribe.

In Charlton County, Georgia, 19.7 percent of the population lives below the poverty level. This is 1.5 percent higher than the average for the State of Georgia and 4.3 percent higher than the national average. Liberty County (100 miles northeast of Charlton County) is in the 87th percentile in the nation for minority populations. Georgia is home to one state-recognized tribe in the affected area, The Cherokee of Georgia Tribal Council, located in Charlton County.

4.4. IMPACT ASSESSMENT

Impact levels are defined in **Section 4.1.2**; analyses in the following sections rely on these definitions such that the basis for an impact finding is directly applicable to how that impact level is defined. Fully predicting the degree of effect is impossible at the programmatic scale being considered here. It is; therefore, imperative that any subsequent approvals of more regional or site-specific analyses consider the most recent science available at the time of the decision.

4.4.1. Alternative A – The Proposed Action

Section 2.3 describes Alternative A by Program Area. This section discusses moderate to major impacts that may result in Program Areas from routine events under the Proposed Action, or any slight timing-related options described in **Section 2.4**. Negligible to minor impacts are identified for all resource areas in **Appendix D**. Discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**.

Some impacts involve features specific to particular Program Areas, and these are identified as warranted. However, most conclusions on impacts involve considerations that are common to all Program Areas. For this reason, the discussion of impacts for Alternative A in this section is not structured by Program Areas. Furthermore, the discussion does not address OCS planning areas, which either encompass an entire Program Area (Chukchi Sea, Beaufort Sea, Cook Inlet) or are adjacent areas in the Gulf of Mexico Program Area (Western and Central Gulf of Mexico) or Atlantic Program Areas (Mid- and South Atlantic) whose separate consideration would not lead to different conclusions on impacts.

4.4.1.1. Air Quality

Potential impacts to air quality associated with the Proposed Action include routine operations involving emissions from vessels, helicopters, stationary engines such as generators, and fugitive emissions. In addition, accidental events may result in emissions from the spill, or from *in situ* burning and vessels used for cleanup. In addition, icebreakers are expected to be used in Cook Inlet and the Beaufort and Chukchi Seas. See the E&D scenarios in **Section 3.1.2** for information on anticipated equipment. While there may be some expansion or modification to existing port facilities, it is unlikely major construction activities will occur onshore. Discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**.

Routine Operations

The criteria pollutants released by OCS sources include CO, NO_2, PM, and SO_2. NO_x and VOCs released by OCS sources are precursor pollutants for O_3, which is formed through photochemical reactions in the atmosphere. When examining the NAAQS Secondary Standards, the USEPA examines NO_x, which includes nitrogen oxide (NO) and nitrogen dioxide (NO_2), and also SO_x, which includes many sulfur oxide varieties (USEPA, 2015d). For consistency, BOEM will do the same in this analysis because this could only overestimate the amount of NAAQS emitted by the Proposed Action.

Table 4.4.1-1 provides the estimated high-case air emissions from OCS activities by planning area for the Proposed Action. These emissions were estimated using emission factors from BOEM's 2012 Revised OECM. This includes emissions increases from diesel and gasoline engines used to power vehicles, aircraft, and vessels used to transport equipment, personnel, and oil products along with all operations, such as drilling equipment and generators.

Table 4.4.1-1. Estimated Air Emissions from the Proposed Action's OCS Activities in Thousands of Tons and Based on the High Case E&D Scenario from the Offshore Economic Cost Model (USDOI, BOEM, 2015c).

Pollutant	Western Gulf of Mexico	Central and Eastern Gulf of Mexico	Mid and South Atlantic	Beaufort Sea	Chukchi Sea	Cook Inlet
NO_x	222.23	1,271.65	177.14	2656.44	783.48	46.83
SO_x	4.78	31.44	4.85	34.32	16.48	2.19
PM_{10}	7.33	40.35	5.16	131.07	36.72	1.19
$PM_{2.5}$	7.12	39.17	5.01	117.58	33.03	1.15
CO	60.81	319.15	51.76	1068.87	297.12	13.00
VOC	11.31	63.29	16.67	320.29	151.08	15.34

CO = carbon monoxide; NO_x = nitrogen oxides; PM = particulate matter; SO_x = sulfur oxides; VOC = volatile organic compound.

Due to USEPA regulations restricting air emissions, routine oil and gas operations are required to limit NO_x, SO_x, PM_{10}, and $PM_{2.5}$ emissions. Impacts in nonattainment areas are expected to be relatively small due to regulatory requirements from BOEM's plan approvals process and the USEPA's permitting process. Both require operators to mitigate impacts if operations affect any nonattainment areas. These mitigations could include offsets or control technology if an action would otherwise affect nonattainment areas. For operations with the potential to impact attainment areas, incremental concentrations of NO_x, SO_x, and PM_{10} are required to be within the maximum allowable PSD increments, and no significant impacts from CO are expected. This will be demonstrated through the USEPA's PSD permit process or BOEM's plan approval process, depending on agency jurisdiction. There could be some visibility impacts due to O_3 formation from NO_x, PM_{10}, and $PM_{2.5}$ emissions; however, these are expected to be minor. There is ongoing research by BOEM to better establish the impact of oil and gas OCS operations on visibility, and the contribution of criteria pollutants onshore. These studies are expected to close in 2017 in the Arctic, and in 2018 in the Gulf of Mexico.

Despite each region having differing levels of emissions and geographical distributions (e.g., distance from shore of emissions sources), impacts are expected to be similar across all Program Areas. The reason for this is activities associated with the Proposed Action that may have negative impacts on air quality are required to comply with BOEM and USEPA regulations to mitigate impacts such that affected areas are expected to make a complete recovery.

The Proposed Action's overall impact on air quality over the OCS and adjacent onshore areas is **moderate**. Emissions of airborne pollutants during oil and gas activities on the OCS will increase pollutant concentrations over adjacent onshore areas. However, due to the dispersion and mixing of pollutants in the atmosphere and regulations requiring the use of emissions control technology or equipment meeting air emissions standards, measurable impacts at the nearest air quality monitoring stations will be **minor** to **moderate**. Despite the differences in industrial infrastructure offshore and onshore and different attainment area status near the program areas, impacts will be similar due to the ability for air quality, and any damage caused by degraded air quality, to recover after emissions cease. BOEM and USEPA regulations require mitigations to prevent or reduce impacts in areas defined as nonattainment by USEPA. For operations that do not demonstrate the potential to impact attainment status, existing methods of regulating pollutants by the USEPA and BOEM are expected to maintain USEPA defined attainment statuses. These existing regulations will also prevent the deterioration of air quality in nearby Class I Areas and reduce impacts to Sensitive Class II Areas from oil and gas development.

4.4.1.2. Water Quality

Through preliminary screening of the activities and affected resources, IPFs for water quality are (1) routine discharges, (2) drilling mud/cuttings/debris, (3) seafloor/land disturbance, and (4) non-routine events (**Table 3.5-3**). An overview of the potential impacts to water quality associated with the Proposed Action, including routine operations and accidental events, is presented in **Figure 4.4.1-1**. Discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**.

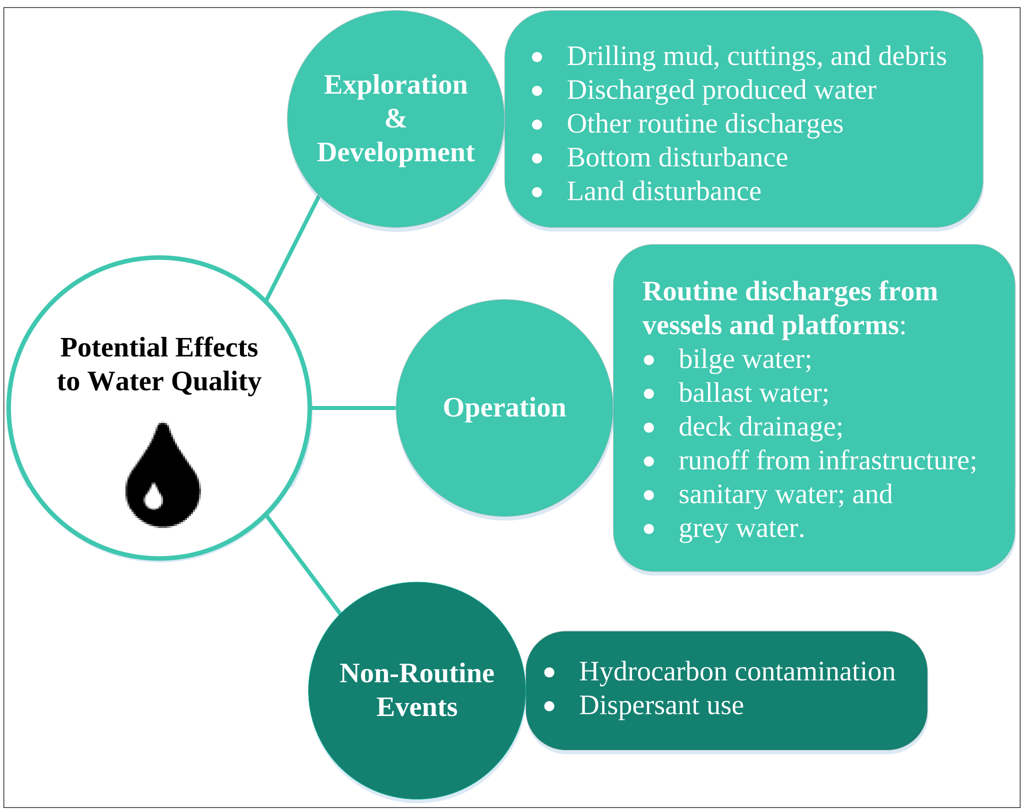


Figure 4.4.1-1. Overview of Potential Impacts to Water Quality.

Routine Operations

Routine Discharges

Routine discharges include sanitary wastes, gray water, cooling water, and other miscellaneous discharges (e.g., bilge, ballast, and fire water; deck drainage). Sources of these discharges are vessels (support, service/construction, seismic, and drilling) and platforms. The types of discharges are discussed in **Section 3.5**.

Vessel traffic for geological and geophysical (G&G) surveys, supply vessels, and other vessels associated with platform use could add to these routine discharges. Discharges would occur during normal operations, in small volumes, and would produce local and temporary effects on water quality. Discharges are expected to be diluted and dispersed rapidly through mixing by currents. Compliance with applicable state-issued or federal National Pollution Elimination System (NPDES) permits and USCG regulations would prevent or minimize most impacts on receiving waters. In the Atlantic and Chukchi coastal waters, routine discharge sources would primarily be from vessels traveling to and from ports. This is due to the proposed 80.5-km (50-mi) buffer in the Atlantic and the existing 40.2-km (25-mi) Presidential withdrawal in the Chukchi.

The Proposed Action would contribute to the use of new and existing onshore facilities located throughout the Program Areas. These onshore support facilities would discharge into local wastewater treatment plants and waterways during routine operations and could impact coastal water quality; the types of onshore facilities are discussed in **Section 3.1**. Indirect impacts could occur from nonpoint-source runoff such as rainfall that has drained from infrastructure (e.g., a public road or parking lot) and may contribute hydrocarbons, trace-metal pollutants, and suspended sediments. These indirect impacts would be minimal due to existing regulations and difficult to discern from other sources. All discharges are regulated by the state, the USEPA and NPDES permitting, or the USCG (**Table 4.4.1-2**). Within marine waters, routine discharges would occur from platforms, drilling vessels, and supply and service/construction vessels as part of normal operations and could contribute to degradation of water quality.

Table 4.4.1-2. Operational and Routine Discharges and Their Disposal Regulations.

IPF	Includes	Occurrence		Disposal		Regulated by
		Coastal	Marine	Coastal	Marine	
Routine Discharges	Sanitary Waste	N/A	X	N/A	Routinely processed through onsite USCG-approved marine sanitation devices before ocean discharge[1]	Sections 402 and 403 of the CWA -NPDES permits
	Gray water	N/A	X	N/A	Screen to remove solids than discharged[1]	
	Miscellaneous water (bilge, ballast, and fire water and deck drainage) including those from service vessels	X	X	Open ocean discharge	Open ocean discharge	All point-source discharges are regulated by USEPA and NPDES storm-water effluent limitation guidelines USCG bilge and ballast water regulations based on the MARPOL Annex I, Regulations for the Prevention of Pollution by Oil
	Point and nonpoint source discharges from onshore facilities	X	N/A	Discharge into local wastewater treatment plants and waterways during routine operations	N/A	All point-source discharges are regulated by USEPA and NPDES stormwater effluent limitation guidelines control stormwater discharges

Table 4.4.1-2. Operational and Routine Discharges and Their Disposal Regulations (Continued).

IPF	Includes	Occurrence		Disposal		Regulated by
		Coastal	Marine	Coastal	Marine	
Routine Discharges (cont).s	Cooling water	N/A	X	N/A	Open ocean discharge	Cooling water discharge is regulated through NPDES permits as established by Section 316(b) of the CWA.
Operational Discharges	Drilling muds/cuttings – SBM and WBM	N/A	X	N/A	Discharge of SBM is prohibited under the CWA, but the SBM-wetted cuttings, WBM, and WBM cuttings are permitted for ocean discharge as long as they meet local regulatory requirements. The spent SBM fluid must be transported to shore for reuse or disposal.	Within Marine Waters, must comply with an existing NPDES permit
	Produced water	N/A	X	N/A	The produced water must be treated then ocean discharge	Within marine waters, must comply with an existing NPDES permit
	Debris	X	X	The discharge or disposal of solid debris from OCS structures and vessels is prohibited	The discharge or disposal of solid debris from OCS structures and vessels is prohibited	

CWA = Clean Water Act; MARPOL = International Convention for the Prevention of Pollution from Ships; N/A = not applicable; NPDES = National Pollutant Discharge Elimination System; OCS = Outer Continental Shelf; SBM = synthetic-based mud; USCG = U.S. Coast Guard; USEPA = U.S. Environmental Protection Agency; WBM = water-based mud.
[1] Waste recovered from the treatment processes would be containerized and shipped to shore for disposal

Additional operations potentially affecting coastal and marine water quality include operational discharges from exploration, development, production wells, and from production structures (i.e., platforms [including gravel islands] and FPSOs). These operational discharges include drilling muds, cuttings, and produced water. Drilling muds, cuttings, and produced water are described in **Section 3.5**. In the Atlantic, the Proposed Action includes an 80.5-km (50-mi) buffer zone from the coast for all activities; therefore, these discharges will have no impact on coastal waters.

The volume of the water-based drilling fluids and cuttings at each wellsite will vary depending on the well characteristics (diameter and depth). Environmental effects of discharged muds and cuttings are localized because of settling, mixing, and dilution (Neff, 2005). While the total volumes of drilling muds and cuttings discharged to the ocean during drilling operations are large, impacts to water quality are minimal (NRC, 1983; Neff, 2005). Discharges of small amounts of materials are intermittent and take place only during drilling operations, spaced over a few to several months. As such, discharged drilling mud does not increase to high concentrations in the water column and affects only a small parcel of water (Neff, 2005). According to the NRC (1983) and Neff (2005), periodic minor increases in turbidity reflecting suspended particulate material concentrations in the upper water column during mud and cuttings discharges are unlikely to have an environmentally significant effect on water quality. Once discharged, the larger particles of cuttings, representing approximately 90 percent of the mass of the mud solids, form a plume that settles quickly to the bottom within 100 m (328 ft) of the discharge point (Neff et al., 2000). The remaining mass forms another plume in the upper water column that drifts with prevailing currents away from the platform and is rapidly diluted in the receiving waters within approximately 1 to 2 km (3,281 to 6,562 ft) downcurrent from the discharge (NRC, 1983; Neff et al., 2000; Neff, 2005).

Within the Chukchi Sea, impacts to the coastal environment will be further mitigated by the 40.2-km (25-mi) coastline buffer under the Proposed Action. Within the Mid- and South Atlantic Ocean, impacts to the coastal environment will be further mitigated by the 80.5-km (50-mi) coastline buffer under the Proposed Action.

Generally, produced water is the largest individual discharge produced by normal operations (Veil et al., 2005) associated with oil and gas production. Commonly, the amount of produced water is low when production begins but increases over time near the end of the field life (NRC, 2003a). In a nearly depleted field, production may be as high as 95 percent water and 5 percent fossil fuels (Rabalais et al., 1991). The composition of produced water depends on whether crude oil or natural gas is being produced and generally includes a mixture of liquid or gaseous hydrocarbons, dissolved or suspended solids, produced solids such as sand or silt, and injected fluids and additives that may have been placed in the formation (e.g., biocides, corrosion inhibitors, water clarifiers) as a result of exploration and production activities (Veil et al., 2005).

Produced water may degrade water and sediment quality in the immediate vicinity of the discharge as it can contain elevated concentrations of salts, petroleum hydrocarbons, metals, and naturally occurring radioactive material (NORM), some of which are toxic and persist in the marine environment. Studies in coastal waters 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). In shallow shelf waters, hydrocarbons from produced water have been shown to accumulate in bottom sediments up to 300 m (984 ft) from an outfall (Rabalais et al., 1991). In offshore waters, contaminated sediments are localized around offshore platforms (NRC, 2003a).

Bierman et al. (2007) conducted a modeling study to assess the incremental impacts of produced water discharges on dissolved oxygen in the northern Gulf of Mexico, to determine the contribution to the hypoxic zone. The predicted incremental impacts of produced water on dissolved oxygen conditions from the model were small and had little impact on the hypoxic zone. Overall, impacts to water quality are expected from the discharge of produced water, but these impacts are anticipated to be localized, and background concentrations are expected to exist away from the immediate discharge location.
Figure 4.4.1-2 shows the environmental processes acting on produced water and drilling waste in the marine environment.

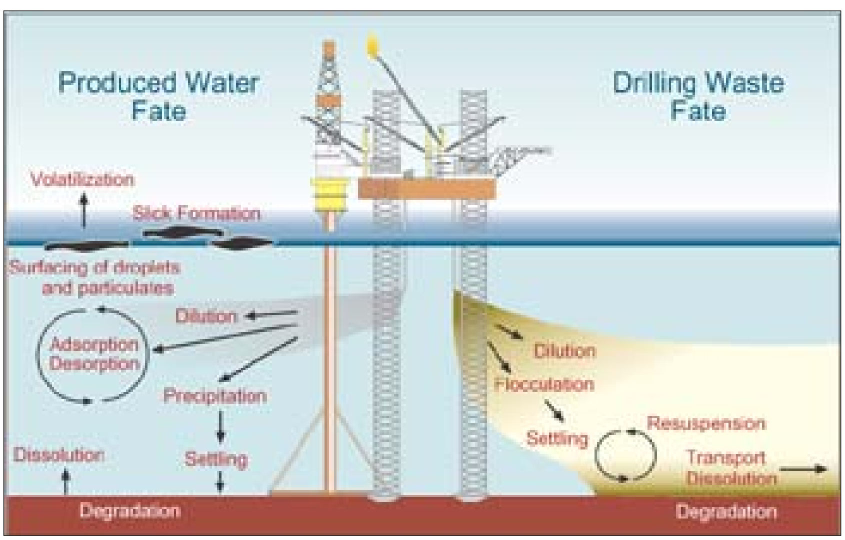


Figure 4.4.1-2. Major Processes Controlling the Environmental Fate of Wastes from Offshore Oil and Gas Drilling and Production Activities (From: http://www2.mar.dfo-mpo.gc.ca/science/review/e/html/2001/bio-english.html).

Impacts to coastal and marine water quality due to routine operations and operational discharges under the Proposed Action would be unavoidable. Compliance with NPDES permit requirements and USCG regulations would reduce or minimize impacts on receiving waters caused by discharges from normal operations. Impacts on water quality from routine operations associated with the Proposed Action are expected to range from **negligible** to **moderate** because there are considerable differences in impacts depending on Program Area and discharge type. Fully predicting the degree of effect from the Proposed Action is impossible at the programmatic scale considered here. It is, therefore, imperative that any subsequent approvals of more regional or site-specific analyses consider the most recent science available at the time of the decision as well as additional mitigations to limit the potential for impacts to water quality.

4.4.1.3. Marine Benthic Communities

IPFs that might cause moderate to major impacts to benthic sources include discharges, bottom-disturbing activities, accidental spills, and CDEs. Discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**.

Routine Operations

Routine Discharges

Drilling Muds, Cuttings, and Debris

As shown in **Section 3.5**, during the E&D phase, drilling cuttings and muds (including synthetic drilling fluids adhering to the cuttings) may be released and 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.

Studies have found drill cuttings may be detectable up to 1 km (0.6 mi) from the wellsite, depending on whether cuttings were discharged near the water surface or near the seafloor (Continental Shelf Associates, Inc., 2004, 2006). Concentrations of barium, heavy metals, hydrocarbons, and synthetic drilling fluids may be elevated around drillsites (Continental Shelf Associates Inc., 2004, 2006). Mud and cuttings discharged close to the seafloor will settle relatively quickly and deposit in thick, concentrated layers. Settled muds could smother organisms, change sediment characteristics and biogeochemical functions, and promote loss of food resources in the immediate area of the discharge. The biodegradable synthetic drilling fluids attached to the drilling waste may deplete oxygen (Trannum et al., 2010) and, therefore, could create local sediment anoxia. These impacts would be especially severe for immobile/sessile organisms that cannot avoid the impacted area (e.g., various invertebrates, algae, some fish). In the case of discharges released near the water surface in deep water, drilling muds would spread out in a thin veneer over a wide area. Their impacts would be less intense than discharges released closer to the seafloor. Evidence for biological, physical, and chemical recovery was detected 1 year after discharge, so full recovery may occur over several years as sediment contaminants biodegrade and are buried by natural deposition and bioturbation (Continental Shelf Associates, Inc., 2004, 2006). Thus, depending on the extent of impact and recovery time, impacts from drilling mud and cuttings discharge may be **negligible** to **moderate** in the immediate vicinity of the impact.

In summation, marine benthic community impacts from drilling mud, cuttings, and debris would be **moderate** in the immediate vicinity of the wells, but **negligible** overall.

Bottom/Land Disturbance

Drilling, Infrastructure Emplacement, Pipeline Trenching, and Structural Removal

Bottom-disturbing activities result in the physical disturbance of the seafloor during the exploration, production, or decommissioning phase of OCS operations (**Section 3.5**). The spatial extent of the seafloor disturbance and the magnitude of the effect on benthic organisms will depend on the specific activity, local environmental conditions (e.g., currents, water depth), and species-specific behaviors and habitat preferences.

Drilling new wells is one of the activities having the greatest impact potential due to the associated sedimentation/turbidity caused by the drilling process, and from the release of drilling cuttings and discharges (**Section 3.5**). Drilling an exploratory well produces approximately 2,000 metric tons of combined drilling fluid and cuttings, though the total mass may vary widely for different wells (Neff, 2005). Cuttings discharged at the surface tend to disperse in the water column and be distributed at low concentrations (Continental Shelf Associates, Inc., 2004). In deepwater, the majority of cuttings discharged at the sea surface likely will be deposited within 250 m (820 ft) of the well (Continental Shelf Associates, Inc., 2006). Cuttings shunted to the seafloor form piles concentrated within a smaller area than do sediments discharged at the sea surface (Neff, 2005).

Drilling impacts may be even higher in the Arctic Program Areas (Beaufort and Chukchi Seas) where specialized infrastructure is used to protect seafloor equipment from ice scour. One such device is a mudline cellar, which may be as tall as a five-story building. Such structures likely would cause a greater benthic disturbance around the drill hole than locations where such equipment is not needed or used.

Apart from the direct impacts of turbidity and sedimentation, the chemical content of drilling muds and cuttings (and, to a lesser extent, produced waters) are another potential IPF because these may contain hydrocarbons, trace metals (including heavy metals), elemental sulfur, and radionuclides (Kendall and Rainey, 1991; Trefry et al., 1995). Substances containing heavy metals and other potentially toxic compounds could be moderately toxic to benthic organisms, but only if the undiluted substances were to come into contact with the organisms (Continental Shelf Associates, Inc., 2004). Although the literature has not reported impacts to chemosynthetic organisms or corals resulting from exposure to contaminants in cuttings, infauna have shown effects at distances <100 m (330 ft) from the discharge. These include reduced reproductive fitness, altered populations, and acute toxicity (Hart et al., 1989; Chapman et al., 1991; Carr et al., 1996; Kennicutt et al., 1996; Montagna and Harper, 1996; Continental Shelf Associates, Inc., 2004). Because of BOEM's distancing requirements for new wells, contact with concentrated and potentially harmful levels of any such toxin is not expected. As they travel from a source, produced waters are rapidly diluted, and impacts are generally observed within very close proximity to the discharge point (Gittings et al., 1992a; Neff, 2005). In addition to the protection offered by BOEM's distancing requirements, releases of toxic discharges are regulated by the USEPA through the issuance of NPDES permits. Adherence to these regulations would help to ensure that water quality is maintained at nontoxic levels.

In addition to drilling activities, the process of installing and removing OCS oil and gas-related infrastructure (i.e., pipelines, platforms, and subsea systems including cables) also has the potential to displace large volumes of sediment. The resulting localized increases in turbidity and sedimentation would have the same indirect impacts as those caused by drilling-related sediment movement.

The OCS oil and gas-related infrastructure/equipment could damage or kill benthic organisms should the equipment itself make direct contact. Direct placement of an object could cause any or all of the potential sublethal impacts already described in relation to turbidity and sediment displacement, including mortality of one or more organisms. The severity of community impacts from direct physical contact will vary in direct proportion to the surface area and mass of the specific equipment. For example, the placement of a large bottom-founded platform on a benthic community would have a much greater impact than placement of a small umbilical cable.

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 on water depth, currents, size of the vessels and anchors, and length of the anchor chain. The amount of seafloor affected by anchored structures would increase with water depth because of the use of larger anchors and longer anchor chains. The degree of impact to marine benthic communities will depend on the number of production platforms, the seafloor impact size, and their location. Anchor damage is one of the greatest threats to benthic biota during routine operations (Rezak and Bright, 1979; Hudson et al., 1982; Rezak et al., 1985; Gittings et al., 1992a). Anchors may break, fragment, or overturn tubeworms, bivalves, corals, sponges, or any other sessile benthic organisms, and the anchor chain or cable may drag across and shear organisms off the substrate (Dinsdale and Harriott, 2004). This would result in consequences ranging from increased stress to mortality (Dinsdale and Harriott, 2004). Damage to a coral community may take decades to recover (Fucik et al., 1984; Rogers and Garrison, 2001). The impact of dragging an anchor across a benthic community will depend on the distance and duration of seafloor contact, but it could be considerable due to the forces involved. Dragged anchors leave scars up to 3 km (2 mi) from a well (Continental Shelf Associates, Inc., 2006) that are visible on side-scan sonar imagery years later. For these reasons, BOEM and its predecessor agencies created avoidance criteria and have implemented these mitigation measures for decades.

Explosive severance methods used during decommissioning activities could result in damage or mortality to organisms within the vicinity of the blast or associated sediment plume, although long-term turbidity is not expected from platform removal operations. The shockwave from a nearby blast also could damage or destroy the underlying hard substrates required to support some benthic communities. The BSEE Interim Policy Document 2013-07, "Rigs-to-Reefs Policy," specifies that the use of explosive severance methods will not be approved if analysis determines they will cause harm to benthic communities.

To minimize benthic community impacts, it is assumed that all authorizations for seafloor-disturbing activities would be subject to restrictions to protect hard/live bottoms and deepwater benthic communities; they may include requirements for mapping and avoidance in areas where these communities are known or suspected, and may require photographic or video surveys of areas where bottom-founded instrumentation and appurtenances are to be deployed. Overall, impacts to marine benthic communities by bottom and land disturbing activities are expected to be **minor** to **moderate**.

4.4.1.4. Coastal and Estuarine Habitats

Through preliminary screening of the activities and affected resources, IPFs for coastal and estuarine habitats are (1) vessel traffic; (2) bottom/land disturbance; and (3) routine and non-routine discharge events (**Table 3.5-3**). **Figure 4.4.1-3** shows potential effects from routine vessel traffic, land disturbance, and non-routine events to coastal and estuarine habitats; however, impact levels would not rise above minor for vessel traffic and land disturbance (**Appendix D**). Expected and unexpected non-routine events could have **minor** to **major** impacts on coastal and estuarine habitats. Discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**.

There are no IPFs associated with routine operations that would result in moderate or major impacts to coastal and estuarine habitats.

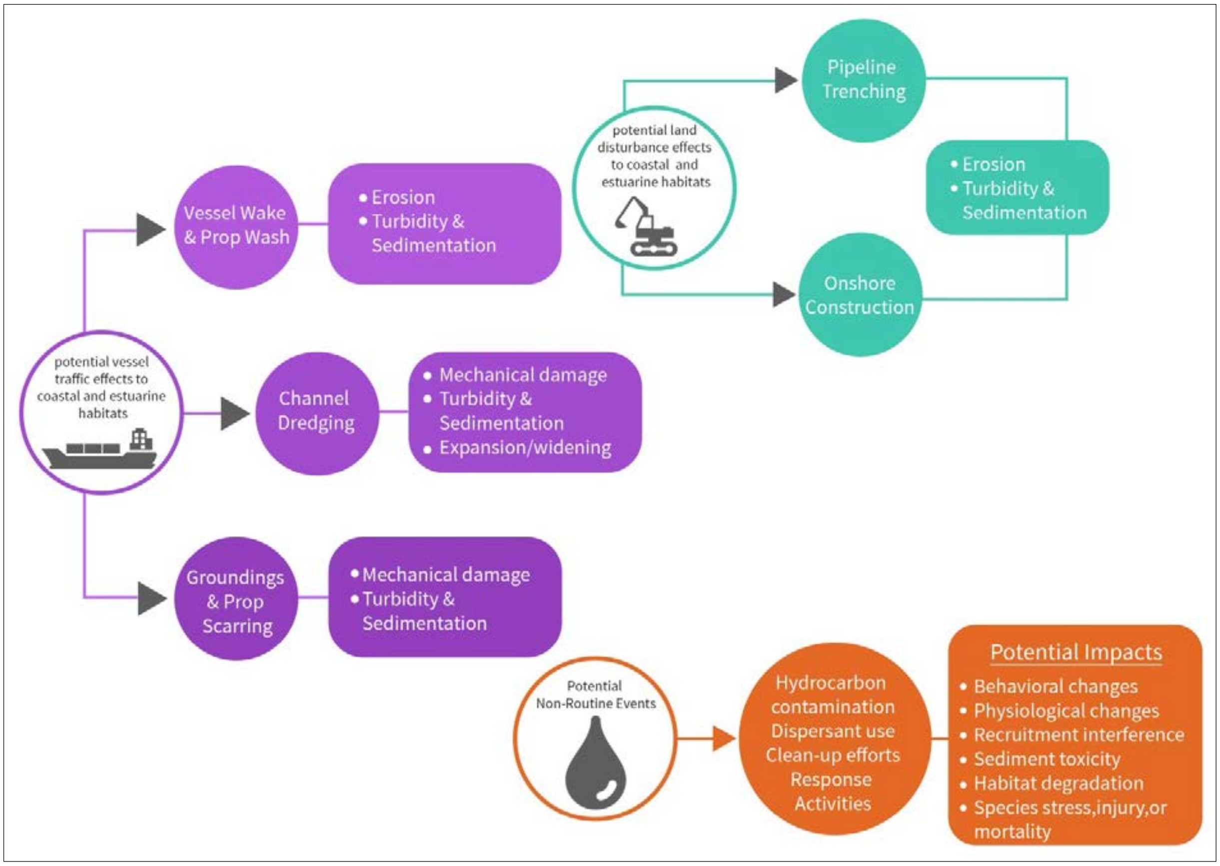


Figure 4.4.1-3. Potential Effects of Vessel Traffic, Land Disturbance, and Non-Routine Events to Coastal and Estuarine Habitats.

4.4.1.5. Pelagic Communities

There are no IPFs associated with routine operations that would result in moderate or major impacts to pelagic communities. Oil spills are considered non-routine, accidental occurrences. They could have **minor** to **major** impacts on pelagic communities. Discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**.

4.4.1.6. Marine Mammals

IPFs associated with routine operations that may result in **negligible** to **major** impact for marine mammals include seismic noise and vessel traffic. For certain marine mammals in Alaska (e.g., walrus, seals, polar bear), aircraft traffic and onshore infrastructure development also may result in **negligible** to **major** impacts. For benthic feeders in the Chukchi Sea (e.g., walrus), drilling muds/cuttings/debris may result in **moderate** to **major** impacts. Oil spills are considered non-routine, accidental occurrences. They could have **major** impacts on marine mammals. Discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**.

Routine Operations

Noise

Overall, there is the potential for impacts to marine mammals from noise associated with activities under the Proposed Action. The potential for mortality or hearing loss is unlikely when the mitigation described in **Appendix G** is applied. There is greater potential for impacts to lead to masking and behavioral disruption given the lower noise intensity needed to cause these effects, the greater spatial scale at which these noise levels occur, compared to those that may result in hearing loss, and the decreased effectiveness of mitigations at these greater distances (**Appendix G**). In addition, it is largely unknown whether masking and behavioral disruption can, and at what levels, result in population-level effects. Research is underway by BOEM and others to study this aspect of the issue more closely.

As stated in **Section 1.4**, in conducting this analysis, the Programmatic EIS examines existing scientific evidence relevant to evaluating the reasonably foreseeable significant adverse impacts of oil and gas E&D activities on the human environment. BOEM has identified impacts from sound (including impacts from particle motion) as an area of incomplete or unavailable information. The subject matter experts that prepared the Programmatic EIS diligently searched for pertinent information, and BOEM's evaluation of such impacts is based on research methods and theory generally accepted in the scientific community. BOEM's subject matter experts acquired and used previously developed and newly available scientifically credible information and, where gaps remained, exercised their best professional judgment to extrapolate baseline conditions and impact analyses using accepted methodologies based on credible information. At the programmatic stage, incomplete and unavailable information does not affect the ability of the decision-maker to make an informed choice. Subsequent site- or project-specific analyses will allow for the incorporation of new research and additional evaluation of unavailable or incomplete information. For purposes of this Programmatic EIS, all impacts reasonably foreseeable at later stages of the oil and gas development process have been considered, and the characterization of impact magnitude and duration is supported by scientific evidence. BOEM's assessment of impacts is not based on conjecture, media reports, or public perception; it is based on research methods, theory, and modeling applications generally accepted by the scientific community. Marine mammals that co-occur with heavy sea ice and ice-breaking activity may be impacted by noise, or their prey species may be disturbed. Some marine mammals may avoid ice-breakers while others may be drawn to take advantage of the temporary leads that are created.

Based on available information about potential effects from these sound sources, it is assumed that impacts to marine mammals from noise associated with routine operations may be **negligible** to **moderate** based on the source of noise (IPF), and the implementation and effectiveness of impact mitigation measures (**Appendix G**). Fully predicting the degree of effect is impossible at the programmatic scale considered here. It is, therefore, imperative that any subsequent approvals of more regional or site-specific analyses consider the most recent science available at the time of the decision as well as additional mitigations to limit the potential for masking or behavioral disruption (e.g., time-area closures, limiting activities in space and time).

Platform Removal (Includes Explosive Use)

Under the Proposed Action, a large number of platforms may be removed with explosives from the Gulf of Mexico Program Area. Most of these removals are limited to the continental shelf. Physical removal of structural components would generate noise that could disturb and displace marine mammals in proximity of the removal (USDOI, MMS, 2005d). In 2006, NMFS issued a Biological Opinion to BOEM that included several conservation recommendations to minimize adverse effects to marine mammals from explosive removals of offshore structures, including limits on the type and size of explosives that can be used; the times when detonations can occur; requirements for the placement of explosives at a minimum depth of 15 m (49 ft) below the surface of the seafloor; and requirements for a monitoring plan that uses qualified observers to monitor the detonation area for protected species, including sea turtles and marine mammals, prior to and after each detonation. The monitoring plan also would specify that any detection of a protected species within the planned blast zone would, without exception, delay detonation of the explosive charges until the individual animals are cleared from the blast area. Implementation of these guidelines by BSEE for all explosive platform removals conducted under the Proposed Action would minimize the potential for physical injuries to marine mammals in the

Program Area. Though monitoring for and clearing the blast area of marine mammals is an effective mitigation to reduce risk of injury, it is possible that marine mammals could still go undetected within the blast area and may still experience non-injurious or injurious disturbances from the detonations. Potential impacts to marine mammals under the Proposed Action are expected to be **negligible** to **moderate**.

Traffic

Vessel traffic may disturb marine mammals, and collisions between moving vessels and marine mammals may result in injury or death of individuals. Impacts to marine mammals from aircraft traffic are largely limited to behavioral disturbances. Most reports of vessel collisions with marine mammals involve large whales, but collisions with smaller species also occur (van Waerebeek et al., 2007). Most severe and lethal whale injuries involved large ships (>80 m [262 ft]). Vessel speed was found to be a significant factor, with 89 percent of the records involving vessels moving as speeds ≥14 kn. Seismic operations generally are conducted at speeds of 4 to 6 kn, with a maximum speed <8 kn. Marine mammal species of concern for possible ship strike include slow-moving cetacean species (e.g., NARWs, North Pacific right whales) and deep-diving species while resting on the surface (e.g., sperm whales, pygmy/dwarf sperm whales, and beaked whales). Generally, it is assumed that the probability of this sort of encounter and, thus impact, is very low. Under the Proposed Action, all authorizations for shipboard surveys would include guidance for vessel strike avoidance. In the unlikely event a collision did occur, its impact would depend on the number of individuals and the population status of the species affected. The impact would be most severe if the continued viability of the population was threatened seriously, including serious diminishment of annual rates of recruitment or survival. Vessel strikes may result in **negligible** to **moderate** impacts to marine mammal populations.

In the Alaska Program Areas, aircraft traffic is an important IPF for certain marine mammals. Aircraft may be used for crew transfers, ice surveys, supply transportation, or other purposes. Many flights may be low-altitude flights due to low cloud ceilings (i.e., for safety). Low-altitude flights may disturb pinnipeds, polar bears, or sea otters resting on ice, on barrier islands, or at coastal haul outs. In addition to energetic costs, pinnipeds such as walrus, which haul out in dense groups, risk being injured by trampling when large groups are disturbed and flee into the water. Calves are at higher risk, but juveniles and adults also may be injured or killed during disturbance events. Aircraft traffic may result in **negligible** to **moderate** impacts to pinnipeds, polar bears, and sea otters.

Bottom/Land Disturbance

Drilling Muds/Cuttings/Debris

Drilling debris released during exploration drilling operations may cover benthic habitat, making it unavailable for some period of time. The depth of the well and the amount of area covered by cuttings would determine the length of time that it would take the habitat to be re-colonized. Benthic-feeding marine mammals (e.g., walrus, gray whales, bearded seals) could be displaced from foraging areas temporarily. The impact to marine mammals in most cases would be **negligible** to **moderate** because, although the area available for foraging is very large in comparison to the amount of habitat lost temporarily, if critical foraging areas are disturbed the impact may be more severe.

4.4.1.7. Sea Turtles

IPFs associated with routine operations that may result in **moderate** to **major** impacts for sea turtles include noise and vessel traffic. Discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**.

Sources of noise that are associated with routine operations within the Gulf of Mexico and Atlantic Program Areas and may affect sea turtles include seismic surveys, vessels, aircraft, drilling, trenching, production, offshore construction, and decommissioning (explosive platform removal) offshore structures. Seismic surveys and decommissioning are expected to have **moderate** noise-related impacts. The potential for impacts to sea turtles from noise generated from these sound sources is highly variable and depends on the specific circumstances.

Routine Operations

Noise

Seismic surveys will occur in open ocean areas where highly motile adult and subadult sea turtles may move freely to avoid the relatively slow-moving sound sources and exposure to injurious sound levels, including levels that would affect behavior beyond aversion. Furthermore, the projected offshore surveys would be performed in a systematic fashion along pre-plotted transects, so it is presumed that exposure to elevated sound would be somewhat localized and short-term in duration, or regional in scale with lengthy periods of time between passages of the source vessel(s) on parallel transects near any given area. Consequently, it is reasonable to assume that adult and subadult sea turtles could and likely would avoid approach of active seismic sound sources where received sound levels would possibly induce auditory injury (permanent threshold shift [PTS] injuries). Post-hatchling sea turtles generally reside at or near the sea surface and may be less likely to be injured by the sound field produced by an airgun array during a survey, due to the location of the airgun approximately 10 m (33 ft) below the surface, the downward focus of the seismic signal, and the rapid decay of waterborne seismic signals at the sea surface due to the “Lloyd mirror” effect (Urick, 1983).

The range of potential effects to sea turtles from noise, in order of decreasing severity and modified slightly from the four zones initially outlined by Richardson et al. (1995), includes death; non-auditory physiological effects; auditory injury–hearing threshold shift; auditory masking; and stress and disturbance, including behavioral response. Given the predominant low-frequency sound sources, limited SPLs and durations, and directionality of higher-frequency sound sources associated with the seismic activities, it is not likely that routine operations would generate sounds loud enough to cause direct mortality to sea turtles. Unlike marine mammals, criteria for the onset of auditory impairment have not been developed for sea turtles, mainly because of the few data that exist on sea turtle hearing. Because there are no hearing criteria for sea turtles, NMFS, during Section 7 ESA consultations, typically applies the criteria for marine mammals to evaluate the potential for similar impacts. The current NMFS criterion for Level A harassment of cetaceans is a received SPL of 180 dB re 1 µPa; although not explicitly referring to temporary threshold shift (TTS), this criterion is based on the potential for “overt behavioral, physiological, and hearing effects on marine mammals in general” (HESS, 1999; Popper et al., 2014) .

TTS, by definition, is temporary and recoverable damage to hearing structures (sensory hair cells) and can vary in intensity and duration. In contrast, PTS results in the permanent though variable loss of hearing through the loss of sensory hair cells (Clark, 1991). Auditory masking is defined as the obscuring of sounds of interest by other, stronger sounds, often at similar frequencies. Spectral, temporal, and spatial overlap between the masking noise and the sender/receiver determines the extent of interference; the greater the spectral and temporal overlap, the greater the potential for masking. Masking sounds can interfere with the acquisition of prey or mates, the avoidance of predators and, in the case of sea turtles, the identification of an appropriate nesting site (Nunny et al., 2008). Because sea turtles appear to be low-frequency specialists, the potential masking noises would fall mainly within the range of 50 to 1,000 Hz. Disturbance can induce a variety of effects, including subtle changes in behavior, more conspicuous dramatic changes in activities, and displacement. Limited data exist on noise levels that may induce behavioral changes in sea turtles (Moein et al., 1995; McCauley et al., 2000) (**Section 4.2.2**).

As stated in **Section 1.4**, in conducting this analysis, the Programmatic EIS examines existing scientific evidence relevant to evaluating the reasonably foreseeable significant adverse impacts of oil and gas E&D activities on the human environment. BOEM has identified impacts from sound (including impacts from particle motion) as an area of incomplete or unavailable information. The subject matter experts that prepared the Programmatic EIS diligently searched for pertinent information, and BOEM's evaluation of such impacts is based on research methods and theory generally accepted in the scientific community. BOEM's subject matter experts acquired and used previously developed and newly available scientifically credible information and, where gaps remained, exercised their best professional judgment to extrapolate baseline conditions and impact analyses using accepted methodologies based on credible information. At the programmatic stage, incomplete and unavailable information does not affect the ability of the decision-maker to make an informed choice. Subsequent site- or project-specific analyses will allow for the incorporation of new research and additional evaluation of unavailable or incomplete information. For purposes of this Programmatic EIS, all impacts reasonably foreseeable at later stages of the oil and gas development process have been considered, and the characterization of impact magnitude and duration is supported by scientific evidence. BOEM's assessment of impacts is not based on conjecture, media reports, or public perception; it is based on research methods, theory, and modeling applications generally accepted by the scientific community.

Overall, there is the potential for impacts to sea turtles from noise associated with activities under the Proposed Action. Existing mitigation protocols for airgun surveys (including ramp-up of airgun arrays, visual monitoring of an acoustic exclusion zone by protected species observers (PSOs), and start-up and shutdown requirements) would be implemented to reduce residual risk further (**Appendix G**). Although these measures are not assumed to be 100 percent effective, they are expected to substantially reduce the risk of impacts to sea turtles. Limitations to the effectiveness of mitigation measures are due to a variety of factors, including the physical conditions, the presence of animals at the surface, and difficulty in detecting individuals when they are on the surface (particularly subadults and juveniles – hatchlings are likely to be missed entirely).

There is greater potential for impacts to lead to masking and behavioral disruption given the lower noise intensity needed to potentially cause these effects, the greater spatial scale at which these noise levels occur (as compared to those that may result in hearing loss), and the decreased effectiveness of mitigations (**Appendix G**) at greater distances. Furthermore, it is largely unknown whether masking and behavioral disruption can, and at what levels, result in population level effects. Research is underway by BOEM and others to study this aspect of the issue more closely.

Based on available information about potential effects from these seismic sources, it is assumed that impacts to sea turtles may be **negligible** to **moderate** based on the mitigation being applied. Fully predicting the degree of effect is impossible at the programmatic scale considered here. It is therefore imperative that any subsequent approvals of more regional or site-specific analyses consider the most recent science available at the time of the decision as well as additional mitigations to limit the potential for masking or behavioral disruption (e.g., time-area closures, limiting activities in space and time).

Platform Removal (Includes Explosive Use)

Under the Proposed Action, a larger number of platforms may be removed with explosives from the Gulf of Mexico Program Area compared to the Atlantic, thus increasing the residual risk to sea turtles in the Gulf of Mexico. Most of the removals are limited to the continental shelf. Potential impacts to sea turtles from explosive removals of offshore structures include physical injury from detonations, including auditory PTS and other physical injuries, temporary auditory impairment (i.e., TTS), and physical disturbance. Physical removal of structure components would generate noise that could disturb and displace sea turtles in proximity of the removal (USDOI, MMS, 2005d). In 2006, NMFS issued a Biological Opinion to BOEM that included several conservation recommendations to minimize adverse effects to sea turtles from explosive removals of offshore structures, including limits on the type and size of explosives that can be used; the times when detonations can occur; requirements for the placement of explosives at a minimum depth of 15 m (49 ft) below the surface of the seafloor; and requirements for a monitoring plan that uses qualified observers to monitor the detonation area for protected species, including sea turtles and marine mammals, prior to and after each detonation. The monitoring plan also would specify that any detection of a protected species within the planned blast zone would, without exception, delay detonation of the explosive charges until the individual animals are cleared from the blast area. The implementation of these guidelines by BSEE for all explosive platform removals conducted under the Proposed Action would minimize the potential for physical injuries to sea turtles in the Program Area. Though monitoring for and clearing the blast area of sea turtles is an effective mitigation to reduce risk of injury, it is possible that sea turtles could still go undetected within the blast area and may still experience non-injurious or injurious disturbances from the detonations. Potential impacts to sea turtles under the Proposed Action are expected to be **negligible** to **moderate**.

Traffic

Vessel traffic is anticipated in association with seismic exploration, drilling and production, construction activities, and platform removal (decommissioning) and will occur primarily in waters of the continental shelf. Sea turtles spend at least 20 to 30 percent of their time at the surface for respiration, basking, feeding, orientation, and mating (Lutcavage et al., 1997), and they are vulnerable to physical disturbance from collisions (ship strike) with moving vessels during this time. Any project-related vessel strike with a sea turtle is expected to result in the death of the sea turtle, and all sea turtle species are listed under the ESA.

Survey vessels conducting seismic airgun surveys are large in size, relatively slow moving, and would account for most of the proposed survey miles traveled; these surveys could occur throughout the Program Areas. Most seismic survey vessels remain in offshore waters during survey projects and receive supplies and fuel by supply vessels and helicopters. Seismic survey areas may be extensive or localized. Though survey vessels generally work at slow speeds (4.5 kn), relatively smaller supply vessels move between shore bases and the survey vessel at higher speeds. Vessels supporting drilling and production as well as offshore construction operations are expected to operate at specific sites and move slowly when working at these sites; however, their transits to and from designated shore bases would be conducted at speed.

All authorizations for shipboard surveys would include guidance for vessel strike avoidance. These guidance measures would include the Joint BOEM-BSEE NTL 2012-G01, which incorporates NMFS's "Vessel Strike Avoidance Measures and Reporting for Mariners" addressing use of observers for protected species identification, vessel strike avoidance, and injured/dead protected species reporting in the Gulf of Mexico region (**Appendix G**). With these mitigation measures in place, survey vessels are unlikely to strike sea turtles during daylight hours. In addition, waters surrounding seismic survey vessels would be monitored during daylight hours by PSOs for the presence of sea turtles. Considering the relatively slow operational speed of these vessels, combined with the implementation of vessel strike avoidance measures during all operations, strikes from seismic vessels are expected to be avoided during daylight hours. However, during transit to and from shore bases, crew/supply vessels and other G&G survey vessels are expected to travel at higher speeds and collisions could occur, especially at night and during periods of poor visibility and poor weather conditions. Though vessel strikes are expected to be a rare occurrence, any collisions likely would be lethal. Overall, potential impacts to sea turtles from vessel strikes under the Proposed Action are expected to be **negligible** to **moderate**.

4.4.1.8. Marine and Coastal Birds

Oil spills are considered non-routine, accidental occurrences and could have **negligible** to **major** impacts on birds. Discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**.

4.4.1.9. Fish and Essential Fish Habitat

The only IPF with the potential for **moderate** impacts to fish and EFH are oil spills. Discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**.

4.4.1.10. Areas of Special Concern

Areas of Special Concern may experience indirect impacts from the Proposed Action. Habitats and species within the Areas of Special Concern may be impacted directly. Tables 9.1-1, 9.1-2, 9.2-1, and 9.3-1 in **Appendix C** identify Areas of Special Concern within the vicinity of the Program Areas, with reference, where appropriate, to the sections in the document that describe impacts to the resources they were designed to protect.

4.4.1.11. Archaeological and Historical Resources

Figure 4.4.1-4 summarizes the potential effects to archaeological and historical resources associated with the Proposed Action. The only IPFs with the potential for **moderate** or **major** impacts to archaeological and historical resources are oil spills and seafloor disturbance. A discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**.

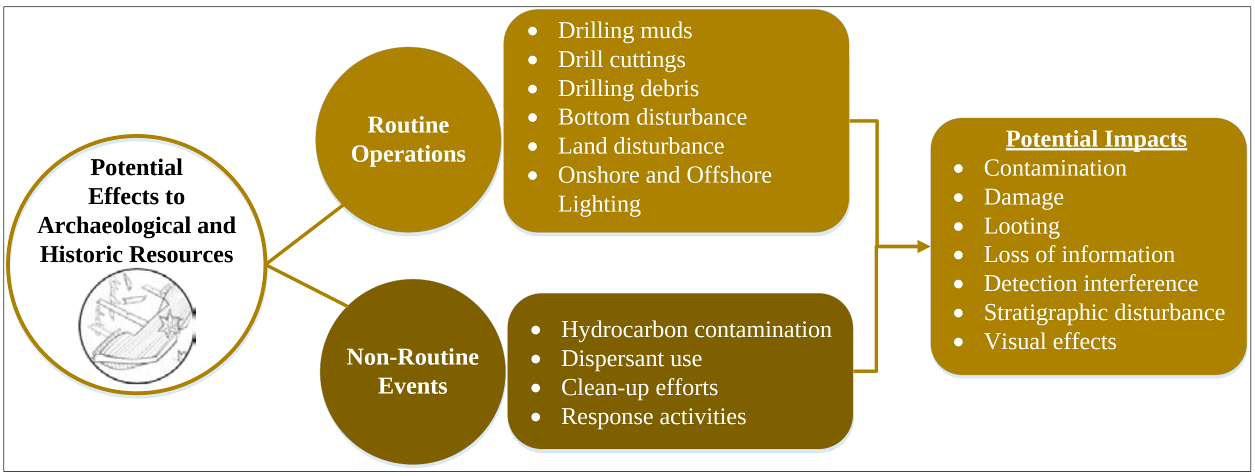


Figure 4.4.1-4. Overview of Potential Impacts to Archaeological and Historical Resources.

Routine Operations

The nature of direct and indirect effects is shown in **Figure 4.4.1-5**. Direct impacts to archaeological sites generally occur when there is an activity that affects the seafloor in which the site is embedded. Direct impacts from oil and gas activities can include anchoring impacts, associated anchoring line (cables and chains) and tackle, bore holes, nodal emplacement, oiling from accidental spills, visual impacts, pipeline construction, and the construction of artificial islands (Arctic, Beaufort Sea). Indirect impacts can include scour related to a structure or pipeline installation, anchoring and site access activities related to oil spill cleanup, and looting from the release of site location data gathered during oil and gas exploration.

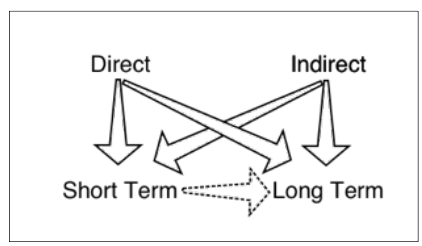


Figure 4.4.1-5. Relationship Between Direct and Indirect Effects.

Direct and indirect effects can be short or long term in nature. With archaeological sites, there is a complex relationship between short-term direct impacts and the resultant long-term effects. For example, if an anchor cable cuts through a shipwreck, there is a direct impact to the site resulting in the loss of cultural information. If the site is not properly stabilized, its disturbance can open new areas of a site that had previously reached an equilibrium with the environment, which then results in rapid change to that part of the site and additional loss of cultural information over the long term until the site reaches a new state of equilibrium (**Figure 4.3.11-1**). Additional damage can occur from storm events acting on the exposed sections of a site, which might have been structurally weakened from the anchoring impact.

Another example relates to the accidental oiling of a shipwreck site. Most shipwrecks serve as habitats and are quickly colonized by a range of marine organisms. As part of the site-formation process, an equilibrium is reached with the environment, which includes marine growth that may provide some protection for the wreck from natural processes (**Figure 4.3.11-1**). If an accidental oil spill impacts a site, some of the marine organisms that have colonized the surface of the wreck may be killed, thereby changing the environmental conditions and associated biological activity at the site due to the addition of hydrocarbon-rich oil. This could accelerate microbial activity on the site of wooden shipwrecks, accelerating deterioration of any remaining wooden structure. These processes are not well understood, and BOEM is undertaking a study to understand the impacts to wooden and metal shipwrecks from oil spills in the Gulf of Mexico (Microbiome Analysis Center [MBAC], 2015).

BOEM's current regulations give discretion to the Regional Director as to whether an archaeological survey will be required for a specific lease block. Where archaeological surveys are required and are conducted in compliance with BOEM survey standards prior to oil and gas activities on the OCS, the majority of potential archaeological sites can be located and mitigation strategies developed to avoid any adverse impacts. The nature of offshore oil and gas E&D activities makes it relatively easy to avoid potential archaeological resources on the OCS identified as a result of archaeological surveys; however, without the data obtained through archaeological surveys, BOEM cannot determine whether a resource is present within a lease and whether it might be impacted through development. The magnitude of potential anchoring, drilling, and decommissioning impacts would be considered **moderate** to **major** if they were to occur on an archaeological site; in some cases, the impacts may not even be realized without a post-activity seafloor survey.

4.4.1.12. Population, Employment, and Income

Impacts to population, employment, and income are not the result of single IPFs related to routine operations, but rather are the result of the full range of direct and indirect industry activities that are expected to take place as a result of the Proposed Action. These include all activities associated with the full life cycle of offshore development projects (i.e., exploration through decommissioning) as projected in BOEM's E&D scenarios. The low- and high-case E&D scenarios described in **Section 3.1.2** are direct inputs to BOEM's regional economic impact models, collectively for different regions referred to as MAG-PLAN.[3] BOEM uses regional MAG-PLAN models to estimate the levels of economic activities needed to support offshore oil and gas exploration, development, and production. Because of the wide range of projected activities in BOEM's E&D scenarios, regional MAG-PLAN models also forecast a wide range of potential economic impacts. Overall, the employment and associated labor income impacts from routine operations are expected to be positive contributions to the affected local and state economies, and thus are not discussed in terms of impact levels. Increases in population can have positive and negative impacts on social systems, and thus are discussed in terms of impact levels. Possible negative impacts from rapid population increases, particularly in remote areas, can include strains on public infrastructure such as local housing, roads, schools, emergency response facilities, and utilities. Impacts to local and state populations associated with increased employment from routine activities are expected to be **negligible** to **moderate** for the Beaufort and Chukchi Sea Program Areas. The next section will present information regarding the aggregate economic impacts of these routine offshore oil and gas activities.

[3] There are three regional versions of the model: MAG-PLAN Alaska (BOEM-2011-059), MAG-PLAN Gulf of Mexico (BOEM 2012-102), and—most recently—MAG-PLAN Atlantic (report not yet published). They share a consistent approach but are tailored to the characteristics of each region, including climate and operating conditions, extent of OCS oil and gas development and supporting infrastructure, onshore demographics, etc.

Oil spills are considered non-routine, accidental occurrences and could have negative impacts on local and state employment and labor income. Discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**.

Routine Operations

Beaufort and Chukchi Sea Program Areas

Impacts on employment and labor income in Alaska resulting from a Beaufort Sea lease sale (the Beaufort Proposed Action) and a Chukchi lease sale (the Chukchi Proposed Action) are expected to be positive and should not have much impact on the immediately adjacent communities. One exception may be during an early infrastructure construction phase resulting from commercial discoveries in the Chukchi Sea. This phase could require construction of temporary or permanent worker enclaves and related infrastructure. On average, MAG-PLAN Alaska estimates that the Beaufort Proposed Action is anticipated to generate approximately 520 jobs under the low-case exploration scenario and up to 23,000 total jobs in Alaska under the high-case scenario, while the Chukchi Proposed Action is anticipated to generate approximately 300 jobs under the low-case exploration scenario and up to 6,100 total jobs in Alaska under the high-case scenario.[4] The associated labor income would range between $10 million and $1.34 billion for the Beaufort Sea and $5 and $355 million for the Chukchi Sea. Overall socioeconomic impacts will depend on future price levels and other factors. If oil and gas prices rise and are consistently high throughout the period of activity (consistent with the high-case scenario), employment and labor income impacts will be toward the high end of the range. The greater the employment increases, the more likely that population would increase as well; however, work schedules in the oil and gas industry are such that the relevant workforce in Alaska already includes a large proportion of employees who commute from larger centers of population and from outside the state, weakening the traditional positive relationship between employment and local population. Thus population impacts are expected to be **negligible** to possibly **moderate** under a high sustained activity scenario. 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. In the Arctic, where there is no commercial fishing and little or no beach recreation, long-term socioeconomic impacts would be largely on subsistence activities rather than on population, employment, and income.

Oil production and overall industry spending would provide important benefits for the NSB and the State of Alaska. Revenues from taxes on onshore support infrastructure, federal 8(g) revenue sharing (from leases within 4.8 km [3 mi] of state waters)[5], and dividends from investments in petroleum service companies are important to the state and local governments, native corporations, and individual citizens. New OCS production to offset continued decline in Prudhoe Bay and other North Slope production areas could extend the viability of the threatened TAPS and thus allow jurisdictions adjacent to the Arctic subregion to maintain revenue collection from onshore facilities associated with continued offshore and onshore production.

Cook Inlet Program Area

Impacts to employment and labor income as a result of the Cook Inlet Proposed Action are expected to be positive. On average, MAG-PLAN Alaska estimates that the Proposed Action is likely to generate 1,200 to 4,580 new jobs with an associated labor income of $65 to $266 million annually. Within these

[4] These include additional direct, indirect, and induced jobs—those created by lessees, contractors, support industries, and worker households. A large proportion of the employment and income impacts would occur in a variety of support industries; therefore, MAG-PLAN does not confine its estimates solely to results that would be reported under the oil and gas sector in standard employment statistics.

[5] Given the distance of the Program Area from shore, 8(g) revenue sharing would not apply to Chukchi acreage.

ranges, if oil and gas prices rise and are consistently high throughout the period of activity, employment and labor income should be toward the high end of the range. The greater the employment increases, the more likely population would increase as well; however, work schedules in the oil and gas industry are such that the relevant workforce in Alaska already includes a large proportion of employees who commute from far away, weakening the traditional positive relationship between employment and local population.

There is a large existing oil and gas workforce living in the KPB, so it is likely that many workers would commute to work sites from nearby communities and that many others would commute from Alaska's larger population centers, or from outside the state. OCS jobs likely would be available to the local populations in all areas, but rural Alaskan employment in the petroleum industry, especially among Alaska Natives, probably would remain relatively low.

Gulf of Mexico Program Area

Because of the historically well-developed support industries for oil and gas activities along and near the Gulf Coast, the employment and labor income generated by the Proposed Action would primarily sustain activity levels rather than create a new influx of workers and income. BOEM uses the MAG-PLAN Gulf of Mexico model to estimate levels of economic activities needed to support offshore oil and gas exploration, development, and production. Because of the wide range of projected activities in BOEM's low- and high-case E&D scenarios, MAG-PLAN Gulf of Mexico also forecasts a wide range of potential economic impacts. BOEM estimates that the Gulf of Mexico Proposed Action would create or save an average of approximately 8,600 to 48,000 jobs annually, with an associated labor income of $520 million to $2.9 billion. The economic impacts would peak 10 to 20 years into the program at levels of 36,000 to 139,000 jobs and $2.2 to $8.4 billion in labor income. The impacts to population would be approximately proportional to the impacts from new employment; however, as previously noted, most of the job estimates presented represent existing labor that will cycle to new projects as previous ones are completed. However, high levels of offshore oil and gas development would cause more new job creation. MAG-PLAN Gulf of Mexico estimates that 30 to 40 percent of the impacts to population, employment, and labor income would occur in Texas, 20 to 30 percent would occur in Louisiana, 5 to 10 percent would occur in Mississippi and Alabama each, up to 5 percent would occur in Florida, and 15 to 25 percent would occur in the rest of the U.S. The exact percentages would depend on the types and locations of offshore activities that would arise.

The Proposed Action would generate government revenues through bonus bids, rental payments, and royalty payments. The Gulf of Mexico Proposed Action is expected to generate average annual federal revenues of approximately $400 million in a very-low-price environment to as much as $4 billion per year in a very-high-price environment. If it is assumed that OCS revenues would be spent in approximately the same proportions as overall federal spending, the revenue impacts of OCS activities would not be overly concentrated along the Gulf Coast. In addition, modest additional portions of OCS revenues have been allocated to Gulf states, including 8(g) revenues (from leases within 4.8 km [3 mi] of state waters) and revenue sharing arising from the Gulf of Mexico Energy Security Act (GOMESA) of 2006. The latter will increase for Gulf states other than Florida in 2017. The Proposed Action also would support local tax bases, corporate profits, and the functioning of energy markets.

Atlantic Program Area

The Atlantic is a frontier oil and gas region, so the economic impacts would evolve differently than for an established area like the Gulf of Mexico. For example, the infrastructure to support offshore oil and gas activities will evolve gradually. Therefore, more economic activity will come from outside regions, like the Gulf of Mexico, that have specialized capabilities. The speed at which Atlantic offshore oil and gas capabilities evolve will depend on the levels of offshore E&D, the results of exploration, energy market developments, the matches between the needs and skills in the region, and the extent to which Atlantic leasing is expected to be maintained in the future.

BOEM has developed a MAG-PLAN Atlantic model to estimate the levels of economic activities that would be supported by offshore oil and gas exploration, development, and production in the Atlantic. MAG-PLAN Atlantic estimates that the Proposed Action would support an annual average of approximately 2,000 to 4,000 jobs with an associated $120 to $240 million in labor income. The economic impacts would peak 15 to 20 years into the program at levels of 12,000 to 16,000 jobs and $710 to $940 million in labor income. **Table 4.4.1-3** shows MAG-PLAN Atlantic's forecasts of the relative geographic distributions of economic impacts to the primary affected states and regions for the low scenario. Approximately 40 percent of the economic impacts would occur in the Gulf of Mexico, while the impacts in the Atlantic would occur in states such as North Carolina, South Carolina, Virginia, and Georgia. Given that the Atlantic is a frontier region, there is a high amount of uncertainty regarding the exact levels and geographic distributions of economic impacts from the Proposed Action. These states have large economies and numerous large population centers, and the relative impacts of the Proposed Action are expected to be small. However, it is possible that supporting infrastructure and economic activities could be developed in some smaller coastal communities, resulting in new employment opportunities as well as additional stresses for local residents and local governments.

Table 4.4.1-3. Percentage of Total Impacts of Leasing in the Atlantic Program Area.

Area	% Employment	% Labor Income
Gulf of Mexico	38	41
North Carolina	12	10
South Carolina	9	7
Virginia	7	7
Georgia	6	5
Maryland	4	4
Pennsylvania	2	2
Florida	1	1
Delaware	0	1
New Jersey	0	0
Rest of U.S.	21	23

Note: The labor income column sums to 101 percent due to independent rounding.

The Proposed Action would generate government revenues through bonus bids, rental payments, and royalty payments. If it is assumed that OCS revenues would be spent in approximately the same proportions as overall federal spending, the revenue impacts of OCS activities would occur throughout the U.S. Given the distance of the Program Area from shore, there would be no 8(g) revenue sharing. However, a revenue sharing agreement between the Federal Government and the Atlantic states similar to that required for the Gulf of Mexico states by the GOMESA could occur, which would increase the economic benefits to those states. The Proposed Action also would support local tax bases, corporate profits, and the functioning of energy markets. However, all of these impacts would be relatively small in the Atlantic states, especially prior to any development and production activities.

4.4.1.13. Land Use and Infrastructure

The development of oil and gas facilities within the Gulf of Mexico, Atlantic, Cook Inlet, and Arctic would have direct and indirect impacts on existing and future land use, development patterns, and infrastructure. Potential impacts of routine activities of the Proposed Action are analyzed by IPF in each Program Area. Discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**. In general, the nature and magnitude of these impacts would depend on 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. **Minor** to **moderate** impacts imply that that the existing land use and infrastructure would likely be able to accommodate new leases. Land use changes would be needed only in frontier areas where new oil and gas facilities would be constructed, and in areas requiring new transportation networks.

Routine Operations

Beaufort and Chukchi Program Areas

Oil and gas production within the Arctic includes the Chukchi and the Beaufort Sea Program Areas. As described in **Appendix C**, Section 12, a majority of the oil and gas supporting infrastructure is located closer to the Beaufort Sea Program Area due to existing onshore operations around Prudhoe Bay. It is anticipated that new OCS oil and gas leasing in the Arctic will be able to tap into the existing network of onshore oil and gas supporting infrastructure and transportation system for oil based out of Prudhoe Bay.

The E&D scenario for the Arctic (**Tables 3.1-1** and **3.1-2**) anticipates oil production in the Beaufort and Chukchi Seas to range from 0 to 3.7 billion barrels of oil (Bbbl) (0 to 3.7 Bbbl in the Beaufort Sea; 0 to 2.8 Bbbl in the Chukchi Sea) and 0 to 6.4 trillion cubic feet (tcf) for gas (0 to 6.4 tcf in the Beaufort Sea; 0 to 3.0 tcf in the Chukchi Sea). Approximately 5 to 30 exploration and delineation wells (10 to 30 in the Beaufort Sea; 5 to 15 in the Chukchi Sea) and 0 to 500 development and production wells (0 to 500 in the Beaufort Sea; 30 to 100 in the Chukchi Sea) would be drilled within the Arctic under the Proposed Action. Per the proposed E&D scenario within the Arctic region, BOEM anticipates the development of approximately 0 to 25 platforms (0 to 25 in the Beaufort Sea; 0 to 6 in the Chukchi Sea), 0 to 660 km (0 to 410 mi) of offshore pipeline (0 to 660 km [0 to 410 mi] in the Beaufort Sea; 0 to 193 km [0 to 120 mi] in the Chukchi Sea), 0 to 483 km (0 to 300 mi) of onshore pipeline (0 to 16 km [0 to <10 mi] in the Beaufort Sea; 0 to 483 km [0 to 300 mi] in the Chukchi Sea), and 1 waste handling facility. While some of these infrastructure needs would be met by existing facilities, the majority of the activities would be considered new development in the Arctic and likely would impact future land use, development patterns, and infrastructure.

Bottom/Land Disturbance

Onshore and offshore construction generally has the potential to interfere with or prevent use by existing owners or tribal communities within areas not already used for oil and gas activities. Impacts regarding subsistence activities and tribal communities are further discussed in **Sections 4.4.1.16** and **4.4.1.17**. While the use of existing facilities generally is preferred over new construction, few of these facilities exist within the Arctic region compared to the Gulf of Mexico and Cook Inlet. The Proposed Action would require significant investment in and adjacent to the Chukchi Sea Program Area to construct offshore platforms, wells, pipelines, and onshore support facilities. Compared to the Chukchi Sea Program Area, the Beaufort Sea Program Area has an existing network of onshore oil and gas infrastructure and a transportation system for oil. Regardless, it is expected that any new construction in the Arctic would result in changes to existing land use patterns.

The physical presence of onshore oil and gas support facilities and a pipeline infrastructure within portions of the Arctic region would represent an initial industrialization of the area. This change in land use would result due to the modification of 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 land use within the region (Arctic Monitoring Assessment Program [AMAP], 2013). In areas such as the Beaufort Sea that already have a relatively well-developed oil and gas infrastructure, the construction of new oil and gas infrastructure would represent a continuation of industrial and commercial activity. In areas lacking existing infrastructure such as the Chukchi Sea, construction would account for a more substantial change in the industrial activity.

The Chukchi Sea does not have an existing transportation system for oil and gas. The TAPS is located approximately 483 km (300 mi) east of a potential Chukchi Sea landfall. To tie into TAPS, Chukchi Sea produced oil would likely require a 483-km (300-mi) overland pipeline. Furthermore, no gas pipeline currently exists to transport gas from the Chukchi or Beaufort Seas, so all produced gas from these areas would need to be re-injected into the oil reservoir until a gas transportation system becomes available. Methods such as enhanced gas recovery associated with oil production in the Chukchi and Beaufort Seas could result in the economic feasibility and subsequent permitting and construction of a gas pipeline adjacent to the current TAPS from Prudhoe Bay to Valdez, or a new pipeline right-of-way from Prudhoe Bay to Cook Inlet (USDOI, BOEM, 2012).

In addition to increased platform, pipeline, construction and processing infrastructure, the E&D scenario demonstrates that substantially increased air transportation from Anchorage to Prudhoe Bay and from Prudhoe Bay to expanded airports in the Chukchi Sea region will be required to support E&D activities. Additional marine transportation, including support facilities such as docks and fueling facilities, will be required to support the Proposed Action. The extent of the impacts associated with these activities could be considered **moderate** and would depend on the specific location within the Arctic and the particular community in which the facilities would be placed.

Visible Infrastructure

In the Arctic, the addition of wells, pipelines, access roads, and other ancillary facilities would result in an industrial landscape throughout the oil or gas field area. The E&D scenario (**Table 3.1-1**) summarizes that for the Beaufort Sea Program Area, existing infrastructure, including airfields, docks, and storage and processing facilities, likely could be utilized. However, a substantial number of new offshore platforms or artificial islands, wells, offshore pipelines, and short onshore tie-ins would be necessary for the development and production of the resources. Offshore visible infrastructure consists of platforms, vessels, and MODUs and is associated with navigational and special-use lighting as well as flaring. Because drilling activities typically take place 24 hours per day, lighting on drill rigs during nighttime hours can result in visual impacts. In more remote areas such as the Chukchi Sea, an influx in oil and gas infrastructure onshore and offshore can be perceived as a significant visual impact. As such, visual impacts on land use are expected to be **minor** to **moderate** depending on the specific area, as impacts may be more drastic in undeveloped subsistence areas where oil and gas infrastructure is not as prolific.

Space-Use Conflicts

The Beaufort Sea and Chukchi Sea Program Areas are fully within the Arctic boundary as defined by the U.S. Arctic Research and Policy Act, a boundary recognized by the USDOD. Conflicts between oil and gas activities and scheduled military operations onshore and offshore can be largely avoided through close coordination with the USDOD and lease sale-specific terms and conditions. Although offshore oil and gas activities associated with Arctic E&D scenario could affect military activities, the USDOD and USDOI have cooperated on oil and gas leasing issues for many years in the Gulf of Mexico and have developed mitigation measures that minimize the potential for conflicts. The same mitigation measures and level of cooperation would likely be applied in the Arctic, which would minimize potential conflicts. A majority of standoff-distance conflicts likely would be encountered from oil and gas infrastructure construction and operation impacts coinciding with subsistence uses. These impacts are further described in **Sections 4.4.1.16** and **4.4.1.17**, but it is anticipated that all new construction will be developed in accordance with local land-use policies. As such, space-use conflicts are expected to be **minor** to **moderate**.

Cook Inlet Program Area

As indicated in **Table 3.1-3**, production within the Cook Inlet Program Area under the Proposed Action is anticipated to range from 0.08 to 0.34 Bbbl of oil, and 0.04 to 0.15 tcf of gas. The E&D scenario for the Proposed Action estimates the development of 5 to 15 exploration wells, 30 to 100 production wells, 2 to 5 new platforms, 145 to 306 km (90 to 190 mi) of new offshore pipeline, and

1 waste handling facility. All of these activities would be considered new development in Cook Inlet, and are expected to impact future land use, development patterns, and current infrastructure. While there currently are no active federal leases within the inlet, offshore producing platforms are located within Cook Inlet in state submerged lands. These platforms are served by >322 km (200 mi) of subsea oil and gas pipelines and other onshore facilities that may be utilized by federal leases. These facilities are further discussed in **Appendix C**, Section 12.

Bottom/Land Disturbance

Due to a long history of oil and gas development, it is anticipated that existing land use categorizations in Cook Inlet would be able to accommodate oil and gas infrastructure development as a result of new leases under the Proposed Action. As such, the extent of the impacts associated with oil and gas activities would depend on their specific locations within the Cook Inlet. Many of the basic onshore support and processing infrastructure necessary to support the anticipated levels of activity are already in place within Cook Inlet, but these transport, loading, and storage capabilities may require expansion or retrofitting to handle an increased volume of produced oil and gas.

If new infrastructure were needed, it would be built 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 facilities that support oil and gas production. For instance, the construction of the pipeline landfall could involve clearing land, preparing a right-of-way, and digging and backfilling trenches. These types of activities or similar ones could alter the physical composition of the landscape, thus potentially limiting the intended, actual, or future use an area. This type of construction may also have significant impacts in and around lands used for subsistence hunting or other similar activities. Further discussion on subsistence use and tribal communities is found in **Sections 4.4.1.16** and **4.4.1.17**. Thus, within the Cook Inlet Program Area, impacts on land use and infrastructure likely would be **minor** and limited in extent due to the presence of existing onshore support infrastructure for oil and gas.

Visible Infrastructure

Visible infrastructure is associated with all phases of the Cook Inlet E&D scenario under the Proposed Action. Offshore visible infrastructure consists of platforms, vessels, and MODUs and is associated with navigational and special-use lighting as well as flaring. Because drilling activities typically take place 24 hours per day, lighting on drill rigs during nighttime hours can impede viewsheds and result in visual impacts. However, impacts from the Proposed Action are not expected to be significant due to the existing oil and gas industry presence in the Cook Inlet from state leasing.

Under the E&D scenario for the Cook Inlet Program Area, construction of a new pipeline and a potential waste handling facility could result in visual impacts to existing onshore land uses. Furthermore, daily operations from new E&D wells will generate more vehicle and vessel traffic, and increase oil and gas activity in an area that currently is being impacted by state leasing. However, the activities proposed would not be a drastic change from current operations in Cook Inlet. Onshore support facilities, including airfields, docks, storage, maintenance, and processing facilities, currently in the Cook Inlet region are expected to support current oil and gas operations and would not result in significant visual impacts. Therefore, it is anticipated that impacts as a result of the Proposed Action would be **minor** to **moderate**.

Space-Use Conflicts

At the northern end of Cook Inlet, immediately adjacent to the city of Anchorage, the Joint Base Elmendorf-Richardson (JBER) comprises 33,993 ha (84,000 ac) that includes $11.4 billion of infrastructure and 5,500 military and civilian personnel. There are no known military or NASA use restrictions such as danger zones or restricted areas in the waters of the Cook Inlet Program Area. The closest military danger zone to the Cook Inlet Program Area is Blying Sound, located east of Cook Inlet in the GOA and near the entrance to Prince William Sound. Any practice firing that takes place within Blying Sound requires 7 days of advance notice to the public and at least 48-hours notice to the USCG and all mariners. As such, space-use conflicts are expected to be **minor** as it is not anticipated that oil and gas operations will conflict with USDOD operations in the Cook Inlet Program Area. In the event that conflicts do arise, the USDOD and USDOI have historically coordinated to minimize conflicts from oil and gas leasing with defense-related activities.

Gulf of Mexico Program Area

As indicated in **Table 3.1-4**, anticipated production of oil in the Gulf of Mexico includes a range of 2.1 to 5.6 Bbbl of oil and 5.5 to 22 tcf of natural gas. The E&D scenario for the Proposed Action anticipates the development of up to 3 gas processing plants and up to 10 pipeline landfalls. Under the 10-sale case as part of the Proposed Action, a majority of increased demand may be met by equipment upgrades or expansions at existing facilities. This is partly due to the well-developed web of infrastructure already in place in the Gulf of Mexico and as a result, will not require extensive development of new facilities to serve new activity. However, these activities still could impact existing and future land use, development patterns, and infrastructure. BOEM continuously collects new data and monitors changes in infrastructure demands in order to support scenario projections that reflect current and future industry conditions.

Bottom/Land Disturbance

Under the Proposed Action, the E&D scenario projects the development of up to three new gas processing plants. While natural gas production on the OCS shelf (shallow water) has been declining, deepwater gas production has been increasing, though not at the same pace. Overall, the combined trends of increasing onshore shale gas development, decreasing offshore gas production, and increasing efficiency and capacity of existing gas-processing facilities have lowered demands for new gas-processing facilities in the Gulf of Mexico region. Spare capacity at existing facilities should be sufficient to satisfy new gas production for many years, although there remains a chance that new gas-processing facilities may be needed given the 10 lease sales proposed as part of the Proposed Action. Furthermore, BOEM projects the potential construction of one new pipeline landfall to connect new operations to the existing offshore pipeline infrastructure.

Bottom/land disturbing activities associated with potential development of a new gas-processing plant and pipeline landfall include activities such as grading and clearing land, excavation, foundation building, and backfilling trenches. These types of activities may alter the existing landscape, and depending on the scale and location, alter the intended use of land in the area. While these changes may be necessary in some locations within the Gulf of Mexico, the bottom/land disturbance activities are expected to be **minor** to **moderate** in nature and site-specific. Given the presence of existing oil and gas infrastructure in the Gulf of Mexico, new construction likely would not cause an extensive change to existing development patterns.

During decommissioning, potential changes to the physical and infrastructural makeup of the Gulf of Mexico coast could occur. The decommissioning of rigs and defunct equipment would utilize onshore facilities, but are not expected to cause substantial changes to land use, development patterns, and infrastructure. These alterations likely would be site-specific and their extent would depend on the existing composition of land use and infrastructure in that area.

The BOEM-funded research by Dismukes et al. (2007) supports that existing solid-waste disposal infrastructure is adequate to support existing and projected offshore oil and gas drilling and production needs in the Gulf of Mexico. Existing onshore facilities would continue to be used to dispose of wastes generated offshore. However, no new disposal facilities are expected to be licensed as a direct result of a Proposed Action. There is no current expectation for new onshore waste disposal facilities to be authorized and constructed during the 2017-2022 period as a direct result of the OCS Program.

If new infrastructure is needed onshore, development of certain facilities may be subject to local, state, or other federal permitting and regulations. While BOEM anticipates that most development would likely occur in areas already established for oil and gas development, specific time lines and requirements would vary by location as BOEM is not typically the permitting or regulating agency for development activities that occur onshore.

Visible Infrastructure

Construction and operation activities may result in potential impacts to visual resources with the development of additional oil and gas infrastructure. Under the Proposed Action, a new pipeline landfall and several natural gas processing facilities may be required to support anticipated Gulf of Mexico E&D activities. These additions as well as other potential ancillary facilities may alter the coastal landscape, visual character, and viewsheds while also contributing to light pollution.

Offshore, it is possible that platforms, vessels, and MODUs may impact intended onshore land uses, including residential development and recreational activities. For example, activities on drilling rigs are conducted 24 hours per day, 7 days per week and special-use lighting and activities such as flaring may impede viewsheds. However, oil and gas activities are not new to the Gulf of Mexico and additional leasing under the Proposed Action is expected to have **minor** impacts on existing land use and coastal infrastructure.

Space-Use Conflicts

Since leasing began in federal waters of the Gulf of Mexico, BOEM has worked to balance domestic energy production with other uses of the OCS. Construction of new infrastructure and potential increases in oil and gas activity in the Gulf of Mexico under the Proposed Action could result in space-use conflicts. In general, the construction and operation of facilities not limited to ports, ship and shipbuilding yards, support and transport, pipelines, pipe coating yards, natural gas processing and storage, refineries, petrochemical plants, and waste management facilities can impact onshore land uses and development patterns. BOEM recognizes that the Gulf of Mexico provides important economic, social, and environmental values and has worked collaboratively with affected parties to resolve these conflicts. While development of new facilities and infrastructure under the Proposed Action would alter land uses, it is not expected that these activities would cause a significant change to existing land use patterns. However, space-use conflicts could be more apparent offshore, where there are competing uses of the OCS not limited to tourism and recreational uses, fisheries production, commercial shipping, and military uses.

Most notable impacts to land use and infrastructure can stem from military operations in the Gulf of Mexico, whereby air, water, and land operations could interfere with the various stages associated with oil and gas E&D. While these operations may range in scope, the USDOI has coordinated with the USDOD on oil and gas leasing issues, and the two agencies have developed mitigation measures and lease stipulations to minimize potential for conflicts. The USDOD and USDOI will continue to coordinate extensively under the 1983 Memorandum of Agreement, which states that the two parties shall reach mutually acceptable solutions when the requirements for mineral E&D and defense-related activities conflict. Military uses of the OCS in the Gulf of Mexico can be found in **Section 3.6.3.2.3.3**.

BOEM also has coordinated with other federal and state agencies regarding Areas of Special Concern, including NMSs, NPs, and MPAs. BOEM recognizes that many of these areas serve as critical habitat and has developed mitigation measures and lease stipulations, or excluded areas from leasing, to protect these biologically diverse areas. However, BOEM recognizes that impacts from construction and development may affect adjacent areas and impact important habitat within the protected areas.

Thus, given the history of oil and gas leasing activities in the Gulf of Mexico and the well-established network of facilities to support these activities, space-use conflicts onshore and offshore are expected to be **minor**.

Atlantic Program Area

As indicated in **Table 3.1-9**, anticipated production of oil includes a range of 0.3 to 0.7 Bbbl and 3.4 to 7.5 tcf of natural gas within the Atlantic. Compared to the Gulf of Mexico, the Atlantic is considered a frontier area and does not have a well-developed web of infrastructure to support potential E&D fully. However, the Atlantic region has areas with significant general infrastructure (e.g., roads, transportation networks, housing) to meet some of the needs required for oil and gas E&D under the Proposed Action. The E&D scenarios for the Proposed Action anticipate the development of 0 general support facilities, 0 crew service facilities, 1 pipe coating facility, 0 to 1 waste disposal facility, 0 to 1 natural gas processing plant, 0 to 1 natural gas storage facility, 0 to 1 LNG facility, and 0 to 1 pipeline shore facility. Some of these activities may be met by equipment upgrades or expansions at existing facilities, but a large portion of these activities would be considered new development in the Atlantic, and are expected to impact future land use, development patterns, and current infrastructure.

Bottom/Land Disturbance

Bottom/land disturbance impacts may result from the projected development of new infrastructure to support production. Given the history of leasing activity in the Atlantic, few facilities are currently identified to support offshore oil and gas E&D. However, oil and gas activity is not new to the Atlantic region, and it is anticipated that several onshore facilities and services will be able to support offshore production in the short term. Under the Proposed Action, **minor** to **moderate** impacts are anticipated in the development of support and transport services, crew service facilities, pipe coating facilities, waste disposal facilities, natural gas processing plants and storage facilities, pipeline short facilities, and oil spill response.

It is expected that initial support services for Atlantic operations would be provided by Gulf of Mexico service companies, which are likely to utilize short-term leasing arrangements in local industrial areas such as Hampton Roads, Virginia; Morehead City and Wilmington, North Carolina; and Baltimore, Maryland. Potential service companies in the Mid-Atlantic region, particularly those involved in onshore shale activities, may expand to accommodate gradual increases in OCS seismic survey and exploration activities. BOEM expects that most crew services will be provided by Gulf of Mexico companies until the level of activity reaches the point that longer-term arrangements are more cost-effective. Under the current E&D scenario for the Proposed Action, 2026 is when the first production structure would be installed.

The nearest pipe coating facilities are located in the Appalachian regions of Pennsylvania and Virginia where they serve onshore oil and gas activities. It is possible that these facilities or Gulf of Mexico facilities may be utilized to satisfy initial demand from Atlantic OCS activities, but possible expansions at current facilities may be necessary under the Proposed Action. Similarly, there are many waste disposal facilities in the region that may be utilized for offshore activity, but there is the potential that some facilities may not have sufficient capacity or be equipped to handle liquid oilfield wastes. Additional investment in the necessary equipment and increased capacity at these facilities may be necessary as result of the Proposed Action.

There currently are no natural gas processing facilities in the coastal Atlantic region. If economically recoverable natural gas is discovered and produced, there will be an anticipated need for a natural gas processing plant in the area that is served by existing gas pipelines or port facilities with sufficient intermodal connections. Natural gas storage facilities also will accommodate the construction of a new natural gas processing facility that will likely be sited nearby.

Pipeline shore facilities are the onshore locations where the first stage of processing usually occurs for OCS pipelines carrying various combinations of oil, condensate, gas, and produced water. These facilities tie into pipeline landfalls, of which BOEM projects that 0 to 2 oil and 0 to 4 gas pipeline landfalls will be needed under the Proposed Action.

While impacts will be further analyzed at the lease sale stage, bottom/land-disturbing activities associated with oil and gas E&D will include activities such as grading and clearing land, excavations, founding building, and backfilling trenches. These types of activities may alter the existing landscape, and depending on the scale and location, alter the intended use of the land in that area. If needed, it could be possible to locate and construct necessary oil and gas infrastructure in areas to avoid direct impacts to wetlands, though pipeline landfalls may possibly impact some wetlands. While these changes may be necessary in some locations within the Atlantic, it is not expected that these bottom/land disturbance activities will cause an extensive change to existing development patterns. Overall, it is expected that impacts to land use and infrastructure may be **minor** to **moderate**, but impacts would be likely localized to areas that currently support industrial activities.

Visible Infrastructure

During the construction and operation phase, impacts to visual resources would occur as a result of the addition of new oil or gas infrastructure. The Atlantic coast does not have an established network of oil and gas facilities to fully support offshore production and the addition of wells, processing facilities, pipelines, access roads, and other ancillary facilities. The addition of these new facilities likely would result in industrial landscapes around the oil or gas field areas. As shown in **Table 3.1-9**, new facilities that would need to be constructed under the Proposed Action may introduce new elements of color, texture, height, form, and line into the coastal landscape. Construction activities and increased vessel traffic under the Proposed Action may impact recreation and tourism activities along Atlantic coast beaches, which often are valued for their remoteness and viewsheds. Furthermore, vehicles and the dust they generate also would contribute to visual impacts. Offshore visible infrastructure consists of platforms, vessels, and MODUs and is associated with navigational and special-use lighting as well as flaring. As drilling activities typically take place throughout the day, lighting of drill rigs could affect nighttime views. However, the closest drilling rig is not expected within 80.5 km (50 mi) of the coast. As such, visual impacts to land use and infrastructure would be **minor** given the potential change in land use patterns on the Atlantic coast.

Space-Use Conflicts

As shown in **Table 3.1-9**, the Proposed Action has the potential to result in onshore and offshore space-use conflicts from the construction and operation of facilities such as ports, ship and shipbuilding yards, support and transport, pipelines, pipe coating yards, natural gas processing and storage, refineries, petrochemical plants, and waste management facilities. BOEM recognizes that the Atlantic region provides important economic, social, and environmental values and is committed to working collaboratively with affected parties to resolve space-use conflicts.

Most of the Atlantic Program Area coincides with USDOD-identified military range complexes and NASA space program use areas. Impacts to land use and infrastructure can stem from air, water, and land operations that could interfere with the various stages associated with oil and gas E&D. In the Gulf of Mexico, the USDOI has coordinated with the USDOD on oil and gas leasing issues, and the two agencies have developed mitigation measures and lease stipulations to minimize potential for conflicts. For potential Atlantic leasing, it is anticipated that the USDOD and USDOI will continue to coordinate extensively under the 1983 Memorandum of Agreement, which states that the two parties shall reach mutually acceptable solutions when the requirements for mineral E&D and defense-related activities conflict.

While the NASA WFF is located in the area proposed for leasing, BOEM and NASA have coordinated in the past to identify suitable areas for offshore wind that minimize conflicts on the OCS. It is anticipated that the two agencies will similarly develop lease-specific conditions in order to allow mineral exploration and space-use programs to co-exist. BOEM has also coordinated with other federal and state agencies regarding areas of special concern including NMSs, National Parks, and MPAs (**Appendix C**, Section 9). As impacts from construction and development can spill over onto adjacent land or into the ocean, BOEM recognizes that many of these areas serve as important habitat and can cumulatively impact the existing environment. In order to protect these areas, BOEM has developed mitigation measures and lease stipulations, or excluded areas from leasing, to protect biologically diverse areas (**Appendix G**). It is anticipated that any new leases in the Atlantic as a result of the Proposed Action will consider all uses of the OCS and implement the necessary lease conditions to reduce conflicts on the OCS. As such, space-use conflicts are expected to be **minor** to **moderate** due to the potential for overlap with tourism and recreational uses, fisheries production, commercial shipping, and military uses.

4.4.1.14. Commercial and Recreational Fisheries

An overview of the potential impacts to commercial and recreational fishing associated with the Proposed Action, including routine operations and accidental events is presented in **Figure 4.4.1-6**.

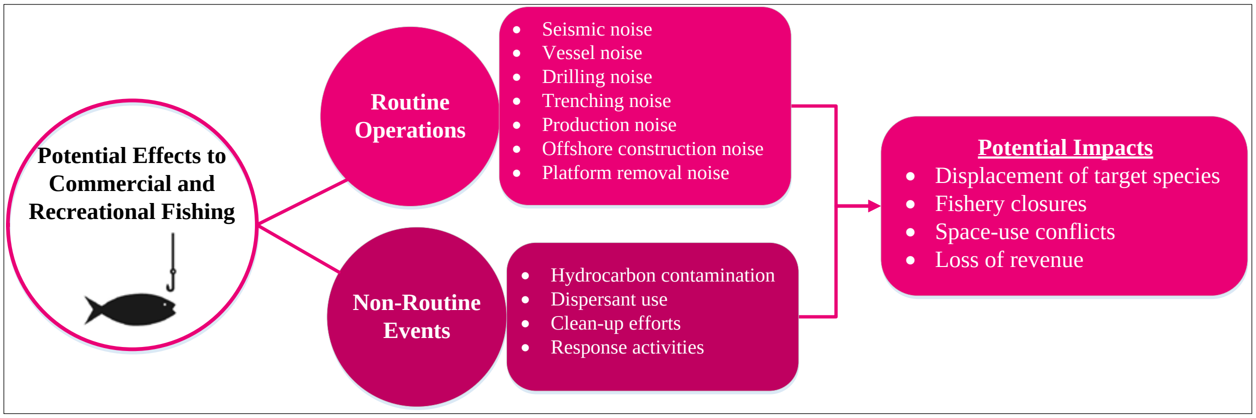


Figure 4.4.1-6. Overview of Potential Impacts to Commercial and Recreational Fishing.

Through preliminary screening of the activities and affected resources, IPFs for commercial and recreational fishing are (1) noise; (2) traffic; (3) space-use conflicts; and (4) non-routine events (**Table 3.5-3**). Discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**.

Routine Operations

There are no IPFs associated with routine operations that would result in moderate or major impacts to coastal and estuarine habitats.

4.4.1.15. Tourism and Recreation

The Proposed Action and associated ancillary activities could impact the scenic quality of coastal areas, where there is little industrial activity on the North Slope of Alaska and little onshore activity in the Atlantic Program Areas (**Appendix D**, Tourism and Recreation). This would likely place increased demands on these coastal communities.

Adverse effects from non-routine (not permitted) actions could affect tourism and recreation areas. Discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**.

Routine Operations

Noise

The Alaska NWR is located 4.8 km (3 mi) south and onshore of the Beaufort Planning Area. Visitors in the north end of the NWR, adjacent to the shore, could be affected by noise sources associated with offshore and onshore construction. This could have a **minor** to **moderate** impact on the remote and natural experience visitors to an NWR would seek.

In the Chukchi Sea, noise associated with offshore construction and drilling operations would be intermittent. Mitigation measures would assist in further limiting impacts to offshore wildlife tourism opportunities. Noise sources associated with drilling operations and platform operations may have a **minor** to **moderate** impact on recreation experience in the area. While far from shore, the coast adjacent to the Beaufort and Chukchi Sea Planning Areas has little ambient noise from development, as it is remote compared to the Atlantic and Gulf of Mexico Program Areas.

Lighting/Visible Infrastructure

In the Beaufort Sea, Chukchi Sea, and Atlantic Program Areas, there is little industrial infrastructure and activity (**Section 4.4.1.13**). The remote wilderness onshore and nearshore of these areas, plays a key role in attracting visitors for recreation. Onshore construction, lighting, and visible infrastructure could impact coastal tourism industries in these areas, depending on their proximity to recreational activities. Onshore construction and visible infrastructure adjacent to the Chukchi and Beaufort Sea Planning Areas would have an impact on the natural landscape and views of the area.

Minor to **moderate** effects on tourism and recreation are expected in the Beaufort and Chukchi Program Areas because there is little development in these remote areas and some small impacts may be more noticeable in such remote locations.

Onshore activity is not under the jurisdiction of BOEM. Therefore, it is imperative that any subsequent approvals of more regional or site-specific analyses consider the most current planning data available at the time of the decision as well additional mitigations designed in concert with affected communities.

4.4.1.16. Sociocultural Systems

The following analysis is for IPFs that range from **moderate** to **major**. A moderate or major effect is in comparison to the baseline of the environment in the description of the affected environment at the beginning of this section. Discussion of impacts from accidental spills and CDEs is provided in **Section 4.4.4**.

Routine Operations

Noise

There are six components of noise that could have a moderate to major impact on marine subsistence in the Chukchi and Beaufort Sea regions. These are seismic; ship, drilling, offshore and onshore construction; and platform removal. These components of the noise IPF could cause bowhead whales to change their normal migration paths and make subsistence hunting more difficult. Subsistence hunting of marine mammals is central to the culture of the Iñupiat in the Chukchi and Beaufort Sea regions. Onshore construction could disrupt the small remote communities that have very little industrial development, and have a **moderate** effect on them.

Traffic

In the Chukchi and Beaufort Seas, vessel traffic could cause bowhead whales to change their normal migration paths and make subsistence hunting more difficult creating a **moderate** to **major** effect (**Section 4.4.1.6**). Subsistence hunting of marine mammals is central to the culture of the Iñupiat in the Chukchi and Beaufort Sea regions.

Bottom/Land Disturbance

In the Chukchi and Beaufort Sea regions, this IPF could disrupt the small remote communities that have very little industrial development, causing a **moderate** to **major** effect.

Visible Infrastructure

In the Chukchi Sea, Beaufort Sea, visible offshore infrastructure could have a **moderate** effect. In these areas, the small remote communities do not have offshore structures and the people are not accustomed to such views. Regarding onshore infrastructure in the Chukchi and Beaufort Sea regions, there is little industrial development comparable to onshore facilities and impacts to the small remote communities could be **moderate** to **major**.

Space-Use Conflicts

In the Chukchi and Beaufort Sea regions, offshore floating OCS facilities such as drilling vessels could have a **moderate** to **major** impact on subsistence activities. They could cause bowhead whales to change their normal migration paths, and make subsistence hunting more difficult. Subsistence hunting of marine mammals is central to the culture of the Iñupiat in the Chukchi and Beaufort Sea areas.

In the Chukchi and Beaufort Sea regions, onshore facilities such as ports and pipelines coming ashore could cause moderate effects. The only facilities are the port facilities at West Dock in Prudhoe Bay and pipelines coming ashore from the Northstar gravel island, so additional facilities could be needed. In addition, the small communities with their own character in the Chukchi and Beaufort Sea areas are spread apart over hundreds of miles and rely significantly on subsistence. They have very little industry comparable to OCS facilities; therefore, onshore facilities could impact subsistence activities at a **moderate** to **major** level.

4.4.1.17. Environmental Justice

IPFs associated with routine operations that may result in **moderate** to **major** impacts for vulnerable communities include noise, discharges, bottom land disturbances, air emissions, lighting, visible infrastructure, space-use conflicts, and non-routine events.

Much of the Alaska Native population resides in the coastal areas of Alaska. Any new onshore and offshore infrastructure occurring between 2017 and 2022 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 and government-to-government consultations with federally recognized Tribes are designed to limit the effects from routine events.

Routine Operations

Noise

There is the potential for impacts to marine mammals from noise associated with activities under the Proposed Action in the Beaufort and Chukchi Sea Planning Areas. Subsea noise is unlikely to directly impact vulnerable communities onshore, but could impact their subsistence harvests (migration behavior) nearshore and offshore. Animals used for subsistence harvest, particularly the bowhead whale, are central to the Iñupiat culture (**Section 4.3.1.16**). These animals may be impacted by noise generated from routine activities (**Sections 4.4.1.6** and **4.4.1.16**).

Construction, vessel traffic, and aircraft traffic noise could have a **moderate** direct impact on people in vulnerable coastal communities adjacent to the Beaufort and Chukchi Sea Planning Areas, who are not accustomed to ambient noise that comes with living in populated areas. This is an added complexity of development in such a remote area.

Based on available information about potential effects to marine mammals (**Section 4.4.1.6**), it is assumed that any construction, vessel traffic, or air traffic noise impacts to marine or terrestrial animals impacting subsistence harvest activities could have a **moderate to major** impact on the communities who rely on them, depending on the mitigation being applied. Fully predicting the degree of effect is impossible at the programmatic stage considered here. Therefore, it is imperative that any subsequent approvals of more regional or site--specific analyses consider the most recent science available at the time of the decision as well as additional mitigations to limit the potential for masking or behavioral disruption (e.g., time-area closures, limiting activities in space and time).

Routine Discharges

There is the potential for impacts to marine mammals from routine discharges associated with activities under the Proposed Action in the Beaufort and Chukchi Sea Planning Areas. Routine (permitted) discharge is unlikely to directly impact vulnerable communities onshore, but could impact their subsistence harvests nearshore and offshore. Animals used for subsistence harvest, particularly the bowhead whale, are central to the Iñupiat culture (**Section 4.3.16**). These animals may be impacted by routine discharges generated from routine activities (**Sections 4.4.1.6** and **4.4.1.16**).

Based on available information about potential effects to marine mammals (**Section 4.4.1.6**), it is assumed that impacts to marine mammals from routine discharges could have a **negligible to moderate** impact on communities who rely on them for food, depending on the mitigation being applied. Fully predicting the degree of effect is impossible at the programmatic stage considered here. Therefore, it is imperative that any subsequent approvals of more regional or site--specific analyses consider the most recent science available at the time of the decision.

Bottom/Land Disturbance

Drilling

In the Arctic and Atlantic Program Areas, there is little oil and gas industrial activity in the offshore environment. Noise and discharges are the primary IPFs that could indirectly affect vulnerable communities who rely on subsistence harvests. These factors are discussed in the previous paragraphs.

It is assumed that any impacts from bottom/land disturbance drilling to marine mammals used for subsistence purposes would have impacts on the communities who rely on them for food. Based on available information about potential effects to marine mammals (**Section 4.4.1.6**), land disturbances other than noise would not have a direct impact on marine mammals, and therefore would not have an indirect impact on coastal communities in the Arctic. It is imperative that any subsequent approvals of more regional or site-specific analyses consider the most recent science available at the time of the decision as well additional mitigations to limit the potential for masking or behavioral disruption (e.g., time-area closures, limiting activities in space and time).

Onshore Construction

In the Arctic and Atlantic Program Areas, there is little industrial infrastructure and activity (**Section 4.3.13**). Onshore construction could impact vulnerable communities in these areas, depending on its proximity to those communities, particularly those located near industrial areas.

Onshore construction in the coastal areas onshore of the Beaufort and Chukchi Sea Planning Areas would be particularly unique in that these communities are geographically isolated. Impacts from these activities would be experienced solely by minority communities, given the cultural identity of the population of the North Slope. Activities associated with onshore construction adjacent to the Beaufort and Chukchi Planning Areas could have a **moderate** to **major** impact on vulnerable communities, depending on the mitigation being applied.

Activities associated with onshore construction adjacent to the Atlantic Planning Areas could have a **minor** to **moderate** impact on vulnerable communities, depending on the mitigation being applied. While zoning laws are designed to protect public health, the effects of historical practices to exclude low-income communities and communities of color still can be observed, often in close proximity to industrial zones (Maantay, 2002). Fully predicting the degree of effect is impossible at the programmatic stage considered here. Onshore activity is not under the jurisdiction of BOEM. Therefore, it is imperative that any subsequent approvals of more regional or site-specific analyses consider the most recent zoning and population data available at the time of the decision as well as additional mitigations designed in concert with affected communities.

Air Emissions

In the Arctic and Atlantic Program Areas, there is little offshore industrial infrastructure and activity (**Section 4.3.13**). Onshore air emissions could impact vulnerable communities in these areas, depending on its proximity to the communities. Locally produced smog and haze has been observed near some villages in Alaska. Air quality and its potential effect on respiratory health is a major concern for the residents who live there (NRC, 2003b).

Activities associated with onshore air emissions could have a **moderate** impact on nearby communities, depending on the mitigation being applied and the output of emissions in proximity to any historically marginalized communities. Despite the differences in industrial infrastructure onshore, impacts to the Arctic and Atlantic communities will be moderate due to the ability for air quality, and any damage caused by degraded air quality, to recover after emissions cease. Fully predicting the degree of effect is impossible at the programmatic stage considered here. Onshore activity is not under the jurisdiction of BOEM. Therefore, it is imperative that any subsequent approvals of more regional or site-specific analyses consider the most recent zoning and population data available at the time of the decision as well as additional mitigations designed in concert with affected communities.

Lighting

Lighting from new onshore facilities in the Atlantic could have a **minor** to **moderate** impact on nearby communities, depending on the mitigation being applied and light pollution proximity to any historically marginalized communities, particularly those located near industrial areas. Fully predicting the degree of effect is impossible at the programmatic stage considered here. Onshore activity is not under the jurisdiction of BOEM. Therefore, it is imperative that any subsequent approvals of more regional or site--specific analyses consider the most recent zoning and population data available at the time of the decision as well as additional mitigations designed in concert with affected communities.

Visible Infrastructure

In the Arctic and Atlantic Program Areas, there is little industrial infrastructure and activity (**Section 4.3.13**). Visible onshore infrastructure could impact vulnerable communities in these areas, depending on its proximity to these communities.

Visible onshore infrastructure could have a **moderate** impact on nearby communities, depending on the mitigation being applied and the viewshed in proximity to any historically marginalized communities. While zoning laws are designed to protect public health, the effects of historical practices to exclude low-income communities and communities of color still can be observed, often in close proximity to industrial zones (Maantay, 2002). Fully predicting the degree of effect is impossible at the programmatic stage considered here. Onshore activity is not under the jurisdiction of BOEM. Therefore, it is imperative that any subsequent approvals of more regional or site--specific analyses consider the most recent zoning and population data available at the time of the decision as well as additional mitigations designed in concert with affected communities.

Space-Use Conflicts

Onshore Facilities

In the Alaska and Atlantic Program Areas, there is little industrial infrastructure and activity compared to the Gulf of Mexico (**Section 4.3.13**). Onshore space-use conflicts could impact vulnerable communities in these areas, depending on their proximity to these communities.

Space-use conflicts of onshore facilities could arise between industry and communities depending on the mitigation being applied. Impacts in the Alaska and Atlantic Program Areas where there is not as much oil and gas infrastructure as the Gulf of Mexico could be **minor** to **moderate**. While zoning laws are designed to protect public health, the effects of historical practices to exclude low-income communities and communities of color still can be observed, often in close proximity to industrial zones (Maantay, 2002). Fully predicting the degree of effect is impossible at the programmatic stage considered here. Onshore activity is not under the jurisdiction of BOEM. Therefore, it is imperative that any subsequent approvals of more regional or site--specific analyses consider the most recent zoning and population data available at the time of the decision as well as additional mitigations designed in concert with affected communities.

Offshore Facilities

There is the potential for impacts to subsistence activities under the Proposed Action in the Beaufort and Chukchi Sea Planning Areas. Subsistence activity is central to the Iñupiat culture (**Section 4.3.16**). Conflicts between industry and subsistence harvesters could have **moderate** to **major** impacts due to industry-related noise or activities that might affect the behavior of resources being harvested, depending on the mitigation being applied. Fully predicting the degree of effect is impossible at the programmatic stage considered here. Therefore, it is imperative that any subsequent approvals of more regional or site-specific analyses consider the most recent science available at the time of the decision as well as additional mitigations to limit the potential for disruption (e.g., time-area closures, limiting activities in space and time).

4.4.2. Alternative B – Reduced Proposed Action

Analysis of environmental effects that would occur under Alternative B considers the potential for different environmental effects associated with reducing the acreage available for leasing in each of the five Program Areas as well as the potential for different environmental effects in EIAs in four of the five Program Areas. There are two principal approaches to avoid or minimize effects considered in Alternative B: (1) the exclusion of specific Program Areas, and (2) the exclusion or programmatic mitigation of EIAs within the Program Areas that may affect the size or location of leasing under the Proposed Action. The EIAs considered in each Program Area are described in **Section 2.4**.

Adverse environmental effects described under Alternative A would not occur in the relevant Program Area that is specifically excluded under the corresponding option of Alternative B wherein no new leasing is proposed in one of the five Program Areas: B(1)(a) – Beaufort Sea, B(2)(a) – Chukchi Sea, B(3)(a) – Cook Inlet, B(4)(a) – Gulf of Mexico, and B(5)(a) – Atlantic. Similarly, positive socioeconomic effects would not occur under the no new leasing options of Alternative B. Varying environmental effects related to substitution energy sources would occur instead under these options of Alternative B proportional to the amount of energy needed to meet demand; these effects may be broadly distributed, and many effects may occur outside the footprint of the Program Area considered. In this regard, the Alternative B options that consider no leasing in a specific Program Area (highlighted above) are inherently related to Alternative C (No Action Alternative).

The removal of a Program Area from the 2017-2022 Program would require energy substitution, described in detail in the Proposed Program. The degree of substitution needed would vary substantially depending on the price and which area would not be included in the Program. Using the mid-price case from the E&D scenario in **Chapter 3**, the following partial contributions to the overall amount of OCS barrels of oil equivalent (BOE) expected to be produced under the Proposed Action would require substitution via other means (**Figure 4.4.2-1**):

- Beaufort, 24 percent
- Chukchi, 17 percent
- Cook Inlet, 2 percent
- Gulf of Mexico, 46 percent
- Atlantic, 11 percent

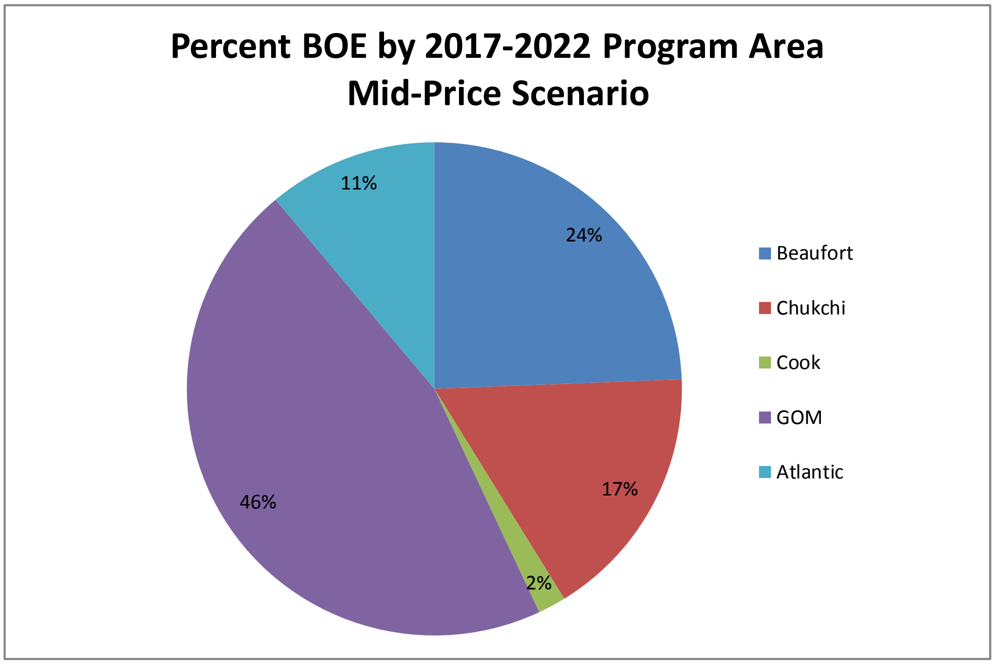


Figure 4.4.2-1. BOE from Each of the 2017-2022 Program Areas at Mid-Price Scenario.

If the Beaufort and Chukchi Sea Program Areas were deselected, energy substitutes would be needed for 41 percent (5.09 Bbbl) of OCS BOE expected to be produced under the Proposed Action, nearly equivalent to the entire amount expected for the Gulf of Mexico. However, at low prices, no production would occur from the Arctic, and thus no substitutions would be needed if either or both Arctic Program Areas were not selected in the 2017-2022 Program.

Energy substitutes are discussed in context of Alternative C in **Section 2.5**. Energy substitutions would result in a different suite of potential environmental impacts that could occur within or outside Program Areas. The potential impacts from substitute energy sources (e.g., more tankers bringing offshore oil) are quite variable (USDOI, BOEM, 2015a), cannot be reasonably predicted, and would be linked to the type and location of substitution (e.g., increase in foreign oil imports, renewable energy, onshore drilling).

Under the other Program Area-specific options considered in Alternative B, the nature of effects that would occur in the Program Areas would be very similar to the impacts described under Alternative A. However, environmental effects would be avoided or minimized within Program-specific EIAs given by the potential exclusion of the EIAs, or through the application of programmatic mitigation to activities potentially occurring in the EIAs. The effects analyses considering EIAs focus on these differences in potential environmental, sociocultural, and socioeconomic effects.

4.4.2.1. B(1)(a) – The Proposed Action not Including the Beaufort Sea Program Area

Removal of the Beaufort Sea Program Area would remove the potential for adverse impacts to any environmental resource within that Program Area from routine or non-routine activities associated with the Proposed Action; this would be a greater environmental benefit than only the removal of the EIAs for this Program Area. Any positive impacts from the Proposed Action also would not be realized. In addition, activities on existing leases would not be affected by the removal of the Beaufort Sea Program Area during the 2017-2022 Program. Approximately 24 percent of the anticipated energy produced from the Program would be forgone through removal of this Program Area (**Section 4.4.2**). Possible impacts from substitute energy sources are similar to but less than those described under Alternative C (**Section 4.4.3**). Impacts from future programs are discussed as a part of the cumulative effects analysis (**Section 4.5**).

4.4.2.2. B(1)(b) – The Proposed Action plus Consideration of EIAs in the Beaufort Sea Program Area

There would not be any change in potential level of impact from Alternative A for the following resource areas: air quality; water quality; coastal and estuarine habitats; pelagic communities; Areas of Special Concern; archaeological and historical resources; land use and infrastructure; population, employment, and income; and tourism and recreation. This is because the exclusion or implementation of mitigation measures within these areas only will benefit resources found with them or that rely on them. Resources for which there may be change in potential impact levels are discussed in the following subsections.

4.4.2.2.1. Marine Benthic Communities

Exclusion of the EIAs under consideration combined with mitigations of other impact-producing activities would provide the highest level of protection for all benthic resources in the Beaufort Sea Program Area (**Table 4.4.2-1**). Taken together, there would be little to no activity in the most sensitive benthic marine habitats in the Beaufort Sea Program Area. Impacts of highest concern are bottom-disturbing activities and non-routine events. Elimination of drilling, pipeline trenching, and other activities which cause disturbance to the seafloor would eliminate the bottom disturbing impacts resulting from these actions. Existing lease activity still could result in negative impacts similar to those discussed earlier. Reducing oil and gas E&D activity in these areas would decrease the potential for cumulative effects and decrease the chances of a non-routine impact occurring in the area.

Table 4.4.2-1. Change in Impact from the Proposed Action for IPFs that may Affect Marine Benthic Communities.

Impact-Producing Factor	Proposed Action Impact Finding	Change in Impact from Proposed Action
Bottom/Land Disturbance: Drilling Mud/Cuttings/Debris	Negligible – Moderate	**Negligible** to **Minor**. In the absence of drilling activity these impacts would be greatly reduced in the EIA.
Bottom/Land Disturbance: Drilling Disturbance	Negligible – Moderate	**Negligible.** In the absence of oil and gas activities, no drilling disturbance is expected to benthic habitats.
Bottom/Land Disturbance: Infrastructure Emplacement (other than noise)	Negligible – Moderate	**Negligible.** In the absence of oil and gas activities, no infrastructure emplacement is expected on benthic habitats.
Bottom/Land Disturbance: Pipeline Trenching	Negligible – Moderate	**Negligible.** In the absence of oil and gas activities, no infrastructure emplacement is expected on benthic habitats.
Bottom/Land Disturbance: Structure Removal (other than noise)	Negligible – Moderate	**Negligible.** In the absence of oil and gas activities, no infrastructure emplacement is expected on benthic habitats.

Barrow Canyon

Barrow Canyon has some areas of high diversity and abundance of benthic organisms. However, the known areas lie outside the Program Area and are in the Chukchi Sea (Schonberg et al., 2014). Thus, most of the hard bottom benthic habitats in Barrow Canyon would not be protected by this particular EIA. However, soft bottom benthic habitats within this EIA would be protected from nearly all IPFs.

Camden Bay

There are some scattered hard bottom habitats in the coastal waters of Camden Bay, including Boulder Island Shoal (Dunton et al., 1984). If Camden Bay is excluded from Program, nearly all IPFs to the benthic habitats in this area would be eliminated.

Cross Island

Boulder Patch, an area of abundant invertebrates and kelp beds, lies close to Cross Island. The Cross Island EIA encompasses this sensitive area, thus offering the highest level of protection to these abundant and diverse benthic communities. Exclusion of this area would eliminate nearly all IPFs, aside from spills which might enter the area from adjacent lease blocks. The size of the EIA makes these remotely sourced impacts unlikely.

Kaktovik

If the Kaktovik EIA were excluded, the benthic habitats within it would be protected from nearly all IPFs. There would still be a potential for negative impacts to benthic resources from spills and CDEs. However, reduced activity in the area would make these events less likely, and perhaps diminish their impacts due to distance from the event.

4.4.2.2.2. Marine Mammals

Exclusions of all EIA areas combined with seasonal restrictions on other impact-producing activities that are permitted by BOEM (e.g., seismic exploration surveys) would provide the highest level of protection for all marine mammal species in the Beaufort Sea Program Area. This would result in little or no E&D taking place within the EIAs. E&D still could occur within these areas on active leases from previous lease sales. Ship and aircraft traffic associated with offshore oil and gas industry activities still could transit the excluded areas. If the exclusion applied only to leasing activities, seismic research vessels could be permitted to operate within the EIAs and ancillary activities could take place on existing leases. The Harrison Bay, Cross Island, and Kaktovik EIAs currently have active leases.

Alternately, a seasonal/temporal exclusion could be applied to all or some of the EIAs. This could exclude impact-producing activities (e.g., seismic surveys, exploration drilling) from taking place during the most sensitive time periods; for example, during time periods when bowhead whales are migrating past Camden Bay and subsistence hunting is taking place. Temporal/seasonal exclusions could be applied to any or all exploration activities within an EIA. If exploration leads to development and production on a particular lease block or blocks, production likely could not be halted seasonally and the impacts associated with production activities would not be reduced.

The IPFs of most relevance for Beaufort Sea marine mammal species are noise and the potential for spills. Bowhead whales and beluga are the most sensitive to noise associated with industry activities. These species reduce communication calls when anthropogenic noise sources are nearby and may move away from the source of the noise. Reducing or eliminating noise impacts by limiting activities during migration and in foraging areas would be of benefit to these species. Polar bears and ice seals are less impacted by noise, but may be more at risk in the event of an accidental oil or fuel spill. Polar bears occur on the barrier islands and along the coastline in late summer and fall, and congregate in large numbers on Cross Island and Barter Island (Kaktovik). Reducing or eliminating activities that could result in a spill at these locations would benefit this species.

Barrow Canyon

Barrow Canyon is a highly productive area due in part to the bathymetry of the canyon and to upwelling and ocean currents. It encompasses areas of high benthic biomass and high productivity, which serve as seasonally important foraging areas for beluga, bowhead whales, and seabirds. Bowhead and beluga whales migrate through the area in fall and spring; in some years, bowhead whales remain in the area for a prolonged foraging period. Ringed and bearded seals also forage here, which in turn draws polar bears. Exclusion or activity restrictions implemented for this area may provide protection of foraging habitat for marine mammals. It also may provide protection to individual marine mammals from auditory injuries and impairment from project-related noise and alteration or destruction of benthic feeding habitat from development activities.

Camden Bay

Camden Bay has been identified as an important ecological and subsistence area by whalers from Kaktovik and Nuiqsut. Whalers also have identified Camden Bay as an important area for bowhead whales (Huntington, 2013). Aerial survey data analysis identifies areas farther east of Kaktovik and west toward Cross Island as being more frequently used by bowhead whales (USDOC, NMFS, 2013). This EIA primarily would benefit subsistence hunters and bowhead whales. Exclusion of this area, or implementation of seasonal activity restrictions for this area, may provide protection to migrating and foraging bowhead whales.

Cross Island

Cross Island is an important bowhead subsistence area for whalers from Nuiqsit and has become a primary resting spot for polar bears awaiting freeze up in fall. As many as 80 polar bears have been seen resting on Cross Island in late August (USDOI, USFWS, unpublished). Polar bears generally are tolerant of human activity in the area and are not deflected by industry activities as frequently as whales may be. Whalers report that bowhead whales are sensitive to anthropogenic noises and smells, which may impact hunting success. Exclusion of this area, or implementation of seasonal activity restrictions for this area, may provide protection to migrating bowhead whales.

Kaktovik

Like Cross Island, Kaktovik (located on Barter Island) is an important bowhead whale subsistence area for whalers and has become a primary resting spot for polar bears awaiting freeze up in fall. In recent years, 40 to 80 polar bears have congregated near the whale bones at the edge of town prior to freeze up. Exclusion of this area, or implementation of seasonal activity restrictions for this area, may provide protection to migrating bowhead whales.

Table 4.4.2-2 provides a summary of the impact determinations for each IPF and how the impact determination would change with the implementation of the EIAs.

Table 4.4.2-2. Change in Impact from the Proposed Action for IPFs that may Affect Marine Mammals.

Impact-Producing Factor	Proposed Action Impact Finding	Change in Impact from Proposed Action
Noise	Minor – Moderate	**Negligible** to **minor** within EIAs where leasing is excluded and BOEM-permitted activities with noise as an IPF are restricted during the open water season and during periods of migration.
Noise: Vessel/Aircraft Traffic	Negligible – Moderate	**No change**. Exclusion of EIA areas could decrease vessel and aircraft traffic within that area. However, most moderate impact would occur within the coastal areas which are outside of the EIA.
Accidental Spills	Minor – Major	**Minor** to **major**. Exclusion of EIA areas would not prevent movement of an oil spill into that area if one should occur. However, limiting activities within the EIA may make it more unlikely that a spill will impact sensitive areas.

4.4.2.2.3. Marine and Coastal Birds

A seasonal/temporal exclusion could be applied to all or some of the EIAs. This could exclude impact-producing activities from taking place during the most sensitive time periods of the open water season; for example, during time periods when waterfowl are congregating in nearshore waters prior to migrating southward. Temporal/seasonal exclusions could be applied for any or all exploration activities within an EIA. If exploration leads to development and production on a particular lease block or blocks, production could not be halted seasonally, and the impacts associated with production activities would not be reduced.

The IPF of most relevance for Beaufort Sea marine and coastal bird species is the potential for accidental spills. Many waterfowl species nest along the coastline at tundra ponds, while some seabirds (e.g., black guillemots [*Cepphus grille*], Arctic terns) nest on the barrier islands. Reducing or eliminating activities that could result in a spill at these locations would benefit these species. The Teshekpuk Lake area has been identified as an IBA of global significance, while Harrison and Camden Bays have been identified as IBAs of continental significance (Audubon, 2010).

Barrow Canyon

Barrow Canyon is a highly productive area due in part to the bathymetry of the canyon and to upwelling and ocean currents. It encompasses areas of high benthic biomass and high productivity, which serve as seasonally important foraging areas for seabirds. Exclusion or activity restrictions implemented for this area may provide protection of foraging habitat for seabird species that occur in the area such as terns, gulls, jaegers, and phalaropes (Ashjian et al., 2010; Smith et al., 2014). Excluding this area seasonally or completely would not change the levels of effect determination for birds.

Camden Bay

Camden Bay has been identified as an important ecological and subsistence area by whalers from Kaktovik and Nuiqsut. Some colonial nesting species (Arctic terns, black guillemots, common eiders, and glaucous gulls [*Larus hyperboreus*]) nest in areas adjacent to or near Camden Bay. Shorebirds gather near the bay in large numbers in fall prior to migration. While excluding this area seasonally or completely would afford some protection to bird species from disturbance and disruption of feeding, it would not change the levels of effect determination for birds.

Cross Island

Cross Island is an important bowhead whale subsistence area for whalers from Nuiqsit and has become a primary resting spot for polar bears awaiting freeze up in fall. Excluding this area seasonally or completely would not change the levels of effect for birds.

Kaktovik

Like Cross Island, Kaktovik (located on Barter Island) is an important bowhead whale subsistence area for whalers and has become a primary resting spot for polar bears awaiting freeze up in fall. Excluding this area seasonally or completely would not change the levels of effect for birds.

4.4.2.2.4. Fishes and Essential Fish Habitat

Exclusion of the EIAs under consideration, or programmatic mitigation of activities proposed in the EIAs, could result in localized reductions in impacts to fishes and EFH, but would result in no change to the Fishes and EFH impact analyses for the overall Beaufort Sea Planning Area. Designated EFH overlaps nearly the entire area, and reflects the distribution of adult and juvenile Arctic cod.

4.4.2.2.5. Sociocultural Systems

The following analysis for mitigation of the effects of IPFs is for all four Beaufort EIAs included under this alternative. The IPFs resulting in a moderate to major effects include noise (seismic, ship, drilling), platform removal, vessel traffic, and space-use conflicts offshore. These IPFs could cause bowhead whales to change their normal migration paths, and make subsistence hunting more difficult (**Figure 4.3.16-1**). Subsistence hunting of marine mammals is central to the culture of the Iñupiat. Bowhead whales and beluga are the marine mammals most sensitive to noise associated with industry activities. These species reduce communication calls when anthropogenic noise sources are nearby, and therefore may move away from the source of the noise.

Onshore construction resulting in land disturbance could disrupt the small remote communities that have very little industrial development, and have a **moderate** effect. Local residents, particularly Iñupiat, are not accustomed to seeing construction of OCS infrastructure onshore, where they butcher whales as part of their subsistence activity.

Visible offshore and onshore infrastructure could have a **moderate** effect. The offshore infrastructure could have such an effect because subsistence hunters go as far as 80.5 km (50 mi) offshore (**Section 4.3.16**). Onshore infrastructure could have such an effect because people in the small remote communities do not have such structures and are not accustomed to such views.

Regarding space-use conflicts, onshore facilities such as ports and pipelines coming ashore could cause **moderate** effects. The only facilities are the port facilities at West Dock in Prudhoe Bay and pipelines coming ashore from the Northstar gravel island, so additional facilities would probably be needed. Also, the small communities in the Chukchi and Beaufort Seas have their own character and are spread apart over hundreds of miles, relying significantly on subsistence. They have very little industry comparable to OCS facilities; therefore, onshore facilities could cause moderate impact.

Cross Island is an important bowhead whale subsistence area for Iñupiat whalers from Nuiqsut. The Cross Island EIA encompasses the subsistence area. The Iñupiat who hunt bowhead whale from Cross Island have long sought a spatial buffer to protect the area where they hunt and the area where bowhead whales migrate in the fall, entering into their hunting area. Noise in this area could deflect whales out of the range of hunters. Whalers report that bowhead whales are sensitive to anthropogenic noises.

Exclusion of all of the areas of the Beaufort Sea EIAs included under this alternative may reduce all impacts to **negligible** (**Table 4.4.2-3**). Temporal restrictions could be applied to noise, vessel traffic, and offshore space-use conflicts. This would reduce the effects of these IPFs to **negligible**. These temporal mitigation restrictions could be applied during the most sensitive time periods when whales are migrating and subsistence hunting is taking place. Temporal mitigation would not change the effects of onshore construction, visible infrastructure, or space-use conflicts, which are considered **moderate**, nor accidental spills, which are considered **moderate** to **major**.

Table 4.4.2-3. Change in Impact from the Proposed Action for IPFs that may Affect Sociocultural Resources.

Impact-Producing Factor	Proposed Action Impact Finding	Impact Change Within or Because of EIA
Noise	Moderate	May reduce effects to **negligible**.
Traffic: Vessel/Aircraft Traffic	Moderate – Major	May reduce effects to **negligible**.
Bottom/Land Disturbance	Moderate – Major	May reduce effects to **negligible**.
Space-use Conflict	Moderate – Major	May reduce effects to **negligible**.
Visible Infrastructure	Moderate – Major	May reduce effects to **negligible**.

4.4.2.2.6. Environmental Justice

Exclusions of all EIAs combined with seasonal restrictions on other impact-producing activities that are permitted by BOEM (e.g., seismic exploration surveys) would provide the highest level of protection for subsistence species (and the communities that rely on them) in the Beaufort Sea Program Area (**Table 4.4.2-4**). This would result in little or no E&D taking place within the EIAs. E&D still could occur within these areas on active leases from previous lease sales. Ship and aircraft traffic associated with offshore oil and gas industry activities still could transit the excluded areas. If the exclusion applied only to leasing activities, seismic research vessels could be permitted to operate within the EIAs, and ancillary activities could take place on existing leases. The Cross Island and Kaktovik EIAs currently have active leases.

Table 4.4.2-4. Change in Impact from the Proposed Action for IPFs that may Affect Environmental Justice.

Impact-Producing Factor	Proposed Action Impact Finding	Impact Change Within or Because of EIAs
Noise[1]	Moderate – Major	**Negligible** to **minor**
Routine Discharge[1]	Moderate	**Negligible**
Bottom/Land Disturbance[1]	Moderate – Major	**Negligible**
Air Emissions	Moderate	**Negligible** to **Minor**. Exclusion of EIA areas would not prevent movement of emissions into those areas. However, limiting activities within the EIA may make it more unlikely that emissions would be localized in nearby communities.
Lighting	Moderate	**Negligible**[2]
Visible Infrastructure	Moderate	**Negligible**[2]
Space-Use Conflict	Moderate – Major	**Negligible**[2]
Accidental Spills	Moderate – Major	**Moderate** to **Major**. Exclusion of EIA areas would not prevent movement of an oil spill into the areas if one should occur. However, limiting activities within the EIA may make it more unlikely that a spill will impact sensitive areas.

[1] Within EIAs where leasing is excluded and BOEM-permitted activities with noise, routine discharge, and bottom/land disturbance as an IPF are restricted during the open water season and during periods of whale migration, which could seriously but indirectly impact vulnerable communities that rely on subsistence resources.

[2] Lighting, visible infrastructure, and space-use conflicts could directly affect vulnerable communities as they are active offshore, but would be negligible, if leasing was excluded in these areas.

If a seasonal/temporal exclusion could be applied to all or some of the EIAs, this could exclude impact-producing activities (e.g., seismic surveys, exploration drilling) from taking place during the most sensitive time periods such as when bowhead whales are migrating past Cross Island and subsistence hunting is taking place. Temporal/seasonal exclusions could be applied for any or all exploration activities within an EIA. If exploration leads to development and production on a particular lease block or blocks, production likely could not be halted seasonally, and the impacts associated with production activities would not be reduced.

The IPFs of most relevance for the Beaufort Sea Alternative in relation to environmental justice issues relate primarily to subsistence for marine mammal species. Even minor impacts to marine mammal species, especially those that may push the species farther offshore and make them unavailable to hunters, would result in impacts to environmental justice. Reducing or eliminating noise impacts during subsistence activities would benefit the communities who rely on subsistence to supplement commercially obtained food sources and for caloric needs. Any impacts to marine mammals are discussed further in **Section 4.4.1.6**.

4.4.2.3. B(2)(a) – The Proposed Action not including the Chukchi Sea Program Area

Removal of the Chukchi Sea Program Area would remove the potential for adverse impacts to any environmental resource within that Program Area from routine or non-routine activities associated with the Proposed Action; this would be a greater environmental benefit than the removal of only the EIAs for this Program Area. Any positive impacts from the Proposed Action also would not be realized. In addition, activities on existing leases would not be affected by the removal of the Chukchi Sea Program Area during the 2017-2022 Program. Approximately 17 percent of the anticipated energy produced from the Program would be forgone through removal of this Program Area (**Section 4.4.2**). Possible impacts from substitute energy sources are similar to but less than those described under Alternative C

(**Section 4.4.3**). Impacts from future programs are discussed as a part of the cumulative effects analysis (**Section 4.5**).

4.4.2.4. B(2)(b) – The Proposed Action plus Consideration of EIAs in the Chukchi Sea Program Area

There would not be any change in potential level of impact from Alternative A for the following resource areas: air quality; water quality; coastal and estuarine habitats; pelagic communities; fish and EFH; Areas of Special Concern; archaeological and historical resources; land use and infrastructure; population, employment, and income; and tourism and recreation. This is because the exclusion or implementation of mitigation measures within these areas only will benefit resources found with them or that rely on them. Resources for which there may be change in potential impact levels are discussed in the following subsections.

4.4.2.4.1. Marine Benthic Communities

The Walrus Foraging Area and the Walrus Movement Corridor, including Hanna Shoal (Dunton et al., 2005), encompass areas of high benthic biomass and especially large numbers of bivalves (Schonberg et al., 2014). Exclusion of this area in the Program would eliminate practically all IPFs to benthic environments (**Table 4.4.2-5**). This would benefit not only the benthic communities in the EIA but also the animals that rely on these assemblages for food, namely walrus and other marine mammals, and potentially species of seabirds.

Table 4.4.2-5. Change in Impact from the Proposed Action for IPFs that may Affect Marine Benthic Communities.

Impact-Producing Factor	Proposed Action Impact Finding	Impact Change Within or Because of EIAs
Bottom/Land Disturbance: Drilling Mud/Cuttings/Debris	Negligible – Moderate	**Negligible** to **Minor**. In the absence of drilling activity these impacts would be greatly reduced in the EIA.
Bottom/Land Disturbance: Drilling Disturbance	Negligible – Moderate	**Negligible**. In the absence of oil and gas activities, no drilling disturbance is expected to benthic habitats.
Bottom/Land Disturbance: Infrastructure Emplacement (other than noise)	Negligible – Moderate	**Negligible**. In the absence of oil and gas activities, no infrastructure emplacement is expected on benthic habitats.
Bottom/Land Disturbance: Pipeline Trenching	Negligible – Moderate	**Negligible**. In the absence of oil and gas activities, no infrastructure emplacement is expected on benthic habitats.
Bottom/Land Disturbance: Structure Removal (other than noise)	Negligible – Moderate	**Negligible**. In the absence of oil and gas activities, no infrastructure emplacement is expected on benthic habitats.
Accidental Spills	Minor – Major	**Negligible** to **Moderate**. Exclusion of EIAs would not prevent movement of an oil spill into those areas if one should occur. However, limiting activities within the EIAs may make it more unlikely that a spill will impact sensitive areas.

4.4.2.4.2. Marine Mammals

The Walrus Foraging Area EIA includes the Hanna Shoal Walrus Use Area (HSWUA). The Movement Corridor includes the area between the HSWUA and terrestrial resting areas, or haul outs. The HSWUA has been identified as important walrus foraging habitat by the USFWS in their *Final Incidental Take Regulations for Polar Bears and Pacific Walrus for the Chukchi Sea* issued June 12, 2013. This determination is based on walrus tagging studies conducted by the U.S. Geological Survey (USGS) that have tracked walrus movements and identified foraging and resting habitat (Jay et al., 2012).

Hanna Shoal is an area of high benthic biomass and is a primary foraging habitat for walrus, gray whales, and a variety of seabird species during the open water season (Brueggeman, 2009; Gall, 2013). Sea ice remnants grounded on the shoal remain after much of the sea ice has retreated off of the shelf area, which provides resting habitat for walrus and seals between foraging attempts. In addition, bowhead whales move through the Hanna Shoal area during the fall migration from August to December (Quakenbush et al., 2012). Once the remnant ice melts, and in recent low-ice years, as many as 35,000 walrus have been hauling out near Point Lay and transiting from terrestrial haul outs to the HSWUA to forage (Aerial Surveys of Arctic Marine Mammals [ASAMM] and USDOI, USGS, unpublished). Exclusion of these areas or implementation of activity restrictions may provide protection of foraging habitat for walrus and other marine mammals from disturbance by industry activities as they forage and move between terrestrial haul outs and foraging areas (**Table 4.4.2-6**). This protection would be limited in the nearshore area, however, as other operators (e.g., commercial aircraft and barges, research vessels, private vessels and aircraft) still would transit along the nearshore corridor and research vessels would continue to operate in the HSWUA. Exclusion activity restrictions in these areas would primarily benefit walrus but also grey whales, bearded seals, and to a lesser extent, other marine mammal and seabird species. A seasonal exclusion would be of limited benefit because much of the Pacific walrus population remains in this area throughout the open water season and industry exploration activity is largely limited to the open water season for practical and safety reasons. Because walrus are benthic feeders, exploration activities that disturb the seafloor and impact the benthos, such as exploration drilling, could impact walrus by reducing available prey species, even if the activities were conducted when walrus were not present.

Table 4.4.2-6. Change in Impact from the Proposed Action for IPFs that may Affect Marine Mammals.

Impact-Producing Factor	Proposed Action Impact Finding	Impact Change Within or Because of EIA
Noise	Minor – Moderate	**Negligible** to **minor** within EIAs where leasing is excluded and BOEM-permitted activities with noise as an IPF are restricted during the open water season and during periods of migration.
Traffic: Vessel/Aircraft Traffic	Negligible – Moderate	**No change**. Exclusion of EIAs could decrease vessel and aircraft traffic within those areas. However, most major impacts would occur within the coastal areas which are outside of the EIA.
Bottom/Land Disturbance: Drilling Muds/Cuttings/Debris	Negligible – Moderate	**Negligible** if the Walrus Foraging Area is excluded.

4.4.2.4.3. Marine and Coastal Birds

The Walrus Foraging Area EIA includes the HSWUA and the corridor between foraging areas and terrestrial resting areas or haul outs. Hanna Shoal is an area of high benthic biomass and is a primary foraging habitat for walrus, grey whales, and a variety of seabird species during the open water season (Brueggeman, 2009; Gall, 2013). Exclusion of this area or activity restrictions implemented for this area primarily would benefit walrus but also gray whales, bearded seals, and to a lesser extent, other marine mammal and seabird species. Excluding this area seasonally or completely would not change the levels of effect determination for birds.

Selection of the HSWUA would not be of significant benefit to birds. Excluding these areas seasonally or completely would not change the levels of effect determination for birds.

4.4.2.4.4. Sociocultural Systems

The most significant component of sociocultural resources is subsistence for marine mammals, central to the culture of the Iñupiat (**Section 4.3.16**). Bowhead whales and beluga are the marine mammals most sensitive to noise associated with industry and commercial activities. These species reduce communication calls when anthropogenic noise sources are nearby, and therefore may move away from the source of the noise (**Section 4.2.2.11**).

Onshore construction resulting in land disturbance could disrupt small remote communities that have very little industrial development, and have a **moderate** effect on them. Local residents, particularly Iñupiat, are not accustomed to seeing construction of OCS infrastructure onshore where they butcher whales as part of their subsistence activities.

Visible offshore and onshore infrastructure could have a **moderate** effect on the viewshed for sociocultural systems. Offshore infrastructure could have such an effect because subsistence hunters go as far as 80.5 km (50 mi) offshore (**Section 4.3.16**). Onshore infrastructure could have such an effect because people in the small remote communities do not have such structures and are not accustomed to such views.

Regarding space-use conflicts, onshore facilities such as ports and pipelines coming ashore, could cause **moderate** effects. In the Chukchi Sea, small communities are spread apart over hundreds of miles and rely significantly on subsistence, each having their own character. They have very little industry comparable to OCS facilities; therefore, onshore facilities could impact these communities at a moderate level.

Exclusion of all the Chukchi Sea EIAs included under this alternative may reduce all impacts to **negligible** (**Table 4.4.2-7**). Temporal restrictions could be applied for noise; vessel traffic; and offshore space-use conflicts. This would change the effects of these IPFs to **negligible**. These temporal mitigation restrictions could be applied during the most sensitive time periods, when whales are migrating and subsistence hunting is taking place. Temporal mitigation would not change the effects of onshore construction, visible infrastructure, or space-use conflicts which are **moderate**.

Table 4.4.2-7. Change in Impact from the Proposed Action for IPFs that may Affect Sociocultural Systems.

Impact-Producing Factor	Proposed Action Impact Finding	Impact Change Within or Because of EIA
Noise	Moderate	May reduce effects to **negligible**.
Traffic: Vessel/Aircraft Traffic	Moderate – Major	May reduce effects to **negligible**.
Bottom/Land Disturbance	Moderate – Major	May reduce effects to **negligible**.
Space-Use Conflicts	Moderate – Major	May reduce effects to **negligible**.
Visible Infrastructure	Moderate – Major	May reduce effects to **negligible**.

4.4.2.4.5. Environmental Justice

As with the Beaufort Sea Program Area, the exclusion of EIAs for the Chukchi Sea Program Area would reduce the potential for impacts to subsistence species. Seasonal restrictions on activities during open water season and periods of migration also would reduce impacts. Reducing or eliminating noise impacts during subsistence activities would benefit the communities that rely on subsistence to supplement commercially obtained food sources.

The analysis suggests time-area closures within this area would be appropriate. However, subsistence harvesters can easily travel >80.5 km (50 mi) seaward from the coast. This alternative covers a portion of the area that subsistence harvesters will traverse. Exclusion of this area or activity restrictions implemented for this area would primarily benefit walrus, but also would benefit gray whales, bearded seals, and to a lesser extent, other marine mammal and seabird species. Because walrus are benthic feeders, exploration activities that disturb the seafloor and impact the benthos, such as exploration drilling, could impact walrus by reducing available prey species even if the activities were conducted when walrus were not present. Reducing or eliminating impacts during subsistence activities would benefit the communities that rely on them (**Table 4.4.2-8**).

Table 4.4.2-8. Change in Impact from the Proposed Action for IPFs that may Affect Environmental Justice.

Impact-Producing Factor	Proposed Action Impact Finding	Impact Change Within or Because of EIA
Noise	Moderate – Major	**Minor**. New leasing would be excluded; however, ancillary activities may or may not be restricted. During periods of whale migration, noise resulting in a change of whale behavior could indirectly impact subsistence whalers.
Routine Discharges	Moderate	**Negligible.** Because new leasing would be excluded, routine discharges from oil and gas activity in this area would not affect coastal communities.
Bottom/Land Disturbance	Moderate – Major	**Negligible**. Because new leasing would be excluded, bottom/land disturbances from oil and gas activity in this area would not affect coastal communities.
Air Emissions	Moderate	**Negligible** to **Minor**. Exclusion of EIAs would not prevent movement of emissions into those areas. However, limiting activities within EIAs may make it more unlikely that emissions would be localized in nearby communities.
Lighting	Minor	**Negligible**. During open water season, it is unlikely that lighting would be an issue for coastal communities adjacent to the Chukchi Sea Planning Areas, due to the long periods of daylight, upwards of 17 hours.
Visible Infrastructure	Moderate	**Negligible**. Because new leasing would be excluded, infrastructure would not be built.
Space-Use Conflict	Moderate – Major	**Negligible**. Because new leasing would be excluded, related space-use conflicts would be eliminated.
Accidental Spills	Moderate to Major	**Moderate** to **Major**. Exclusion of EIAs would not prevent movement of an oil spill into those areas if one should occur. However, limiting activities within EIAs may make it more unlikely that a spill will impact sensitive areas.

4.4.2.5. B(3)(a) – The Proposed Action not Including the Cook Inlet Program Area

Removal of the Cook Inlet Program Area would remove the potential for adverse impacts to any environmental resource within that Program Area from routine or non-routine activities associated with the Proposed Action; this would be a greater environmental benefit than only the removal of the EIA for this Program Area. Any positive impacts from the Proposed Action also would not be realized. Approximately 2 percent of the anticipated energy produced from the Program would be forgone through removal of this Program Area (**Section 4.4.2**). Possible impacts from substitute energy sources are similar to but less than those described under Alternative C (**Section 4.4.3**). Impacts from future programs are discussed as a part of the cumulative effects analysis (**Section 4.5**).

4.4.2.6. B(3)(b) – The Proposed Action plus Consideration of EIAs in the Cook Inlet Program Area

There would not be any change in potential level of impact from Alternative A for all resources except marine mammals because this EIA consists of a small area of beluga whale critical habitat.

4.4.2.6.1. Beluga Whale Critical Habitat

A small portion of the proposed lease sale area overlaps with beluga whale critical habitat at the northern edge of the Program Area. The Cook Inlet beluga whale is one of five genetically distinct populations in Alaska. It is geographically isolated, and remains year-round in Cook Inlet for mating, rearing, and feeding. Cook Inlet belugas were designated as endangered under the ESA in 2008. Surveys conducted by NMFS have estimated a current population of approximately 300 belugas in Cook Inlet, down from historical estimates of 1,300 (USDOC, NMFS, 2015).

Belugas are highly vocal and use calls for social purposes and to locate prey. Belugas may reduce vocal activity in noisy environments (Širović and Kendall, 2009; Small et al., 2011) and especially when frightened or in the presence of predators (Sjare and Smith, 1986a,b; Finley, 1990; Karlsen et al., 2002; Belikov and Bel'kovich, 2003). Anthropogenic noise and its impacts to prey species and habitat have been identified as threats to the belugas in their Recovery Plan (USDOC, NMFS, 2015). Reducing anthropogenic noise and activity by excluding this area may be of some benefit to the remaining small numbers of Cook Inlet beluga whales (**Table 4.4.2-9**). It would not have any appreciable affect for other marine mammal species in Cook Inlet.

Table 4.4.2-9. Change in Impact from the Proposed Action for IPFs That may Affect Beluga Whales.

Impact-Producing Factor	Proposed Action Impact Finding	Impact Change Within or Because of EIA
Noise	Minor – Moderate	**Minor** to **moderate**. The critical habitat areas are so small that they may not provide adequate protection from noise, especially seismic activities.
Traffic: Vessel/Aircraft Traffic	Negligible – Moderate	**Negligible** to **minor** if vessels and aircraft avoid critical habitat areas.
Accidental Spills	Minor – Major	**Minor** to **major**. The small size of the beluga area likely would not provide any protection from accidental spills.

4.4.2.7. B(4)(a) – The Proposed Action not Including the Gulf of Mexico Program Area

Removal of the Gulf of Mexico Program Area would remove the potential for adverse impacts to any environmental resource within that Program Area from routine or non-routine activities associated with the Proposed Action. Any positive impacts from the Proposed Action also would not be realized. In addition, activities on existing leases would not be affected by the removal of this Program Area during the 2017-2022 Program. Approximately 46 percent of the anticipated energy produced from the Program would be forgone through removal of this Program Area (**Section 4.4.2**). Possible impacts from substitute energy sources are similar to but less than those described under Alternative C (**Section 4.4.3**). Impacts from future programs are discussed as a part of the cumulative effects analysis (**Section 4.5**).

4.4.2.8. B(5)(a) – The Proposed Action not Including the Atlantic Program Area

Removal of the Atlantic Program Area would remove the potential for adverse impacts to any environmental resource within that Program Area from routine or non-routine activities associated with the Proposed Action; this would be a greater environmental benefit than only the removal of the EIA for this Program Area. Any positive impacts from the Proposed Action also would not be realized. Approximately 11 percent of the anticipated energy produced from the Program would be forgone through removal of this Program Area (**Section 4.4.2**). Possible impacts from substitute energy sources are similar to but less than those described under Alternative C (**Section 4.4.3**). Impacts from future programs are discussed as a part of the cumulative effects analysis (**Section 4.5**).

4.4.2.9. B(5)(b) – The Proposed Action plus Consideration of EIAs in the Atlantic Program Area

There would not be any change in potential level of impact from Alternative A for the following resource areas: air quality; water quality; coastal and estuarine habitats; pelagic communities; Areas of

Special Concern; archaeological and historical resources; land use and infrastructure; and tourism and recreation. This is because the exclusion or implementation of mitigation measures within these areas only will benefit resources found within them or that rely on them. Resources for which there may be change in potential impact levels are discussed in the following subsections.

4.4.2.9.1. Marine Benthic Communities

Norfolk and Washington Canyons

The Washington and Norfolk Canyons are among several Atlantic canyons identified as areas of deepwater coral habitat and that support a high abundance of diverse fish and invertebrate assemblages. The implementation of this EIA would provide protection to marine benthic resources from all routine impacts (**Table 4.4.2-10**). Non-routine IPFs still would pose a threat to these sensitive areas depending on the size and location of a spill. It is assumed under this EIA and Alternative A that other biologically sensitive habitats in the Atlantic Program Area (e.g., remaining canyons and seamounts that support live/hard bottom communities) would be protected through mitigations similar to those found in the Gulf of Mexico under NTL 2009-G40.

Table 4.4.2-10. Change in Impact from the Proposed Action for IPFs that may Affect Marine Benthic Communities.

Impact-Producing Factor	Proposed Action Impact Finding	Impact Change Within or Because of EIA
Bottom/Land Disturbance: Drilling Mud/Cuttings/Debris	Negligible – Moderate	**Negligible** to **Minor**. In the absence of drilling activity these impacts would be greatly reduced in the EIA.
Bottom/Land Disturbance: Drilling Disturbance	Negligible – Moderate	**Negligible**. In the absence of oil and gas activities, no drilling disturbance is expected to benthic habitats.
Bottom/Land Disturbance: Infrastructure Emplacement (other than noise)	Negligible – Moderate	**Negligible**. In the absence of oil and gas activities, no infrastructure emplacement is expected on benthic habitats.
Bottom/Land Disturbance: Pipeline Trenching	Negligible – Moderate	**Negligible**. In the absence of oil and gas activities, no infrastructure emplacement is expected on benthic habitats.
Bottom/Land Disturbance: Structure Removal (other than noise)	Negligible – Moderate	**Negligible**. In the absence of oil and gas activities, no infrastructure emplacement is expected on benthic habitats.

4.4.2.9.2. Marine Mammals

Norfolk and Washington Canyons

The Washington and Norfolk Canyons support high levels of benthic and pelagic biodiversity. They provide important habitat for fishes and hard substrate epibiota, including corals, and are associated with important foraging habitat for whales and seabirds. The waters overlying and surrounding the canyons support high cetacean density, especially for toothed whales such as beaked and sperm whales. Although the canyon areas are <1 percent of the total Program Area, they encompass a high-use area for marine mammals. Elimination of most routine IPFs through exclusion of these areas would result in a localized impact reduction to the species that occur in these areas (**Table 4.4.2-11**). The relative importance of these areas to marine mammals based on density estimates suggests that even a localized reduction in impacts could provide benefits across the population. This is especially true for species that may spend the majority of the year in this area or that have high site fidelity (e.g., sperm whales, beaked whales, pilot whales).

Table 4.4.2-11. Change in Impact from the Proposed Action for IPFs that may Affect Marine Mammals.

Impact-Producing Factor	Proposed Action Impact Finding	Impact Change Within or Because of EIA
Noise	Minor – Moderate	**Negligible** to **Minor** within Canyons EIA (exclusion). Localized reduction in exposure to noise may result in fewer impacts to marine mammals as compared to the Proposed Action.
Traffic: Vessel/Aircraft Traffic	Negligible – Major	**Negligible** to **Minor** in areas where vessel speed is restricted and PSOs are used during transit. Vessel speed reductions or having active PSOs during transit within sensitive areas such as the waters overlying the canyons may mitigate the risk of a major impact to NARW and other species (such as other marine mammals and sea turtles).

4.4.2.9.3. Marine and Coastal Birds

Norfolk and Washington Canyons

The Washington and Norfolk Canyons support high levels of benthic and pelagic biodiversity. They provide important habitat for fishes and corals and are associated with important foraging habitat for whales and seabirds. Recent tagging studies indicate high use of this area by foraging shearwaters (unpublished data, Stellwagen Bank NMS). Decreasing activity in these areas would reduce the potential for disturbance to foraging or resting seabirds, but would not change the level of effect determination for seabirds.

4.4.2.9.4. Commercial and Recreational Fisheries

Norfolk and Washington Canyons

Washington and Norfolk Canyons are among several Atlantic canyons identified as areas of importance to highly migratory and deepwater fishes. The canyons are sites of intense recreational and commercial fishing activity (e.g., for tilefish, lobsters, red crab, tunas, swordfish). Excluding Washington and Norfolk Canyons can mitigate impacts to tilefish and HMS fisheries that target these canyon areas. It would not change the overall impact finding related to commercial and recreational fisheries.

4.4.3. Alternative C – The No Action Alternative

Under Alternative C (the No Action Alternative), there would be no new leasing in any of the five Program Areas between 2017 and 2022. However, exploration, development, and production operations stemming from past and current sales (where applicable) would continue and may possibly occur relatively sooner than may otherwise occur. Past lease sale activity is addressed for each region below. It also is assumed that no new leasing in the 2017-2022 Program would represent a significant shift in federal policy and energy prioritization, to where subsequent leasing under future OCS oil and gas programs may not be expected, especially in well-established regions. Energy needs would have to be replaced by a combination of imports, alternative energy sources, and conservation. If no future leasing was revisited in a future program, impacts from the Proposed Action would simply be delayed until the time that leasing might occur.

In the Arctic, activities from past leasing would be expected to continue; however, with no new leasing, there may be less incentive to move forward with oil and gas activities because of less possible connectivity to other new leases. Active leases remain in the Beaufort Sea from the following sales: Beaufort in 1979, 124 in 1991, 144 in 1996, 186 in 2003, 195 in 2005 and Sale 202 held in 2007. There are no activities currently occurring on these active leases. Most of the leases will expire by

December 31, 2017, unless activity begins on them or the lease term is extended. In the Chukchi Sea, all active leases are from Sale 193 held February 6, 2008. These leases are set to expire between September and December 2020, unless activity begins on them or the lease term is extended. The pace of OCS oil and gas development has been slow in the Beaufort and Chukchi Sea Planning Areas, but BOEM still envisions possible E&D on the existing leases. Operators are expected to try to explore leases in the Chukchi Sea despite disappointing results from Royal Dutch Shell exploration in 2015. Other projects are taking form in the Beaufort Sea Planning Area such as the Liberty Project (http://www.boem.gov/About-BOEM/BOEM-Regions/Alaska-Region/Leasing-and-Plans/Leasing/Liberty/Liberty_Project_2.aspx), in addition to the existing North Star Project (http://doa.alaska.gov/ogc/annual/current/18_Oil_Pools/Northstar-%20Oil/1_Oil_1.htm). Active leases can be found at http://www.boem.gov/Alaska-Detailed-Listing-of-Active-Leases/. New infrastructure (e.g., pipelines) also would be required in the Arctic for existing leases that may be developed before they expire. On-lease G&G activities would continue to occur, and off-lease G&G activities probably would occur only for scientific purposes.

In Cook Inlet, there are no existing OCS oil and gas leases; therefore, none would be expected under the No Action Alternative. The No Action Alternative equates with no activity in the Cook Inlet OCS.

The Gulf of Mexico OCS is a mature area for oil and gas development, so the No Action Alternative is more complex and does not equate with no activity. In the Gulf of Mexico, OCS oil and gas activities from past leasing and any leasing remaining in the existing program through 2017 would be expected to continue. In the Gulf of Mexico, there would be little decline in existing OCS activity for at least 5 to 10 years because of an accumulation of leases. Thereafter, there would be a much sharper decline of activity compared with the Proposed Action (**Figure 4.4.3-1**), especially if future Programs are not re-instituted. Newer leases in the Gulf of Mexico would require new drilling and well development as well as the construction of platforms and pipeline infrastructure to explore and develop any new discoveries and to further delineate and develop existing discoveries through offset drilling and production (e.g., USDOI, BOEM, 2015e). However, after 20 years, estimated overall oil and gas activity under the No Action Alternative in the Gulf of Mexico would be approximately half of that expected under the Proposed Action and associated cumulative scenario. After approximately 40 years under the No Action Alternative, new oil and gas activity would be essentially absent in the Gulf of Mexico OCS compared to the Proposed Action, and the associated cumulative scenario. Decommissioning in the Gulf of Mexico would be accelerated for older leases because equipment life would no longer be extended by new leasing connections and facility tie-backs. Decommissioning would be mostly complete in approximately 50 years.

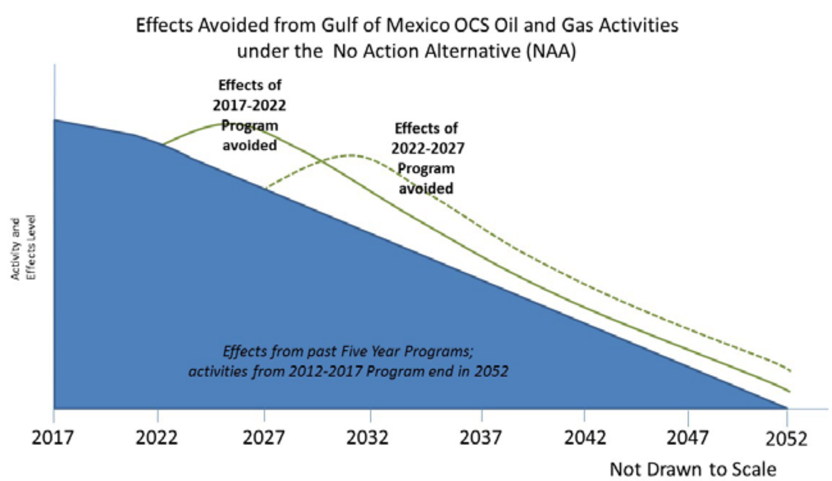


Figure 4.4.3-1. Schematic of Effects Avoided over a Period of 40 Years from Gulf of Mexico OCS Oil and Gas Activities Under the No Action Alternative.

In the Atlantic Program Area, there are no existing OCS oil and gas leases; therefore, none would be expected under the No Action Alternative. Alternative C equates with no oil and gas activity on the OCS. Off-lease G&G activity would still occur, but at drastically reduced levels, mainly associated with renewable energy, sand and gravel projects, and scientific research. Deep seismic G&G activities (e.g., scientific research) in the Atlantic would be curtailed severely under Alternative C.

Under Alternative C, none of the potential environmental impacts under the Proposed Action (**Section 4.4.1**) would occur to the physical and biological resources (e.g., air quality, water quality, coastal and estuarine habitats) in the Atlantic and Cook Inlet Program Areas. These precluded impacts would include the anticipated effects under the Proposed Action of routine operations and non-routine events. For the Arctic and particularly for the Gulf of Mexico Program Areas, Alternative C still would have potential physical and biological impacts from current and past programs, but at reduced levels. In the Gulf of Mexico, potential impacts from Alternative C would decline rapidly, compared to the Proposed Action, and would be eliminated under Alternative C after approximately 40 years in the Gulf of Mexico. Because the Arctic Program Area is a frontier area with little current development, future development would be less likely with the No Action Alternative. Because Alternative C would eliminate all oil and gas activities that are projected to occur under the Proposed Action and future programs, there would be impacts resulting from the loss of leasing on socioeconomic and sociocultural resources (i.e., population, employment, and income; land use and infrastructure; commercial and recreational fisheries; tourism and recreation; sociocultural systems; environmental justice) mainly in the Gulf of Mexico Program Area, and to a lesser extent in the Arctic Program Area. Impacts to vulnerable communities (i.e., environmental justice) could still occur from existing leases prior to the Proposed Action, in the Gulf of Mexico and Alaska regions.

Because the demand for energy would not decrease commensurately, Alternative C would require energy substitutes and/or conservation to replace the oil and gas production that would not occur as a result of the Program (**Figure 4.4.3-2**). The energy substitutions would be associated with their own potential environmental impacts that could occur within or outside Program Areas that are considered in the Proposed Action and these environmental impacts would depend on the mix of specific energy substitutes that would be used (see Beronja et al., 2015).

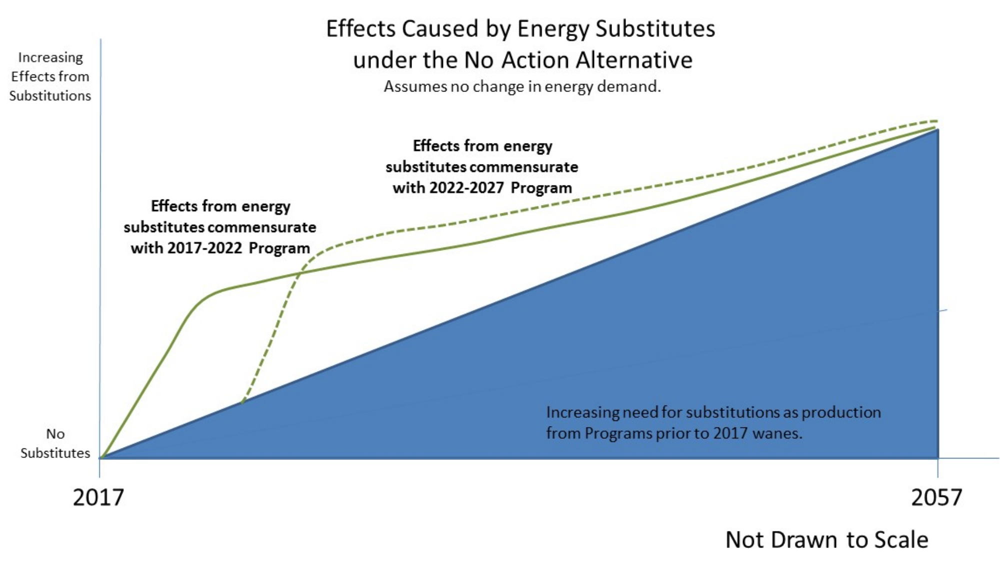


Figure 4.4.3-2. Schematic of Gulf of Mexico OCS – No Action Alternative "Effects Caused" Assumes No Change in Energy Demand over a 40-Year Period.

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). The process for calculating these impacts begins with the application of MarketSim, a multimarket equilibrium model that simulates the energy supply, demand, and price effects of OCS oil and gas production compared with baseline projections from the USEIA (2015). In addition to simulating oil and natural gas markets, MarketSim addresses substitution effects across coal and electricity segments of the energy market. Modeling each of these sectors, MarketSim produces an estimate of the energy market's response to the absence of OCS production. **Table 4.4.3-1** presents the changes in energy markets projected by MarketSim.

Table 4.4.3-1. Energy Substitutions Under Alternative C.

Energy Sector	Replacement Percent
Domestic onshore oil and gas	28
Domestic offshore oil and gas	1
Oil and gas imports	58
Other	2
Coal	3
Electricity from sources other than coal, oil, and natural gas	1
Reduced demand	7

From: Output from BOEM's MarketSim model.

To ensure that demands for oil and gas are met, a sharp increase in oil and gas imports, via tanker and pipeline, would be likely. The quantities of domestic onshore production of oil and natural gas also are anticipated to increase accounting for approximately 26 percent of foregone OCS production. The reduction in OCS oil and gas production under Alternative C would be replaced by an increase in domestic coal production, electricity production, and reduced demand or energy conservation measures. Conservation might take the form of increased fuel economy (e.g., driving more fuel efficient vehicles, driving smaller and lighter cars, driving at slower speeds, replacing gasoline engines with hybrids and diesel engines) or reducing miles traveled by private vehicles through use of public transportation.

Potential impacts from substitute energy sources (e.g., more tankers bringing offshore oil) are quite variable and would be determined by the type and location of substitution (e.g., increase in foreign oil imports, renewable energy, onshore drilling). An exception could be made when increased energy efficiency or conservation are the effective substitutes, as those actions often will result in decreased use of the energy resources that give rise to adverse environmental consequences.

Principal Effects of No Action Energy Substitutes

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. Some issues of particular environmental concern from energy substitutions are identified here.

Oil Spills. Oil imported into the U.S. may result in tanker spills in different OCS planning areas. In comparison to the Proposed Action, the number and potential volume of oil spills that could result from import tanker accidents is less. Part of this reduction is explained by the fact that the volume of oil imports under Alternative C is smaller than the precluded volume of OCS oil that would have been produced under the Proposed Action. Another factor is that tankering has a lower spill risk than OCS production, in part because OCS production includes the risk of spills during production and transportation phases, while tankering involves risk only during transportation. The exploration and production risk associated with oil import substitutes would occur in oil-exporting nations. Because there are no oil import ports or terminals in the Arctic Program Areas, Alternative C would eliminate the risk of oil spills in that region. The reduction in the risk of oil spills from OCS production redistributes, rather than totally eliminates, the spill risk. The Atlantic and Pacific coasts could be exposed to an additional import tanker spill occurrence under Alternative C, whereas these areas would have no or more limited exposure to oil spill risk from OCS activities under the No Action Alternative. Terrestrial spills associated with onshore production or transport could affect waterways, aquatic ecosystems, and wetlands adversely; wildlife that depends on these important habitats could be injured or killed depending on the severity of exposure.

Waste Management. Waste management issues also are a concern, with the biggest concern being associated with nuclear and coal-fired power plants. The country has been struggling for decades to determine how the spent fuel from nuclear power plants and coal ash from coal will be managed on a long-term basis because of possible heavy metal and radiation contamination of ground and surface water.

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 related to enhanced recovery operations, including hydraulic fracturing. In addition, oil and gas wells may lead to groundwater contamination from accidental spills, losses of well control, or pipeline leaks.

Other Discharges from Oil and Gas Operations. 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 and 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. Additional impacts could include possible degradation of surface water and groundwater quality from spills or leaks of processing chemicals during handling, mixing, or injection, or increased potential for chemical contamination of drinking water by injected fluids left in the reservoir.

Air Quality Deterioration from Emissions. The major environmental impacts associated with expanded oil imports via tanker, domestic onshore oil and gas, coal combustion, and renewable energy production include potential degradation of local ambient air quality from atmospheric emissions of dust, engine exhaust, off gassing, flaring and burning products, particulates, SO_2, CO, NO_x, hydrogen sulfide (H_2S), and hydrocarbons. For example, tanker emissions occur not only in transport but for long periods in port while imported oil is being unloaded.

Aquatic Ecosystem Effects from Hydropower. Hydroelectric facilities can have major impact on aquatic ecosystems if mitigation actions are not taken (e.g., fish ladders and intake screens). Fish and other aquatic life can be injured and killed by turbine blades. In addition to direct contact with the turbine blades, there also can be fish and wildlife impacts at the reservoir site and downstream from the facility because of habitat alteration, changes in upstream and downstream migration of biota, and changes in river flow and sediment patterns. See Bunn and Arthington (2002) for a synopsis of impacts of altered riverine flow regimes.

Habitat and Wildlife Disturbance. Habitat and wildlife impacts associated with onshore facilities, coal mines, solar energy, and wind energy include fragmentation and loss of land. Depending on scale, these constructions and installations may displace wildlife and cause deforestation and general distortion of the terrestrial landscape.

Low-Probability Catastrophic Effects. The potential exists for low-probability catastrophic consequences from the development and use of energy substitutes to OCS oil and gas. For example, a nuclear accident could occur as a result of nuclear power production, or a CDE could occur in offshore waters of other nations during oil and gas exploration and production activities.

Socioeconomic and Sociocultural Effects. OCS oil and gas-related activities have been an important source of employment and income in Gulf of Mexico coastal areas. Alternative C would result in reduced employment and income opportunities and could affect the stability and cohesion of communities and cultures. Alternative C also could be interpreted as a boom-bust event. The infrastructure and population of affected areas in the Gulf of Mexico have developed over decades in association with a regular occurrence of lease sales and resulting OCS activities. Alternative C could result in situations in which local infrastructure and populations could not be maintained, resulting in out-migration and a reduction in public services. Furthermore, Alternative C's disruption of a continuous process of activity in the Gulf of Mexico could affect future investments, which would compound the social, economic, and cultural effects associated with Alternative C. In other Program Areas such as the Atlantic that have little or no offshore oil and gas activity, the impact would be limited to foregone employment and tax revenue opportunities.

4.4.4. Accidental Spills and Catastrophic Discharge Events

Oil spills are accidental and unauthorized events. Industry practices and government regulations minimize the risk of oil spills, and industry and government entities prepare to respond should a spill occur. Despite these efforts, there is no way to guarantee that oil spills will not occur. Therefore, it is imperative for BOEM to analyze the potential for spills of various sizes, and their potential impacts to the environment as well as assess opportunities for prevention and mitigation to reduce oil spill occurrence and improve spill response. This analysis applies to effects from an actual spill as well as spill containment and cleanup activities. Such an analysis is presented here, and applies across the broad spectrum of environmental resource areas discussed in this chapter.

For the purpose of this Programmatic EIS analysis, accidental oil spills are classified into two broad categories: (1) expected accidental small (≥1 to <1,000 bbl) and large (≥1,000 bbl) spills from platforms and pipelines; and (2) a low-probability CDE. See **Section 3.2** for information on historical oil spill data and probabilities for the Proposed Action. A CDE references a large spill well outside of the normal range of probability that could result from OCS exploration, development, and production activities involving rigs, facilities, pipelines, tankers, and/or support vessels. A CDE is not considered within any Proposed Action or development scenario and is considered an unlikely event. Although a CDE is unauthorized and not an expected outcome of the Proposed Action, the potential impacts of such a low-probability incident still are considered within this Programmatic EIS because of the possible magnitude and severity of potential impacts.

The magnitude and severity of impacts from a spill on any resource would depend on the spill's location, size, depth, and duration as well as the type of spill, meteorological conditions such as wind speed and direction, seasonal and environmental conditions, and the effectiveness of response activities. The aforementioned factors can have a substantial effect on weathering processes such as evaporation, emulsification, dispersion, dissolution, microbial degradation and oxidation, and transport of the spilled products.

4.4.4.1. Fate and Transport of Oil

In considering oil spill impacts, it is important to understand physical transport and fate of the spilled products. As mentioned, several factors (e.g., environmental, spill type) contribute to the fate of spilled oil. However, understanding circulation patterns and physical oceanographic conditions is vital for examining oil and gas production and exploration activities with respect to preserving the environment (Ji, 2004; Lugo-Fernandez and Green, 2011). A brief overview of regional circulation patterns is provided in the following text and figures.

4.4.4.2. Gulf of Mexico

In the Gulf of Mexico, the dynamic factors that have the greatest potential to affect potential impacts from accidental and unauthorized events can be characterized as those associated with episodic weather events (e.g., hurricanes, tropical storms), large-scale circulation patterns such as the Loop Current and its associated mesoscale eddies (**Figure 4.4.4-1**), vertically coherent deepwater currents, and high-speed jets (DiMarco et al., 2004).

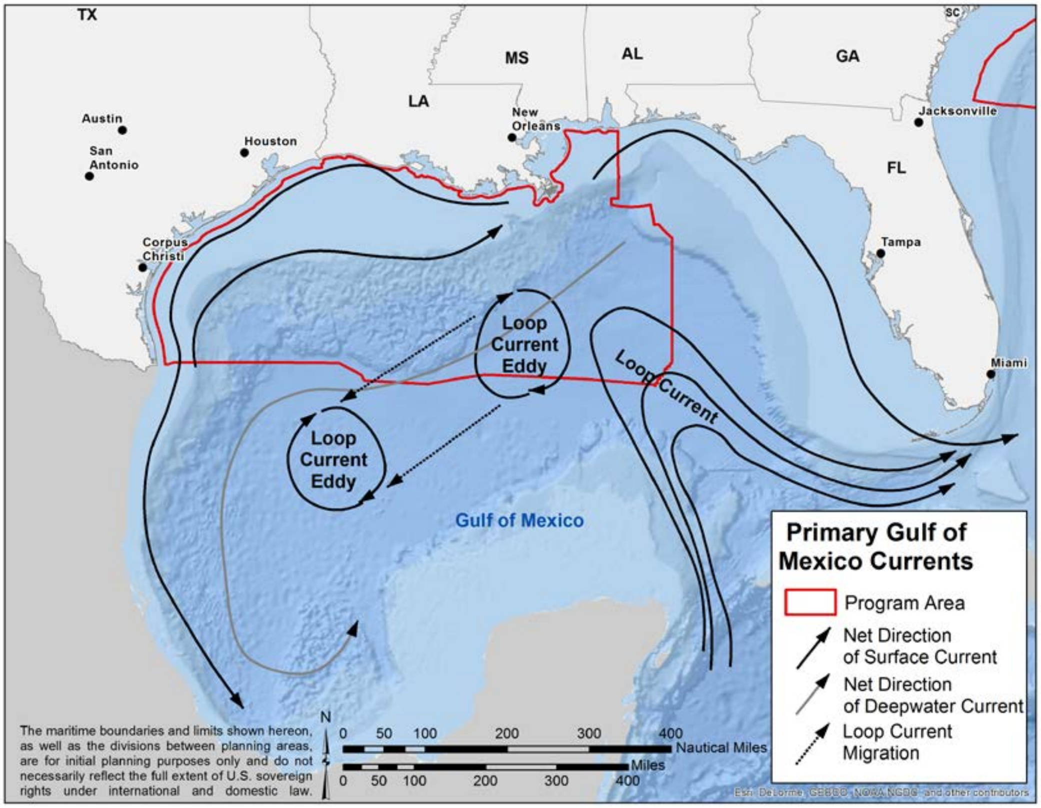


Figure 4.4.4-1. Major Circulation Features in the Gulf of Mexico.

4.4.4.3. Alaska – Beaufort Sea, Chukchi Sea, and Cook Inlet

In Alaska, sea ice, ocean currents, tides, waves, and storm surges affect offshore oil and gas operations located near the coastline (**Figures 4.4.4-2** and **4.4.4-3**). Tides are considered minor along the coastal regions of the Arctic Ocean (NRC, 2003b; Weingartner, 2003), but tidal ranges in Cook Inlet are among the largest in the world (Archer and Hubbard, 2003). Arctic Alaskan coastal waters largely are covered by sea ice, with some open water areas between October and June. The minimum sea ice extent occurs in September as sea ice begins to form, reaching a maximum extent in March (Weeks and Weller, 1984). In Cook Inlet, sea ice is present for a considerably shorter period of time. Arctic climate conditions (i.e., cold water and cold air temperatures) typically result in lower rates of oil weathering processes such as evaporation, emulsification, and oxidation (Thomas, 1983) as well as lower rates of dispersion because of the increased viscosity of oil at lower temperatures (Payne et al., 1991). However, studies have shown that preexisting microbes within Arctic waters are capably of substantially degrading oil when present in the water column (McFarlin et al., 2014).

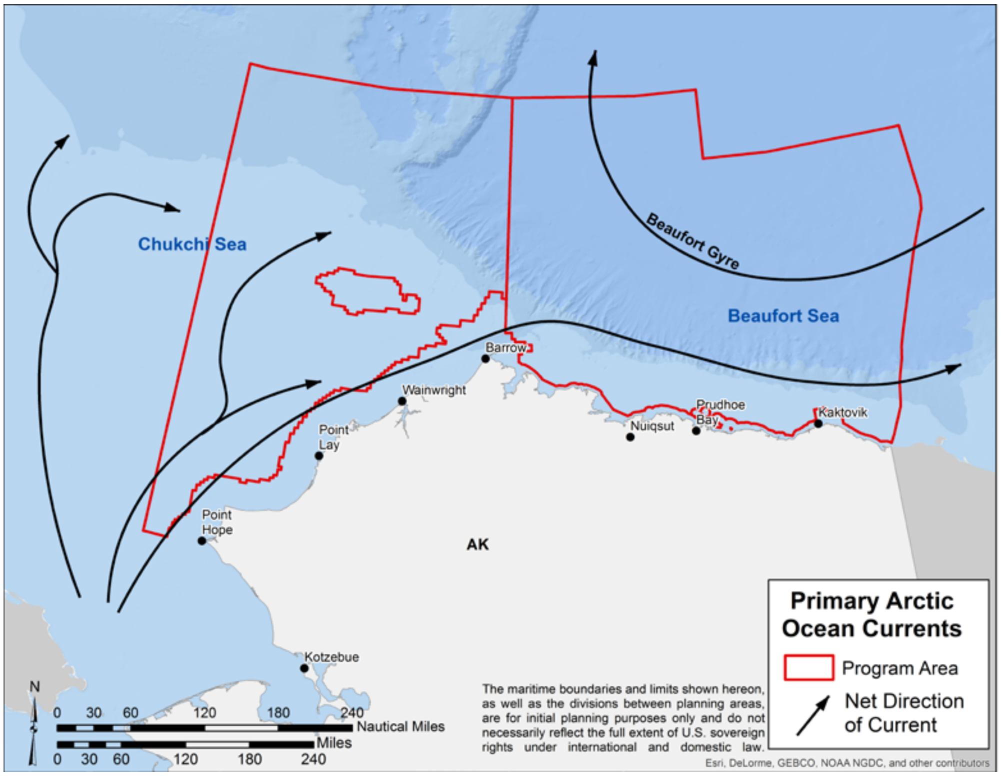


Figure 4.4.4-2. Major Circulation Features in the Beaufort and Chukchi Seas.

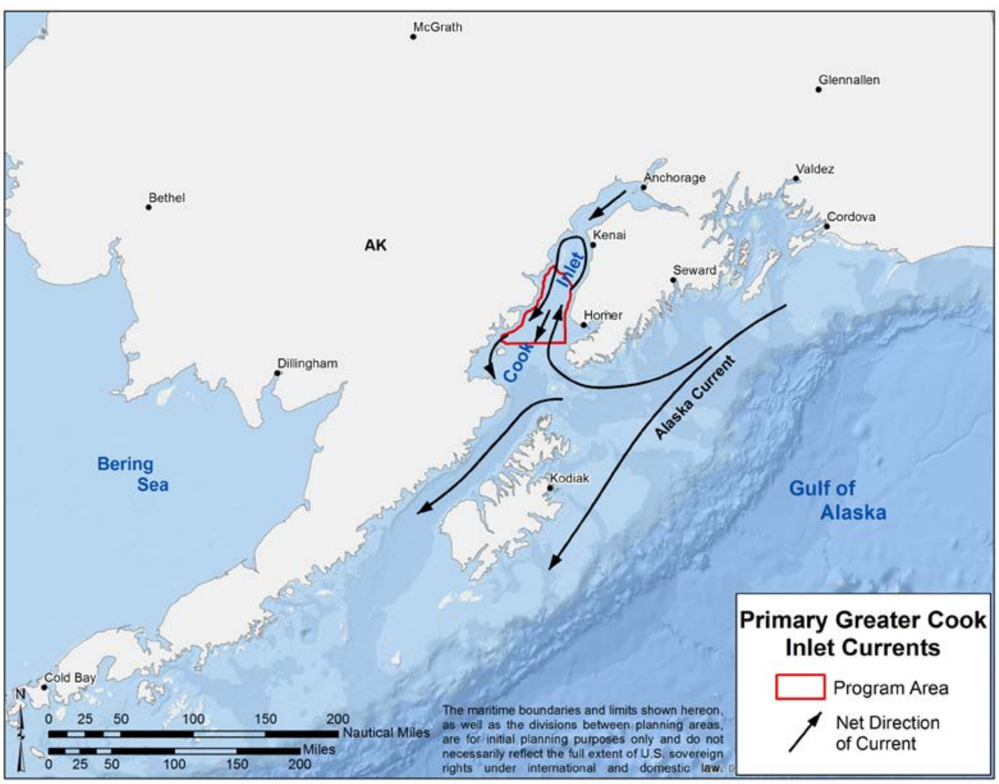


Figure 4.4.4-3. Major Circulation Features in Cook Inlet.

The presence of sea ice has the potential to confine oil spills (Weeks and Weller, 1984). A large spill occurring on or under ice would be trapped and persist until the ice melted, allowing the trapped oil to disperse. Volatile components of the oil would be more likely to freeze into the ice rather than dissolve or disperse into the water column. In addition, seasonally limited daylight can be a major issue for oil spill response during freeze up, and over the winter (NRC, 2014). If a spill were to occur in the Beaufort or Chukchi Seas or in Cook Inlet during fall or winter, the presence of ice could partially contain the oil and reduce spreading and other physical degradation processes. However, oil spill response and cleanup also would be more difficult due to the presence of ice. Additionally, oil from spills occurring in the winter may be trapped under ice, resulting in localized degradation of water and sediment quality and persistence in the environment (Payne et al., 1991; Buist et al., 2008). The interaction of oil and ice is shown in **Figure 4.4.4-4**.

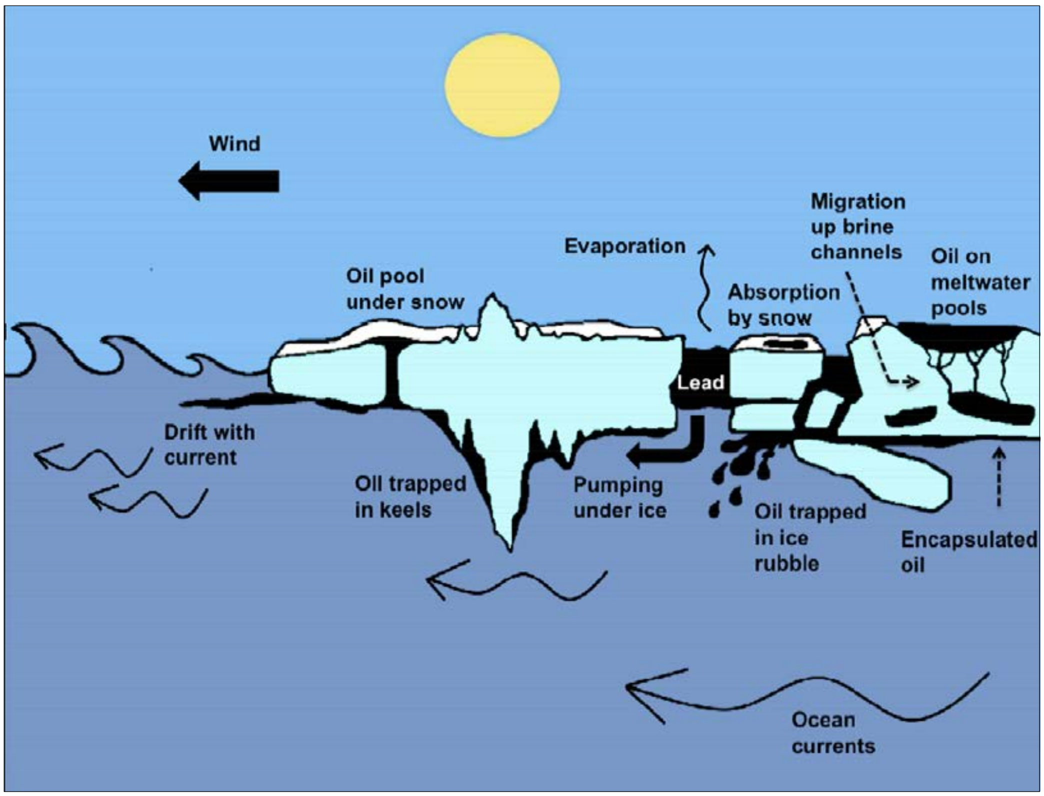


Figure 4.4.4-4. Interactions Between Oil and Ice (From: Drozdowski et al., 2011).

4.4.4.4 Atlantic

In the Atlantic, the Labrador Current flows southward from the Arctic along the continental shelf (**Figure 4.4.4-5**). Once this general southern flow reaches Cape Hatteras, the shelf width becomes constricted and cross-shelf mixing with slope waters and the Gulf Stream occurs (Churchill and Berger, 1998). Circulation patterns from Cape Hatteras south are heavily influenced by the northeasterly motion of the Gulf Stream. As the Gulf Stream turns to the east, north of Cape Hatteras, gyres may break off and continue northerly.

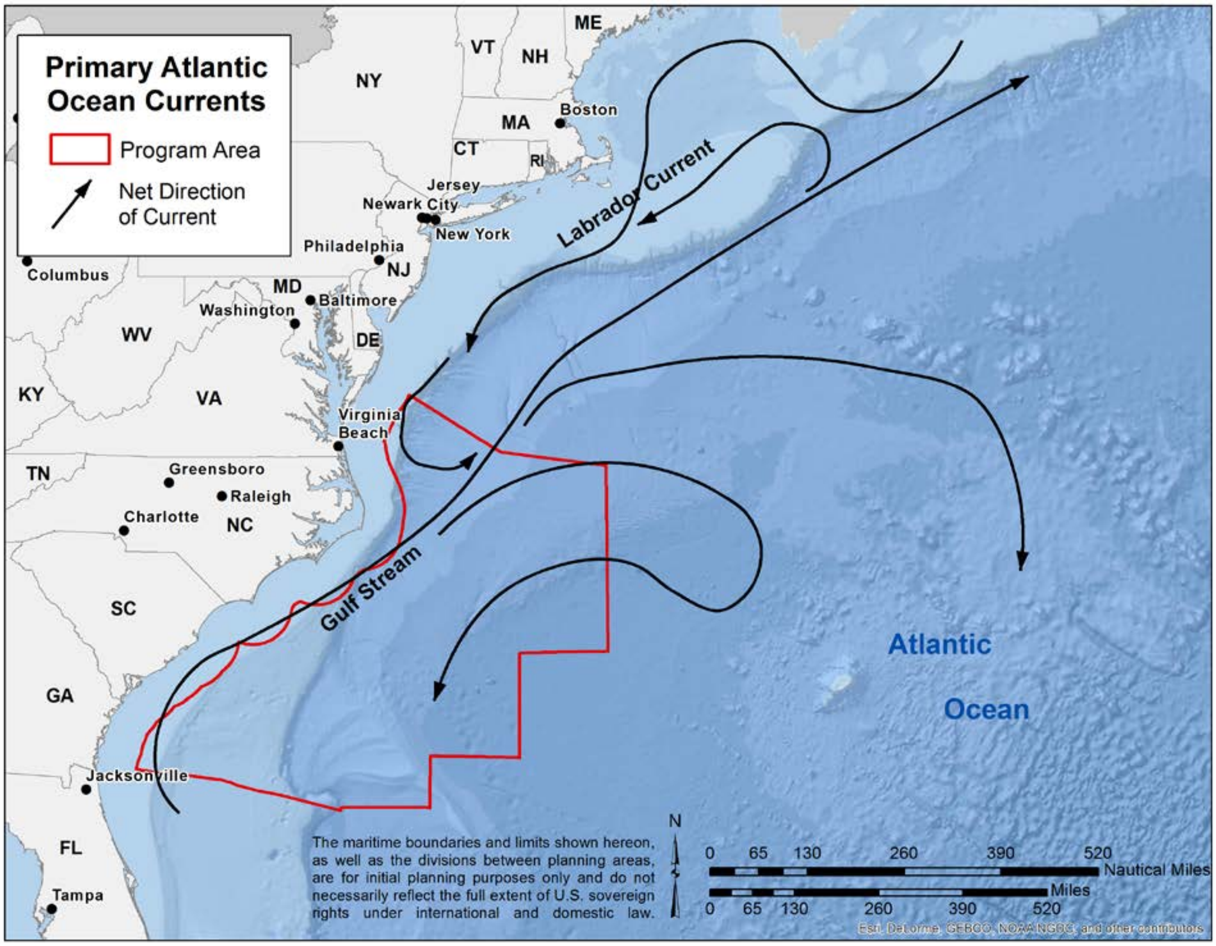


Figure 4.4.4-5. Major Circulation Features in the Atlantic.

4.4.4.5. Potential Impacts per Resource Area

As noted previously, the magnitude and severity of potential impacts from a spill on any resource would depend on the spill's location, size, depth, and duration as well as the type of spill, meteorological conditions such as wind speed and direction, seasonal and environmental conditions, and the effectiveness of response activities. Associated spill response and cleanup activities also could affect resource areas. **Figure 4.4.4-6** provides a conceptual model of potential impacts to environmental resources from a spill.

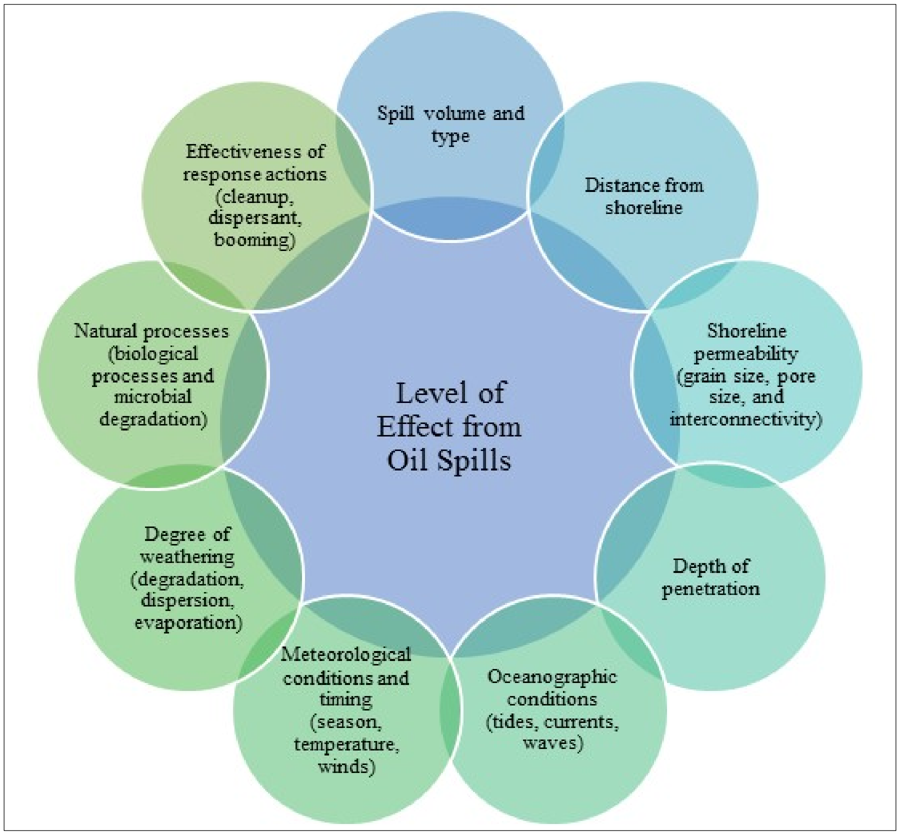


Figure 4.4.4-6. Factors that can Determine the Level of Effect to Resources from Oil Spills.

A high level summary of the potential range of effects of oil spills per resource area analyzed under this Programmatic EIS is provided here.

Air quality impacts to ambient VOC concentrations resulting from a spill would be high in the immediate vicinity of the spill area, but would decrease quickly due to dispersion of the spill itself, and of the VOCs by winds, waves, and currents. Concentrations of criteria pollutants may temporarily exceed NAAQS, but over time, air quality would return to pre-spill conditions. *In situ* burning of spilled crude or diesel, a potential component of the spill response strategy, would generate a plume of black smoke and emissions of NO_2, SO_2, CO, PM_{10}, and $PM_{2.5}$ that temporarily would affect air quality. PM_{10} and $PM_{2.5}$ in the form of soot, would land on surfaces near the fire but would dissolve or wash off in subsequent rains for soot landing onshore. Such exposure would be limited by the distance from the proposed activities to shore. After the burn, air quality would quickly return to pre-burn conditions. Some oil and gas reservoirs contain H_2S, a toxic gas. An accidental release of H_2S in the atmosphere near a platform could present a serious hazard to platform workers and people in close proximity. 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; however, a larger leak may reach the atmosphere. The impact of accidental events, including the occurrence of accidental oil and fuel spills and unexpected CDEs, on air quality is likely to be **minor** for smaller spills to **moderate** for CDEs, given the potential increase in airborne pollutants and limited options for mitigation.

Water quality could be impacted by the dissolution and dispersion of the petroleum constituents throughout the water column (including the surface) as well as from response activities (e.g., vessel discharges or use of dispersants). A spill could also release natural gas into the water column, which would reduce the dissolved oxygen levels due to microbial degradation of the methane, potentially creating hypoxic or "dead" zones, although studies have shown this is not likely (Camilli et al., 2010; Kessler et al., 2011a,b). A spill in Alaskan waters could lead to long-term water quality impacts from entrainment in ice. To an extent, natural processes will physically, chemically, and biologically aid the degradation of oil (NRC, 2003b). A CDE in coastal or marine waters 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 on the duration of the release and the area impacted by the spill. A CDE at depth would introduce large quantities of oil into the water column, with chemically or mechanically dispersed and suspended oil droplets potentially creating a plume at depth (Reddy et al., 2012; Valentine et al., 2014). It would also cause large patches of sheen or oil on the sea surface. Overall, depending on the location, timing, and magnitude of the event as well as the effectiveness of containment and cleanup activities, impacts from expected accidental spills into the coastal and marine environment are expected to range from **minor** to **major**. A CDE could present sustained degradation of water quality depending on the time, location, type, and size of the spill, and impacts are expected to range from **moderate** to **major**.

Benthic communities could be impacted by spills in several ways. Spills that persist long enough to reach shore could contaminate shoreline benthic communities. Sublethal impacts that may occur to exposed deepwater benthic organisms may include reduced feeding, reduced reproduction and growth, physical tissue damage, and altered behavior. Laboratory tests by DeLeo et al. (2015) on the relative effects of oil, chemical dispersants, and chemically dispersed oil mixtures on three species of northern Gulf of Mexico deepwater corals found much greater health declines in response to chemical dispersants and oil-dispersant mixtures than to oil-only treatments, which did not result in mortality. It is important to note that, generally, laboratory experimental concentrations are designed to discover toxicity thresholds (as in DeLeo et al., 2015) that exceed probable exposure concentrations in the field.

Some oil eventually may settle on the seafloor through a binding process with suspended sediment particles (adsorption), or after aggregation as marine snow (Passow et al., 2012). It is expected that the greatest amount of adsorbed oil particles would be deposited close to the spill, with the concentrations reducing with distance from the source. If the spill occurred close to a deepwater benthic habitat, some of the organisms might be smothered by the particles, and experience long-term exposure to hydrocarbons (Hsing et al., 2013; Fisher et al., 2014; Valentine et al., 2014). Beyond the localized area of impact in that case, particles would increasingly biodegrade and disperse. Impacts to deepwater benthic organisms would be expected to be largely sublethal and could include reduced recruitment success, reduced growth, and reduced biological cover as a result of impaired recruitment (Rogers, 1990; Kushmaro et al., 1997). Overall, impacts on marine benthic communities from expected accidental spills are expected to range from **minor** to **major**. Impacts from an unexpected CDE are expected to range from **moderate** to **major**. The degree of these potential impacts depends on the location, timing, and magnitude of the event as well as the effectiveness of containment and cleanup activities.

Potential impacts to **coastal and estuarine habitat** are very complex and depend on several interrelated factors, including oil type, time of year in which a spill occurs, and specific habitat characteristics. Highly sensitive shoreline habitats include marshes, sheltered tidal flats, and sheltered rocky shores (USDOC, NOAA, 1994). The vulnerability of intertidal habitats generally is rated as highest for vegetated wetlands (Hayes et al., 1992; USDOC, NOAA, 1994, 2010), and semipermeable substrates that are sheltered from wave energy and strong tidal currents. Oil contacting these habitats is less likely to be removed by waves. Oil that impacts beaches will thicken as its volatile components are lost and may form tarballs or aggregations that incorporate sand, shell, and other materials. Oil that impacts wetlands or vegetated submerged habitats may result in substantive injury to vegetation, plant mortality will be realized, and some permanent wetland loss will occur. Coastal wetlands are highly sensitive to oiling, and can be significantly affected because of the inherent toxicity of hydrocarbon and non-hydrocarbon components (Lin and Mendelssohn, 2012). Indirectly, oil can affect animals that use submerged habitats and wetlands during their life cycles, especially benthic organisms that reside in the sediments and are an important component of the food web. Habitat degradation could persist and have long-term residual impacts to the community structure and habitat function. In addition, the elimination of vegetation along coastal salt marshes may accelerate erosion and retreat of shorelines (Sillman et al., 2012). Furthermore, oil from winter spills may be trapped under ice, resulting in localized, delayed, or persistent degradation of habitat quality and ecosystem function. Overall, impacts on coastal and estuarine habitats from expected accidental spills are expected to range from **minor** to **major**. Impacts from an unexpected CDE are expected to range from **moderate** to **major**. The degree of these potential impacts depends on the location, timing, and magnitude of the event as well as the effectiveness of containment and cleanup activities.

Pelagic communities could experience cascading effects from a spill due to localized impacts to planktonic habitats (such as *Sargassum*), reduction in water quality, or direct contact with oil, which could lead to impacts on plankton and other organisms that utilize pelagic habitats. Following the *Deepwater Horizon* oil spill, there was substantial loss and subsequent recovery of *Sargassum* mats in the Gulf of Mexico (Powers et al., 2013). A crude oil release from a wellhead (subsurface release, blowout) or from a drilling rig (surface release) could impact phytoplankton and zooplankton within an affected area. Zooplankton are especially vulnerable to acute crude oil pollution, showing increased mortality and sublethal changes in physiological activities (e.g., egg production) (Moore and Dwyer, 1974; Linden, 1976; Lee et al., 1978; Suchanek, 1993). In addition, zooplankton may accumulate PAHs through ingestion of micro-droplets (e.g., Berrojalbiz et al., 2009; Lee et al., 2012) or through absorption by crude oil droplets attaching to zooplankton, as observed in laboratory and field studies (see Almeda et al., 2013).

Oil floating on the surface could directly contact ichthyoplankton found at or near the surface, coating eggs and larvae. Most ichthyoplankton would be unable to avoid spills, and affected individuals may be at risk of death, delayed development, abnormalities, endocrine disruption, or other effects resulting in decreased fitness and reduced survival rates (Incardona et al., 2014; Mager et al., 2014; Brown-Peterson et al., 2015; Snyder et al., 2015). In general, early life stages are more sensitive to acute oil exposure than adults, but some research indicates embryos, depending on the developmental stage, may be less sensitive to acute exposure than larval stages (Fucik et al., 1995). Localized loss of eggs and one or more size classes may occur in areas affected by high oil concentrations or if oil contacts spawning habitats in coastal and nearshore waters. Another notable group, reef-building corals, also release reproductive bundles that rise through the water column to the surface during very limited times of the summer. Surface spills would have significant impacts on these coral spawning products if a spill occurs during or near spawning. Overall, impacts on marine pelagic communities from expected accidental spills are expected to range from **minor** to **major**. Impacts from an unexpected CDE are expected to range from **moderate** to **major**. The degree of these potential impacts depends on the location, timing, and magnitude of the event as well as the effectiveness of containment and cleanup activities.

Marine mammals could be affected by oil spills through various pathways: direct surface contact, inhalation of fuel or its volatile components, or ingestion (via direct ingestion or by the ingestion of contaminated prey). These pathways may lead to decreased health, reproductive fitness, and longevity as well as increased vulnerability to disease. An oil spill also can 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, which 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). In Alaska, an oil spill during periods of restricted open water could have severe effects, as cetaceans such as bowhead and beluga whales use ice leads during their migrations and may concentrate within these leads in the spring (USDOI, BOEM, 2012). Furthermore, pinnipeds and polar bears also may be directly exposed to oil while coming ashore onto impacted beaches. Sea otters and polar bears would be particularly vulnerable due to their reliance on fur to maintain body heat. Once oiled, sea otters quickly become hypothermic, and both species ingest oil while grooming, resulting in lethal impacts to organs. Impacts to calving grounds could result in population-level effects. Overall, oil spills associated with accidental events are expected to result in **minor** to **major** impacts to marine mammals within a Program Area, depending on the numbers of individuals coming into contact with the spilled fuel and their exposure time as well as the exposure of federally listed species to the spill. Impacts from an unexpected CDE are expected to range from **minor** to **major**. The degree of these potential impacts depends on the location, timing, and magnitude of the event as well as the effectiveness of containment and cleanup activities.

Sea turtles could be affected by oil spills depending on the time of year. Effects of spilled oil on sea turtles are discussed by Geraci and St. Aubin (1987), Lutcavage et al. (1995, 1997), Milton et al. (2003), and Shigenaka et al. (2010). Oil, including refined diesel fuel, may affect sea turtles through various pathways, including direct contact, inhalation of the fuel and its volatile components, and ingestion directly or indirectly through the consumption of fouled prey species (Geraci and St. Aubin, 1987). The effects of contact with spilled oil may include decreased health, reproductive fitness, and longevity as well as increased vulnerability to disease and contamination of prey species. Studies have shown that direct exposure of sensitive tissues (e.g., eyes, nares, other mucous membranes) and soft tissues to volatile hydrocarbons associated with oil spills may produce irritation and inflammation. Oil or diesel fuel can adhere to sea turtle skin and shells. Sea turtles surfacing within or near an oil spill would be expected to inhale petroleum vapors, causing respiratory stress. Ingested oil, particularly the lighter fractions, can be acutely toxic to sea turtles. In addition, several aspects of sea turtle biology and behavior place them at risk, including lack of avoidance behavior, indiscriminate feeding in convergence zones, inhalation of large volumes of air before dives (Milton et al., 2003), and affinity to the *Sargassum* community for food and cover (Witherington et al., 2012).

Female sea turtles seasonally emerge during the warmer summer months to nest on Gulf of Mexico and Atlantic beaches. Though sea turtles could physically nest on oiled beaches, it is likely that nesting females may abandon nesting attempts. If nesting occurs, the nesting female and eggs could get oiled. Hatchlings will have to traverse the beach and shore-face through oiled sand and water to reach preferred habitats of offshore *Sargassum* floats. It is not likely that the spill would result in long-term displacement of adult sea turtles from preferred feeding, breeding, or nesting habitats or migratory routes. Impacts from accidental events may affect individual sea turtles in the area, but impacts are unlikely to rise to the level of population effects or significance given the size and scope and probability of accidental spills. Overall, impacts on sea turtles from expected accidental spills are expected to range from **negligible** to **major**. Impacts from an unexpected CDE are expected to range from **negligible** to **major**. The degree of these potential impacts depends on the location, timing, and magnitude of the event as well as the effectiveness of containment and cleanup activities.

Marine and coastal birds may be adversely affected through direct contact with spilled oil, by the fouling of their habitats and contamination of their food by oil, and as a result of oil spill response activities. Direct contact with oil can lead to tissue and organ damage from oil ingested and inhaled during feeding and grooming as well as interference with food detection, predator avoidance, homing of migratory species, disease resistance, growth rates, reproduction, and respiration. Oiled birds quickly become hypothermic, lose buoyancy, are unable to fly, and die from direct exposure to the toxicity of the oil itself. Raptors and scavenging birds also may ingest oil while scavenging other oiled wildlife, which may lead to vomiting, diarrhea, and hemorrhaging. 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 and lead to displacement of affected birds to secondary locations, while contamination of foods may lead to a variety of lethal and sublethal toxic and physiological effects. Even a small spill could have a major impact on ESA-listed spectacled eiders in the Chukchi Sea if it were to occur in Ledyard Bay in late summer when spectacled eiders congregate there while molting and flightless. Conversely, a larger spill could occur in an offshore area in winter when few birds are present and have only a minor impact on bird species. Overall, impacts on marine and coastal birds from expected accidental spills are expected to range from **negligible** to **major**. Impacts from an unexpected CDE are expected to range from **minor** to **major**. The degree of these potential impacts depends on the location, timing, and magnitude of the event as well as the effectiveness of containment and cleanup activities.

Fish and EFH could be impacted by persistence of spilled oil in the environment. A large spill in open waters of the OCS proximal to mobile adult fishes would likely be sublethal; potential effects would be reduced because adult fish have the ability to avoid adverse conditions, metabolize hydrocarbons, and excrete metabolites and parent compounds. Impacts to adult fishes in an affected area may be indistinguishable from natural variation in a population. However, long-term exposure to contaminants could result in a higher incidence of chronic sublethal effects (Murawski et al., 2014; Baguley et al., 2015; Millemann et al., 2015; Snyder et al., 2015). Oil floating on the surface could directly contact ichthyoplankton found at or near the surface, coating eggs and larvae. Most ichthyoplankton would be unable to avoid spills, and affected individuals may be at risk of death, delayed development, abnormalities, endocrine disruption, or other effects resulting in decreased fitness and reduced survival rates (Incardona et al., 2014; Mager et al., 2014; Brown-Peterson et al., 2015; Snyder et al., 2015). In general, early life stages are more sensitive to acute oil exposure than adults, but some research indicates embryos, depending on their developmental stage, may be less sensitive to acute exposure than larval stages (Fucik et al., 1995). Spills reaching nursery habitat or overlapping spatiotemporally with a spawning event have the greatest potential for affecting the early life stages of fishes and invertebrates. Overall, impacts on fish and EFH from expected accidental spills are expected to range from **negligible** to **moderate**. Impacts from an unexpected CDE are expected to range from **negligible** to **major**. The degree of these potential impacts depends on the location, timing, and magnitude of the event as well as the effectiveness of containment and cleanup activities.

Archaeological and historical resources could be impacted by a spill if PM contaminated with oil reaches the seafloor and directly impacts a shipwreck site by disrupting the local environment, resulting in degradation of the resource and loss of information (**Section 4.4.1.11**). In the event that a spill impacts coastal areas, it could affect shallow-water shipwrecks and coastal historic and prehistoric archaeological sites. Overall, impacts to archaeological and historical resources from expected accidental spills and an unexpected CDE would range from **negligible** to **moderate**, depending on the location, timing, and magnitude of the event as well as the effectiveness of containment and cleanup activities.

Population, employment, and income impacts of a spill highly depend on spill size, location, and other factors discussed previously, and could 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 (Austin et al., 2014a,b; Eastern Research Group, 2014). For example, oil spills could impact industries that depend on resources that are damaged or rendered unusable for a period of time. Beach recreation, recreational fishing, and commercial fishing would be vulnerable if beach or fish resources were damaged. An oil spill also could impact transportation routes or affect the operations of port facilities. 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 commercial and recreational fishing and/or tourism if these activities were to suffer due to real or perceived impacts of the spill, and could include substantial losses.

In Alaska, subsistence users supplement current income and wages through subsistence hunting for food sources and artifacts for selling. For a large release event, negative and significant economic and sociocultural impacts may be felt by subsistence users. In the Atlantic Program Area, the 80.5-km (50-mi) buffer between shore and drilling and production operations and the prevailing currents, which move along—rather than toward—the coast would lessen the likelihood that a spill would directly damage coastal resources. However, offshore spills still could lead to impacts to other resource areas (e.g., fishing and biological resources). In the Gulf of Mexico, larger spills could lead to decreased levels of oil and gas industry operations, through direct damages or indirect policy changes imposing additional restrictions on new or existing activities. The impacts to an affected industry also would ripple through that industry's supply chain; consumer spending by employees of these firms also would have impacts to the broader economy.

In all areas, under analysis within this Programmatic EIS, the response and cleanup operations following an oil spill could impact local economies. A large amount of money would be spent on cleanup and compensation, but the amounts—and the percentage that would be received by local communities—could vary considerably, depending on specific circumstances, and negative effects and economic opportunities are likely to be unevenly distributed among local residents and their businesses. The influx of response workers to local areas can have positive economic impacts, especially for local residents and businesses that assist with cleanup or provide housing, goods, or services for cleanup efforts. However, that influx of workers and cleanup activity also can disrupt the normal functioning of local economies, possibly compounding the negative effects of the event itself. In addition, people and equipment that are dedicated to oil spill response efforts may be diverted from some existing services such as hospitals, firefighting, and emergency services available to local residents. Overall, impacts on population, employment, and income from expected accidental spills are expected to range from **negligible** to **minor**. Impacts from an unexpected CDE are expected to range from **moderate** to **major** (at least to some affected industries and communities). The degree of these potential impacts depends on the location, timing, and magnitude of the event as well as the effectiveness of containment and cleanup activities.

Land use and infrastructure impacts would depend on the nature and magnitude of any spill and also the level and location of new construction, the degree to which the area already is developed, and the location of the spill. Potential impacts to land use and infrastructure likely would include stresses of the spill response on existing infrastructure, direct land-use impact (such as impacts of oil contamination to ships and port facilities), and restricted access to coastal infrastructure while cleanup is being conducted. These impacts generally would be temporary and localized, particularly for small spills. For large spills, the degree of impact would be influenced by many factors such as distance from the shoreline, oceanographic conditions (i.e., tides, winds, currents, waves), degree of weathering (i.e., degradation, evaporation), and effectiveness of response actions. Recovered oil and waste generated from the cleanup could impact capacity at waste disposal sites, and operations at ports and related infrastructure could be impacted if oil were to come ashore at these areas. Given the history of oil and gas leasing in the Gulf of Mexico and Cook Inlet, major impacts to land use and infrastructure would not be expected because existing spill response infrastructure is already in place, or would be readily available in the event of a CDE. In the Atlantic, oil spills have historically occurred as a result of refinery operations and other industrial activities. As a result, several companies would be available to provide oil spill response services in the region. For example, the Marine Spill Response Corporation operates on the Atlantic coast and has provided oil spill response services to the USCG (Dismukes, 2014). In the Arctic, responses to a spill 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, limited docking facilities are present along the Arctic coast and are located in shallow water, making vessel access difficult. In addition, a large portion of Arctic communities are not connected to each other or to the rest of the state by onshore roadways, and the few major airstrips that could handle cargo aircraft also are not connected to highways or docks. As such, the impacts from operating in the Arctic likely would be greater in the event of an accidental spill or CDE. Overall, impacts to land use and infrastructure would range from **minor** to **major** depending on the location, timing, and magnitude of the event as well as the effectiveness of containment and cleanup activities.

Commercial and recreational fisheries could be affected by spills, with the magnitude and severity of impacts dependent on the spill location and size, the type of product spilled, environmental conditions at the time of the spill, and effectiveness of response activities. Small spills rapidly dissipate, and fish kills rarely occur. Species and life stages residing in the upper water column are most at risk for contact with spilled oil. Pelagic species and filter feeders such as menhaden that forage at the water's surface would be most likely to encounter a surface spill. Tunas, mackerels, billfishes, and dolphinfishes known to feed at the surface likely would avoid small spills. Planktonic early life stages (i.e., eggs and larvae) of many fish species would be less able to avoid a spill and, therefore, are most vulnerable to toxic properties of oil. Depending on the location and duration of a spill, commercial and recreational fishing opportunities would be lost. Revenues for commercial fisheries may temporarily decline. State or federal agencies will close affected areas to fishing and maintain closures until the threat of contamination of gear or target species is deemed over. Fishers will experience additional expenditures required to move to unaffected fishing grounds. Larger spills could contaminate target species and result in large-scale fishery closures. Closures will result in loss of revenue to commercial fishers. Public perception of seafood quality and safety following an unexpected CDE may affect revenues far into the future. A minimum loss of $247 million was estimated from the fishery closures associated with the *Deepwater Horizon* oil spill (McCrea-Strub et al., 2011). Recreational fishing opportunities will be lost, and recreational fishers will turn to other forms of recreation. Overall, impacts on commercial and recreational fisheries from expected accidental spills are expected to range from **negligible** to **major**. Impacts from an unexpected CDE are expected to range from **moderate** to **major**. The degree of these potential impacts depends on the location, timing, and magnitude of the event as well as the effectiveness of containment and cleanup activities.

Tourism and recreation impacts would be similar to those discussed under the population, employment, and income section. Impacts of a spill highly depend on spill size and could 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 (Austin et al., 2014a,b; Eastern Research Group, 2014). Oil spills could impact industries (e.g., tourism, fishing) that depend on resources that have been damaged (e.g., fisheries) or rendered unusable for a period of time. Beach recreation and recreational fishing would be vulnerable to damage caused by a spill and subsequent cleanup efforts. An oil spill could also impact transportation routes or affect the operations of port facilities. Longer-term impacts could affect tourism if spills or resulting activities were to suffer due to real or perceived impacts of the spill and could include substantial losses.

The south-central tourist region of Alaska encompasses the Cook Inlet Planning Area, and accounts for 50 percent of visitor industry-related employment and 44 percent of visitor-related spending in the state (McDowell, 2015; Travelalaska, 2015). Ecotourism accounts for the majority of tourism-related activities near the Cook Inlet, particularly during the open water seasons, and in the Beaufort and Chukchi Sea Program Areas. In the Atlantic Program Area, the 80.5-km (50-mi) buffer between shore and drilling and production operations and the prevailing currents, which move along—rather than toward—the coast would lessen the likelihood that a spill would directly damage coastal resources.

Deposition of floating debris on beaches and platform placement could affect commercial fishing temporarily. Beaches and recreational fishing could be impacted from an oil spill and any associated cleanup activities, which would disrupt local tourism industries.

The *Deepwater Horizon* event affected many coastal communities that were still rebounding from the impacts of Hurricane Katrina, complicating the response by community members to the *Deepwater Horizon* event (Goldstein et al., 2011).

Overall, impacts on tourism and recreation from expected accidental spills are expected to range from **minor** to **major**. Impacts from an unexpected CDE are expected to range from **moderate** to **major**. The degree of these potential impacts depends on the location, timing, and magnitude of the event as well as the effectiveness of containment and cleanup activities.

Sociocultural systems can be affected by oil spills. For example, see the impact discussions on archaeological/historic resources; commercial and recreational fishing; and population, employment, and income. Oil spills also could have major impacts on subsistence activities. Considering the cultural significance and ties to the traditional way of life that subsistence activities represent for the Iñupiat and Alaska Natives, the Native communities of the North Slope have historically expressed serious concerns about what would happen if there were an accidental oil spill in the Arctic. An oil spill could have physical, psychological, social, economic, spiritual, and cultural impacts on Alaska Natives, who use the ocean as a source of food and consider it part of their cultural heritage. Major areas of concern are with impacts on subsistence resources, especially the bowhead whale, and oil spill cleanup. In addition, there are concerns about exposure of indigenous populations to contaminants, primarily through traditional food (subsistence) consumption (AMAP, 2009). Persistent contaminants (e.g., organic chemicals, metals) moving through food chains and accumulating in food items could contribute to health impacts. This is true whether it relates to subsistence use of harvested animals or concerns about contaminated seafood in Cook Inlet and other Program Areas. Humans can be affected through contact with the contaminants, such as through inhalation, skin contact, or intake of contaminated foods; reduced availability of subsistence resources; interference with subsistence harvest patterns; and stress due to fears of long-term implications of the spill (USDOI, BOEM, 2012). Overall, impacts on sociocultural systems from expected accidental spills are expected to range from **minor** to **major**. Impacts from an unexpected CDE are expected to range from **moderate** to **major**. The degree of these potential impacts depends on the location, timing, and magnitude of the event as well as the effectiveness of containment and cleanup activities.

Environmental justice issues arise because low-income and minority populations are more vulnerable to oil spills in coastal waters than members of the general population. Low-income and minority populations may be more sensitive to spills in coastal waters than the general population because of higher dietary reliance on wild coastal resources, reliance on these resources for other subsistence purposes such as sharing and bartering, limited flexibility in substituting wild resources with purchased ones, and likelihood of participating in cleanup efforts and other mitigating activities (USDOI, BOEM, 2015g). In addition, there are potential human health risks associated with involvement in spill cleanup activities such as decreased liver function (D'Andrea et al., 2014). Overall, impacts to these populations from expected accidental spills and the unexpected CDE is the same as under the sociocultural discussion and would range from **minor** to **major**, depending on the location, timing, and magnitude of the event as well as the effectiveness of containment and cleanup activities.

As discussed in **Section 4.4.1.12**, much of the Alaska Native population resides in coastal areas. Any new onshore and offshore infrastructure occurring within this 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 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 operations.

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 physical and mental health of community members. Changes in the traditional way of life can lead to deteriorating physical well-being and mental health, which may contribute to other negative social consequences. North Slope 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 who must travel in more dangerous seas to hunt. Increased stress and anxiety from oil and gas development may contribute to mental health issues of Alaskans (NRC, 2003b). The increased development has increased smog and haze near some villages, and air quality is a major concern for residents (NRC, 2003b). Increased rates of diabetes are likely the result of residents consuming higher concentrations of non-subsistence foods, and consuming less fish and marine mammal products (NRC, 2003b). The geographical isolation of the NSB communities could cause stress to municipal resources, and compromise the availability of potable water resources for responders in the event of an emergency or oil spill (NSB Comprehensive Plan, 2005).

The *Deepwater Horizon* event affected many communities that had health disparities compared to others in the U.S. and that were still suffering from the impacts of Hurricane Katrina (Goldstein et al., 2011). Louisiana currently is 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). In addition, in the case of the *Deepwater Horizon* event, many communities were still recovering from Hurricane Katrina, complicating the response by community members to the *Deepwater Horizon* event (Goldstein et al., 2011). The Centers for Disease Control reported that 50 percent 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).

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 Hurricane Katrina (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 Alaska Native communities with the *Exxon Valdez* spill (Goldstein et al., 2011), it is likely that the *Deepwater Horizon* event lead to higher levels of depression, generalized anxiety disorder, post-traumatic stress disorder, violence, and other psychological problems among minority communities.

Summary

Oil spills are unwanted, accidental, and unauthorized events but can occur despite best efforts to prevent them. Oil spills can affect the environment, but the magnitude and severity of impacts on a particular resource depend on many factors, including spill location, size, depth of spill, duration of spill, type of spill, meteorological conditions such as wind speed and direction, seasonal and environmental conditions, susceptibility of specific resource, and the effectiveness of response activities. In addition, temperature and oceanographic conditions can have a significant effect on weathering processes such as evaporation, emulsification, and oxidation as well as the transport of the spilled products.

It is difficult at the broader five-year level of the Proposed Action to fully predict an accidental event. It becomes a more manageable assessment at the individual lease sale stage where more information is known regarding the location, amount of activity, spill risk of activities being proposed, and specific environmental resources in the area. It is at this level of detail that BOEM's Oil Spill Risk Analysis Modeling can be conducted in order to better estimate spill risk, spill trajectories, and probability of contact with an environmental resource (see http://www.boem.gov/Oil-Spill-Modeling-Program/). Modeling results then are used by BOEM experts to ascertain potential risk to specific environmental resources and to determine how that risk may be further mitigated.

As noted in **Section 3.3**, a CDE is not expected as a result of the Proposed Action. This is partly given the extremely low probability of such a spill in general but, more importantly, as a result of the comprehensive reforms to offshore oil and gas regulation and oversight put in place after the *Deepwater Horizon* event. By learning from these past experiences and strengthening regulatory oversight, these reforms help ensure that the U.S. can safely and responsibly expand development of its domestic energy resources. For more information on these reforms, see http://www.bsee.gov/uploadedFiles/BSEE/BSEE_Newsroom/BSEE_Fact_Sheet/5%20YR%20DWH%20fact%20sheet%20-%20FINAL.pdf.

4.4.5. Programmatic Mitigation for Environmentally Important Areas

As discussed in **Section 1.4.5**, several EIAs were identified during scoping by BOEM's internal experts that represent regions of important environmental value where there is potential for conflict between ecologically important or sensitive habitats; maintenance of social, cultural, and economic resources; and possible oil and gas development. After scoping, BOEM analyzed all EIAs and grouped them into the categories below. Each category indicates where in this Programmatic EIS specific EIAs are further discussed.

(1) Those that could be geographically defined, were supported by adequate data, *and* could affect the size or location of potential leasing (analyzed under Alternative B in **Section 2.4**);
(2) Those that could be geographically defined, were supported by adequate data, but *would not* affect the size or location of potential leasing (analyzed in this section); and
(3) Those that were not spatially discrete, lacked adequate support at this point to include as an alternative, or a component thereof, or as programmatic mitigation, or were unlikely to coincide with potential leasing under the Proposed Action; these were eliminated from further analysis within this Programmatic EIS, given they are not essential for decision-making at this stage, but may still be considered in subsequent NEPA analyses (**Section 2.6.5**).

This section then describes the EIAs for the second category in that they can be geographically defined, are supported by adequate data, occur in areas that may be leased under the Proposed Action but *would not* affect the size or location of leasing. As with the discussion under Alternative B, this section provides the Secretary of the Interior with information to determine, at her discretion, whether to adopt programmatic mitigation measures into the Program or defer application of programmatic mitigations to the lease sale decision stage.

4.4.5.1 Harrison Bay

The Harrison Bay EIA is located in the Beaufort Sea Program Area (**Figure 4.4.5-1**). This is an important nearshore area that encompasses relatively high productivity and is important to birds and seals during the open water season. The Harrison Bay area is also a feeding and denning area for polar bears. Programmatic mitigation for Harrison Bay would limit or modify activities that may impact birds, specifically. Other resource areas may also benefit from this mitigation.

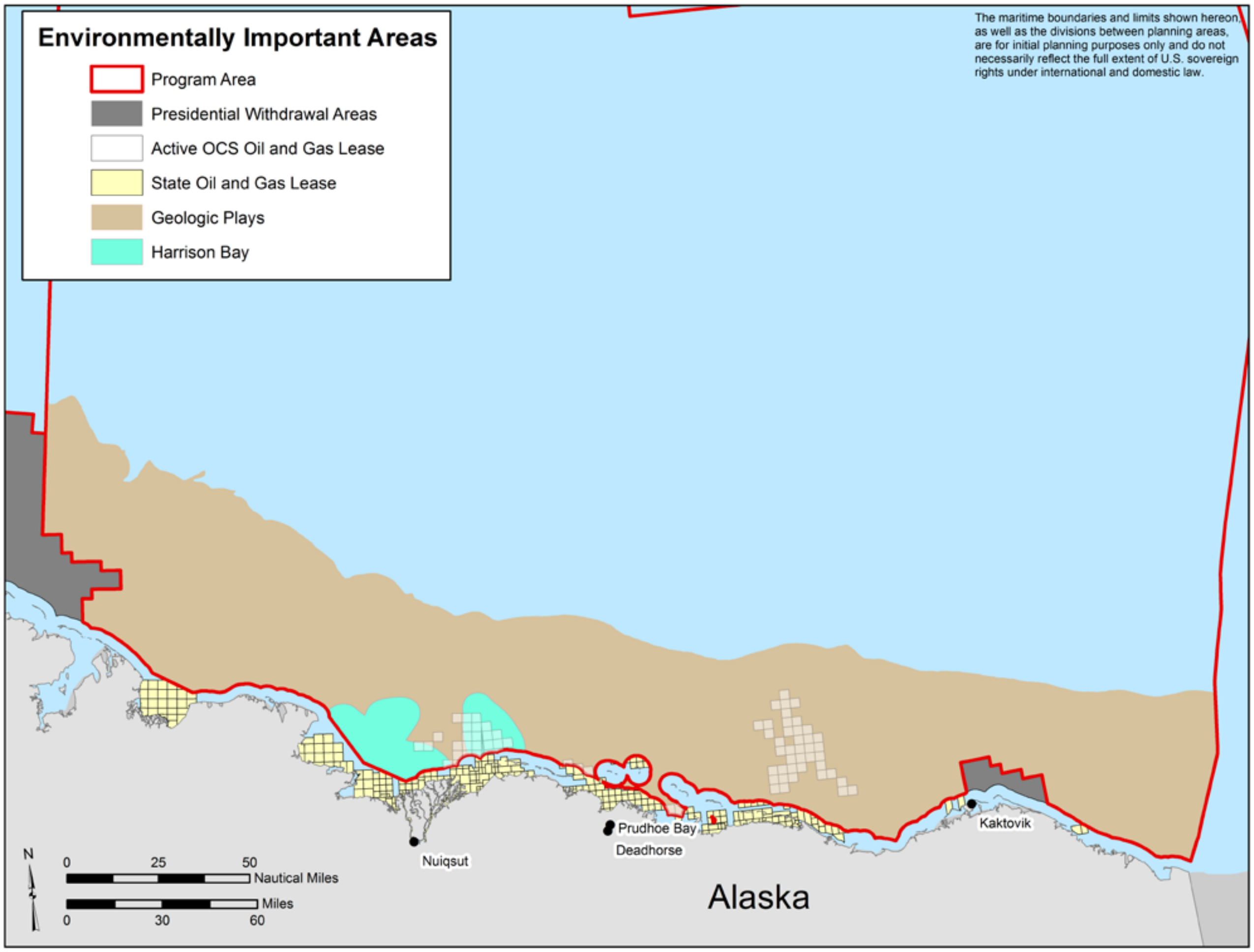


Figure 4.4.5-1. Harrison Bay EIA.

4.4.5.1.1 Marine and Coastal Birds

Harrison Bay has been identified by Audubon as an IBA of continental significance for long-tailed ducks (*Clangula hyemalis*), king eiders (*Somateria spectabilis*), red-throated loons (*Gavia stellata*), Arctic terns, surf scoters (*Melanitta perspicillata*), brants (*Branta bernicla*), and glaucous gulls. It also has been identified by the ADFG as a most environmentally significant area. This EIA has been identified primarily for the protection of bird species. It is a major migration staging area for red-throated and yellow-billed loons (*Gavia adamsii*) in summer and fall; and for spectacled and king eiders in spring and fall. Spectacled eiders are an ESA-listed species. Limiting activities in this area through a time-area closure from June through August would provide additional protection from disturbance, which can have high energetic costs for birds staging prior to long migrations.

4.4.5.1.2 Marine Benthic Communities

If activity within Harrison Bay was limited between June and August, the benthic habitats within it would be protected from most of the adverse impacts caused by IPFs. There still would be a potential for adverse impacts to benthic resources from spills and CDEs. However, reduced activity in the area would make these events less likely and perhaps diminish their impacts due to distance from the event.

4.4.5.1.3 Marine Mammals

Ringed and spotted seals concentrate in Harrison Bay and the adjacent shoreline has been identified by the USFWS as a polar bear denning area. This EIA has been identified primarily for the protection of bird species, but may be of some small benefit to seals and polar bears. This EIA would not be of obvious benefit to other marine mammal species, which may pass through the area but do not remain for appreciable amounts of time.

4.4.5.1 Chukchi Corridor

The Chukchi Corridor EIA is located in the Chukchi Sea Program Area (**Figure 4.4.5-2**). This area includes a corridor along the existing Presidential Withdrawal areas that contains important seasonal habitat for many species, including marine mammals and birds, as well as important subsistence use areas and spring ice lead systems. Programmatic mitigation for this area would limit or modify activities during migration periods and until after the spring lead system has broken up and the sea ice has retreated.

4.4.5.2. Chukchi Corridor EIA

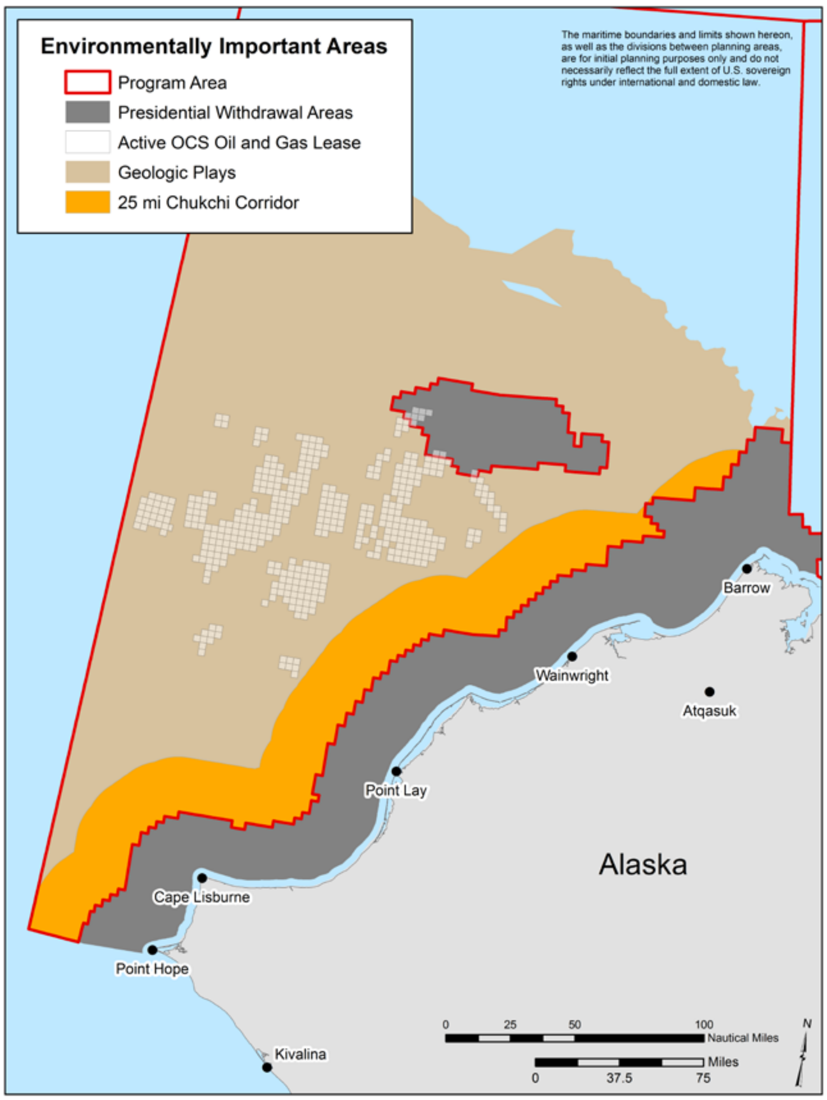


Figure 4.4.5-2. Chukchi Corridor EIA.

4.4.5.2.1 Marine Benthic Communities

The Chukchi Sea is an area of high benthic productivity (Dunton et al., 2005). The Chukchi Corridor EIA would provide additional protection for the nearshore benthic habitats in the Program Area. This corridor, in addition to the existing Presidential Withdrawal areas, encompasses the majority of the known hard bottom habitats in the Chukchi Sea. These hard bottom habitats harbor diverse assemblages of benthic organisms including kelp beds, corals, bivalves, and polychaetes (Iken, 2009). These areas also are dominated by soft bottom benthic communities that support higher trophic level organisms such as seabirds and marine mammals (Dunton et al., 2005; Grebmeier et al., 2006). This EIA would protect these areas from most of the adverse impacts caused by IPFs, aside from those caused by non-routine spills.

4.4.5.2.2. Marine Mammals

The Chukchi Corridor EIA would provide additional protection for the nearshore lead system area that most marine mammals and seabirds transit during migration in spring. The spring migration includes beluga, bowhead whale, walrus, and a variety of seabird and sea duck species. Gray whales (*Eschrichtius robustus*) migrate up the coastline later in the open water season, and fin and humpback whales have been seen near shore in the Chukchi Sea as well. Seals and polar bears use the lead system extensively while foraging in late winter and spring. The corridor extension also would provide an additional buffer between industrial activities and subsistence activities, which tend to occur primarily within 56 to 80.5 km (35 to 50 mi) of shore. Programmatic mitigations implemented for this area may provide additional protection for a variety of marine mammal and seabird species as well as an additional buffer for subsistence activities. A seasonal closure during migration periods and until after the spring lead system has broken up and the sea ice has retreated would benefit many species, including beluga, bowhead and other whales, and migrating sea ducks and seabirds. It would partially benefit species that continue to use the nearshore corridor throughout the open water season, such as walrus and colonial seabird species. If exploration of leases within the corridor leads to production activities, these activities could not be limited to seasonal occurrences.

4.4.5.2.3. Marine and Coastal Birds

The Chukchi Corridor EIA would provide additional protection for the nearshore lead system area that most marine mammals and seabirds transit during migration in spring. The spring migration includes eiders, loons, and a variety of seabird and sea duck species. The corridor extension would provide an additional buffer between industrial activities and birds who nest and forage primarily within 56 to 80.5 km (35 to 50 mi) of shore, including large colonies of seabirds at Cape Lisbourne, concentrations of Brant and other waterfowl in Kaseguluk Lagoon, and eiders in Ledyard Bay (**Figure 4.4.5-3**). A seasonal closure during migration periods and until after the spring lead system has broken up and the sea ice has retreated would benefit migrating sea ducks and seabirds. Programmatic mitigation for this area may provide for an additional buffer from the potential for it to be impacted by oil and gas industry-related spills, but would not protect against spills from other sources (e.g., barge traffic, shipping, tourism cruises), and would not change the overall levels of effect determination for birds. Expanding the coastal buffer may provide some benefit to nesting and foraging marine and coastal birds by decreasing disturbance impacts and the risk of a spill in nearshore waters, particularly for nesting and molting birds.

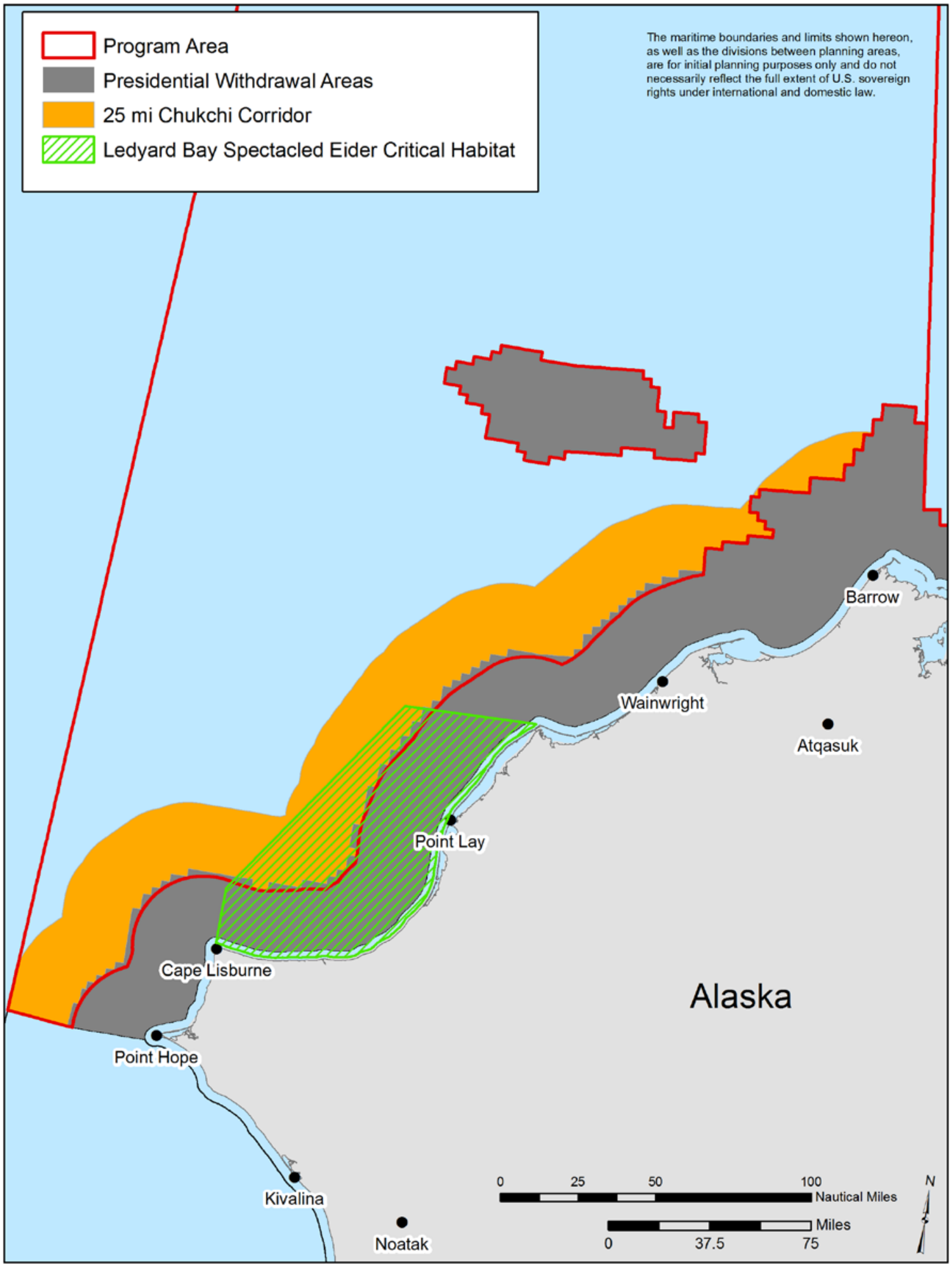


Figure 4.4.5-3. Ledyard Bay Spectacled Eider Critical Habitat.

4.4.5.3. Topographic Features EIA

Topographic stipulations (i.e., NTL 2009-G39) are designed to avoid or minimize harm to sensitive and unique topographic features found across the Gulf of Mexico Program Area from seafloor-disturbing activities. This EIA includes topographic banks found around the Flower Gardens Banks NMS. At this Programmatic stage, including impact-reducing mitigation typically applied at the lease sale stage would streamline subsequent environmental reviews and decisions at the lease sale stage.

The Topographic Features EIA for the Gulf of Mexico comprises all Western and Central Gulf of Mexico topographic features currently covered by the Topographic Features Stipulation (**Figure 4.4.5-4**). Selection of this EIA would eliminate the need to implement the Topographic Features Stipulation for lease sales. Currently, a tiered combination of exclusion and mitigation is currently used to protect these areas. This is based on incremental distancing from the most sensitive biological areas, the latter of which are defined via bathymetric contours. For example, the tops of shallow-water banks such as the Flower Gardens are characterized by the presence of highest coral concentrations, which are most sensitive to disturbance. The "No Activity" Zones directly over these sensitive bank features are exclusionary of all activity, while a progression of expanding buffer distances (e.g., 1.6 km [1 mi], 4.8 km [3 mi]) does not entirely exclude activities but provides appropriate levels of protection by restricting specific types of activities within each zone. These customized mitigations have proven effective and are supported by extensive and ongoing science.

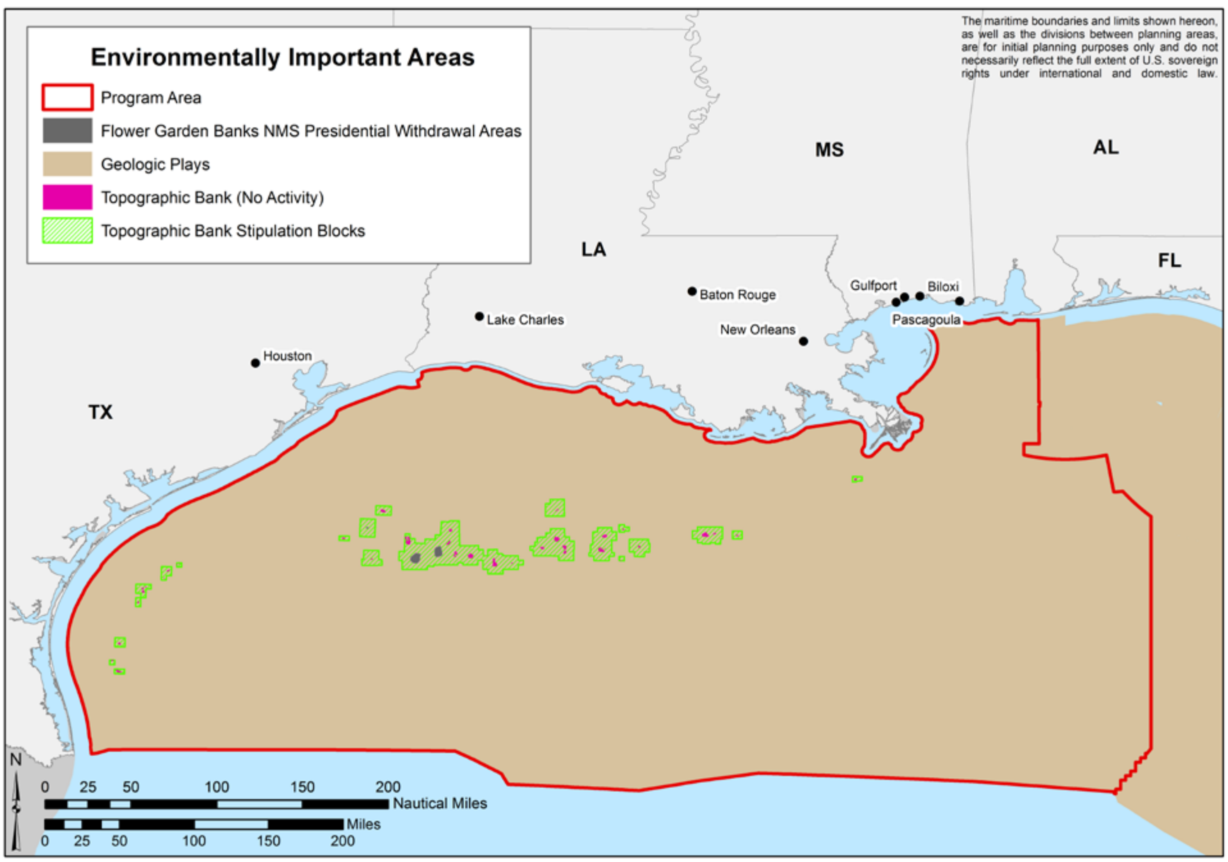


Figure 4.4.5-4. Topographic Features EIA in the Gulf of Mexico Program Area.

An exclusion of the topographic features under this EIA would continue these effective protections which eliminate nearly all IPFs to these biologically sensitive areas. Impacts from adjacent areas (e.g., spills, CDEs) may still affect these features. The nature and magnitude of any such impacts on benthic communities of these topographic features will depend on the location, size, and duration of any spills in the other portions of the Program Areas. 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 shallower water may be adversely affected to some degree.

It assumed that the mitigations described under NTL 2009-G39 (providing avoidance and mitigation requirements for biologically sensitive hard/live bottom areas in waters 300 m [984 ft] or less) would continue under this EIA and Alternative A. Additional features such as pinnacles, low relief live bottoms, and potentially sensitive biological features still would require adequate mitigation to protect these biologically important areas (BIAs) from negative impacts of OCS activities. Overall, the protections in NTL 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 E&D activities. Thus, appropriately siting discharge locations in pre-disturbance mitigation plans would be critical in minimizing the effects of bottom disturbance and discharges.

4.4.5.4. Right Whale Biologically Important Areas

BIAs are based on best available information from scientific literature, unpublished data, and expert knowledge. They identify areas where cetaceans are known to occur but where there are not enough data to do quantitative analyses such as density mapping. BIAs may be focused on reproductive, feeding, or migratory areas. Refer to NOAA (2015) and LaBrecque et al. (2015) for additional information. Several BIAs for NARWs were identified along the Atlantic coast of the U.S., including a migratory BIA that overlaps with the Atlantic Program Area. The northern portion of this migratory BIA is off northern North Carolina and Virginia, and the southern portion of the BIA lies off southern North Carolina, South Carolina, and Georgia (**Figure 4.4.5-5**). The portion of the BIA that does not intersect with the Atlantic Program Area is not shown. NARWs occur in the mid-Atlantic region year-round; however, they are expected to have peak occurrence in the northern portion of the BIA in fall (October/November) and spring (April/May). In the southern portion of the BIA, particularly off Georgia, peak occurrence is November through April. During this time, individuals are moving into the breeding and calving areas off Florida and Georgia, including designated critical habitat areas (**Figure 4.3.6-1**).

Seasonal restrictions of all oil and gas activity (e.g., November through April) would effectively increase the 80.5-km (50-mi) buffer to include areas of NARW occurrence and would have the same effect as a complete exclusion. In the northern portion of the BIA, the primary routine IPFs for NARWs are noise and vessel strike. Using this EIA component to reduce potential effects from those routine IPFs during the periods when NARWs are expected to occur is the most effective way to protect the animals. Limiting activities that produce noise (e.g., drilling, seismic surveys, explosive decommissioning, construction) in areas of expected peak occurrence (October/November and April/May) would be most effective. Vessel strikes may be mitigated at any time of the year by reducing vessel speeds and using PSOs for transiting vessels within the BIA. Seasonal restrictions on noise-producing activities in the NARW BIA may preclude impacts from the Proposed Action to marine mammals within those areas (during certain times of the year for the BIA). Impacts from the Proposed Action may be reduced to **negligible** to **minor** within the NARW BIA during periods of restricted activities. Vessel speed reductions or having active PSOs during transit within sensitive areas such as the NARW BIA will mitigate the risk of a major impact to NARWs and other species (i.e., other marine mammals and sea turtles).

4.4.5.5. Loggerhead Overwintering Critical Habitat

This area includes the portion of loggerhead turtle overwintering critical habitat overlapping with the Program Area (**Figure 4.4.5-5**). This includes designated critical habitat for loggerhead turtles, which are listed as threatened under the ESA. Specifically, this component addresses critical habitat offshore North Carolina between the months of November and April, when loggerhead turtles rely on warm waters in the region.

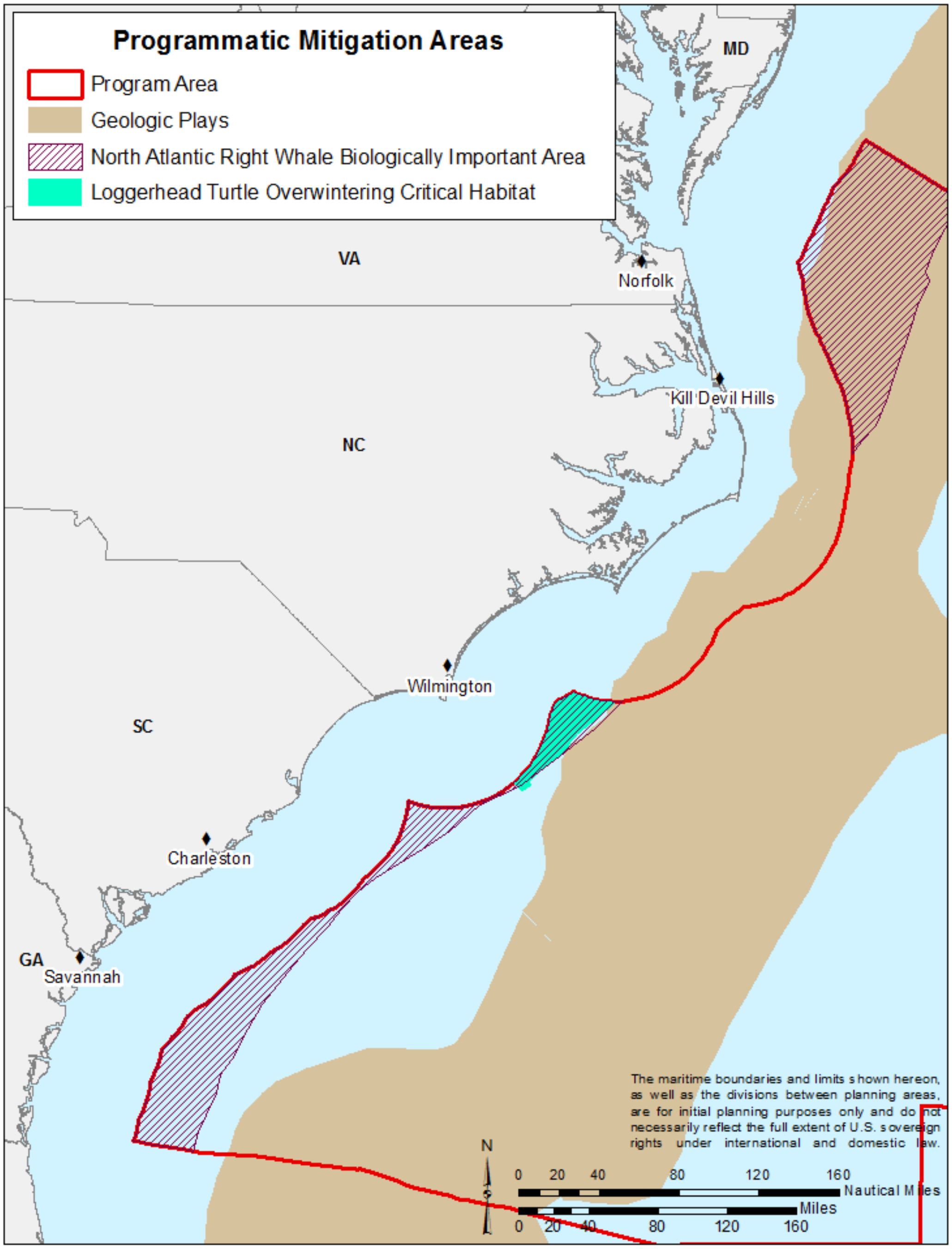


Figure 4.4.5-5. Programmatic Mitigation Areas in the Atlantic Showing the Overlap of NARW Biologically Important Areas with Loggerhead Sea Turtle Overwintering Critical Habitat.

Critical habitat has been designated for the Northwest Atlantic Ocean DPS of loggerhead turtles in many areas of the U.S. southeast (79 FR 39856). The overwintering critical habitat was designated to protect warm-water areas that loggerhead turtles use adjacent to the Gulf Stream when migrating south from northern foraging areas during colder months (November through April). A portion of the designated overwintering habitat occurs within the Atlantic Program Area and is located east of Cape Fear, North Carolina.

Cold water temperatures can be lethal for ectothermic marine sea turtles, with temperatures lower than 10°C leading to cold stunning, the metabolic suppression of activity which may result in stranding and death (George, 1997; Milton and Lutz, 2003). Water temperatures north of Cape Hatteras decrease in the fall, which coincides with a southerly migration of loggerhead turtles in search of more favorable habitat (Lutcavage and Musick, 1985; Byles, 1988; Shoop and Kenney, 1992; Keinath, 1993; Morreale and Standora, 2005; Mansfield et al., 2009). Hawkes et al. (2011) suggested that loggerhead turtles inhabiting northern foraging areas during the summer likely move to winter areas to avoid declining water temperatures (which fall as low as 5°C), whereas loggerhead turtles found in southern foraging areas (off Georgia and Florida) year-round do not need to migrate across latitudes in the fall and winter because water temperatures generally remain above 18°C in winter. The best available data suggest that the features off southern North Carolina along the edge of the Gulf Stream serve to concentrate juvenile and adult loggerhead turtles, especially those foraging in northern latitudes. Without the thermal influence of the Gulf Stream, waters in this area would be prohibitively cold (<10°C in mid-winter).

Inhabiting this area during the colder winter months minimizes migratory distance to summer foraging areas, and therefore time and energy needed, while avoiding cold winter temperatures in inshore waters at the same latitude, and reducing energetic costs necessary to maintain a position within the strong currents of the Gulf Stream (Epperly et al., 1995a; Hawkes et al., 2007). The dive behavior of loggerhead turtles in this wintering area is unique and reflective of a “hibernation” state to conserve energy. Data suggest that loggerhead turtles dive for significantly longer periods compared to their dives in summer habitat areas, with long “hibernating” dive periods, and surfacing only 4 to 6 times a day. It is likely that large numbers of loggerhead turtles are carrying this mixed strategy of migration/hibernation at the northerly edge of their range to capitalize on more seasonally productive northern foraging areas, minimize migratory distance, and avoid exposure to life-threateningly cold water at any part of their range (Hawkes et al., 2007). Based on review of satellite telemetry data, the greatest concentration of loggerhead turtles in the winter area south of Cape Hatteras occurs from November through April (Hawkes et al., 2007, 2011; Mansfield et al., 2009).

IPFs within the loggerhead turtle overwintering critical habitat component that could be minimized through programmatic mitigation are seismic noise and vessel strike. Implementation of mitigation for these IPFs would have the same effect as complete exclusion based on prior analysis conducted. Complete exclusion of the loggerhead overwintering component is not recommended because this area is most critical to loggerhead turtles from November through April, and mitigation of impacts during this time would be as effective as complete exclusion. Considering the small number of anticipated platform removal events and the inability to control accidental or CDE spills from locations outside of the designated area, programmatic mitigations are not proposed for these IPFs because there would be limited incremental gain from their implementation.

As previously discussed, loggerhead sea turtles are concentrated in high abundance within the overwintering designation, and primarily confined to the edge of the warm Gulf Stream waters. Though only a small portion of the habitat is included within the Atlantic Program Area when considering the 80.5-km (50-mi) buffer, this small portion represents the southeast corner of the habitat and is located closest to the Gulf Stream edge. During the colder winter months, it is likely that this southern portion of the habitat could support higher concentrations of loggerhead turtles within the overall designation. Furthermore, the behavior of these sea turtles is a unique strategy for only those northerly migrating animals that includes a low metabolic “hibernation” state with long dive periods during the winter months. Though these sea turtles are not spending long periods of time at the surface, they are in high concentration and exhibit slower movements while under metabolic suppression, and therefore are more vulnerable to vessel strike during the periods when they are at the surface. Additionally, considering the high concentration of animals coupled with long hibernating dive durations, the existing standard mitigations for seismic surveys may not be completely effective in only assessing for animals at the surface as a trigger for implementing exclusion zones. These residual risks within the loggerhead overwintering habitat component could be mitigated during the expected peak occurrence period from November through April by implementing the following:

- Reducing vessel speeds and using PSOs for transiting vessels when practicable; and
- Excluding seismic survey activities.

4.5. 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 2017-2022 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 Program Areas into the foreseeable future as discussed in **Sections 3.1** and **3.6**. 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).

Accidental oil spills can occur from OCS and non-OCS activities, and the magnitude and severity of potential impacts from a spill on any resource would depend on the spill location and size, depth of spill, duration of spill, type of spill, meteorological conditions such as wind speed and direction, seasonal and environmental conditions, and the effectiveness of response activities. Accidental spills from OCS activities are covered in detail in **Section 4.4.4**. Non-OCS activities that have the potential for accidental spills include state oil and gas exploration, development, and production; the domestic transportation of oil; foreign crude oil imports; commercial shipping; commercial fishing; and private vessel use. In addition, hurricanes and extreme weather events can damage pipelines and infrastructure resulting in a release of oil.

Because of the variability associated with accidental oil spills, inclusion of the oil spill impacts results in a broadening of the potential impact range in the cumulative scenario in every resource section, which masks the incremental contribution of other OCS and non-OCS routine activities; therefore, these impacts will not be discussed in detail in the cumulative impacts section for each resource. For all the resource sections, accidental oil spill impacts range from **negligible** or **minor** to **major**, with the exception of air quality and archaeological and historical resources, where the upper threshold is **moderate**.

The cumulative impacts section does not include catastrophic events in the analysis, such as a CDE (e.g., the *Deepwater Horizon* spill) or hurricane (e.g., Hurricane Katrina). Although such events may occur, they are not a part of the reasonably foreseeable future activities. CDEs are discussed in **Section 4.4.4**.

4.5.1. Air Quality

The Proposed Action could impact air quality when added to other impacts from similar and unrelated past, present, and reasonably foreseeable future actions over the next 40 years.

Table 4.5.1-1 provides the estimated high case annual air emissions from OCS activities, by planning area, for the Proposed Action as well as ongoing and future OCS oil and gas activities. These emissions were estimated using emission factors from BOEM's 2012 Revised OECM. The majority of emissions would come from well drilling, support vessels, and construction of new production platforms and pipelines.

Table 4.5.1-1. Estimated Air Emissions from the Proposed Action's OCS Activities in Thousands of Tons and Based on the High Case E&D Scenario.

Pollutant	Beaufort Sea	Chukchi Sea	Cook Inlet	Western Gulf of Mexico	Central and Eastern Gulf of Mexico	Mid- and South Atlantic
NO_x	4,566.07	3,295.13	118.70	1,787.71	7,902.71	506.06
SO_x	59.36	67.71	5.50	42.23	175.53	13.87
PM_{10}	225.52	154.80	3.03	54.67	243.39	15.01
$PM_{2.5}$	202.25	139.25	2.93	53.10	236.42	14.59
CO	1,844.87	1,252.92	33.64	523.00	2504.96	146.77
VOC	546.94	619.81	39.21	115.22	583.06	48.27

CO = carbon monoxide; NO_x = nitrogen oxides; PM = particulate matter; SO_x = sulfur oxides; VOC = volatile organic compound.

The Proposed Action would contribute to onshore levels of NO_2, SO_2, and PM_{10}, but concentrations onshore would remain within the NAAQS (USEPA, 2015b) and PSD increments (40 CFR part 55). The types of effects from future OCS program activities are expected to remain constant for the foreseeable future; however, these effects will be new to the Atlantic and Alaska Program Areas. The Gulf of Mexico and Atlantic coasts have places where ozone is classified as nonattainment (**Figures 4.3.1-1** and **4.3.1-2**); however, the contribution from OCS program activities to O_3 concentrations remains low. Ozone concentrations are expected to continue their long-term decline due to air pollution control measures implemented by state and federal regulatory agencies. The Gulf of Mexico coastal region has substantial visibility impairment from anthropogenic emission sources. However, visibility is expected to improve somewhat as a result of regional and national emission reduction programs. The contribution from cumulative case OCS oil and gas activities to visibility impairment is expected to remain small.

In addition to the oil and gas activities described, other past, present, and future actions may generate emissions on or near the OCS. This includes ongoing and future oil and gas exploration, development, and production onshore and in state, Mexican, Canadian, and Russian waters. Other activities that could generate emissions within and adjacent to the OCS include bridge and coastal road construction; military operations; NASA activities; harbor, port, and terminal operations; alternative energy development; marine vessel traffic; onshore coal and mineral mining; scientific research; commercial fishing; recreation and tourism; and dredging and marine disposal. In addition, climate change is expected to increase the amount of vegetation, which release VOCs and will interact with NO_x released from oil and gas operations to produce increased haze and ozone at ground levels.

Emission reductions are likely in the future. In 2012, the USEPA adopted international emission standards for ships operating off North American coasts, requiring ships operating within 370 km (200 nmi) of U.S. and Canadian coastlines to use low-sulfur fuels, reducing emissions of SO_x and $PM_{2.5}$. Engine-based controls also will reduce NO_x emissions. The USEPA also is phasing in several new Tier 3 and Tier 4 NO_x emission standards applicable to newly built marine diesel engines (40 CFR 1042 subpart B). The 2012 Cross-State Air Pollution Rule requires 27 states in the eastern U.S. to reduce power plant emissions contributing to O_3 or $PM_{2.5}$ while other states must significantly reduce SO_2 and NO_x.

Cumulative impacts to air quality on and near the OCS associated with the Proposed Action, ongoing and future OCS oil and gas programs, as well as unrelated activities are expected to be **moderate**. The Proposed Action will allow for exploration, development, and production in the less industrialized Alaska Program Areas, leading to a **minor** contribution to air quality impacts in the Arctic and Cook Inlet areas. However, the Proposed Action's contribution remains a small portion of criteria pollutants, and is expected to be **minor** in the Gulf of Mexico and Atlantic regions.

4.5.2. Water Quality

Cumulative impacts on water quality result from the incremental impacts of the Proposed Action 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. These include marine vessel traffic-related discharges and disturbance of bottom sediments.

Water quality also is 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 related discharges, wastewater discharge, natural oil seepage, dredging and marine disposal, marine mineral mining, military and NASA operations, renewable energy development, and oil and gas-related activities as well as infrastructure in state-owned marine waters. In areas such as Cook Inlet, impacts from the Proposed Action and ongoing OCS programs may lessen with time because oil and gas production in the Cook Inlet is currently on the decline.

Impacts from activities associated with the Proposed Action and non-OCS program activities will be mitigated (i.e., minimized) by the various regulatory controls already in place to protect the coastal and marine waters. The cumulative impacts to water quality on and near the OCS associated with the Proposed Action, ongoing and future OCS oil and gas programs, as well as unrelated activities, are expected to be **negligible** to **moderate**. The incremental contribution of the Proposed Action would represent a small percentage of the total cumulative impacts.

4.5.3. Marine Benthic Communities

The cumulative impact assessment considers effects to marine benthic communities from the Proposed Action's activities on the OCS, including noise, drilling muds, cutting, and debris, and bottom/land disturbance. Impacts associated with these activities include habitat displacement or degradation, chronic seafloor disturbance, and seafloor sediment disturbance. Similar activities would occur from previous and future sales during the life of the Program.

Drilling muds, cuttings, and debris can temporarily increase turbidity, cover, and alter the composition of sediment if deposited in sufficient quantities. Bottom disturbances also will result from the installation and removal of oil and gas E&D, and offshore structures and pipelines. Installing structures and pipelines into and on the seafloor can crush, smother, and displace benthic communities, while platform removal with explosives can result in physical impacts to surrounding sediments and benthic communities. Numerous ongoing non-Program activities contribute to bottom disturbances as discussed in **Section 3.6.3**.

Marine benthic ecosystems are at risk to impacts of climate change and ocean acidification. Changes in ocean water temperature can affect community structure as well as the fitness of individual organisms, including mortality, reproduction, and development (Beukema et al., 1998; Phillppart et al., 2003; Kirby et al., 2007). Latitudinal shifts in marine benthic species have been documented for benthic organisms (Southward et al., 2004; Mieszkowska et al., 2006; Eggleton et al., 2007). Ocean acidification, the result of excess CO_2 in the atmosphere, can also impact benthic communities. Changes in ocean pH already have begun to impact the fitness of benthic organisms such as corals, shellfish, fish, and pteropods (Orr et al., 2005; Hofmann et al., 2010; Gattuso and Hansson, 2011). Deepwater corals on the OCS are especially sensitive to pH shifts. Increasing temperatures may lead to declines in oxygen concentrations in the ocean due to reduced solubility and reduced ventilation from stratification and circulation changes. Lower oxygen levels can negatively impact organism health and community structure (Levin et al., 1991). Changes in storm intensity, storm frequency, and circulation patterns may become additional stressors to benthic communities (Birchenough et al., 2015).

The cumulative impacts on marine benthic communities from all OCS and non-OCS activities are expected to be **minor** to **moderate**. The incremental contribution of the Proposed Action would represent a small percentage of the total cumulative impacts.

4.5.4. Coastal and Estuarine Habitats

Coastal and estuarine habitats that are present along the pertinent shorelines include barrier islands, beaches, tidal flats, rocky shores, tidal rivers, wetlands and marshes, and submerged aquatic vegetation. Typical oil and gas activities associated with the Proposed Action that could impact coastal and estuarine habitats in the Arctic, Cook Inlet, Gulf of Mexico, and Atlantic Program Areas include construction of new or modification of existing infrastructure, including ports, roads, construction facilities, oil and gas pipelines/landfalls, and onshore processing facilities. Offshore activities include vessel activity such as tanker and barge transport, survey vessel trips, and activity of support vessels.

Numerous non-OCS-related activities can impact coastal habitats. Wetlands and seagrass beds can be impacted by anchoring, fishing/trawling, and recreational use. The most substantive threats include conversion of wetlands to other land uses and climate change, in particular, sea level rise and possible increases in hurricane intensity and frequency due to warmer ocean temperatures. Other stressors to wetlands include stormwater runoff from upland development and watershed modification (e.g., channelization)as well as vessel traffic associated with state oil and gas development, oil and gas imports, commercial fishing, military and NASA operations, commercial shipping, scientific research, mineral mining, and recreational use. Any onshore activities that alter the hydrology or change the estuarine flow can lead to saltwater intrusion, which can destroy freshwater marshes. Upland non-OCS related activities can introduce contaminants or pollutants from agricultural runoff, wastewater discharges, and municipal discharges resulting in degradation of water quality (**Section 4.5.2**), which can negatively affect wetlands and seagrass. Indirect impacts to seagrass habitats can occur from the aforementioned activities and naturally occurring events such as natural seepage of oil in the Gulf of Mexico, which may be substantial. Any of the activities that impact coastal wetlands and seagrass beds can lead to increased shoreline erosion and loss of habitat.

For example, non-OCS oil and gas activities considered in the cumulative impact scenario for the Cook Inlet region include harbors, ports, and terminal operations; the Port of Anchorage Intermodal Expansion Project (in the vicinity of Cook Inlet); industry; transportation facilities; the Knik Arm Crossing Project (in the vicinity of Cook Inlet); mining (coal and minerals); recreation and tourism along the shore and beaches; scientific research; and subsidence from natural processes, oil and gas extraction, and mining activities. These actions also could generate bottom/land disturbance and oil spills that could affect coastal and estuarine habitats for long periods.

The cumulative impacts on coastal and estuarine habitats from all non-OCS activities are expected to be **minor** to **major**, depending on the location and mainly due to possible sea level rise. The incremental contribution of the Proposed Action would represent a small percentage of the total cumulative impacts.

4.5.5. Pelagic Communities

In all planning areas, pelagic communities are represented by phytoplankton, zooplankton, and ichthyoplankton. Other components of the pelagic food web (fishes, birds, and mammals) are described separately.

Noise associated within the Proposed Action areas has the potential to impact pelagic communities within each of the planning areas. Numerous ongoing and future OCS programs and other non-OCS program activities contribute to regional anthropogenic noise levels. Existing, ongoing, and future OCS activities (in state and federal waters) that will contribute to noise levels include offshore construction activities, seismic surveys, exploratory drilling, platform decommissioning, and vessel traffic. Existing, ongoing, and future non-OCS actions that will result in incremental impacts from noise include oil and gas imports, commercial fishing, alternative energy development, military and NASA operations, marine vessel traffic, scientific research, LNG import terminals, marine mineral mining, dredging, and recreation and tourism. The Gulf of Mexico is one of the world's most concentrated shipping areas (USDOC, NOAA, 2011). These sources of vessel noise are compounded with seismic and HRG surveys and decommissioning operations using explosives. Seismic surveys and explosive use will account for the highest levels of sound sources in the Gulf of Mexico. Little is known about the population-level effects of anthropogenic or E&D sound activities on pelagic communities; however, physiological effects have been documented (Normandeau Associates, Inc., 2012). These noise-producing activities can be reasonably expected to continue into the future.

Discharges related to drilling muds are very specific to E&D operations; other non-OCS-related discharge activities that pose threats to pelagic communities include onshore industry and agriculture, dredging and marine disposal, scientific research related to geophysical sampling through drilling operations, marine mineral mining, and wastewater discharges.

Lighting from offshore production structures (platforms and FPSOs) could impact marine pelagic communities. Impacts are expected to continue as part of existing, ongoing, and future OCS activities in state and federal waters. Existing, ongoing, and future non-OCS actions that will result in incremental impacts from lighting include onshore industry, agriculture, scientific research, LNG import terminals, and recreation and tourism.

Pelagic communities would be affected by various activities associated with the Program as well as activities resulting from already scheduled lease sales. These include noise, routine discharges, drilling muds/cuttings/debris, lighting, accidental oil spills, and CDEs. Pelagic communities also are affected by numerous factors, including river inflows, urban runoff, agricultural runoff, and municipal waste discharges. Non-OCS program activities likely to contribute to cumulative impacts include infrastructure in state-owned marine waters as well as activities discussed earlier. Natural seepage of oil in the Gulf of Mexico may be significant. The cumulative impacts on pelagic communities from all OCS and non-OCS activities are expected to be **negligible to major**. The incremental contribution of the Proposed Action would represent a small percentage of the total cumulative impacts.

4.5.6. Marine Mammals and Sea Turtles

Cumulative impacts to marine mammals and sea turtles are primarily focused on noise because of the potential population-level impacts or in the case of endangered species, impacts to individuals. Vessel strikes and accidental oil spills also are discussed because of the potential to impact individuals. Additional sources of impacts to marine mammals and/or sea turtles that are part of the background of cumulative impacts include entanglements or ingestion of trash or debris, climate change-related impacts, changes in prey availability, and legal and illegal harvest.

Sources of noise include vessel traffic (e.g., cruise ships; whale-watching vessels; commercial shipping; commercial fishing; USCG, military, and NASA vessels; icebreakers; private vessels and research vessels), sonar from fisheries, research, military and NASA operations, and ongoing energy development; industrial construction (including DP, drilling, pile driving and thruster use in constructing energy infrastructure (including renewable and nonrenewable energy sources); explosions (including military exercises and rig decommissioning); marine mineral extraction; mobile bottom gear (trawling and dredging); and acoustic harassment devices used in aquaculture or bycatch reduction. Noise impacts under the cumulative case are significant because of auditory masking, and are not expected to result in potential acute auditory injuries to marine mammals, but can lead to chronic impacts to population fitness.

As described in **Section 3.5**, marine mammals and sea turtles could be affected by various noise-producing activities associated with the 2017-2022 Program. Noise-producing activities in the Proposed Action include geophysical and geohazard surveys, vessel and helicopter traffic, construction, drilling and production activities, and decommissioning of offshore structures. Most of the sources of noise (with the exception of seismic surveys and explosive removals of offshore structures) are not expected to result in potential auditory injuries to sea turtles or marine mammals when effective mitigations are in place. Impacts are expected to be limited to the disturbance or displacement of individuals.

The possibility exists for collisions between vessels and sea turtles or marine mammals, particularly slow-moving species such as the endangered manatee in coastal and nearshore waters, and deep-diving species that spend time at the surface between dives (e.g., beaked whales, pygmy sperm whales, endangered sperm whales, North Pacific right whales, and NARWs). Any collisions with sea turtles or marine mammals are expected to result in injury or mortality.

Ongoing anthropogenic activities and associated impacts are much higher in the Gulf of Mexico, Atlantic, and Cook Inlet than in the Beaufort and Chukchi Seas. Impact levels also vary between areas due to the differences in risk, based on population level, and status of other ongoing IPFs. For example, NARWs are highly endangered and at great risk from collisions regardless of the source of the shipping traffic. Polar bears, found only in the Beaufort and Chukchi Planning Areas, are at great risk from climate change regardless of other ongoing anthropogenic activities. Sea turtles are commonly found in the Gulf of Mexico and Atlantic Planning Areas and are rare occurrences in the Cook Inlet Planning Area. OCS activities related to the Proposed Action will add a small incremental level of effect, particularly with regard to noise, accidental discharges, and potential for collisions, to ongoing and future OCS oil and gas programs as well as unrelated activities. The cumulative impacts on marine mammals and sea turtles from all OCS and non-OCS activities are expected to be **minor** to **moderate**. The incremental contribution of the Proposed Action would represent a small percentage of the total cumulative impacts.

4.5.7. Marine and Coastal Birds

In all Program Areas, marine and coastal birds may be adversely affected by exposure to oil via direct contact, through the inhalation or ingestion of oil or tar deposits, or through impacts to prey species. Spills may occur from program and non-program activities, especially near coastal areas, and affect feeding and nesting areas.

Marine and coastal birds found in North America are subject to several population level stresses, the most prominent of these are related to climate change, commercial fishing, loss of nesting/ breeding habitat, and changes in abundance and location of prey species (North American Bird Conservation Initiative [NABCI], 2014). Human disturbance at nesting and migration staging areas, chronic marine pollution, and entanglement with or ingestion of trash and debris have all been identified as factors impacting marine and coastal bird populations (Yasue, 2006; NABCI, 2014). One recently published study, extrapolated from species for whom long-term population or breeding assessments have been conducted, determined that seabird species may have declined by nearly 70 percent globally since the 1950s (Paleczny et al., 2015).

Other non-program activities that likely would have a negative impact on marine and coastal birds are noise, traffic, land disturbance, lighting, and visual infrastructure from industry, transportation facilities, military and NASA operations, marine mineral mining/beach nourishment, and recreation and tourism along the shoreline and beaches. Construction, operation, and decommissioning of offshore renewable energy structures could impact some species, including certain threatened and endangered species. The cumulative impacts to marine and coastal birds are expected to be **negligible** to **moderate**. The incremental contribution of the Proposed Action would represent a small percentage of the total cumulative impacts.

4.5.8. Fishes and EFH

Fish resources and EFH would be affected by various activities associated with the Program over the next 40 to 50 years as well as by activities resulting from already scheduled lease sales. These include noise, routine discharges, drilling muds and cuttings, and bottom (seafloor) disturbance. Fish and EFH also are affected by numerous factors not associated with the Program, including freshwater inflows, coastal commercial and residential development, agricultural runoff, and commercial and recreational fishing. Conversion of wetlands to open water as a result of coastal development, channelization and flood control, dredging, and vessel traffic poses one of the greatest threats to estuarine-dependent fishes (Levin and Stunz, 2005; Jordan et al., 2012; Greene et al., 2014; Lowe and Peterson, 2014; Scyphers et al., 2015). Another important factor is fishing activity. Although many stocks are rebuilding or have been rebuilt, certain fishing practices and overfishing can have long-term effects on target species and EFH. For example, the structure of a rebuilt stock may differ from historic demographics, resulting in a less resilient population, or habitat could be altered such that species diversity and abundance are affected (Wells et al., 2008; NRC, 2014; Pusceddu et al., 2014; Secor et al., 2015). The cumulative impact of long-term, large-scale fisheries activity on fishes and habitat resources is not known. In addition, non-OCS program activities occurring in state waters are likely to contribute to cumulative impacts on fish and EFH. Infrastructure emplacement, vessel traffic, military and NASA operations, and scientific research generate impact producing factors similar to those resulting from OCS-related activities.

The cumulative impacts on fish and EFH from all OCS and non-OCS activities are expected to be **minor** to **moderate**. The incremental contribution of the Proposed Action would represent a small percentage of the total cumulative impacts.

4.5.9. Areas of Special Concern

The resources within Areas of Special Concern may be affected by various activities associated with the Program as well as activities resulting from already scheduled lease sales. Depending on the resource, a range of impacts from **negligible** to **major** may occur. Non-OCS program activities are likely to contribute to cumulative impacts, and the IPFs may vary depending on the area. The cumulative effects for specific resources that are protected with individual Areas of Special Concern are discussed in the resource sections, where appropriate.

The cumulative impacts on resources within Areas of Special Concern from all OCS and non-OCS activities may range from **negligible** to **major**. The incremental contribution of the Proposed Action would represent a small percentage of the total cumulative impacts.

4.5.10. Archaeological and Historical Resources

Archaeological and historic resources may be affected by various activities associated with the Program as well as activities resulting from already scheduled lease sales. These include bottom (seafloor) disturbance and visual effects. Non-OCS program activities likely to contribute to cumulative impacts include infrastructure in state-owned marine waters, oil and gas activities in state-owned waters, commercial fishing (such as trawling), dredging, marine disposal, and looting.

The cumulative impacts on archaeological and historical resources from all OCS and non-OCS activities are expected to be **minor** to **moderate**, while impacts to individual sites could be **major**. The incremental contribution of the Proposed Action would represent a small percentage of the total cumulative impacts.

4.5.11. Population, Employment, and Income

This analysis employs the economic and demographic projections from Woods and Poole Economics, Inc. (2015) to define the contributions of other likely projects, actions, and trends to the cumulative case. These projections are based on local, regional, and national trend data as well as likely changes to local, regional, and national economic and demographic conditions. The projections include population and employment associated with the continuation of current patterns in OCS leasing activity (including the Proposed Action) as well as the continuation of trends in other industries important to these regions. The Woods and Poole Economics, Inc. (2015) projections represent a more comprehensive and accurate appraisal of cumulative conditions than could be generated using the traditional list of possible project actions.

Table 4.5.11-1 presents Woods and Poole Economics, Inc.'s (2015) estimates of the average annual percentage changes of population, employment, and labor income from 2015 to 2035 in the states that would be most impacted by the Proposed Action. The year 2035 was chosen as an approximate peak year of economic activity arising from the Proposed Action. Average population increases are expected to range from 0.3 to 1.5 percent per year, average employment increases are expected to range from 0.9 to 1.8 percent per year, and average labor income increases are expected to range from 1.8 to 2.7 percent per year. Population, employment, and labor income growth are highly correlated among states. In terms of employment, the fastest growth is forecast in Texas, Florida, North Carolina, and Virginia; the slowest employment growth is forecast in Pennsylvania, New Jersey, Alabama, and Mississippi.

Table 4.5.11-1. Average Annual Growth in Population, Employment, and Labor Income.

States	Population (%)	Employment (%)	Labor Income (%)
Alaska	1.1	1.3	2.1
Gulf of Mexico			
Texas	1.5	1.8	2.7
Florida	1.3	1.6	2.4
Louisiana	0.7	1.2	1.8
Alabama	0.6	1.1	1.9
Mississippi	0.7	1.1	1.8
Atlantic			
Virginia	1.2	1.5	2.4
North Carolina	1.3	1.5	2.3
Georgia	1.2	1.4	2.1
South Carolina	1.1	1.4	2.1
Delaware	1.0	1.3	2.1
Maryland	0.8	1.2	2.0
New Jersey	0.5	1.0	1.8
Pennsylvania	0.3	0.9	1.8

With the possible exception of the Arctic, the impacts to population, employment, and income from the Proposed Actions in each Program Area relative to the overall cumulative state and local economies is likely to be small. The Alaska OCS is a frontier area, with huge resource potential combined with sparsely populated rural communities in the Arctic, and lower levels of industrialization as compared to other coastal states, even in south Alaska. Sustained levels of very high oil and natural gas prices could lead to much greater oil and gas activity with the commensurate impacts on population, employment, and income, although existing workforce commuting patterns already provide for increased employment with lower impacts on local communities than would be the case if all workers had to live in the state.

The Gulf of Mexico has an established oil and gas industry and related employment and population. The Proposed Action would support the existing economies and is anticipated to add new employment only in the case of sustained high prices.

The Atlantic Coast is largely industrialized with large population centers. Much of the activity would be staged out of the Gulf of Mexico area during the initial exploration stage. However, commercial discoveries leading to production likely would result in new jobs and residents for Atlantic communities. Most of the growth likely would be negligible in comparison with existing populations and economic activity, but a few coastal communities could see growth of support industries at a level that would cause noticeable changes.

Cumulative impacts to population, employment, and income associated with the Proposed Action, ongoing and future OCS oil and gas programs, as well as unrelated activities are expected to be **negligible** to **minor**, with the exception of the high sustained activity case in the Arctic, where there may be some **moderate** impacts due in large part to the activities from the Proposed Action.

4.5.12. Land Use and Infrastructure

Localized impacts to land use and existing infrastructure are anticipated as a result of ongoing and future OCS and non-OCS program activities in the Gulf of Mexico, Atlantic, Arctic, and Cook Inlet Program Areas. 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 Gulf of Mexico would be **minor** because the existing infrastructure is sufficient to handle increases in demands for roads, utilities, and public services related to the Program. Similarly, the incremental contribution of routine operations in the Cook Inlet would be **minor** because the Program would not introduce new kinds of activities that would alter existing land uses given the presence of oil and gas activity from state leases in the area. For more frontier areas like the Arctic and Atlantic, the incremental contribution of routine operations under the Program to cumulative impacts would range from **minor** to **major** due to increases in vehicular traffic, modifications to current land use designations (e.g., onshore construction of pipeline and transportation networks), and infrastructure expansion to accommodate oil and gas production.

4.5.13. Commercial and Recreational Fisheries

Existing OCS program actions that could affect commercial and recreational fisheries negatively include noise, vessel traffic, and space-use conflicts. Levels of vessel activity, noise, and space-use conflicts are expected to increase in the Gulf of Mexico, Atlantic, and Alaska regions. **Section 3.6** indicates minor contributions from the Proposed Action to the cumulative case for numbers of E&D wells drilled, total structures installed, and miles of pipeline installed. The cumulative number of explosive removals could have spatially localized consequences for red snapper and other economically important fishes in the Gulf of Mexico. Seismic airguns are an intensive but transient source of noise that can affect the behavior and distribution of target species.

Commercial and recreational fishing in the planning areas would be affected by a variety of activities associated with the Proposed Action coupled with the ongoing OCS program and other actions. Other actions include commercial shipping, recreational vessel traffic, marine mining, military and NASA operations, cruise ship discharges, climate change, warming water temperatures, increased storm events that may lead to increased coastal erosion, and decreases in ice cover in the Alaska region. Fishing and/or overfishing may alter habitat and affect the demographics of exploited species, which may contribute to the cumulative scenario. Some specific fisheries are already in decline (e.g., king salmon in Cook Inlet, red snapper in the Gulf of Mexico) and are expected to continue to decline. However, the incremental contribution of the Proposed Action would represent a small percentage of the total cumulative impacts.

4.5.14. Tourism and Recreation

Non-OCS activities or phenomena affecting tourism and recreation 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 potentially adverse aesthetic impacts on beach recreation and sightseeing, and potentially positive impacts on diving and recreational fishing.

Severe storm events such as hurricanes and storm surges could impact the recreation and tourism economy if they result in severe beach damage or destruction of existing public infrastructure. Hurricanes regularly occur in the Gulf of Mexico and Atlantic regions. These storms can destroy recreational beaches, public piers, hotels, casinos, marinas, recreational pleasure craft, charter boats, and numerous other recreational infrastructures.

Routine operations under the Program could result in incremental increases in effects on National Sanctuaries, National Parks, NWRs, and NERRs. Development of onshore facilities within NPS lands in the vicinity of the areas included in the Program is outside of BOEM's jurisdiction, but is considered unlikely.

Cumulative impacts on tourism and recreation as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be **minor** to **moderate** in areas where no similar infrastructure yet exists, and competition for accommodations and air transport may slow tourism for a time. The incremental contribution of the Proposed Action would represent a small percentage of the total cumulative impacts.

4.5.15. Sociocultural Systems

Cumulative impacts to sociocultural systems associated with the Proposed Action, ongoing and future OCS oil and gas programs, as well as non-OCS activities are expected to vary based on the Program Area.

The Beaufort and Chukchi Planning Areas of Arctic Alaska are adjacent to several subsistence-based Native Villages. These villages have little development outside of their communities and rely on a tradition of kinship and sharing for survival; however, the coast adjacent to these planning areas has robust oil and gas activity onshore, and ongoing activity in state waters, in the Beaufort Sea. Given these factors, cumulative impacts on the sociocultural systems for the Proposed Action are considered **moderate** to **major**.

Cumulative impacts on the culture for the onshore areas adjacent to the Cook Inlet Planning Area are expected to be **negligible** to **minor** over the lifecycle of the Proposed Action. There is existing oil and gas development adjacent to the coast of the KPB, and infrastructure is in place that supports the oil and gas industry.

The Gulf of Mexico region has a robust oil and gas industry that contributes to the culture and economy of the states along the Gulf Coast. Industry-related activity is present onshore, nearshore, and offshore of the Gulf states. Cumulative impacts on the culture for the onshore areas adjacent to the Gulf of Mexico Planning Areas are expected to be **negligible** to **minor** over the lifecycle of the Proposed Action.

The Atlantic Program Areas currently have no major oil and gas-related service industry infrastructure. Impacts could include an increase in onshore industrial development and an increase in vessel traffic, but is unlikely to affect viewshed, given the 80.5-km (50-mi) leasing buffer. Cumulative impacts on the culture of the onshore areas adjacent to the Atlantic Program Areas are expected to be **minor** to **moderate**.

Overall, the incremental contribution of routine Program activities to sociocultural systems would be a small portion of the cumulative impacts, although in the Arctic where some communities have very little development, the incremental contribution could be substantial.

4.5.16. Environmental Justice

Impacts to vulnerable communities occur when any activity or trend results in adverse health or environmental impacts that are significantly higher than that of the majority population, and so disproportionately affect minority and low-income populations. A large number of minority and low-income individuals reside in the shoreline counties of southwest Texas, southeast Louisiana, southern Mississippi, southwest Alabama, Georgia, South Carolina, southern North Carolina, southeast Virginia, and the North Slope of Alaska.

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 who may rely more heavily on coastal areas for subsistence.

The majority of Alaska's population resides adjacent to the Cook Inlet Program Area. Ongoing and future oil and gas development likely would continue to affect low-income and minority populations in the KPB by increasing the proximity to existing oil and gas infrastructure and associated health, environmental, and visibility impacts. Given these factors, cumulative impacts on minority and low-income populations for the Proposed Action are considered **minor** to **major**.

The Beaufort and Chukchi Planning Areas of Arctic Alaska are adjacent to several subsistence-based Native Villages. Subsistence harvests are a central part of the cultural heritage of these communities and are used for food and clothing as well as fuel and art (ADFG, 2015). Part of the culture of people in these communities is the remote environment in which they live. These villages have little development outside of their communities and rely on a tradition of kinship and sharing for survival. However, the coast adjacent to these planning areas has robust oil and gas activity onshore, and ongoing activity in state waters, in the Beaufort Sea. Given these factors, cumulative impacts on minority and low-income populations for the Proposed Action are considered **minor** to **major**.

The Gulf of Mexico region is still recovering from the adverse effects of several hurricanes over the past 15 years as well as the effects of the 2010 *Deepwater Horizon* oil spill. These events have had high and disproportionate effects on minority and low-income populations, especially in terms of property damage and loss of income. Ongoing and future oil and gas development would continue to affect low-income and minority populations in some counties of the Gulf of Mexico 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 in the coming decades. Given all these factors, cumulative impacts on minority and low-income populations for the Proposed Action are considered **minor** to **major**.

The Atlantic Program Areas currently have no major oil and gas-related service industry infrastructure and would have an 80.5-km (50-mi) buffer from any industry-related activities offshore for subsistence fishing. However, the onshore support activity has yet to be established and poses some risk of proximity to oil and gas infrastructure and associated health, environmental, and visibility impacts to historically marginalized communities. Given these factors, cumulative impacts on minority and low-income populations for the Proposed Action are considered **minor** to **major**.

Cumulative impacts to any historically marginalized communities in onshore areas associated with the Proposed Action, ongoing and future OCS oil and gas programs, as well as non-OCS oil and gas program activities, are expected to be incremental, with some offshore leases expiring and some being developed. **Minor** impacts from routine activities associated with the PP assumes proper representation and public participation for onshore activities. The overall impact to vulnerable communities associated with the Proposed Action adjacent to the Atlantic Program Areas and Chukchi and Beaufort Program Areas is expected to be **moderate** to **major** and assumes proper representation and public participation for onshore activities (which are outside of BOEM jurisdiction), due to the fact that there is presently little to no industry infrastructure currently existing onshore.

Overall, the incremental contribution of routine Program activities to environmental justice would be a small portion of the overall cumulative impact, although in the Arctic and the Atlantic, where there is very little to no industry infrastructure currently existing onshore, the incremental contribution could be substantial.

5. OTHER NEPA CONSIDERATIONS

NEPA regulations require an EIS to include discussions of "any adverse environmental effects which cannot be avoided should the Proposed Action be implemented, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented" (40 CFR § 1502.16). The U.S. Court of Appeals for the District of Columbia ruled that at the Program stage no irreversible and irretrievable commitment of resources is made that may adversely affect the environment (*Center for Biological Diversity* v. *Department of the Interior*, 385 563 F.3d 466 [D.C. Cir. 2009]; *Center for Sustainable Economy v. Jewell*, 779 F.3d 588 [D.C. Cir. 2015]). The following provides a general discussion of unavoidable, long-term, and lasting effects that could be realized if leasing, exploration, and development occur following approval of the Program.

5.1. Unavoidable Adverse Environmental Effects

Each of the geographic regions has unique characteristics that influence the resources present and the potential for unavoidable adverse effects. While numerous adverse effects to resources can be avoided or minimized by adherence to regulations, guidance, and conventions; use of best management practices and industry standards; and implementation of mitigation measures, some unavoidable adverse effects can be expected to remain regardless of avoiding, minimizing, rectifying, reducing, or eliminating the impact over time. The unavoidable adverse effects can vary in context, intensity, duration, and spatial extent across the three regions.

Physical Resources

Air Quality

- Air emissions could cause temporary changes in regional air quality, but air quality would not be permanently changed.
- Activities may increase the ambient air concentrations of criteria pollutants to some extent.
- Potential for visibility effects due to ozone formation from NO_x and VOC emissions.

Water Quality

- Routine and operational discharges from support facilities, vessels, and production structures would affect water quality.
- Sediment resuspension and turbidity from activities could degrade water quality temporarily in localized areas.
- Discharges would undergo mixing, dilution, and dispersion within large bodies of water, resulting in highly localized and temporary effects.

Acoustic Environment

- An increase in noise level within the Program Areas during operations (surveys, drilling, ship noise, etc.) in the survey areas, project locations, and vessel and helicopter routes may occur.

Ecological Resources

Coastal and Estuarine Habitats
- Localized sedimentation, accelerated erosion, and physical habitat alteration due to an increase in vessel traffic and possible onshore construction. Onshore activities could result in loss of wetlands or modification of the habitat, hydrology, and ecological function if not mitigated through CZMA and CWA permitting authorities.

Marine Benthic Communities
- Potential for unavoidable adverse effects to benthic communities would be to low-relief or small, isolated, unmapped live bottom habitat. Effects to soft bottom communities would result from structure placement and removal.
- Discharges may result in temporary alteration of the biological, physical, and chemical composition of sediments surrounding activity areas.

Pelagic Communities
- Sea surface pelagic communities (*Sargassum*) could experience unavoidable adverse effects such as impingement on vessel water intakes.
- Planktonic communities in the water column could experience unavoidable adverse, localized, short-term effects from routine discharges.

Marine Mammals
- Some marine mammals would be adversely affected by noise and disturbances associated with routine offshore and onshore activities in localized areas for short durations.
- Air traffic may result in minor to major impacts on marine mammals.
- Ship traffic may result in ship strikes of marine mammals, which may be expected to have minor to major impacts on marine mammal populations.
- Drilling debris may temporarily displace benthic feeders.

Sea Turtles
- Unavoidable adverse effects to sea turtles could occur from individuals being struck by vessels or as a result of decommissioning activities, resulting in injury or death. Noise may affect sea turtles in localized areas for short durations and would likely result in behavioral changes.

Marine and Coastal Birds
- 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 available habitat.

Fishes and Essential Fish Habitat (EFH)
- Unavoidable adverse impacts to fish and EFH could occur from noise in localized areas for short durations and would likely result in behavioral changes. Decommissioning via explosives would cause fatal impacts to fish in direct proximity to the activity.

Areas of Special Concern
- Unavoidable adverse effects from routine operations to most Areas of Special Concern would be avoided and minimized since activities may be prohibited or limited in these areas.

Social, Cultural, and Economic Resources

Archaeological and Historic Resources

- Unavoidable adverse effects from routine operations to archaeological resources would be avoided and minimized with existing regulations; however, there is always a risk of impact to archaeological resources where surveys are not required, inadequate, or unavailable.

Population, Employment, and Income

- Unavoidable adverse effects from routine operations to population, employment, and income are unlikely to occur except in sparsely populated communities near frontier areas and only as a result of sustained high levels of industry activity.

Land Use and Infrastructure

- Unavoidable adverse effects from routine activities onshore from creation or expansion of infrastructure could occur, increasing demands on coastal communities in areas where oil and gas activities are not currently occurring. Long-term changes may include a shift in land use during the life of the Program.

Commercial and Recreational Fisheries

- 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.

Tourism and Recreation

- Unavoidable adverse effects on scenic quality from visible infrastructure in some areas with infrastructure close to shore.

Sociocultural Systems

- Some unavoidable adverse effects on subsistence harvests in the Alaska Program Areas may result from routine activities, potentially causing localized displacement or loss of small numbers of subsistence resources, which could adversely affect subsistence.

Environmental Justice

- Unavoidable adverse effects from routine activities onshore from creation or expansion of infrastructure could occur, increasing demands on low-income or minority populations (i.e., environmental justice) in areas where oil and gas activities are new or expansion is required. Unavoidable adverse effects could occur from routine activities nearshore and offshore affecting fish and marine mammals used by subsistence communities.

5.2. RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

By adopting mitigation 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 exploration and development occurs. After the completion of oil and gas production, the marine environment that may be affected by routine operations is expected to remain at or return to its anticipated long-term productivity levels. With proper removal of offshore oil and gas facilities or their retention in areas designed to enhance recreational fishing, offshore areas will continue to maintain fish resources and provide habitat for marine resources long after oil and gas operations have ceased. The long-term productivity of the marine environment in Gulf of Mexico, Atlantic, 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 may be in 40 to 50 years when the Program activities would be complete. The onshore effects 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, baseline environmental conditions are changing as a consequence of climate change. For example, relative sea level rise; ocean acidification; ocean heat content; the intensity, return interval, duration, and extent of storm events; changes in albedo (reflectivity); and distribution and abundance of precipitation are expected to occur regardless of offshore oil and gas activity (see IPCC [2014] for full synopsis).

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 Program, which is estimated to be 40 to 50 years, with 10 to 15 years for oil and gas exploration and delineation activity and 30 to 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 biological 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 provide short-term energy sources, reducing the U.S. dependency on oil imports. The production of offshore oil and natural gas for the Program would perhaps provide additional time for the development of long-term alternative energy sources or substitutes for these nonrenewable resources.

Several natural resources may incur long-term effects to biological productivity, whether due to Program-related events or not (e.g., CDEs such as the Gulf of Mexico *Deepwater Horizon* spill in 2010 or the Alaska *Exxon Valdez* spill in 1989). Studies on the effects of the *Exxon Valdez* spill on biota and habitats in Prince William Sound show some resources have recovered while others still present possible spill effects and yet others have no clear indication of the presence or absence of long-term effects (see discussions for each resource in **Chapter 4**). Studies from the Gulf of Mexico Research Initiative and other funding sources on the effects of the *Deepwater Horizon* spill that could generate three petabytes of data are ongoing. Findings indicate that effects were spatially and temporally limited and do not demonstrate a long-term impact to populations. Changes in productivity are not expected. However, it may still be too early to ascertain the long-term effects. **Appendix C** includes information relative to select resources in the Gulf of Mexico Region pertaining to the *Deepwater Horizon* event. Long-term impacts of large oil spills to local economies and sociocultural systems may also be expected.

Onshore facility construction (e.g., pipelines, processing facilities, service bases), most likely in the Atlantic and Alaska Regions, causes short- and long-term changes, with possible localized long-term effects on coastal habitats. Some biological resources may have difficulty repopulating altered habitats and could be permanently displaced from the 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 areas could be mitigated with habitat reclamation. 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 could disrupt coastal communities in the short term in the Atlantic and Alaska regions; however, in the Gulf of Mexico no difference from existing conditions would occur. In Alaska, there could be an incentive to shift from a subsistence-based economy to a cash-based economy or a possible reduction in subsistence resources and a decrease in subsistence activities, all of which 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 may have long-term consequences to affected communities and populations in all regions.

Archaeological and historic finds discovered during development would enhance long-term knowledge. Overall, finds may help to locate other sites, but possible destruction of artifacts or damage to sites would represent long-term losses.

5.3. Irreversible and Irretrievable Commitments of Resources

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. At the Program stage, no irreversible and irretrievable commitment of resources is made that may adversely affect the environment. The irreversible and irretrievable commitment of resources would only occur if leasing, exploration, and development follow approval of the Program. The following discussions consider these effects within the context of irreversible and irretrievable commitment of mineral, biological, land, and archaeological resources.

5.3.1. Mineral Resources

Future exploration, development, and production activities resulting from Program-associated lease sales would result in the consumption of hydrocarbons (i.e., fuel), minerals (e.g., coal, iron), and other materials. Decommissioning activities may result in the recycling and repurposing of infrastructure (e.g., platforms, subsea completions, pipelines). Consumption rates would be commensurate with respective levels of activity. Fuel consumption resulting from Program-associated activities represents an irreversible and irretrievable commitment of hydrocarbon resources (i.e., any offshore oil and gas resources consumed would be irretrievable).

5.3.2. Biological Resources

Future exploration, development, production, and decommissioning activities resulting from Program-associated lease sales would result in minor to moderate effects on biological resources. For most biological resources, population-level effects resulting in irreversible and irretrievable commitment of those resources are not expected. Direct habitat loss or displacement may occur as a result of offshore or onshore exploration and development activities, producing reductions in local populations. Displacement and habitat loss may become irretrievable if alterations to the environment are permanent. Application of mitigation measures (e.g., sensitive habitat identification and avoidance, habitat restoration) should limit the amount of habitat permanently lost.

If one or more individuals of a listed species (i.e., ESA, MMPA) is injured or killed, or if important habitats utilized by these species are disturbed, an irretrievable and irreversible commitment of biological resources may be incurred. Consultation and coordination (e.g., with the USFWS or NOAA) prior to oil and gas exploration and development activities is expected to result in the identification of appropriate mitigation measures. Implementation of applicable mitigation measures would reduce the potential for an irreversible and irretrievable commitment of these biological resources.

5.3.3. Land Resources

Future exploration, development, production, and decommissioning activities resulting from Program-associated lease sales would result in minor effects on land resources. In mature oil and gas areas (e.g., the Gulf of Mexico), only limited expansion of onshore activity and associated land use is expected, with reliance on existing infrastructure most likely. In frontier or developing areas (e.g., Atlantic, Cook Inlet, Arctic), additional land disturbance may occur.

5.3.4. Archaeological Resources

Future exploration, development, production, and decommissioning activities resulting from Program-associated lease sales would result in minor effects on archaeological resources. Damage and subsequent loss of known or unknown archaeological sites and cultural materials may occur though indiscriminate or accidental activity. Implementation of appropriate mitigation and protective measures should avoid the vast majority of losses.

6. CONSULTATION AND COORDINATION

6.1. PROCESS FOR THE PREPARATION OF THE 2017-2022 OCS OIL AND GAS LEASING PROGRAMMATIC EIS

6.1.1. Draft Proposed Program and Draft Programmatic EIS

This Programmatic EIS has been prepared to help inform the Secretary of the Interior's decision on the Proposed Program (**Figure 6.1-1**).

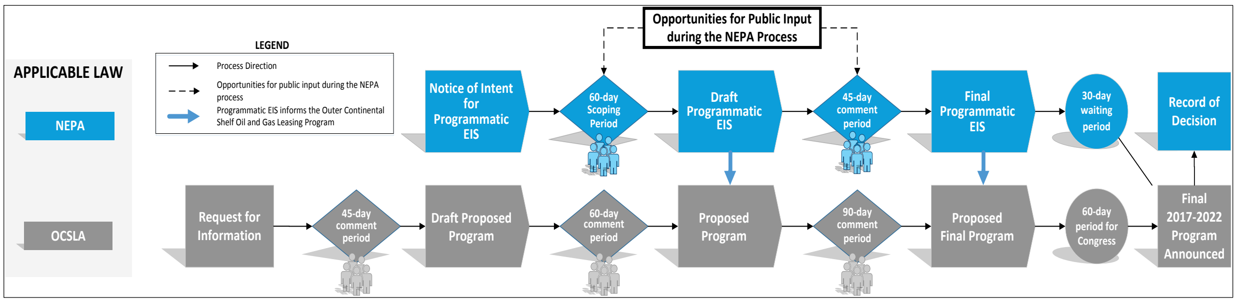


Figure 6.1-1. Relationship Between the Proposed Program and the Programmatic EIS.

6.1.2. Scoping for the Draft Programmatic EIS

Scoping activities occurred over a 60-day scoping period during January through March 2015 to solicit input from the stakeholders. BOEM posted a Scoping Report summarizing scoping comments online at boemoceaninfo.com in June 2015.

BOEM is required, per 43 CFR § 46.225, to invite eligible government entities to participate as cooperating agencies during the development of an EIS. As defined by CEQ regulations (40 CFR § 1508.5), a cooperating agency may be any federal agency that has jurisdiction by law or special expertise with respect to environmental impacts resulting from a proposed activity. The NOI, published on January 29, 2015, issued an invitation to other federal agencies as well as state, tribal, and local governments to consider becoming cooperating agencies in the preparation of the Programmatic EIS. From that invitation, BOEM established cooperating agency status via formalized Memoranda of Understanding (MOUs). MOUs, which allow cooperating agencies to coordinate and collaborate during preparation of this Programmatic EIS, were established with the NASA Office of Strategic Infrastructure, the NPS Southeast Region, and the state of Alaska. These MOUs are included as supplemental information available on the project website (boemoceaninfo.com). In addition, NOAA provided informal cooperation with the preparation of this Programmatic EIS by providing geographic information systems (GIS) data that were used to help create figures and perform analyses included in this Programmatic EIS.

Information provided by the cooperating agencies may be found within this Programmatic EIS as follows:

- NASA information is included in **Section 3.6.3.2.4.2** and **Appendix C**;
- NPS information is included in **Appendix C**; and
- State of Alaska data are included in **Appendix C**.

6.1.3. Commenting on the Proposed Program and Draft Programmatic EIS

BOEM will hold public meetings to solicit comments on the Draft Programmatic EIS; the meetings are an additional avenue to submit comments during the comment period. The meetings will provide the Secretary of the Interior with information from interested parties to help in the evaluation of potential effects of the Proposed Action and with development of Alternatives. People are encouraged to provide comments through boemoceaninfo.com and www.regulations.gov. Based on the consideration and analysis of comments on the Draft Programmatic EIS, a Final Programmatic EIS will be prepared.

Public meetings are scheduled to be held in applicable Program Areas; an announcement of the dates, times, and specific locations of the public meetings will be included in the NOA for this Draft Programmatic EIS and are also available on boemoceaninfo.com.

6.2. Distribution of the Draft Programmatic EIS

As part of the notification of the comment period on the Draft Programmatic EIS, BOEM has:

- Published an NOA for the Draft Programmatic EIS in the *Federal Register*, announcing a 45-day comment period. All comments received during the comment period will be included as part of the Programmatic EIS Administrative Record and considered during preparation of the Final Programmatic EIS;
- Provided notification of availability of the Draft Programmatic EIS and how to comment to groups and agencies that participated in scoping, as identified in list below;
- Emailed a group notification concerning the availability of the Draft Programmatic EIS and how to comment to all individuals who had provided their email address to BOEM during scoping or had requested to be on such a mailing list;
- Placed multiple notices in print and online newspapers that serve local media markets in potentially affected areas, announcing availability of the Draft Programmatic EIS, all public meeting locations and times, and how to comment on the Draft Programmatic EIS;
- Posted the Draft Programmatic EIS on the project website and updated website information to notify the public about meetings and methods to comment (boemoceaninfo.com); and
- Mailed official letters to the Governor's Offices and Tribes (and coordinated meetings) of all states adjacent to the proposed Program Areas that may have an interest in providing input on the proposed leasing activities, in accordance with BOEM's policy of consultation and coordination with state, local, and tribal governments.
- Coordinated meetings with Alaska Native Village corporations and Alaska Native Villages adjacent to the Alaska proposed Program Areas that may have an interest in providing input on proposed leasing activities, in accordance with USDOI policy on Alaska Native Claims Settlement Act (ANCSA)-to-Government and Government-to-Government consultation.

The BOEM Office of Public Affairs (BOEM OPA) maintains a robust database of more than 8,400 media and stakeholder contacts segmented into 247 individual lists targeted to specific interests. The BOEM OPA will send out notification about availability of the Draft Programmatic EIS to appropriate contacts on those lists. These contacts are routinely made aware of announcements, events, and services provided by BOEM. Contacts are added to the database according to requests and involvement in the issue being addressed. The lists are organized based on location (state or region), bureau program, interest, and specific events. The development of the Five-Year Program and the Draft Programmatic EIS is of great interest to virtually all individuals in the BOEM OPA's databases.

List of Agencies and Groups that were notified of the Draft Programmatic EIS availability.

Government Agencies	
Alaska Chamber	North Slope Borough
Alaska Governor	Office of Rep. Frank Pallone, Jr.
Alaska Senator John Coghill, Senate Majority Leader	Office of the Governor, North Carolina
Beaufort County, South Carolina	Outer Banks Chamber of Commerce
Board of Commissioners, Borough of Monmouth Beach	Outer Banks Visitors Bureau
Cape May County, New Jersey, Chamber of Commerce	Outer Continental Shelf Governors Coalition
City of Beaufort, South Carolina	Sandbridge Beach Civic League
City of Charleston, South Carolina	South Carolina Department of Natural Resources
City of Georgetown, South Carolina	St. Johns County, Florida
City of Nags Head, North Carolina	St. Johns County Commission
City of Tybee Island, Georgia	State of Georgia House of Representatives
Clay County, Florida, Chamber of Commerce	State of South Carolina
Dare County, North Carolina, Board of Commissioners	State Representative District 46, North Carolina
Dare County, North Carolina, Tourism Board	The Senate of South Carolina
Delaware Coastal Management Program	Town of Beaufort, North Carolina
Georgia Department of Natural Resources Nongame Section	Town of Duck, North Carolina
Idaho State Senate, Energy Producing States Coalition	Town of Hilton Head, South Carolina
Kentucky House of Representative	Town of Kill Devil Hills, North Carolina
Marine Mammal Commission	Town of Kitty Hawk, North Carolina
Maryland Coastal Bays Program	Town of Manteo, North Carolina
Maryland Department of Natural Resources	Town of Nags Head, North Carolina
Mayor, Town of Sullivan's Island	Town of Sunset Beach, North Carolina, Town Council
Mid-Atlantic Fishery Management Council	Tybee Island, Georgia, City Council
National Park Service	Virginia DCR, Division of Natural Heritage
New Jersey Department of Environmental Protection	Virginia DEQ, Division of Environmental Enhancement
North Carolina House of Representatives	Wrightsville Beach, North Carolina, Chamber of Commerce
Industry	
Alaska Frontier Constructors	Louisiana Oil Marketers & Convenience Store Association
Alaska Trucking Association	North American Submarine Cable Association
American Chemistry Council	North Carolina Farm Bureau Federation
American Iron and Steel Institute	Northern Gas Pipelines
American Trucking Associations	OffshoreAlabama.com
Associated Industries of Florida	Partnership for Affordable Clean Energy
Axistrade, Inc.	Perennial Environmental Services
Center for Regulatory Effectiveness	Ports Association of Louisiana
ConocoPhillips	Resource Development Council
Consumer Energy Alliance	Rock Acres Consulting
Consumer Energy Alliance-Texas	Shell
Dominion Resources	Solid Rock Engineering
Hawk Consultants	Tennessee Oil and Gas Association
Kentucky Oil and Gas Association	Texas Association of Business
LA 1 Coalition	Texas Association of Manufacturers
Louisiana Oil & Gas Association	W.D. Scott Group, Inc.

Nongovernmental Organizations	
Alaska Libertarian Party	One Hundred Miles
Alaska Wilderness League	Our Children's Trust
Altamaha Riverkeeper	Outer Banks Center for Dolphin Research
American Littoral Society	Outer Banks Surfrider Chapter
Assateague Coastal Trust	Sandy Hook Sealife Foundation
Audubon, Oceana, Ocean Conservancy, PEW, WWF	Save Our Rivers, Inc.
Audubon North Carolina	Sierra Club
Bald Head Island Conservancy	Sierra Club Ocean County
Center for a Sustainable Coast	South Carolina Wildlife Federation
Center for Biological Diversity	Southern Environmental Law Center
Clean Water for North Carolina	St. Marys EarthKeepers
Friends of Hunting Island State Park, Inc.	Surfrider Foundation
Georgia Climate Change Coalition	Surfrider Foundation- Florida Chapters
LegaSea OBX	Surfrider Foundation- Sebastian Inlet Chapter
Marine Conservation Institute	Surfrider Outerbanks
Matanzas Riverkeeper/Friends of Matanzas	The Dolphin Project
Natural Resources Defense Council	The Nature Conservancy
New Progressive Alliance	The Ocean Foundation
NO to Off Shore Oil Drilling in North Carolina's waters!	The Wilderness Society
North Carolina Coastal Federation	Virginia Chapter of the Sierra Club
NotTheAnswerNC	Waterkeepers Chesapeake
NY4Whales	Winyah Group
Ocean Conservation Research	Winyah Rivers Foundation
Oceana, Inc.	World Wildlife Fund
Ogeechee Audubon Society	
Federally Recognized Indian Tribes	
Atlantic Program Area	
Alabama-Quassarte Tribal Town	Mashantucket Pequot Tribe of Connecticut
Absentee Shawnee Tribe of Oklahoma	Mashpee Wampanoag Tribe
Apache Tribe	Miami Tribe of Oklahoma
Aroostook Band of Micmacs	Miccosukee Tribe
Caddo Nation of Oklahoma	Modoc Tribe of Oklahoma
Catawba Indian Nation	Mohegan Indian Tribe of Connecticut
Cayuga Nation	Muscogee (Creek) Nation
Cherokee Nation	Narragansett Indian Tribe
Cherokee Nation	Oneida Nation of New York
Cheyenne-Arapaho Tribes	Onondaga Nation
Chickasaw Nation	Osage Tribe
Choctaw Nation of Oklahoma	Otoe-Missouria Tribe of Indians
Citizen Potawatomi Nation	Ottawa Tribe of Oklahoma
Comanche Nation	Pamunkey Indian Tribe
Delaware Nation	Passamaquoddy Tribe - Indian Township
Delaware Tribe of Indians	Passamaquoddy Tribe - Pleasant Point
Eastern Band of Cherokee Indians	Pawnee Nation of Oklahoma
Eastern Shawnee Tribe of Oklahoma	Penobscot Nation
Fort Sill Apache Tribe of Oklahoma	Peoria Tribe of Indians of Oklahoma
Houlton Band of Maliseet Indians	Ponca Tribe of Indians of Oklahoma
Iowa Tribe of Oklahoma	Quapaw Tribe of Indians
Kaw Nation	Sac & Fox Nation
Kialegee Tribal Town	Saint Regis Mohawk Tribe
Kickapoo Tribe of Oklahoma	Seminole Nation of Oklahoma
Kiowa Indian Tribe of Oklahoma	Seminole Tribe of Florida

Atlantic Program Area (continued)	
Seneca Nation of New York	Tonawanda Band of Seneca Indians
Seneca-Cayuga Tribe of Oklahoma	Tonkawa Tribe of Indians of Oklahoma
Shawnee Tribe	Tuscarora Nation
Shinnecock Indian Nation	United Keetoowah Band of Cherokee Indians
Shinnecock Indian Nation	Wampanoag Tribe of Gay Head (Aquinnah)
Stockbridge-Munsee Community of Mohican Indians	Wichita and Affiliated Tribes (Wichita, Keechi, Waco and Tawakonie)
Thlopthlocco Tribal Town	Wyandotte Nation
Gulf of Mexico Program Area	
Alabama Coushatta Tribe of Texas	Mississippi Band of Choctaw Indians
Chitimacha Tribe	Poarch Band of Creek Indians
Chitimacha Tribe of Louisiana	Texas Band Kickapoo Tribal Council
Coushatta Tribe	Tunica-Biloxi Indian Tribe
Jena Band of Choctaw	Ysleta de Sur Pueblo
Beaufort Sea Program Area	*Cook Inlet Program Area*
Iñupiat Native Village of Kaktovik	Native Village of Nanwalek
Iñupiat Native Village of Nuiqsut	Ninilchik Village Tribe
Chukchi Sea Program Area	The Eklutna Native Village
Iñupiat Native Village of Barrow	The Kenaitze Indian Tribe
Iñupiat Native Village of Point Hope	The Native Village of Port Graham
Iñupiat Native Village of Point Lay	The Native Village of Tyonek
Iñupiat Native Village of Wainwright	The Seldovia Village
	The Village of Salamatof