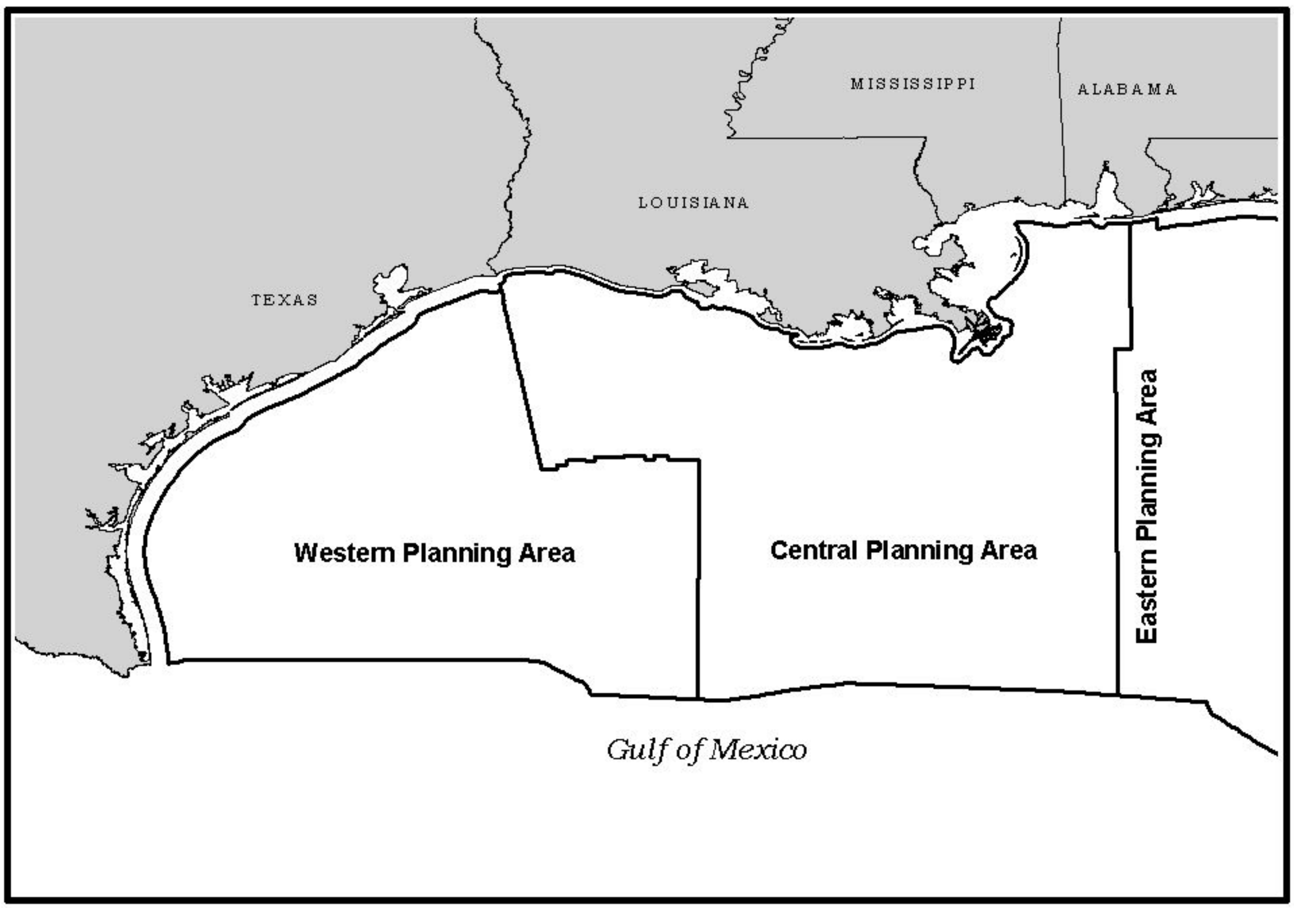
OCS EIS/EA
MMS 2002-052

Gulf of Mexico OCS Oil and Gas Lease Sales: 2003-2007

Central Planning Area Sales 185, 190, 194, 198, and 201
Western Planning Area Sales 187, 192, 196, and 200

Final Environmental Impact Statement

Volume I: Chapters 1-10



U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

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REGIONAL DIRECTOR'S NOTE

In the *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007,* five annual areawide lease sales are scheduled for the Central Planning Area and five annual areawide lease sales are scheduled for the Western Planning Area. This environmental impact statement (EIS) addresses nine of these proposed Federal actions; a separate environmental analysis was prepared for the first proposed lease sale. Federal regulations allow for several related or similar proposals to be analyzed in one EIS (40 CFR 1502.4). Since each lease sale proposal and projected activities are very similar each year for each planning area, the Minerals Management Service (MMS) has prepared a single EIS for the nine Central and Western Gulf sales. An additional environmental analysis will be prepared for each proposed action after the initial one in each planning area. By eliminating essentially duplicate EIS's, MMS will be able focus the subsequent environmental reviews on new and changing issues.

The Gulf of Mexico Outer Continental Shelf (OCS) Region of MMS has been conducting environmental analyses of the effects of OCS oil and gas development since the inception of the National Environmental Policy Act (NEPA) of 1969. We have prepared and published more than 40 draft and final EIS's. Our goal has always been to provide factual, reliable, and clear analytical statements in order to inform decisionmakers and the public about the environmental effects of proposed OCS activities and their alternatives. We view the EIS process as providing a balanced forum for early identification, avoidance, and resolution of potential conflicts. It is in this spirit that we welcome comments on this document from all concerned parties.

Chris C. Oynes

Chris C. Oynes
Regional Director
Minerals Management Service
Gulf of Mexico OCS Region

COVER SHEET

Environmental Impact Statement for Proposed Central Gulf of Mexico OCS Oil and Gas Lease Sales 185, 190, 194, 198, and 201, and Proposed Western Gulf of Mexico OCS Oil and Gas Lease Sales 187, 192, 196, and 200

	Draft ( )	**Final (x)**
Type of Action:	Administrative (x)	Legislative ( )

Area of Potential Impact: Offshore Marine Environment and Coastal Counties/Parishes of Texas, Louisiana, Mississippi, Alabama, and northwestern Florida

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ABSTRACT

This Final Environmental Impact Statement (EIS) covers the proposed 2003-2007 Central and Western Gulf of Mexico OCS oil and gas lease sales. The proposed Central Gulf of Mexico lease sales are Sale 185 in 2003, Sale 190 in 2004, Sale 194 in 2005, Sale 198 in 2006, and Sale 201 in 2007; the proposed Western Gulf of Mexico lease sales are Sale 187 in 2003, Sale 192 in 2004, Sale 196 in 2005, and Sale 200 in 2007. The proposed actions are major Federal actions requiring an EIS. This document provides the following information in accordance with NEPA and its implementing regulations, and it will be used in making decisions on the proposal. This document includes the purpose and background of the proposed actions, identification of the alternatives, description of the affected environment, and an analysis of the potential environmental impacts of the proposed actions, alternatives, and associated activities, including proposed mitigating measures and their potential effects. Potential contributions to cumulative impacts resulting from activities associated with the proposed actions are also analyzed.

Hypothetical scenarios were developed on the levels of activities, accidental events (such as oil spills), and potential impacts that might result if a proposed action is adopted. Activities and disturbances associated with a proposed action on biological, physical, and socioeconomic resources are considered in the analyses.

Additional copies of this EIS and the referenced MMS publications and visuals may be obtained from the MMS, Gulf of Mexico OCS Region, Public Information Office (MS 5034), 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123-2394, or by telephone at 504-736-2519 or 1-800-200-GULF.

SUMMARY

This environmental impact statement (EIS) addresses nine proposed Federal actions that offer for lease areas on the Gulf of Mexico Outer Continental Shelf (OCS) that may contain economically recoverable oil and gas resources. Under the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007* (the proposed 5-Year Program), five annual areawide lease sales are scheduled for the Central Planning Area (CPA) and five annual areawide lease sales are scheduled for the Western Planning Area (WPA). The first proposed lease sale – Western Gulf Sale 184 – is not addressed in this multisale EIS; a separate environmental analysis was done for Sale 184. The Central Gulf sales addressed in this EIS are Sale 185 in 2003, Sale 190 in 2004, Sale 194 in 2005, Sale 198 in 2006, and Sale 201 in 2007. The Western Gulf sales are Sale 187 in 2003, Sale 192 in 2004, Sale 196 in 2005, and Sale 200 in 2006. Federal regulations allow for several related or similar proposals to be analyzed in one EIS (40 CFR 1502.4). Since each lease sale proposal and projected activities are very similar each year for each planning area, a single EIS is being prepared for the nine Central and Western Gulf sales. At the completion of this EIS process, decisions will be made only for proposed Sale 185 in the CPA and proposed Sale 187 in the WPA. A National Environmental Policy Act (NEPA) review will be conducted before each subsequent lease sale.

Proposed Actions and Alternatives

Alternatives for Proposed Central Gulf Sales 185, 190, 194, 198, and 201

Alternative A – The Proposed Action(s): This alternative would offer for lease all unleased blocks within the CPA for oil and gas operations (Figure 2-1), with the following exceptions: Lund South (Area NG16-07) Blocks 172, 173, 213-217, 252-261, 296-305, and 349; Amery Terrace (Area NG15-09) Blocks 280, 281, 318-320, and 355-359; and portions of Amery Terrace (Area NG15-09) Blocks 235-238, 273-279, and 309-359 are deferred from the proposed actions under the "Treaty Between The Government of the United States of America And The Government Of The United Mexican States on the Delimitation Of The Continental Shelf In the Western Gulf of Mexico Beyond 200 Nautical Miles," which took effect in January 2001. The CPA encompasses about 47.8 million acres (ac) located from 4.8 to 354 km (3 to 220 mi) offshore in water depths ranging from 4 to more than 3,400 m (13 to more than 11,000 ft). No unleased areas are excluded from the CPA. The estimated amount of resources projected to be developed as a result of any one proposed CPA lease sale is 0.276-0.654 billion barrels of oil (BBO) and 1.590-3.300 trillion cubic feet (tcf) of gas.

Alternative B – The Proposed Action(s) Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features: This alternative would offer for lease all unleased blocks in the CPA, as described for the proposed action(s), with the exception of any unleased blocks within the 167 blocks subject to the Topographic Features Stipulation.

Alternative C – The Proposed Action(s) Excluding the Unleased Blocks within 15 Miles of the Baldwin County, Alabama, Coast: This alternative would offer for lease all unleased blocks in the CPA, with the exception of any unleased blocks within 15 mi of the Baldwin County, Alabama, coast.

Alternative D – No Action: This alternative is equivalent to cancellation of one or more proposed CPA lease sales scheduled in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007.* The opportunity for development of the estimated oil and gas resources that could have resulted from any proposed action(s) would be precluded or postponed, and any potential environmental impacts resulting from the proposed action(s) would not occur or would be postponed.

Alternatives for Proposed Western Gulf Sales 187, 192, 196, and 200

Alternative A – The Proposed Action(s): This alternative would offer for lease all unleased blocks within the WPA for oil and gas operations (Figure 2-1), with the following exceptions: High Island Area East Addition, South Extension, Blocks A-375 and A-398 and portions of other blocks within the Flower Garden Banks National Marine Sanctuary are excluded from leasing; Mustang Island Area Blocks 793, 799, and 816 have been identified by the Navy as needed for testing equipment and for training mine warfare personnel and have been removed from the proposed actions; and Sigsbee Escarpment (Area

NG15-08) Blocks 11, 57, 103, 148, 149, 194, 239, 284, and 331-341, and portions of Sigsbee Escarpment (Area NG15-08) Blocks 12-14, 58-60, 104-106, 150, 151, 195, 196, 240, 241, 285-298, and 342-349 and Keathley Canyon (Area NG15-05) Blocks 978-980 are deferred from the proposed actions under the "Treaty Between The Government of the United States of America And The Government Of The United Mexican States on the Delimitation Of The Continental Shelf In the Western Gulf of Mexico Beyond 200 Nautical Miles," which took effect in January 2001. The WPA encompasses about 28.4 million ac located from 14 to 357 km (9 to 220 mi) offshore in water depths ranging from 8 to more than 3,000 m (26 to more than 9,000 ft). The estimated amount of resources projected to be developed as a result of any one proposed WPA lease sale is 0.136-0.262 BBO and 0.810-1.440 tcf of gas.

Alternative B – The Proposed Action(s) Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features: This alternative would offer for lease all unleased blocks in the WPA, as described for the proposed action(s), with the exception of any unleased blocks within the 200 blocks subject to the Topographic Features Stipulation.

Alternative C – No Action: This alternative is equivalent to cancellation of one or more proposed WPA lease sales scheduled in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007*. The opportunity for development of the estimated oil and gas resources that could have resulted from any proposed action(s) would be precluded or postponed, and any potential environmental impacts resulting from the proposed action(s) would not occur or would be postponed.

Mitigating Measures

All of the proposed actions include existing regulations and proposed lease stipulations designed to reduce environmental risks. Five lease stipulations are included as part of each of the proposed actions in the CPA: the Live Bottom (Pinnacle Trend) Stipulation; the Topographic Features Stipulation; the Military Areas Stipulation; the Blocks South of Baldwin County, Alabama, Stipulation; and the Law of the Sea Convention Royalty Payment Stipulation. Four lease stipulations are included as part of each of the proposed actions in the WPA: the Topographic Features Stipulation; the Military Areas Stipulation; the Naval Mine Warfare Area Stipulation; and the Law of the Sea Convention Royalty Payment Stipulation. The Live Bottom (Pinnacle Trend) Stipulation requires detection and avoidance of sensitive pinnacle features. The Topographic Features Stipulations establish "No Activity Zones" around 16 banks in the CPA and 23 banks in the WPA. The military stipulations are intended to reduce potential multiple-use conflicts between OCS operations and Department of Defense activities. The Blocks South of Baldwin County, Alabama, Stipulation reduces visual impacts from development operations. The Law of the Sea Convention Royalty Payment Stipulation applies to blocks or portions of blocks beyond the United States (U.S.) Exclusive Economic Zone (EEZ) (generally greater than 200 nautical miles (nmi) from the U.S. coastline). Leases on these blocks may be subject to special royalty payments under the provisions of the 1982 Law of the Sea Convention, if the U.S. becomes a party to the Convention prior to or during the life of the lease.

Application of these stipulations will be considered by the Assistant Secretary of the Interior for Land and Minerals (ASLM). The analysis of the stipulations as part of the proposed actions does not ensure that the ASLM will make a decision to apply the stipulations to leases that may result from any proposed lease sale, nor does it preclude minor modifications in wording during subsequent steps in the prelease process if comments indicate changes are necessary or if conditions change. Any stipulations or mitigation requirements to be included in a lease sale will be described in the Record of Decision and Final Notice of Sale for that lease sale. Mitigation measures in the form of lease stipulations are added to the lease terms and are therefore enforceable as part of the lease.

Scenarios Analyzed

The proposed CPA and WPA actions analyzed are expected to be "typical" of any of the Central and Western Gulf sales, respectively, held during 2003-2007. The proposed action and OCS Program scenarios analyzed in the EIS are based on projections of the activities needed to support the exploitation of the oil and gas resources on leases resulting from a sale. The scenarios are presented as ranges of the amounts of undiscovered, unleased hydrocarbon resources estimated to be leased and discovered as a result of a proposed action. The analyses are based on an assumed range of activities that would be needed to develop and produce the amount of resources estimated to be leased. These activities include the number of platforms, wells, pipelines, and service-vessel trips.

The cumulative analysis considers environmental impacts that result from the incremental impact of the lease sales when added to all past, present, and reasonably foreseeable future human activities, including non-OCS activities such as import tankering and commercial fishing, as well as all OCS activities.

Significant Issues

The major issues that frame the environmental analyses in this EIS are the result of concerns raised during years of scoping for Gulf of Mexico OCS lease sale EIS's. Issues related to OCS exploration, development, production, and transportation activities include oil spills, wetlands loss, air emissions, discharges, water quality degradation, trash and debris, structure and pipeline emplacement activities, platform removal, vessel and helicopter traffic, multiple-use conflicts, support services, population fluctuations, demands on public services, land-use planning, tourism, aesthetic interference, cultural impacts, environmental justice, and consistency with State coastal zone management programs. Environmental resources and activities determined through the scoping process to warrant an environmental analysis are sensitive coastal environments, sensitive offshore resources, water and air quality, marine mammals, sea turtles, coastal and marine birds, commercial fisheries, recreational resources and activities, archaeological resources, and socioeconomic conditions.

Impact Conclusions

A summary of the potential impacts on each environmental resource and the conclusions of the analyses can be found in Chapters 2.3.1 and 2.4.1. The full analyses are presented in Chapters 4.2 (impacts of routine activities from a proposed action in the CPA), 4.3 (impacts of routine activities from a proposed action in the WPA), and 4.4 (impacts from accidental events). An analysis of cumulative impacts is provided in Chapter 4.5. Below is a general summary of the potential impacts resulting from typical proposed actions.

Impacts on Sensitive Coastal Resources

No significant impacts to the physical shape and structure of barrier beaches and associated dunes are expected to occur as a result of a proposed action in the CPA or WPA. Should a spill contact a barrier beach, sand removal during cleanup activities is expected to be minimized.

Adverse initial impacts and more importantly secondary impacts of pipeline and navigation canals are considered the most significant proposed-action-related impacts to wetlands. Although initial impacts are considered locally significant and are largely limited to where OCS-related canals and channels pass through wetlands, secondary impacts may have substantial, progressive, and cumulative adverse impacts to the hydrologic basin or subbasin in which they are found. Offshore oil spills resulting from a proposed action are not expected to significantly damage inland wetlands. The greatest threat to wetland habitat is from an inland spill from a vessel accident or pipeline rupture. While a resulting slick may cause minor impacts to wetland habitat, equipment and personnel used to clean up a slick over the impacted area may generate the greatest direct impacts to the area.

Normal OCS activities are expected to have little adverse impact on seagrass communities. Impacts from pipeline installation activities are expected to be very small and short-term. Inshore spills from vessel collisions or pipeline ruptures pose the greatest potential threat to seagrass communities.

No significant impacts to listed beach mice are expected to occur as a result of a proposed action in the CPA or WPA. Adverse impacts to Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice in the CPA are unlikely. Impacts may result from consumption of beach trash and debris. No direct impacts from oil spill are expected. Protective measures required under the Endangered Species Act should prevent any oil-spill response and cleanup activities from having significant impact to the beach mice and their habitat.

Adverse impacts on endangered/threatened and nonendangered/nonthreatened coastal and marine birds are expected to be sublethal. These effects include behavior changes, eating OCS-related contaminants or discarded debris, and displacement of localized groups from optimal habitats. Chronic sublethal stress, however, is often undetectable in birds. As a result of stress, individuals may weaken and be prone to infection or disease, have reduced reproductive success, or have disturbed migration patterns. Oil spills pose the greatest potential direct and indirect impacts to coastal and marine birds. If physical oiling of individuals or local groups of birds occurs, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected. Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration. Reproductive success can be affected by the toxins in oil. Indirect effects occur by fouling of nesting habitat, and displacement of individuals, breeding pairs, or populations to less favorable habitats. Dispersants used in spill cleanup activity can have toxic effects similar to oil on the reproductive success of coastal and marine birds. The air, vehicle, and foot traffic that takes place during shoreline cleanup activity can disturb nesting populations and degrade or destroy habitat.

Routine activities resulting from a proposed action in the CPA are expected to have little impacts on Gulf sturgeon. Impacts on Gulf sturgeon may occur from resuspended sediments and OCS-related discharges. Contact with spilled oil could cause irritation of gill epithelium and disturbance of liver function in Gulf sturgeon.

Impacts to coastal water quality from a proposed action in the CPA or WPA are expected to be minimal. The primary impacting sources to water quality in coastal waters are point-source and nonpoint-source discharges from OCS support facilities and support-vessel discharges.

Emissions of pollutants into the atmosphere from the activities associated with a proposed action are not projected to have significant impacts on onshore air quality. Emissions from OCS activity are not expected to have concentrations that would change onshore air-quality classifications. Increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than the maximum increases allowed in the PSD Class II areas or the PSD Class I area.

The impact from a proposed action in the CPA or WPA on Gulf Coast recreational beaches is expected to be minimal. A proposed action may result in an incremental increase in noise from helicopter and vessel traffic, nearshore operations that may adversely affect the enjoyment of some Gulf Coast beach uses, and some increases in beached debris; these impacts are expected to have little effect on the number of beach users. Impacts from oil spills are expected to be short-term and localized; a large volume of oil contacting a recreational beach could close the area to recreational use for up to 30 days.

Routine activities associated with a proposed action in the CPA or WPA are not expected to impact coastal historic archaeological resources. It is very unlikely that an oil spill would occur and contact coastal historic archaeological sites from accidental events associated with a proposed action in the CPA or WPA. The major effect from an oil-spill impact would be visual contamination of a historic coastal site, such as a historic fort or lighthouse. As historic archaeological sites are protected under law, it is expected that any spill cleanup operations would be conducted in such a way as to cause little or no impacts to historic archaeological resources. These impacts would be temporary and reversible.

A proposed action in the CPA or WPA is not expected to result in impacts to coastal prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost. It is unlikely that an oil spill would occur and contact coastal, barrier island prehistoric sites as a result of a proposed action in the CPA or WPA. Should a spill contact an archaeological site, unique or significant archaeological information could be irreversibly damaged or lost; damage might include loss of radiocarbon-dating potential, direct impact from oil-spill cleanup equipment, and/or looting. Previously unrecorded sites could be impacted by oil-spill cleanup operations on beaches.

Activities resulting from a proposed action in the CPA or WPA are expected to minimally affect the analysis area's land use, infrastructure, or demographic characteristics of the Gulf coastal communities. A proposed action is expected to generate less than a 1 percent increase in employment in the Texas, Louisiana, Mississippi, and Alabama subareas. Nowhere would these impacts be significant because demand will be met primarily with the existing population and available labor force. Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on land use or demographics. Coastal or nearshore spills could have short-term adverse effects on coastal infrastructure requiring cleanup of any oil or chemicals spilled. The opportunity costs associated with oil-spill cleanup activities are expected to be temporary and of short duration.

A proposed action in the CPA or WPA is not expected to have a disproportionate effect on low-income or minority populations. Impacts related to a proposed action are expected to be economic and have a limited but positive effect on these populations. Accidental spill events associated with a proposed action are not expected to have disproportionate adverse environmental or health effects on minority or low-income people.

Impacts on Sensitive Offshore Environments

Adverse impacts to pinnacles or topographic features from routine activities resulting from a proposed action in the CPA or WPA are not expected because the Live Bottom (Pinnacle Trend) Stipulation and Topographic Features Stipulations establish requirements for setbacks from these features. Adverse impacts from accidental seafloor oil releases or blowouts are expected to be rare because drilling and pipeline operations are not permitted in the vicinity of pinnacles or topographic features and because both pinnacles and topographic features are small in size and dispersed within the areas that they occur; no community-wide impacts are expected. If contact were to occur between diluted oil and adult sessile biota, including coral colonies in the case of the Flower Garden Banks, the effects would be primarily sublethal and there would be limited incidents of mortality.

No adverse impacts to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities or to the widespread, typical, deep-sea benthic communities are expected to occur as a result of a routine activities or accidental events resulting from a proposed action in the CPA or WPA. The potential for adverse impacts to the rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities are expected to be greatly reduced by the requirement for OCS activities to avoid potential chemosynthetic communities by a minimum of 1,500 ft (NTL 2000-G20). High-density chemosynthetic communities could experience minor impacts from drilling discharges or resuspended sediments located at more than 1,500 ft away.

Impacts to marine water quality occur from discharges of drilling fluids and cuttings during exploration and production. Impacts to marine water quality are expected to be minimal as long as all regulatory requirements are met. Spills <1,000 bbl are not expected to significantly impact marine water quality. Larger spills, however, could impact marine water quality. Chemical spills, the accidental release of SBF, and blowouts are expected to have temporary localized impacts on marine water quality.

Emission of pollutants into the atmosphere from offshore facilities are not expected to significantly impact offshore air quality because of emission heights and rates. Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. Other emissions of pollutants into the atmosphere from accidental events as a result of a proposed action are not projected to have significant impacts.

The routine activities related to a proposed action in the CPA or WPA are not expected to have long-term adverse effects on the size and productivity of any marine mammal species or population stock endemic to the northern Gulf of Mexico. Routine OCS activities are expected to have impacts that are sublethal. Small number of marine mammals could be harmed or killed by chance collisions with service vessels and by eating indigestible trash and plastic debris from proposed-action-related activities. Lethal "takes" due to explosive removal of OCS platform or production facilities are not expected because of established mitigation measures. Populations of marine mammals in the northern Gulf are expected to be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes. Chronic or acute exposure may result in the harassment, harm, or mortality to marine mammals occurring in the northern Gulf. In most foreseeable cases, exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick will result in sublethal impacts to marine mammals.

The routine activities resulting from a proposed action in the CPA or WPA are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or population in the Gulf of Mexico. Routine activities are expected to have impacts that are sublethal. Adverse impacts are localized degradation of water quality from operational discharges near platforms; noise from helicopters, service vessels platform and drillship operations; and disorientation caused by brightly-lit platforms. Sea turtles could be harmed or killed from chance collisions with service vessels and from eating floating plastic debris from proposed-action-related activities. Lethal "takes" due to explosive removals of OCS facilities are expected to be rare due to established mitigation measures (e.g., NMFS Observer Program). Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact small to large numbers of sea turtles in the Gulf of Mexico. Populations of sea turtles in the northern Gulf will be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes. Chronic or acute exposure may result in the harassment, harm, or mortality to sea turtles occurring in the northern Gulf. In most foreseeable cases, exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick will result in sublethal impacts to sea turtles. Death would likely occur to sea turtle hatchlings exposed to, becoming fouled by, or consuming tarballs.

A less than 1 percent decrease in fish resources and/or standing stocks or in essential fish habitat (EFH) would be expected as a result of a proposed action in the CPA or WPA. Coastal and marine environmental degradation resulting from a proposed action is expected to have little effect on fish resources or EFH. Recovery of fish resources and EFH can occur from more than 99 percent, but not all, of the expected coastal and marine environmental degradation. Fish populations, if left undisturbed, would regenerate in one generation, but any loss of wetlands as EFH would be permanent. Impacts are expected to result in less than a 1 percent change in commercial fishing "pounds landed" or in the value of landings. Oil spills estimated to result for a proposed action would cause less than a 1 percent decrease in standing stocks of any population, commercial fishing efforts, landings, or value of those landings. The resultant impact on fish populations and commercial fishing activities within the CPA or WPA lease sale areas would be negligible and indistinguishable from variations due to natural causes. Any affected commercial fishing activity would recover within 6 months.

Routine activities associated with a proposed action in the CPA or WPA are not expected to impact offshore historic or prehistoric archaeological resources. The greatest potential impact to an offshore historic archaeological resource would result from direct contact between an offshore activity and a historic shipwreck. The archaeological survey and archaeological clearance required prior oil and gas activities on a lease are expected to be highly effective (90%) at identifying and protecting archaeological resources. Offshore oil and gas activities resulting from a proposed action could contact a shipwreck because of incomplete knowledge on the location of shipwrecks in the Gulf. Although this occurrence is not probable, such an event could result in the disturbance or destruction of important historic archaeological information. Should an offshore prehistoric archaeological site be contacted by proposed-action-related activities, unique or significant archaeological information could be lost.

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ABBREVIATIONS AND ACRONYMS

ACAA	Alabama Coastal Area Act
ACAMP	Alabama Coastal Area Management Plan
ACP	Area Contingency Plans
ACT	American College Test
ADNCR	Alabama Department of Conservation and Natural Resources
ADEM	Alabama Department of Environmental Management
AHTS	anchor-handling towing supply/mooring vessels
ANWR	Aransas National Wildlife Refuge
APD	Application for Permit to Drill
API	American Petroleum Institute
ASLM	Assistant Secretary of the Interior for Land and Minerals
ASMFC	Atlantic States Marine Fisheries Commission
ATB	articulated tug barge
BACT	best available control technology
BAST	best available and safest technology
bbl	barrel
BBO	billion barrels of oil
BOE	barrels of oil equivalent
BBOE	billion barrel of oil equivalent
Bcf	billion cubic feet
BO	Biological Opinion
BOD	biochemical oxygen demand
BOP	blowout preventer
B.P.	before present
BRD	Biological Resources Division (USGS)
CAA	Clean Air Act of 1970
CAAA	Clean Air Act Amendments of 1990
Call	Call for Information and Nominations
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resource System
CCA	Coastal Coordination Act (Texas)
CCMP	Comprehensive Conservation and Management Plan
CD	Consistency Determination
CDP	common-depth-point (seismic surveying)
CEI	Coastal Environments, Inc.
CEQ	Council on Environmental Quality
CER	categorical exclusion review
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
cf.	compare, see
CFDL	Coastal Facilities Designation Line (Texas)
CFR	Code of Federal Regulations
CIAP	Coastal Impact Assistance Program
CIS	corrosion inhibiting substance
CNG	compressed natural gas
CNRA	Coastal Natural Resources Area
COE	Corps of Engineers (U.S. Army)
COF	covered offshore facilities
CPA	Central Planning Area
CSA	Continental Shelf Associates
CWA	Clean Water Act
CWPPRA	Coastal Wetlands Protection, Planning & Restoration Act
CZARA	Coastal Zone Act Reauthorization Amendments of 1990
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
CZPA	Coastal Zone Protection Act of 1996
DGD	Dual gradient drilling
DOCD	Development Operations Coordination Document
DOD	Department of Defense (U.S.)
DOI	Department of the Interior (U.S.) (also: USDOI)
DOT	Department of Transportation (U.S.) (also: USDOT)
DP	dynamically positioned
DWOP	Deepwater Operations Plan
dwt	dead weight tonnage
E&D	exploration and development
E&P	exploration and production
EA	environmental assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
e.g.	for example
EIA	Energy Information Administration (USDOE)
EIS	environmental impact statement
EP	Exploration Plan
EPA	Eastern Planning Area
ESA	Endangered Species Act of 1973
ESI	Environmental Sensitivity Indices
ESP	Environmental Studies Plan
et al.	and others
et seq.	and the following
EWTA	Eglin Water Test Area
FAA	Federal Aviation Administration
FCF	Fishermen's Contingency Fund
FDA	Food and Drug Administration
FDEP	Florida Department of Environmental Protection
FERC	Federal Energy Regulatory Commission
FMC	Fishery Management Council
FMP	Fishery Management Plan
FPS	floating production system
FPSO	floating production, storage, and offloading system
FR	*Federal Register*
FWS	Fish and Wildlife Service
G&G	geological and geophysical
GEMS	Gulf Ecological Management Site
GERG	Geochemical and Environmental Research Group
GINS	Gulf Islands National Seashore
GIS	geographical information system
GIWW	Gulf Intracoastal Waterway

GLPC	Greater Lafourche Port Commission
GMAQS	Gulf of Mexico Air Quality Study
GMFMC	Gulf of Mexico Fishery Management Council
GMP	Gulf of Mexico Program
GOM	Gulf of Mexico
GPS	global positioning system
GS	Geological Survey (also: USGS)
GSA	Geological Survey of Alabama
GSMFC	Gulf States Marine Fisheries Commission
GTFP	green turtle fibropapillomatosis
HAPC	Habitat Areas of Particular Concern
HMS	highly migratory species
IADC	International Association of Drilling Contractors
i.e.	specifically
INTERMAR	International Activities and Marine Minerals Division (MMS)
IT	incidental take
LA	Louisiana
LADNR	Louisiana Department of Natural Resources (also: LDNR)
LARI	Louisiana Artificial Reef Initiative
LATEX	Texas-Louisiana Shelf Circulation and Transport Process Program (MMS-funded study)
LCE	Loop Current Eddy
LCRP	Louisiana Coastal Resources Program
LDNR	Louisiana Department of Natural Resources (also: LADNR)
LNG	liquefied natural gas
LOOP	Louisiana Offshore Oil Port
LPG	liquefied petroleum gas
LSU	Louisiana State University
MAFLA	Mississippi, Alabama, and Florida
MARPOL	International Convention for the Prevention of Pollution from Ships
Mcf	thousand cubic feet
MCP	Mississippi Coastal Program
MFCMA	Magnuson Fishery Conservation and Management Act of 1976
MRGO	Mississippi River Gulf Outlet
Mbbl	thousand barrels
MMbbl	million barrels
MMBOE	million barrels of oil equivalent
MMC	Marine Mammal Commission
MMPA	Marine Mammal Protection Act of 1972
MMS	Minerals Management Service
MPA	Marine Protected Area
MSA	Metropolitan Statistical Area
MSD	marine sanitation device
MSRC	Marine Spill Response Corporation
MSW	municipal solid waste
Mta	million metric tons annually
MODU	mobile offshore drilling unit
MOU	Memorandum of Understanding
MPPRCA	Marine Plastic Pollution Research and Control Act of 1987
MPRS	Marine Protection, Research, and Sanctuaries Act of 1972
MTBE	methyl tertiary butyl ether
Mya	Million years ago
NAAQS	National Ambient Air Quality Standards
NACE	National Association of Corrosion Engineers
NARP	National Artificial Reef Plan
NAS	National Academy of Sciences
NEP	National Estuary Program
NEPA	National Environmental Policy Act
NERBC	New England River Basins Commission
NFEA	National Fishing Enhancement Act
NGL	natural-gas liquids
NGVD	National Geodetic Vertical Depth
NHAP	National Historic Preservation Act
NHS	National Highway System
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent to Prepare an EIS
NORM	naturally occurring radioactive material
NOS	National Ocean Service
NOSAC	National Offshore Safety Advisory Committee
NOW	nonhazardous oil-field waste
NPDES	National Pollutant and Discharge Elimination System
NPFC	National Pollution Funds Center
NPS	National Park Service
NRC	National Research Council
NRDA	Natural Resource Damage Assessment
NTL	Notice to Lessees and Operators
NWRC	National Wetland Research Center
OBF	oil-based drilling fluids
OCD	Offshore and Coastal Dispersion model
OCRM	Office of Ocean and Coastal Resource Management
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
ODD	Ocean Disposal Database
OPA	Oil Pollution Act of 1990
OPA 90	Oil Pollution Act of 1990
OPEC	Organization for Petroleum Exporting Countries
OSCP	Oil Spill Contingency Plan
OSFR	oil-spill financial responsibility
OSM	Office of Safety Management
OSRA	Oil Spill Risk Analysis
OSRO	Oil Spill Removal Organization
OSRP	oil-spill response plans
OSTLF	Oil Spill Liability Trust Fund
OSV	offshore supply vessels
P.L.	Public Law
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PINC	Potential Incident of Noncompliance
PINS	Padre Island National Seashore
PM_{10}	particulate matter smaller than 10 microns

ppm	parts per million
PSD	Prevention of Significant Deterioration
PSI	pounds per square inch
PSV	platform supply vessel
R&D	research and development
RCRA	Resource Conservation and Recovery Act
RD	Regional Director
RFG	reformulated motor gasoline
ROTAC	Regional Operations Technology Assessment Committee
ROV	remotely operated vehicle
RP	Recommended Practice
RTR	Rigs-to-Reef
SAFMC	South Atlantic Fishery Management Councils
SARA	Superfund Amendments and Reauthorization Act
SAT	School-based Administration Test
SBF	synthetic-based drilling fluid
SEAMAP	Southeastern Area Monitoring and Assessment Program
SEIS	supplemental environmental impact statement
SIC	Standard Industrial Classification
SIP	State implementation program
SOLAS	Safety of Life at Sea
sp.	species
spp.	multiple species
Stat.	Statutes
TA&R	Technical Assessment & Research Program (MMS)
TAAS	Texas Assessment of Academic Skills
TAMU	Texas A&M University
tcf	trillion cubic feet
TCMP	Texas Coastal Management Plan
TD	total depth
TED	turtle excluder device
TGLO	Texas General Land Office
THC	total hydrocarbon content
TIMS	Technical Information Management System (MMS)
TLP	tension leg platform
TRW	topographic Rossby wave
TSP	total suspended particulate matter
TSS	traffic separation schemes
TWC	treatment, workover, and completion
TX	Texas
U.S.	United States
U.S.C.	United States Code
USCG	U.S. Coast Guard
USDOC	U.S. Department of Commerce
USDOI	U.S. Department of the Interior (also: DOI)
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey (also: GS)
VOC	volatile organic compounds
WBF	water-based drilling fluids
WBNP	Wood Buffalo National Park
WPA	Western Planning Area

CONVERSION CHART

Measurements in this EIS are given in SI metric units (International System of Units) except where U.S. units are the accepted standard (for example, altitudes for aircraft). For the reader's convenience, both SI metric and U.S. customary units are included in the Summary. Factors for converting SI metric to U.S. customary units are provided in the following table.

To convert from	To	Multiply by
millimeter (mm)	inch (in)	0.03937
centimeter (cm)	inch (in)	0.3937
meter (m)	foot (ft)	3.281
kilometer (km)	mile (mi)	0.6214
meter^2 (m^2)	foot^2 (ft^2)	10.76
	yard^2 (yd^2)	1.196
	acre (ac)	0.0002471
hectare (ha)	acre (ac)	2.47
kilometer^2 (km^2)	mile^2 (mi^2)	0.3861
meter^3 (m^3)	foot^3 (ft^3)	35.31
yard^3 (yd^3)	1.308	
liter (l)	gallons (gal)	0.2642
degree Celsius (°C)	degree Fahrenheit (°F)	°F = (1.8 x °C) + 32

1 barrel (bbl) = 42 gal = 158.9 l = approximately 0.1428 metric tons

1 nautical mile (nmi) = 6,076 ft or 1.15 mi

CHAPTER 1

THE PROPOSED ACTIONS

1. THE PROPOSED ACTIONS

1.1. PURPOSE OF AND NEED FOR THE PROPOSED ACTIONS

The proposed Federal actions addressed in this environmental impact statement (EIS) are nine areawide oil and gas lease sales in the Central Planning Area (CPA) and Western Planning Area (WPA) of the Gulf of Mexico Outer Continental Shelf (OCS) (Figure 1-1). Under the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007* (5-Year Program), two sales would be held each year — one in the CPA and one in the WPA (Table 1-1). The proposed Central Gulf lease sales are Sale 185 in 2003, Sale 190 in 2004, Sale 194 in 2005, Sale 198 in 2006, and Sale 201 in 2007; the proposed WPA lease sales are Sale 187 in 2003, Sale 192 in 2004, Sale 196 in 2005, and Sale 200 in 2006. The purpose of the proposed Federal actions is to offer for lease those areas that may contain economically recoverable oil and natural gas resources. The proposed lease sales will provide qualified bidders the opportunity to bid upon and lease acreage in the Gulf of Mexico OCS in order to explore, develop, and produce oil and natural gas. This EIS analyzes the potential impacts of the proposed actions on the marine, coastal, and human environments. Although this EIS addresses nine proposed lease sales, at the completion of this EIS process, decisions will be made only for proposed Sale 185 in the CPA and proposed Sale 187 in the WPA. A National Environmental Policy Act (NEPA) review will be conducted for each subsequent proposed lease sale in the 5-Year Program. Formal consultation with other Federal agencies, the affected States, and the public will be carried out to assist in the determination of whether or not the information and analyses in this original multisale EIS are still valid. These consultations and NEPA reviews will be completed before decisions are made on the subsequent sales.

The Outer Continental Shelf Lands Act (OCSLA) of 1953 (67 Stat. 462), as amended (43 U.S.C. 1331 *et seq*. (1988)), established Federal jurisdiction over submerged lands on the OCS seaward of the State boundaries. Under the OCSLA, the Department of the Interior (DOI) is required to manage the leasing, exploration, development, and production of oil and gas resources on the Federal OCS. The Secretary of the Interior (Secretary) oversees the OCS oil and gas program and is required to balance orderly resource development with protection of the human, marine, and coastal environments while simultaneously ensuring that the public receives an equitable return for these resources and that free-market competition is maintained. The Act empowers the Secretary to grant leases to the highest qualified responsible bidder(s) on the basis of sealed competitive bids and to formulate such regulations as necessary to carry out the provisions of the Act. The Secretary has designated the Minerals Management Service (MMS) as the administrative agency responsible for the mineral leasing of submerged OCS lands and for the supervision of offshore operations after lease issuance.

The Central and Western Gulf of Mexico constitutes one of the world's major oil and gas producing areas, and has proved a steady and reliable source of crude oil and natural gas for more than 50 years. Oil from the Gulf of Mexico can help reduce the Nation's need for oil imports and reduce the environmental risks associated with oil tankering. Natural gas is generally considered to be an environmentally preferable alternative to oil, both in terms of the production and consumption.

1.2. DESCRIPTION OF THE PROPOSED ACTIONS

The proposed actions are annual areawide oil and gas lease sales in the CPA and WPA (except for the first lease sale – Sale 184) as scheduled under the proposed 5-Year Program for 2002-2007. Federal regulations allow for several related or similar proposals to be analyzed in one EIS (40 CFR 1502.4). Since each lease sale proposal and projected activities are very similar each year for each planning area, the MMS has decided to prepare a single EIS for the nine CPA and WPA sales in the proposed 5-Year Program. As scheduled in the proposed 5-Year Program and announced in the Area Identification (Area ID), each of the sales is proposed as a planning-area-wide sale; however, the area for each sale, after the first sale in each planning area, will be reviewed during preparation of a sale-specific environmental assessment (EA). The multisale approach is intended to focus the NEPA/EIS process on differences between the proposed sales and on new issues and information. The multisale EIS will eliminate the issuance of complete draft and final EIS's for each annual set of sales in the CPA and WPA.

Each of the CPA and WPA proposed actions includes a lease stipulation for blocks or portions of blocks beyond the United States (U.S.) Exclusive Economic Zone (EEZ) (generally greater than 200 nautical miles (nmi) from the U.S. coastline). Leases on these blocks may be subject to special royalty payments under the provisions of the 1982 Law of the Sea Convention, if the U.S. becomes a party to the Convention prior to or during the life of the lease.

The proposed Central Gulf lease sales are Sale 185 in 2003, Sale 190 in 2004, Sale 194 in 2005, Sale 198 in 2006, and Sale 201 in 2007. The CPA includes about 47.8 million acres (ac) located from 4.8 to 354 kilometers (km) offshore in water depths ranging from 4 to 3,400 meters (m). Each proposed sale would offer for lease all unleased blocks in the CPA, with the following exceptions. The following blocks are deferred from the proposed actions under the "Treaty Between The Government of the United States of America And The Government Of The United Mexican States on the Delimitation Of The Continental Shelf In the Western Gulf of Mexico Beyond 200 Nautical Miles," which took effect in January 2001.

- Blocks in the Lund South area (the area beyond the EEZ known as the Northern Portion of the Eastern Gap (Area NG 16-07)):
  - Lund South Area Blocks 172,173, 213-217, 252-261, 296-305, and 349.
- Blocks in the Amery Terrace Area (the area beyond the EEZ formerly known as the Northern Portion of the Western Gap (Area NG 15-09)) that lie within the 1.4-nmi buffer zone north of the continental shelf boundary between the United States and Mexico:
  - Whole blocks: Amery Terrace Area Blocks 235-238, 273-279, 309-317; and
  - Partial blocks: Amery Terrace Area Blocks 280, 281, 318-320, and 355-359.

The proposed CPA sales include proposed lease stipulations designed to reduce environmental risks. The Topographic Features Stipulation establishes "No Activity Zones" around 16 banks in the CPA. The proposed Live Bottom (Pinnacle Trend) Stipulation establishes detection and avoidance measures to protect pinnacle trend features. The Military Areas Stipulation requires coordination between OCS operators and the Department of Defense to reduce potential multiuse conflicts on the OCS. The stipulation for blocks south of and within 15 mi of Baldwin County, Alabama, requires industry to minimize the visual impacts from development operations in these blocks. It is estimated that each proposed sale could result in the production of 0.276-0.654 billion barrels of oil (BBO) and 1.590-3.300 trillion cubic feet (tcf) of gas.

The proposed annual WPA lease sales are Sale 187 in 2003, Sale 192 in 2004, Sale 196 in 2005, and Sale 200 in 2006. The WPA includes about 35.9 million ac located from 14 to 357 km offshore in water depths ranging from 8 to 3,000 m. Each proposed sale would offer for lease all unleased blocks in the WPA, with the following exceptions:

(1) High Island Area, East Addition, South Extension, Blocks A-375 (East Flower Garden Bank) and A-398 (West Flower Garden Bank), and the portions of other blocks within the boundary of the Flower Garden Banks National Marine Sanctuary.

(2) The following blocks are deferred under the "Treaty Between The Government of the United States of America And The Government Of The United Mexican States on the Delimitation Of The Continental Shelf In the Western Gulf of Mexico Beyond 200 Nautical Miles," which took effect in January 2001.

Blocks in the Sigsbee Escarpment and Keathley Canyon Areas (areas beyond the EEZ formerly known as the Northern Portion of the Western Gap (Areas NG 15-08 and NG 15-05)) that lie within the 1.4-nmi buffer zone north of the continental-shelf boundary between the United States and Mexico:

- Whole blocks: Sigsbee Escarpment Area Blocks 11, 57, 103, 148, 149, 194, 239, 284, and 331-341; and
- Partial blocks: Keathley Canyon Area Blocks 978-980; and Sigsbee Escarpment Area Blocks 12-14, 58-60, 104-106, 150, 151, 195, 196, 240, 241, 285-298, and 342-349.

The proposed WPA lease sales include proposed lease stipulations designed to reduce environmental risks. The Topographic Features Stipulation establishes "No Activity Zones" around 23 banks in the WPA. The Military Areas Stipulation requires coordination between OCS operators and the Department of Defense to reduce potential multiuse conflicts on the OCS. The Naval Mine Warfare Area Stipulation restricts the use of sea-surface structures in areas identified by the Navy as needed for testing equipment and for training mine warfare personnel. It is estimated that each proposed lease sale in the WPA could result in the production of 0.136-0.262 BBO and 0.810-1.440 tcf of gas.

Although this EIS addresses nine proposed sale actions, only two sales (one in the CPA and one in the WPA) are proposed to be held each year. At the completion of this EIS process, decisions will be made only for proposed CPA Sale 185 and proposed WPA Sale 187, scheduled for 2003. Subsequent to these first sales, an EA and formal consultation with other Federal agencies, the affected States, and the public will be completed before decisions are made on proposed sales. The EA will result in either a Finding of No New Significant Impact (FONNSI) or the determination that the preparation of a Supplemental EIS (SEIS) is warranted. The EA, and SEIS if deemed necessary, will use much of the material contained in this initial multisale EIS and will incorporate this material by reference.

The proposed action analyses in this EIS address one "typical" CPA sale and one "typical" WPA sale. A set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors developed for each "typical" proposed action are presented. The analyses of these "typical" proposed actions are expected to be "typical" of any of the proposed CPA or WPA sales scheduled in the 5-Year Program. In other words, each of the proposed sales in the 5-Year Program is expected to be within the ranges used for the analyzed "typical" proposed action in the corresponding planning area.

1.3. Regulatory Framework

Federal laws mandate the OCS leasing program and the environmental review process. Several Federal regulations establish specific consultation and coordination processes with Federal, State, and local agencies. In addition, the OCS leasing process and all activities and operations on the OCS must comply with other Federal, State, and local laws and regulations. The following are summaries of the major, applicable, Federal laws and regulations.

Outer Continental Shelf Lands Act

The OCSLA of 1953 (43 U.S.C. 1331 *et seq.*), as amended, established Federal jurisdiction over submerged lands on the OCS seaward of State boundaries. The Act, as amended, provides guidelines for implementing an OCS oil and gas exploration and development program. The basic goals of the Act include the following:

- to establish policies and procedures for managing the oil and natural gas resources of the OCS that are intended to result in expedited exploration and development of the OCS in order to achieve national economic and energy policy goals, assure national security, reduce dependence on foreign sources, and maintain a favorable balance of payments in world trade;
- to preserve, protect, and develop oil and natural gas resources of the OCS in a manner that is consistent with the need
  - — to make such resources available to meet the Nation's energy needs as rapidly as possible;

— to balance orderly resource development with protection of the human, marine, and coastal environments;

— to ensure the public a fair and equitable return on the resources of the OCS; and

— to preserve and maintain free enterprise competition; and

- to encourage development of new and improved technology for energy resource production, which will eliminate or minimize the risk of damage to the human, marine, and coastal environments.

Under the OCSLA, the Secretary of the Interior is responsible for the administration of mineral exploration and development of the OCS. Within the Department of the Interior, the MMS is charged with the responsibility of managing and regulating the development of OCS oil and gas resources in accordance with the provisions of the OCSLA. The MMS operating regulations are in Chapter 30, Code of Federal Regulations, Part 250 (30 CFR 250); 30 CFR 251; and 30 CFR 254.

Under Section 20 of the OCSLA, the Secretary shall ". . . conduct such additional studies to establish environmental information as he deems necessary and shall monitor the human, marine, and coastal environments of such area or region in a manner designed to provide time-series and data trend information which can be used for comparison with any previously collected data for the purpose of identifying any significant changes in the quality and productivity of such environments, for establishing trends in the area studied and monitored, and for designing experiments to identify the causes of such changes." Through the Environmental Studies Program (ESP), the MMS conducts studies designed to provide information on the current status of resources of concern and notable changes, if any, resulting from OCS Program activities.

In addition, the OCSLA provides a statutory foundation for coordination with the affected States and, to a more limited extent, local governments. At each step of the procedures that lead to lease issuance, participation from the affected States and other interested parties is encouraged and sought.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 *et seq*.) provides a national policy that encourages "productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man . . . ." The NEPA requires that all Federal agencies use a systematic, interdisciplinary approach to protection of the human environment; this approach will ensure the integrated use of the natural and social sciences in any planning and decisionmaking that may have an impact upon the environment. The NEPA also requires the preparation of a detailed EIS on any major Federal action that may have a significant impact on the environment. This EIS must address any adverse environmental effects that cannot be avoided or mitigated, alternatives to the proposed action, the relationship between short-term uses and long-term productivity of the environment, and any irreversible and irretrievable commitments of resources involved in the project.

In 1979, the Council on Environmental Quality (CEQ) established uniform guidelines for implementing the procedural provisions of NEPA. These regulations (40 CFR 1500 to 1508) provide for the use of the NEPA process to identify and assess the reasonable alternatives to proposed actions that avoid or minimize adverse effects of these actions upon the quality of the human environment. "Scoping" is used to identify the scope and significance of important environmental issues associated with a proposed Federal action through coordination with Federal, State, and local agencies; the public; and any interested individual or organization prior to the development of an impact statement. The process is also intended to identify and eliminate, from further detailed study, issues that are not significant or that have been covered by prior environmental review.

The Marine Mammal Protection Act

Under the Marine Mammal Protection Act (MMPA) of 1972 (16 U.S.C. 1361 *et seq*.), the Secretary of Commerce is responsible for all cetaceans and pinnipeds, except walruses; authority for implementing the Act is delegated to the National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries), formerly known as the National Marine Fisheries Service (NMFS). The Secretary of the Interior is responsible for walruses, polar bears, sea otters, manatees, and dugongs; authority is delegated to the Fish and Wildlife Service (FWS). The Act established the Marine Mammal Commission (MMC) and its Committee of Scientific Advisors on Marine Mammals to provide oversight and advice to the responsible regulatory agencies on all Federal actions bearing upon the conservation and protection of marine mammals.

The MMPA established a moratorium on the taking of marine mammals in waters under U.S. jurisdiction. The MMPA defines "take" to mean "to harass, harm, shoot, wound, trap, hunt, capture, or kill, or attempt to engage in any such conduct (including actions that induce stress, adversely impact critical habitat, or result in adverse secondary or cumulative impacts)." Harassment is the most common form of taking associated with OCS Program activities. The moratorium may be waived when the affected species or population stock is within its optimum sustainable population range and will not be disadvantaged by an authorized taking (e.g., will not be reduced below its maximum net productivity level, which is the lower limit of the optimum sustainable population range). The Act directs that the Secretary, upon request, authorize the unintentional taking of small numbers of marine mammals incidental to activities other than commercial fishing (e.g., offshore oil and gas exploration and development) when, after notice and opportunity for public comment, the Secretary finds that the total of such taking during the 5-year (or less) period will have a negligible impact on the affected species. The MMPA also specifies that the Secretary shall withdraw, or suspend, permission to take marine mammals incidental to oil and gas and other activities if, after notice and opportunity for public comment, the Secretary finds (1) that the applicable regulations regarding methods of taking, monitoring, or reporting are not being complied with or (2) the taking is, or may be, having more than a negligible impact on the affected species or stock.

In 1994, a subparagraph (D) was added to the MMPA to simplify the process for obtaining "small take" exemptions when unintentional taking incidental to activities such as offshore oil and gas development is by harassment only. Specifically, incidental take (IT) by harassment can now be authorized by permit for periods of up to one year (as opposed to the lengthy regulation/Letter of Authorization process that was formerly in effect). The new language also sets a 120-day time limit for processing harassment IT authorizations.

In October 1995, NOAA Fisheries issued regulations (50 CFR 228) authorizing and governing the taking of bottlenose and spotted dolphins incidental to the explosive removal of oil and gas drilling and production structures in State waters and on the Gulf OCS for a period of five years (*Federal Register*, 1995a). Letters of Authorization must be requested from, and issued to, individual applicants (operators) to conduct the activities (structure removals) pursuant to the regulations. Since 1986, the MMS, the U.S. Army Corp of Engineers, operators, and removal contractors have been following strict NOAA Fisheries requirements in order to avoid the incidental taking of marine mammals and to prevent adverse impacts to endangered sea turtles. Regulations allowing for the incidental taking of coastal dolphin species by harassment (Subpart M of 50 CFR 216) expired in November 2000. The MMS and NOAA Fisheries are working to develop improved measures to minimize the take of marine mammals and endangered or threatened species as a result of removing OCS structures using explosives. During the interim period while new Subpart M regulations are being formalized, OCS lessees and operators are required to follow, at a minimum, the mandatory mitigation measures set forth in the expired Subpart M regulations.

To ensure that OCS activities adhere to the MMPA, the MMS has conducted studies to identify possible associations between cetaceans and high-use areas of the northern Gulf of Mexico. For example, MMS and the Biological Resources Division (BRD) of the U.S. Geological Survey (USGS) funded the "GulfCet" (Gulf cetaceans) Program, which was conducted jointly by Texas A&M University at Galveston and NOAA Fisheries. The purpose of GulfCet was to determine the distribution and abundance of cetaceans along the continental slope in the northern Gulf of Mexico and to help MMS assess the potential effects of deepwater oil and gas exploration and production on marine mammals in the Gulf of Mexico. The studies included systematic aerial and shipboard (visual and acoustic) surveys, behavioral observations, and photo-identification of individual sperm whales. During 1991-1994, the GulfCet I study examined seasonal and geographic distribution of cetaceans along the continental slope in the north-central and western Gulf (Davis and Fargion, 1996). GulfCet II (1996-1997) was designed, in part, to determine the distribution and abundance of whales and dolphins in the Eastern Gulf, an area of potential oil and gas exploration and production (Davis et al., 2000). Another component of GulfCet II was to conduct focal studies specifically designed to address whale and dolphin associations with habitats (physical environment and available prey). The GulfCet Program demonstrated that whales and dolphins are not sighted randomly throughout the northern Gulf. Cetacean distribution is influenced by both bottom depth and by the presence of mesoscale hydrographic features.

The Endangered Species Act

The Endangered Species Act (ESA) (16 U.S.C. 1631 *et seq*.) of 1973, as amended (43 U.S.C. 1331 *et seq*.), establishes a national policy designed to protect and conserve threatened and endangered species and the ecosystems upon which they depend. The ESA is administered by FWS and NOAA Fisheries. Section 7 of the ESA governs interagency cooperation and consultation. Under Section 7, MMS formally consults with NOAA Fisheries and FWS to ensure that activities in the OCS under MMS jurisdiction do not jeopardize the continued existence of threatened or endangered species and/or result in adverse modification or destruction of their critical habitat. The results of these consultations are presented as a Biological Opinion (BO).

The FWS and NOAA Fisheries make recommendations on the modification of oil and gas operations to minimize adverse impacts, although it remains the responsibility of MMS to ensure that proposed OCS activities do not impact threatened and endangered species. If an unauthorized taking occurs, or if the authorized level of incidental take (as described in the previous section) is exceeded, reinitiation of formal consultation is required.

The MMS Environmental Studies Program (Chapter 1.6) complies with the ESA's intent of conserving endangered or threatened species by contracting research on sea turtles and cetaceans.

The Clean Air Act

The 1970 Clean Air Act (CAA) (42 U.S.C. 7401 *et seq*.) established the National Ambient Air Quality Standards (NAAQS). The CAA required Federal promulgation of national primary and secondary standards. The primary NAAQS standards are to protect public health; the secondary standards are to protect public welfare. Under the Clean Air Act, the U.S. Environmental Protection Agency (USEPA) sets limits on how much of a pollutant can be in the air anywhere in the United States. Although the CAA is a Federal law covering the entire country, the states do much of the work to carry out the Act. The law allows individual states to have stronger pollution controls, but states are not allowed to have weaker pollution controls than those set for the whole country. The law recognizes that it makes sense for states to take the lead in carrying out the CAA because pollution control problems often require special understanding of local industries, geography, housing patterns, etc.

States may have to develop state implementation plans (SIP's) that explain how each state will come into or remain in compliance with the CAA, as amended. The states must involve the public, through hearings and opportunities to comment, in the development of the SIP. The USEPA must approve the SIP, and if the SIP is not acceptable, USEPA can take over enforcing the CAA, as amended, in that state. The U.S. Government, through USEPA, assists the states by providing scientific research, expert studies, engineering designs, and money to support clean air programs.

The CAA established the Prevention of Significant Deterioration (PSD) program to protect the quality of air in the regions of the United States where the air is cleaner than required by the NAAQS. Under the PSD program, air quality attainment areas in the United States were classified as Class I or Class II (a Class III designation was codified but no areas were classified as such). Class I areas receive the most protection. Any new major (250 tons per year or larger) permanent source of emissions is required to receive a review by the Federal permitting agency, and the Federal permitting agency must consult with the appropriate Federal land manager prior to granting approval. The FWS is the Federal land manager for Breton, St Marks, Okefenokee, and Chassahowitzka Class I areas. The National Park Service (NPS) is the Federal land manager for the Everglades Class I area.

The CAA, as amended, delineates jurisdiction of air quality between the USEPA and DOI. For OCS operations in the Gulf of Mexico, those operations east of 87.5°W. longitude are subject to USEPA air quality regulations and those west of 87.5°W. longitude are subject to MMS air quality regulations. In the OCS areas under MMS jurisdiction, the MMS regulations at 30 CFR 250 are in force.

The 1990 Clean Air Act Amendments (CAAA) (Public Law No. 101-549)) required that MMS conduct and complete a study to evaluate impacts from the development of OCS petroleum resources in the Gulf on air quality in the ozone nonattainment areas. (Florida was not included in the study area since, at that time, the counties in the Panhandle were in compliance with the Federal ozone standard.) That study was completed in late 1995. Based on the results of this study, the Secretary has consulted with the USEPA Administrator to determine if new requirements are needed for the OCS areas in the Gulf of Mexico that remain under MMS jurisdiction (the areas west of 87°30′W. longitude). Based on the consultation, it was determined that no new requirements are needed at this time.

The MMS air quality regulations are at 30 CFR 250 Subpart C. These regulations are based on potential impacts; as such, the farther away from shore, the larger the allowable emission rate before an air quality impact analysis is required. All OCS plans are required to include emission information and receive air quality review. The regulations allow MMS to select which OCS plans require emissions information for air quality review. In 1994, the Gulf of Mexico Region issued a Letter to Lessees requiring operators to submit standardized emissions information with all OCS plans. This requirement is more stringent than corresponding onshore requirements because MMS applies the same exemption levels and significance levels to temporary sources as it does to permanent sources. Under the onshore PSD regulations temporary sources are typically exempt from air quality permitting requirements. The MMS's impact-based regulations establish a three-tier process for identifying potentially significant emission sources. There are no screening models developed for offshore use. The only model approved by USEPA as a preferred model for modeling offshore emission sources' impacts upon onshore areas is the Offshore and Coastal Dispersal (OCD) model developed by MMS in 1989. The OCD model is based on steady-state Gaussian assumptions.

The Clean Water Act

The Clean Water Act (CWA) is a 1977 amendment to the Federal Water Pollution Control Act of 1972. The CWA establishes the basic structure for regulating discharges of pollutants to waters of the United States. Under the CWA, it is unlawful for any person to discharge any pollutant from a point source into navigable waters without a National Pollution Discharge Elimination System (NPDES) permit. The USEPA may not issue a permit for a discharge into ocean waters unless the discharge complies with the guidelines established under Section 403(c). These guidelines are intended to prevent degradation of the marine environment and require an assessment of the effect of the proposed discharges on sensitive biological communities and aesthetic, recreation, and economic values, both directly and as a result of biological, physical, and chemical processes altering the discharges.

All waste streams generated from offshore oil and gas activities are regulated by the USEPA, primarily by general permits. Under Sections 301 and 304 of the CWA, USEPA issues technology-based effluent guidelines that establish discharge standards based on treatment technologies that are available and economically achievable. The most recent effluent guidelines for the oil and gas extraction point-source category were published in 1993 (58 FR 12454). Within the Gulf of Mexico, USEPA Region 4 has jurisdiction over the eastern portion of the Gulf, including all of the OCS Eastern Planning Area and part of the CPA off the coasts of Alabama and Mississippi. The USEPA's Region 6 has jurisdiction over the majority of the CPA and all of the WPA. Each region has promulgated general permits for discharges that incorporate the 1993 effluent guidelines as a minimum. In some instances, a site-specific permit is required. The USEPA also published new guidelines for the discharge of synthetic-based drilling fluids (SBF) on January 22, 2001 (66 FR 6850).

The USEPA Region 4 general permit was issued on October 16, 1998 (63 FR 55718), was modified on March 14, 2001 (66 FR 14988), and expires on October 31, 2003. Region 4 has not revised the general permit to incorporate new guidelines for SBF and other nonaqueous-based drilling fluids. The USEPA Region 6 general permit was issued on November 2, 1998 (63 FR 58722), was modified on April 19, 1999 (64 FR 19156), and expires in April 2004. On December 18, 2001, Region 6 published a notice of revision to the general permit, which became effective on February 16, 2002. The revision authorizes the discharge of drill cuttings produced using SBF and other nonaqueous-based drilling fluids and wastewater used to pressure test existing piping and pipelines.

Other sections of the CWA also apply to offshore oil and gas activities. Section 404 of the CWA requires a Corps of Engineers' (COE) permit for the discharge or deposition of dredged or fill material in all the waters of the United States. Approval by the COE, with consultation from other Federal and State agencies, is also required for installing and maintaining pipelines in coastal areas of the Gulf of Mexico. Section 303 of the CWA provides for the establishment of water quality standards that identify a designated use for waters (e.g., fishing/swimming). States have adopted water quality standards for ocean waters within their jurisdiction (waters of the territorial sea that extend out to 3 mi off Louisiana, Mississippi, and Alabama, and 3 leagues off Texas and Florida). Section 402(b) of the CWA authorizes USEPA approval of State permit programs for discharges from point sources.

The Oil Pollution Act

The Oil Pollution Act of 1990 (OPA or OPA 90) (33 U.S.C. 2701 *et seq*.) is comprehensive legislation that includes, in part, provisions to (1) improve oil-spill prevention, preparedness, and response capability; (2) establish limitations on liability for damages resulting from oil pollution; and (3) implement a fund for the payment of compensation for such damages.

The OPA, in part, revised Section 311 of the Clean Water Act to expand Federal spill-response authority, increase penalties for spills, establish U.S. Coast Guard (USCG) prepositioned oil-spill response equipment sites, require vessel and facility response plans, and provide for interagency contingency plans. Many of the statutory changes required corresponding revisions to the National Oil and Hazardous Substances Pollution Contingency Plan.

If a spill or substantial threat of a spill of oil or a hazardous substance from a vessel, offshore facility, or onshore facility is considered to be of such a size or character to be a substantial threat to the public health or welfare of the U.S., under provisions of the Act, the President (through the USCG) now has the authority to direct all Federal, State, and private actions to remove a spill or to mitigate or prevent the threat of the spill. Potential impacts from spills of oil or a hazardous substance to fish, shellfish, wildlife, other natural resources, or the public and private beaches of the U.S. would be an example of the degree or type of threat considered to be of such a size or character to be a substantial threat to the U.S. public health or welfare. In addition, the USCG's authority to investigate marine accidents involving foreign tankers was expanded to include accidents in the Exclusive Economic Zone. The Act also established USCG oil-spill district response groups (including equipment and personnel) in each of the 10 USCG districts, with a national response unit, the National Strike Force Coordination Center, located in Elizabeth City, North Carolina.

The OPA strengthened spill planning and prevention activities by providing for the establishment of interagency spill contingency plans for areas of the U.S. To achieve this goal, Area Committees composed of qualified Federal, State, and local officials were created to develop Area Contingency Plans. The OPA mandates that contingency plans address the response to a "worst case" oil spill or a substantial threat of such a spill. It also required that vessels and both onshore and offshore facilities have response plans approved by the President. These plans were required to adhere to specified requirements, including the demonstration that they had contracted with private parties to provide the personnel and equipment necessary to respond to or mitigate a "worst case" spill. In addition, the Act provided for increased penalties for violations of statutes related to oil spills, including payment of triple costs by persons who fail to follow contingency plan requirements.

The Act further specifies that vessel owners, not cargo owners, are liable for spills and raises the liability limits from $150 per gross ton to $1,200 per gross ton for vessels. The maximum liability for offshore facilities is set at $75 million plus unlimited removal costs; liability for onshore facilities or a deepwater port is set at $350 million. Willful misconduct, violation of any Federal operating or safety standard, failure to report an incident, or refusal to participate in a cleanup subjects the spiller to unlimited liability under provisions of the Act.

Pursuant to the Act, double hulls are required on all newly constructed tankers. Double hulls or double containment systems are required on all tank vessels less than 5,000 gross tons (i.e., barges). Since 1995, existing single-hull tankers are being phased out based on size and age.

An Interagency Coordinating Committee on Oil Pollution Research was established by the provisions of the Act and tasked with submitting a plan for the implementation of an oil-pollution research, development, and demonstration program to Congress. The plan was submitted to Congress in April 1992. This program addressed, in part, an identification of important oil-pollution research gaps, an establishment of research priorities and goals, and an estimate of the resources and timetables necessary to accomplish the identified research tasks.

In October 1991, Executive Order 12777 delegated the provisions of OPA to various departments and agencies within the U.S. Government, including the USCG, USEPA, Department of Transportation (DOT), and DOI. The Secretary of the Interior was delegated Federal Water Pollution Control Act authority over offshore facilities and associated pipelines (except deepwater ports) for all Federal and State waters. The Secretary's functions under the Executive Order include spill prevention, Oil Spill Contingency Plans (OSCP's), equipment, financial responsibility certification, and civil penalties.

The Oil Spill Liability Trust Fund (OSLTF), authorized under OPA and administered by the USCG, is available to pay for removal costs and damages not recovered from responsible parties. The Fund provides up to $1 billion per incident for cleanup costs and other damages. The OSLTF was originally established under Section 9509 of the Internal Revenue Code of 1986. It was one of several similar Federal trust funds funded by various levies set up to provide for the costs of water pollution. The OPA generally consolidated the liability and compensation schemes of these prior Federal oil pollution laws and authorized the use of the OSLTF, which consolidated the funds supporting those regimes. Those prior laws included the Federal Water Pollution Control Act, Trans-Alaska Pipeline Authorization Act, Deepwater Port Act, and Outer Continental Shelf Lands Act. On February 20, 1991, the National Pollution Funds Center (NPFC) was commissioned to serve as fiduciary agent for the OSLTF.

The OPA 90 provides that parties responsible for offshore facilities demonstrate, establish, and maintain oil-spill financial responsibility (OSFR) for those facilities. The OPA 90 replaced and rescinded the OCSLA OSFR requirements. Executive Order 12777 assigned the OSFR certification function to the Department of the Interior; the Secretary of the Interior, in turn, delegated this function to MMS.

The minimum amount of OSFR that must be demonstrated is $35 million for covered offshore facilities (COF's) located on the OCS and $10 million for COF's located in State waters. A COF is any structure and all of its components, equipment, pipeline, or device (other than a vessel or other than a pipeline or deepwater port licensed under the Deepwater Port Act of 1974) used for exploring for, drilling for, or producing oil or for transporting oil from such facilities. The regulation provides an exemption for persons responsible for facilities having a potential worst-case oil spill of 1,000 bbl or less, unless the risks posed by a facility justify a lower threshold volume.

The Secretary of Transportation has authority for vessel oil-pollution financial responsibility, and the USCG regulates the oil-spill financial responsibility program for vessels. A mobile offshore drilling unit (MODU) is classified as a vessel. However, a well drilled from a MODU is classified as an offshore facility under this rule.

Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (42 U.S.C. 9601 *et seq*.), modified by the 1986 Superfund Amendments and Reauthorization Act (SARA) and Section 1006 of OPA 90, requires the promulgation of regulations for the assessment of natural resource damages from oil spills and hazardous substances. These Acts provide for the designation of trustees who determine resource injuries, assess natural resource damages (including the costs of assessing damages), present claims, recover damages, and develop and implement plans for the restoration, rehabilitation, replacement, or acquisition of the equivalent of the injured natural resources under the trusteeship.

The DOI was given the authority under CERCLA to develop regulations and procedures for the assessment of damages for natural resource injuries resulting from the release of a hazardous substance or oil spills (Natural Resource Damage Assessment (NRDA) Regulations). These rulemakings are all codified at 43 CFR 11. The CERCLA specified two types of procedures to be developed: type "A" procedures for simplified, standard assessments requiring minimal field observations in cases of minor spills or releases in certain environments; and type "B" site-specific procedures for detailed assessments for individual cases.

The Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) (42 U.S.C. 6901 *et seq*.) provides a framework for the safe disposal and management of hazardous and solid wastes. The OCS wastes taken to shore are regulated under RCRA. The USEPA has exempted many oil and gas wastes from coverage under the hazardous wastes regulations of RCRA. Exempt wastes include those generally coming from an activity directly associated with the drilling, production, or processing of a hydrocarbon product. Therefore, most oil and gas wastes taken onshore are not regulated by the Federal Government but by various Gulf States' programs. If wastes generated on the OCS are not exempt and are hazardous, the wastes must be transported to shore for disposal at a hazardous waste facility. Exempt wastes taken from the Gulf OCS for disposal are regulated in all five Gulf States.

Marine Plastic Pollution Research and Control Act

The Marine Plastic Pollution Research and Control Act of 1987 (MPPRCA) (33 U.S.C. 1901 *et seq*.) implements Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL). Under provisions of the law, all ships and watercraft, including all commercial and recreational fishing vessels, are prohibited from dumping plastics at sea. The law also severely restricts the legality of dumping other vessel-generated garbage and solid-waste items both at sea and in U.S. navigable waters. The USCG is responsible for enforcing the provisions of this law and has developed final rules for its implementation (33 CFR 151, 155, and 158), calling for adequate trash reception facilities at all ports, docks, marinas, and boat-launching facilities.

The Gulf of Mexico has received "Special Area" status under MARPOL, thereby prohibiting the disposal of all solid waste into the marine environment. Fixed and floating platforms, drilling rigs, manned production platforms, and support vessels operating under a Federal oil and gas lease are required to develop waste management plans and to post placards reflecting discharge limitations and restrictions. The MMS regulations explicitly prohibit the disposal of equipment, cables, chains, containers, or other materials into offshore waters. Portable equipment, spools or reels, drums, pallets, and other loose items must be marked in a durable manner with the owner's name prior to use or transport over offshore waters. Smaller objects must be stored in a marked container when not in use.

Final rules published under MPPRCA explicitly state that fixed and floating platforms, drilling rigs, manned production platforms, and support vessels operating under a Federal oil and gas lease are required to develop Waste Management Plans and to post placards reflecting MARPOL dumping restrictions. Waste Management Plans will require oil and gas operators to describe procedures for collecting, processing, storing, and discharging garbage and to designate the person who is in charge of carrying out the plan. These rules also apply to all oceangoing ships of 12 m (39 feet (ft)) or more in length that are documented under the laws of the U.S. or numbered by a State and that are equipped with a galley and berthing. Placards noting discharge limitations and restrictions, as well as penalties for noncompliance, apply to all boats and ships 8 m (26 ft) or more in length. Furthermore, the Shore Protection Act of 1988 (33 U.S.C. 2601 *et seq*.) requires ships transporting garbage and refuse to assure that the garbage and refuse is properly contained on-board so that it will not be lost in the water from inclement wind or weather conditions.

The Magnuson Fishery Conservation and Management Act

The Magnuson Fishery Conservation and Management Act (MFCMA) of 1976 (16 U.S.C. 1251 *et seq*.) established and delineated an area from the States' seaward boundary outward 200 nmi as a fisheries conservation zone for the United States and its possessions. The Act established national standards for fishery conservation and management.

Congress amended and reauthorized the MFCMA through passage of the Sustainable Fisheries Act of 1996. The Act, as amended, established eight Regional Fishery Management Councils (FMC's) to exercise sound judgment in the stewardship of fishery resources through the preparation, monitoring, and revision of fishery management plans (FMP). An FMP is based upon the best available scientific and economic data. The reauthorization also promotes domestic commercial and recreational fishing under sound conservation and management principles, including the promotion and catch and release programs in recreational fishing and encouraging the development of currently underutilized fisheries. The reauthorization requires that the FMC's identify Essential Fish Habitat (EFH). To promote the protection of EFH, Federal agencies are required to consult on activities that may adversely affect EFH designated in the FMP's.

Essential Fish Habitat

There are FMP's in the Gulf region for shrimp, red drum, reef fishes, coastal migratory pelagics, stone crabs, spiny lobsters, coral and coral reefs, billfish, and highly migratory species (HMS). The Gulf of Mexico Fishery Management Council (GMFMC) *Generic Amendment for Addressing Essential Fish Habitat Requirements (1998)* amends the first seven FMP's listed above, identifying estuarine/inshore and marine/offshore EFH for over 450 managed species (about 400 in the Coral FMP). Although not part of the Gulf of Mexico Fishery Management Council's FMP's, separate FMP's have been finalized by NOAA Fisheries for Atlantic tunas, swordfish and sharks, and the Atlantic billfish fishery (USDOC, NMFS, 1999a and b).

The GMFMC *Generic Amendment for Addressing Essential Fish Habitat Requirements* identifies threats to EFH and makes a number of general and specific habitat preservation recommendations for pipelines and oil and gas exploration and production activities within State waters and OCS areas (Chapter 3.2.9.2). The MMS and NOAA Fisheries have entered into consultation agreements for EFH related to OCS activities in the lease areas. The EFH conservation measures recommended by NOAA Fisheries consist primarily of environmental stipulations and other mitigative measures normally required by MMS. Additional conservation provisions and circumstances that require project-specific consultation have been agreed to through a Programmatic Consultation. These agreements, including avoidance distances from topographic-features No Activity Zones and live-bottom pinnacle features appear in Notice to Lessees and Operators (NTL) 2002-G08.

Essential Fish Habitat Consultation

The current programmatic consultation between MMS and NOAA Fisheries for the Central and Western Gulf of Mexico applies to pipeline rights-of-way, plans for exploration and production, and platform removal. The programmatic consultation does not encompass the bidding or granting of leases through lease sales by the MMS, although no impact to EFH is implicit *per se* from holding a lease sale.

This EIS addresses impacting factors that could result from multiple lease sales at a regional, OCS planning area level. The NOAA Fisheries has stated that EFH consultations should be consolidated, where appropriate, within existing environmental review procedures, such as during the NEPA process. Included in this EIS are the components of an EFH Assessment that would be submitted to NOAA Fisheries in request of an EFH consultation. These required components are outlined below, as well as the sections of this EIS where the EFH discussion and other related material can be located.

1. A description of the proposed action

   Chapters 1.1-1.6; Chapters 2.3 and 2.4; and throughout Chapter 3 with specific sections on Fishery Resources and EFH in Chapter 3.2.9.

2. An analysis of the effects, including cumulative effects, of the proposed action on EFH

   Chapter 4.1, *Routine Operations*; Chapter 4.2.1.10, Central Gulf sales impacts; Chapter 4.3.1.8, Western Gulf sales impacts; Chapter 4.4.3.10, impacts from accidental events; and Chapter 4.5.10, cumulative impacts.

3. The MMS's views regarding the effects of the action on EFH

   Summary and conclusion statements are included at the end of each impact discussion outlined under item 2 above. Summaries of impacts also appear in Chapter 2, *Alternatives Including the Proposed Action*.

4. Proposed Mitigations

   Mitigations are presented in Chapter 2.2.2. Mitigating measures include lease stipulations discussed in Chapters 2.3.1.3.1 and 2.3.1.3.2. The programmatic consultation agreement between the MMS and NOAA Fisheries includes "Additional EFH Conservation Recommendations," outlined in Chapter 3.2.9.2.

The NOAA Fisheries' EFH consultation letter and MMS's response appear in Appendix 9.3.

National Fishing Enhancement Act

The National Fishing Enhancement Act of 1984 (33 U.S.C. 2601 *et seq*.), also known as the Artificial Reef Act, establishes broad artificial-reef development standards and a National policy of the United States to encourage the development of artificial reefs that will enhance fishery resources and commercial and recreational fishing. The Secretary of Commerce provided leadership in developing a National Artificial Reef Plan that identifies design, construction, siting, and maintenance criteria for artificial reefs and that provides a synopsis of existing information and future research needs. The Secretary of the Army issues permits to responsible applicants for reef development projects in accordance with the National Plan, as well as regional, State, and local criteria and plans. The law also limits the liability of reef developers complying with permit requirements and includes the availability of all surplus Federal ships for consideration as reef development materials. Although the Act mentions no specific materials other than ships for use in reef development projects, the Secretary of the Interior cooperated with the Secretary of Commerce in developing the National Plan, which identifies oil and gas structures as acceptable materials of opportunity for artificial-reef development. The MMS adopted a Rigs-to-Reefs policy in 1985 in response to this Act and to broaden interest in the use of petroleum platforms as artificial reefs.

Fishermen's Contingency Fund

Final regulations for the implementation of Title IV of the OCSLA, as amended (43 U.S.C. 1841-1846), were published in the *Federal Register* on January 24, 1980 (50 CFR 296). The OCSLA, as amended, established the Fishermen's Contingency Fund (not to exceed $2 million) to compensate commercial fishermen for actual and consequential damages, including loss of profit due to damage or loss of fishing gear by various materials and items associated with oil and gas exploration, development, or production on the OCS. This Fund, administered by the Financial Services Division of NOAA Fisheries, mitigates most losses suffered by commercial fishermen due to OCS oil and gas activities.

As required in the OCSLA, nine area accounts have been established — five in the GOM, one in the Pacific, one in Alaska, and two in the Atlantic. The five Gulf accounts cover the same areas as the five MMS Gulf of Mexico OCS Region Districts. Each area account is initially funded at $100,000 and cannot exceed this amount. The accounts are initiated and maintained by assessing holders of leases, pipeline rights-of-way and easements, and exploration permits. These assessments cannot exceed $5,000 per operator in any calendar year.

The claims eligible for compensation are generally contingent upon the following: (1) damages or losses must be suffered by a commercial fisherman; and (2) any actual or consequential damages, including loss of profit, must be due to damages or losses of fishing gear by items or obstructions related to OCS oil and gas activities. Damages or losses that occur in non-OCS waters may be eligible for compensation if the item(s) causing damages or losses are associated with OCS oil and gas activities.

Ineligible claims for compensation are generally (1) damages or losses caused by items that are attributable to a financially responsible party; (2) damages or losses caused by negligence or fault of the commercial fishermen; (3) occurrences before September 18, 1978; (4) claims of damages to, or losses of, fishing gear exceeding the replacement value of the fishing gear; (5) claims for loss of profits in excess of 6 months, unless supported by records of the claimant's profits during the previous 12 months; (6) claims or any portions of damages or losses claimed that will be compensated by insurance; (7) claims not filed within 60 days of the event of the damages or losses; and (8) damages or losses caused by natural obstructions or obstructions unrelated to OCS oil and gas activities.

There are several requirements for filing claims, including one that a report stating, among other things, the location of the obstruction, must be made within 5 days after the event of the damages or losses; this 5-day report is required to gain presumption of causation. A detailed claim form must be filed within 60 days of the event of the damages or losses. The specifics of this claim are contained in 50 CFR 296. The claimant has the burden of establishing all the facts demonstrating eligibility for compensation, including the identity or nature of the item that caused the damages or losses and its association with OCS oil and gas activity.

Damages or losses are presumed to be caused by items associated with OCS oil and gas activities provided the claimant establishes that (1) the commercial fishing vessel was being used for commercial fishing and was located in an area affected by OCS oil and gas activities; (2) the 5-day report was filed;

(3) there is no record in the most recent Department of Commerce's National Oceanic and Atmospheric Administration/National Ocean Service (NOAA/NOS) nautical charts or weekly USCG Notice to Mariners of an obstruction in the immediate vicinity; and (4) no proper surface marker or lighted buoy marked the obstruction. Damages or losses occurring within a one-quarter-mile radius of obstructions recorded on charts, listed in the Notice to Mariners, or properly marked are presumed to involve the recorded obstruction.

Shipping Safety Fairways, Anchorages, and Traffic Separation Schemes

The Ports and Waterways Safety Act (33 U.S.C. 1223) authorizes the USCG to designate safety fairways, fairway anchorages, and traffic separation schemes (TSS's) to provide unobstructed approaches through oil fields for vessels using Gulf ports. The USCG provides listings of designated fairways, anchorages, and TSS's in 33 CFR 166 and 167, along with special conditions related to oil and gas production in the Gulf of Mexico. In general, no fixed structures, such as platforms, are allowed in fairways. Temporary underwater obstacles such as anchors and attendant cables or chains attached to floating or semisubmersible drilling rigs may be placed in a fairway under certain conditions. Fixed structures may be placed in anchorages, but the number of structures is limited. In addition, the USCG may designate a specific safety zone around an OCS structure.

A TSS is a designated routing measure that is aimed at the separation of opposing streams of traffic by appropriate means and by the establishment of traffic lanes (33 CFR 167.5). The Galveston Bay approach TSS and precautionary areas is the only TSS established in the Gulf of Mexico.

Marine and Estuarine Protection Acts

The Sanctuaries and Reserves Division, National Ocean Service, National Oceanic and Atmospheric Administration of the U.S. Department of Commerce, administers the National Marine Sanctuary and National Estuarine Research Reserve programs. The marine sanctuary program was established by the Marine Protection, Research, and Sanctuaries Act of 1972, and the estuarine research reserve program was established by the Coastal Zone Management Act of 1972.

Marine sanctuaries and estuarine research reserves are designed and managed to meet the following goals, among others:

- enhance resource protection through the implementation of a comprehensive, long-term management plan tailored to the specific resources;
- promote and coordinate research to expand scientific knowledge of sensitive marine resources and improve management decision making;
- enhance public awareness, understanding, and wise use of the marine environment through public interpretive and recreational programs; and
- provide for optimum compatible public and private use of special marine areas.

The Congress declared that ocean dumping in the territorial seas or the contiguous zone of the United States would be regulated under the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRS) (33 U.S.C. 1401 *et seq*.). Under 40 CFR 228, pursuant to Section 103 of the MPRS, sites and times for ocean dumping of dredged and nondredged materials were designated by the USEPA after a determination that such dumping will not unreasonably degrade or endanger human health, welfare, or the marine environment. The EIS's on these disposal sites describe impacts that are expected to occur over a period of 25 years. Under 33 U.S.C. 1413 (33 CFR 324), the Department of the Army, Corps of Engineers, reviews applications for permits to transport dredged and nondredged materials for the purpose of dumping it in ocean waters. On December 31, 1981, 33 U.S.C. 1412a mandated the termination of ocean dumping of sewage sludge and industrial waste.

Marine Protection, Research, and Sanctuaries Act

The Marine Protection, Research, and Sanctuaries Act of 1972 established the National Marine Sanctuary Program, which is administered by the National Oceanic and Atmospheric Administration of the Department of Commerce. A single National Marine Sanctuary (NMS) exists in the northern Gulf of Mexico, specifically in the WPA. The Flower Garden Banks NMS was designated in 1992. The Department of the Interior has taken action to protect the biological resources of the Flower Garden Banks NMS from damage due to oil and gas exploration and development activities. Two blocks (Blocks A-375 and A-398 in High Island Area, East Addition, South Extension), wholly underlain by the Flower Garden Banks, are excluded from leasing. The MMS has also established a "No Activity Zone" around the Flower Garden Banks and has established other operational restrictions as described in the Topographic Features Stipulation. Stetson Bank was added to the Flower Garden Banks NMS in 1996. Stetson Bank is currently protected by a "No Activity Zone."

National Estuarine Research Reserves

Four Estuarine Research Reserves have been established in the Gulf of Mexico: Rookery Bay National Estuarine Research Reserve and Apalachicola National Estuarine Research Reserve in Florida, which are not within the region covered by this multisale EIS; and Weeks Bay National Estuarine Research Reserve in Alabama, and Grand Bay National Estuarine Research Reserve in Mississippi, which are within the area of potential impacts covered within this multisale EIS.

Weeks Bay National Estuarine Research Reserve covers a small estuary of approximately 1,215 ha (3,000 ac) in Baldwin County, Alabama. Weeks Bay is a shallow open bay with an average depth of less than 1.5 m (4.9 ft) and extensive vegetated wetland areas. The bay receives waters from the spring-fed Fish and Magnolia Rivers and connects with Mobile Bay through a narrow opening.

Grand Bay National Estuarine Research Reserve covers about 7,470 ha (18,400 ac) in Jackson County, Mississippi. Located between Pascagoula and the Alabama State line, it contains diverse habitats that support several rare or endangered plants and animals. The reserve's fishery resources include oysters, fish, and shrimp. The area also has recreational resources and archaeological sites.

No other sites in the Gulf of Mexico have been formally proposed as National Estuarine Research Reserves.

The National Estuary Program

In 1987, an amendment to the Clean Water Act, known as the Water Quality Act (P.L. 100-4), established the National Estuary Program (NEP). The purpose of the NEP is to identify nationally important estuaries, to protect and improve their water quality, and to enhance their living resources. Under the NEP, which is administered by the USEPA, comprehensive management plans are generated to protect and enhance environmental resources. The governor of a state may nominate an estuary for the Program and request that a Comprehensive Conservation and Management Plan (CCMP) be developed for an estuary. Representatives from Federal, State, and interstate agencies; academic and scientific institutions; and industry and citizen groups work during a 5-year period to define objectives for protecting the estuary, to select the chief problems to be addressed in the Plan, and to ratify a pollution control and resource management strategy to meet each objective. Strong public support and subsequent political commitments are needed to accomplish the actions called for in the Plan; hence, the 5-year time period to develop the strategies. A total of 22 estuaries have been selected for the Program, 7 of which are in the Gulf: Galveston Bay and Corpus Christi Bay in Texas; the Barataria-Terrebonne Estuarine Complex in Louisiana; Mobile Bay in Alabama; and Sarasota Bay, Charlotte Harbor, and Tampa Bay in Florida.

Executive Order 11990 (May 24, 1977), Protection of Wetlands

Executive Order 11990 establishes that each Federal agency shall provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities. The Executive Order applies to the following Federal activities: managing and disposing of Federal lands and facilities; providing federally undertaken, financed, or assisted construction and improvements; and conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

Coastal Barrier Resources Act

The Coastal Barrier Resources Act (CBRA) (16 U.S.C. 3501 *et seq.*) established that undeveloped coastal barriers, per the Act's definition, may be included in a Coastal Barrier Resource System (CBRS).

The CBRA prohibits all new Federal expenditures and financial assistance within the CBRS, with certain specific exceptions, including energy development. The purpose of this legislation was to end the Federal Government's encouragement for development on barrier islands by withholding Federal flood insurance for new construction of or substantial improvements to structures on undeveloped coastal barriers.

The National Historic Preservation Act

The National Historic Preservation Act (NHPA) of 1966, as amended (16 U.S.C. 470 *et seq.*), states that any Federal agency, before approving federally permitted or federally funded undertakings, must take into consideration the effect of that undertaking on any property listed on, or eligible for, the National Register of Historic Places. Implied in this legislation and Executive Order 11593 is that an effort be made to locate such sites before development of an area. Section 101(b)(4) of NEPA states that it is the continuing responsibility of the Federal Government to preserve important historic and cultural aspects of our natural heritage. In addition, Section 11(g)(3) of the OCSLA, as amended, states that "exploration (oil and gas) will not . . . disturb any site, structure, or object of historical or archaeological significance."

The NHPA provides for a National Register of Historic Places to include districts, sites, buildings, structures, and objects noteworthy in American history, architecture, archaeology, and culture. These items may bear National, State, or local significance. The NHPA provides funding for the State Historic Preservation Officer and his staff to conduct surveys and comprehensive preservation planning, establishes standards for State programs, and requires States to establish mechanisms for certifying local governments to participate in the National Register nomination and funding programs.

Section 106 of the Act requires that Federal agencies having direct or indirect jurisdiction over a proposed Federal, federally assisted, or federally licensed undertaking, prior to approval of the expenditure of funds or the issuance of a license, take into account the effect of the undertaking on any district, site, building, structure, or object included in or eligible for inclusion in the National Register of Historic Places, and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment with regard to the undertaking. This Council, appointed by the President, has implemented procedures to facilitate compliance with this provision at 36 CFR 800.

Section 110 of the NHPA directs the heads of all Federal agencies to assume responsibility for the preservation of National Register listed or eligible historic properties owned or controlled by their agency as well as those not under agency jurisdiction and control but are potentially affected by agency actions. Federal agencies are directed to locate, inventory, and nominate properties to the National Register, to exercise caution to protect such properties, and to use such properties to the maximum extent feasible. Other major provisions of Section 110 include documentation of properties adversely affected by Federal undertakings, the establishment of trained Federal preservation officers in each agency, and the inclusion of the costs of preservation activities as eligible agency project costs.

A Section 106 review refers to the Federal review process designed to ensure that historic properties are considered during Federal project planning and execution. The review process is administered by the Advisory Council on Historic Preservation, an independent Federal agency, together with the State Historic Preservation Office.

Rivers and Harbors Act

Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 401 *et seq.*) prohibits the unauthorized obstruction or alteration of any navigable water of the United States. The construction of any structure in or over any navigable water of the United States, the excavating from or depositing of dredged material or refuse in such waters, or the accomplishment of any other work affecting the course, location, condition, or capacity of such waters is unlawful without prior approval from the U.S. Army Corps of Engineers. The legislative authority to prevent inappropriate obstructions to navigation was extended to installations and devices located on the seabed to the seaward limit of the OCS by Section 4(e) of the OCSLA of 1953, as amended.

National Ocean Pollution Planning Act

The National Ocean Pollution Planning Act of 1978 (33 U.S.C. 1701 *et seq*.) calls for the establishment of a comprehensive, coordinated, and effective ocean pollution research, development, and monitoring program. The Act requires that the Department of Commerce, NOAA, in consultation with other agencies, prepare a comprehensive 5-year Federal Plan for Ocean Pollution Research, Development, and Monitoring every three years. The Plan contains major elements that consider an assessment and prioritization of National needs and problems, existing Federal capabilities, policy recommendations, and a budget review.

Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) (16 U.S.C. 1451 *et seq*.) was enacted by Congress in 1972 to develop a national coastal management program that comprehensively manages and balances competing uses of and impacts to any coastal use or resource. The national coastal management program is implemented by individual State coastal management programs in partnership with the Federal Government. The CZMA Federal consistency regulations require that Federal activities (e.g., OCS lease sales) be consistent to the maximum extent practicable with the enforceable policies of a State's coastal management program. The Federal consistency also requires that other federally approved activities (e.g., activities requiring Federal permits, such as activities described in OCS plans) be consistent with a State's federally approved coastal management program. The Federal consistency requirement is an important mechanism to address coastal effects, to ensure adequate Federal consideration of State coastal management programs, and to avoid conflicts between States and Federal agencies. The Coastal Zone Act Reauthorization Amendments of 1990 (CZARA), enacted November 5, 1990, as well as the Coastal Zone Protection Act of 1996 (CZPA), amended and reauthorized the CZMA. The CZMA is administered by the Office of Ocean and Coastal Resource Management (OCRM) within NOAA's National Ocean Service. The CZMA is currently due for reauthorization and legislation is pending before Congress.

Executive Order 12898: Environmental Justice

The environmental justice policy, based on Executive Order 12898 of February 11, 1994, requires agencies to incorporate analysis of the environmental effects of their proposed programs on minorities and low-income populations and communities into NEPA documents. The MMS's existing NEPA process invites participation by all groups and communities in the development of its proposed actions, alternatives, and potential mitigation measures. Scoping and review for the EIS is an open process that provides an opportunity for all participants, including minority and low-income populations, to raise new expressions of concern that can be addressed in the EIS. The effects of the proposed actions on local populations or resources used by local groups including minority and low-income groups are considered in the analyses of socioeconomic conditions, commercial fisheries, air quality, and water quality.

Executive Order 13186: Responsibilities of Federal Agencies to Protect Migratory Birds

Executive Order 13186 of January 10, 2001, requires Federal Agencies taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations to develop and implement a Memorandum of Understanding (MOU) with the FWS. The MOU is intended to establish protocols to promote the conservation of migratory bird populations. The MMS has initiated development of such an MOU with FWS.

Occupational Safety and Health Act

The Occupational Safety and Health Act of 1970 (29 U.S.C. 651-678) was enacted to assure, to the extent possible, safe and healthful working conditions and to preserve our human resources. The Act encourages employers and employees to reduce occupational safety and health hazards in their places of employment and stimulates the institution of new programs and the perfection of existing programs for providing safe and healthful working conditions. The Act establishes a National Institute for Occupational Safety and Health, which is authorized to develop and establish occupational safety and health standards. The Act also establishes a National Advisory Committee on Occupational Safety and Health.

The Act empowers the Secretary of Labor or his representative to enter any factory, plant, establishment, workplace, or environment where work is performed by employees and to inspect and investigate during regular working hours and at other reasonable times any such place of employment and all pertinent conditions and equipment therein. If, upon inspection, the Secretary or authorized representative believes that an employer has violated provisions of the Act, the employer shall be issued a citation and given 15 days to contest the citation or proposed assessment of penalty.

1.4. PRELEASE PROCESS

The MMS published the Call for Information (Call) and the Notice of Intent to Prepare the EIS (NOI) for the proposed 2003-2007 Central and Western Gulf Lease Sales in the *Federal Register* on September 12, 2001. In accordance with the Council on Environmental Quality's (CEQ) regulations implementing NEPA, scoping was conducted to solicit comments on the proposed CPA and WPA lease sales and to update the Gulf of Mexico's environmental information base for the Gulf of Mexico. Scoping provides those with an interest in the OCS Program an early opportunity to participate in the events leading to the publication of the Draft EIS. Although the scoping process is formally initiated by the publication of the NOI, scoping efforts and other coordination meetings are ongoing. Formal scoping meetings were held in October 2001 in Galveston, Houston, New Orleans, and Mobile. In addition, the MMS received 10 written comments in response to the NOI. A summary of the scoping meetings and written comments can be found in Chapter 5. Federal, State, and local agencies, along with other interested parties, were requested to send written comments to the MMS on the scope of the EIS, on issues that should be addressed, and on alternatives and mitigating measures that should be considered. The comment period on the Call/NOI closed on October 12, 2001. Additional public notices were distributed via newspapers, mailouts, and the Internet. The MMS received four comments in response to the Call.

The MMS also conducted early coordination with appropriate Federal and State agencies and other MMS Region customers to discuss the proposed CPA and WPA lease sales. Key agencies and organizations included NOAA Fisheries, FWS, the Department of Defense (DOD), USCG, USEPA, State Governors' offices, and industry groups.

The Area ID decision for the CPA and WPA leases sales scheduled under the proposed 5-Year Program was made January 16, 2002. The Area ID describes the geographical areas of the proposed actions and any alternatives to the proposed actions, as well as the mitigative measures and issues to be analyzed in the NEPA documents prepared for the proposed actions.

The publication of the Draft EIS initiated a 60-day public review and comment period. A Notice of Availability was published in the *Federal Register*. Additionally, a public notice was mailed out and placed on the MMS website. Copies of the Draft EIS were sent to Federal, State, and local agencies; libraries; industry; special interest groups; and private individuals. Formal public hearings on the Draft EIS and the proposed actions were held in the affected coastal States during the comment period. Written or electronic comments were accepted until the close of the comment period on May 31, 2002. Summaries or copies of the comments and responses are included in Chapter 5.

The Proposed Notice of Sale for Central Gulf Sale 185 and the Final EIS will be published at about the same time. The publication of the Final EIS initiates a 30-day comment period. After the end of the comment period, the Department of the Interior reviews the Final EIS and all comments received on both the Draft and Final EIS's. The Assistant Secretary of the Interior for Land and Minerals (ASLM) then decides which of the proposed alternatives will be implemented.

Concurrent with the preparation of the Final EIS, a consistency review and subsequent Consistency Determination (CD) is done. For presale consistency determinations, MMS reviews each affected State's coastal zone management program, analyzes the potential impacts to the coastal zone management program, and makes an assessment of consistency with the enforceable policies of each State's program. If a State disagrees with MMS's CD, the State is required to do the following under the CZMA: (1) indicate how the MMS presale proposal is inconsistent with their coastal program; (2) suggest alternative measures to bring the MMS proposal into consistency with their coastal program; or (3) describe the need for additional information that would allow a determination of consistency. Unlike the consistency process for specific OCS plans and permits, there is no procedure for administrative appeal to the Secretary of Commerce for Federal agency consistency determinations for presale activities. Either MMS or the State may request mediation. Mediation is voluntary and the Department of Commerce would serve as the mediator. Whether there is mediation or not, the final consistency determination is made by the Department of the Interior and is the final administrative action for the presale consistency process.

A Final Notice of Sale is published in the *Federal Register* at least 30 days prior to the scheduled lease sale. The Final Notice identifies the specific configuration of the proposed sale as decided upon by the ASLM.

Lease sale stipulations are considered to be a normal part of the OCS operating regime in the Gulf of Mexico. Compliance with lease stipulations is mandatory; application of a stipulation(s) is a condition of the lease.

1.5. Postlease Activities

The MMS is responsible for managing, regulating, and monitoring oil and natural gas exploration, development, and production operations on the Federal OCS to promote orderly development of mineral resources and to prevent harm or damage to, or waste of, any natural resource, any life or property, or the marine, coastal, or human environment. Regulations for oil, gas, and sulphur lease operations are specified in 30 CFR 250, 30 CFR 251, and 30 CFR 254.

Measures to mitigate potential impacts are an integral part of the OCS Program. These measures are implemented through lease stipulations, operating regulations, NTL's, and project-specific requirements or approval conditions. Mitigating measures address concerns such as endangered and threatened species, geologic and manmade hazards, military warning and ordnance disposal areas, air quality, oil-spill response planning, chemosynthetic communities, operations in H_2S-prone areas, and shunting of drill effluents in the vicinity of biologically sensitive features. Standard mitigation measures in the Gulf of Mexico OCS include

- limiting the size of explosive charges used for structure removals;
- requiring placement explosive charges at least 15 ft below the mudline;
- requiring site-clearance procedures to eliminate potential snags to commercial fishing nets;
- establishment of No Activity and Modified Activity Zones around high-relief live bottoms;
- requiring remote-sensing surveys to detect and avoid biologically sensitive areas such as low-relief live bottoms, pinnacles, and chemosynthetic communities; and
- requiring coordination with the military to prevent multiuse conflicts between OCS and military activities.

The MMS issues Notices to Lessees and Operators (NTL's) to provide clarification, description, or interpretation of a regulation; guidelines on the implementation of a special lease stipulation or regional requirement; or transmit administrative information. A detailed listing of current Gulf of Mexico OCS Region NTL's is available through the MMS, Gulf of Mexico OCS Region's Internet Homepage at http://www.gomr.mms.gov or through the Region's Public Information Office at (504) 736-2519 or 1-800-200-GULF.

Conditions of approval are mechanisms to control or mitigate potential safety or environmental problems associated with proposed operations. Conditions of approval are based on MMS technical and environmental evaluations of the proposed operations. Comments from Federal and State agencies (as applicable) are also considered in establishing conditions. Conditions may be applied to any OCS plan, permit, right-of-use of easement, or pipeline right-of-way grant.

Some MMS-identified mitigation measures are implemented through cooperative agreements or efforts with the oil and gas industry and Federal and State agencies. These measures include the NOAA Fisheries Observer Program to protect marine mammals and sea turtles when OCS structures are removed using explosives, minimum helicopter altitudes to prevent disturbance of wildlife, labeling of operational supplies to track sources of accidental debris loss, development of methods of pipeline landfall to eliminate impacts to barrier beaches, and semiannual beach cleanup events.

Geological and Geophysical Activities

A geological and geophysical (G&G) permit must be obtained from MMS prior to conducting geological or geophysical exploration or scientific research on unleased OCS lands or on lands under lease to a third party (30 CFR 251). Geological investigations include various seafloor sampling techniques to determine the geochemical, geotechnical, or engineering properties of the sediments.

Seismic surveys are performed to obtain information on surface and near-surface geology and on subsurface geologic formations. Low-energy, high-resolution seismic surveys collect data on surficial geology used to identify potential shallow geologic or manmade hazards (e.g., faults or pipelines) for engineering and site planning for bottom-founded structures. The high-resolution surveys are also used to identify environmental and archaeological resources such as low-relief live-bottom areas, pinnacles, chemosynthetic community habitat, and shipwrecks. High-energy, deep-penetration, common-depth-point (CDP) seismic surveys obtain data about geologic formations thousands of feet below the seafloor. The two-dimensional (2D) and three-dimensional (3D) CDP data are used to map structure features of stratigraphically important horizons in order to identify potential hydrocarbon traps. They can also be used to map the extent of potential habitat for chemosynthetic communities.

The MMS has nearly completed a programmatic EA on Geological and Geophysical Exploration for Mineral Resources on the Gulf of Mexico Outer Continental Shelf (USDOI, MMS, in preparation). Upon receiving a complete G&G permit application, MMS prepares a Categorical Exclusion Review (CER), an environmental assessment (EA), or an EIS in accordance with NEPA and other applicable MMS policies and guidelines. When required under an approved coastal zone management program, proposed G&G permit activities must receive State concurrence prior to MMS permit approval.

Exploration and Development Plans

To ensure conformance with the OCSLA, other laws, applicable regulations, and lease provisions, and to enable MMS to carry out its functions and responsibilities, formal plans (30 CFR 250.203 and 250.204) with supporting information must be submitted for review and approval by MMS before an operator may begin exploration, development, or production activities on any lease. Supporting environmental information, archaeological reports, biological reports (monitoring and/or live-bottom survey), and other environmental data determined necessary must be submitted with an OCS plan. This information provides the basis for an analysis of both offshore and onshore impacts that may occur as a result of the activities. The MMS may require additional specific supporting information to aid in the evaluation of the potential environmental impacts of the proposed activities. The MMS can require amendment of an OCS plan based on inadequate or inaccurate supporting information.

The OCS plans are reviewed by geologists, geophysicists, engineers, biologists, archaeologists, air quality specialists, oil-spill specialists, and technicians. The plans and accompanying information are evaluated to determine whether any seafloor or drilling hazards are present; that air and water quality issues are addressed; that plans for hydrocarbon resource conservation, development, and drainage are adequate; that environmental issues and potential impacts are properly evaluated and mitigated; and that the proposed action is in compliance with NEPA, MMS operating regulations, and other requirements. Federal agencies, including FWS, NOAA Fisheries, USEPA, the U.S. Navy, the U.S. Air Force, and the USCG, may be consulted if the proposal has the potential to impact areas under their jurisdiction. Each Gulf Coast State has a designated CZM agency that take part in the review process. The OCS plans are also made available to the general public for comment through the MMS, Gulf of Mexico OCS Region's Public Information Office.

In response to increasing deepwater activities in the Gulf, MMS developed a comprehensive strategy to address NEPA compliance and environmental issues in the deepwater areas. A key component of that strategy was the completion of a programmatic EA to evaluate the potential effects of the deepwater technologies and operations (USDOI, MMS, 2000a). As a supplement to the EA, MMS prepared a series of technical papers that provide a summary description of the different types of structures that may be employed in the development and production of hydrocarbon resources in the deepwater areas of the Gulf of Mexico (Regg et al., 2000). Subsequent to the EA, MMS developed a biologically based grid system to ensure systematic analysis of the deepwater region. The grid system divides the deepwater area of the WPA and CPA into 17 areas of biological similarity. A programmatic or "grid" EA will be prepared for at least one OCS development plan within each of the 17 grids. The grid EA will be comprehensive in terms of the potential impacting factors and the environmental and socioeconomic resources described and analyzed. Future environmental evaluations will use much of the information in the grid EA – tiering (40 CFR 1502.20) from the grid EA and incorporating by reference appropriate sections. This approach will allow subsequent analyses to focus on specific issues and effects related to specific proposals.

On the basis of the MMS reviews of the OCS plan; the findings of the proposal-specific CER, EA, or EIS or the grid EA; and other applicable MMS studies and NEPA documents, the OCS plan is approved or disapproved by MMS, or modification of the plan is required. Although very few OCS plans are ultimately disapproved, many must be amended prior to approval to fully comply with MMS operating regulations and requirements, to address reviewing agencies' concerns, or to avoid potential hazards or impacts to environmental resources.

Exploration Plans

An exploration plan (EP) must be submitted to MMS for review and decision before any exploration activities, except for preliminary activities, can begin on a lease. The EP describes exploration activities, drilling rig or vessel, proposed drilling and well-testing operations, environmental monitoring plans, and other relevant information, and includes a proposed schedule of the exploration activities. Guidelines and environmental information requirements for lessees and operators submitting an EP are addressed in 30 CFR 250.203 and further explained in NTL 2000-G10.

After receiving an EP, MMS performs technical and environmental reviews. The MMS evaluates the proposed exploration activities for potential impacts relative to geohazards and manmade hazards (including existing pipelines), archaeological resources, endangered species, sensitive biological features, water and air quality, oil-spill response, and other uses (e.g., military operations) of the OCS. The EP is reviewed for compliance with all applicable laws and regulations.

A CER, EA, and/or EIS is prepared in support of the NEPA environmental review of the EP. The CER, EA, and/or EIS is based on available information, which may include the geophysical report (for determining the potential for the presence of deepwater benthic communities); archaeological report; air emissions data; live-bottom survey and report; biological monitoring plan; and recommendations by the affected State(s), DOD, FWS (for selected plans under provisions of a DOI agreement), NOAA Fisheries, and/or internal MMS offices. As part of the review process, most EP's and supporting environmental information are sent to the affected State(s) for consistency certification review and determination under the States' approved CZM programs.

After EP approval and prior to conducting drilling operations, the operator is required to submit and obtain approval for an Application for Permit to Drill (APD) (see *Wells* under *Permits and Applications* below).

Deepwater Operations Plans

In 1992, MMS formed an internal Deepwater Task Force to address technical issues and regulatory concerns relating to deepwater (greater than 1,000 ft or 305 m) operations and projects utilizing subsea technology. Based on the Deepwater Task Force's recommendation, an NTL (NTL 96-4N, superseded by NTL 98-8N effective June 1, 1998) was developed, which required operators to submit a Deepwater Operations Plan (DWOP) for all operations in deepwater and all projects using subsea technology. DeepStar, an industry-wide cooperative workgroup focused on deepwater regulatory issues and critical technology development issues, worked closely with the MMS Deepwater Task Force to develop the initial guidelines for the DWOP. The DWOP was established to address regulatory issues and concerns that were not addressed in the existing MMS regulatory framework and is intended to initiate an early dialogue between MMS and industry before major capital expenditures on deepwater and subsea projects are committed. Deepwater technology has been evolving faster than the MMS's ability to revise OCS regulations; the DWOP was established through the NTL process, which provides for a more timely and flexible approach to keep pace with the expanding deepwater operations and subsea technology. The DWOP requirements are being incorporated into MMS operating regulations via the proposed rulemaking for revisions to 30 CFR 250 Subpart B.

The DWOP is intended to address the different functional requirements of production equipment in deep water, particularly the technological requirements associated with subsea production systems, and the complexity of deepwater production facilities. The DWOP provides MMS with information specific to deepwater equipment issues to demonstrate that a deepwater project is being developed in an acceptable manner as mandated in the OCS Lands Act, as amended, and the MMS operating regulations at 30 CFR 250. The MMS reviews deepwater development activities from a total system perspective, emphasizing operational safety, environmental protection, and conservation of natural resources. The DWOP process is a phased approach that parallels the operator's state of knowledge about how a field will be developed. A DWOP outlines the design, fabrication, and installation of the proposed development/production system and its components. A DWOP will include structural aspects of the facility (fixed, floating, subsea); stationkeeping (includes mooring system); wellbore, completion, and riser systems; safety systems; offtake; and hazards and operability of the production system. The DWOP provides the MMS with the information to determine that the operator has designed and built sufficient safeguards into the production system to prevent the occurrence of significant safety or environmental incidents. The DWOP, in conjunction with other permit applications, provides MMS the opportunity to assure that the production system is suitable for the conditions in which it will operate.

The MMS recently completed a review of several industry-developed, recommended practices that address the mooring and risers for floating production facilities. The recommended practices address such things as riser design, mooring system design (stationkeeping), and hazard analysis. The MMS is in the process of incorporating these recommended practices into the existing regulations. Hazard analyses allow MMS to be assured that the operator has anticipated emergencies and is prepared to address such, either through their design or through the operation of the equipment in question.

Conservation Reviews

One of MMS's primary responsibilities is to ensure development of economically producible reservoirs according to sound conservation, engineering, and economic practices. The MMS has established requirements for the submission of conservation information (NTL 2000-N05) for production activities. Conservation reviews are performed to ensure that economic reserves are fully developed and produced.

Development Operations and Coordination Documents

Development Operations Coordination Documents (DOCD's) must be submitted to MMS for review and decision before any development operations can begin on a lease in the CPA or WPA. The DOCD's describe the proposed development activities, drilling activities, platforms or other facilities, proposed production operations, environmental monitoring plans, and other relevant information, and include a proposed schedule of development and production activities. Requirements for lessees and operators submitting a DOCD are addressed in 30 CFR 250.204, and information guidelines for DOCD's are given in NTL 2000-G10, dated April 27, 2000.

After receiving a DOCD, MMS performs technical and environmental reviews. The MMS evaluates the proposed activity for potential impacts relative to geohazards and manmade hazards (including existing pipelines), archaeological resources, endangered species, sensitive biological features, water and air quality, oil-spill response, and other uses (e.g., military operations) of the OCS. The DOCD is reviewed for compliance with all applicable laws and regulations.

A CER, EA, and/or EIS is prepared in support of the NEPA environmental review of a DOCD. The CER, EA, and/or EIS is based on available information, which may include the geophysical report (for determining the potential for the presence of deepwater benthic communities); archaeological report; air emissions data; live-bottom survey and report; biological monitoring plan; and recommendations by the affected State(s), DOD, FWS (for selected plans under provisions of a DOI agreement), NOAA Fisheries, and/or internal MMS offices.

As part of the review process, the DOCD and supporting environmental information may be sent to the affected State(s) for consistency certification review and determination under the States' approved CZM programs. The OCSLA (43 U.S.C. 1345(a) through (d) and 43 U.S.C. 1351(a)(3)) provides for this coordination and consultation with the affected State and local governments concerning a DOCD.

Alternative Compliance and Departures

The MMS project-specific engineering safety review ensures that the equipment proposed for use is designed to withstand the operational and environmental condition in which it will operate. When an OCS operator proposes the use of technology or procedures not specifically addressed in established MMS regulations, the operations are evaluated for alternative compliance or departure approval. Any new technologies or equipment that represent an alternative compliance or departure from existing MMS regulation must be fully described and justified before such will be approved for use. For MMS to grant alternative compliance or departure approval, the operator must demonstrate an equivalent or improved degree of protection as specified in 30 CFR 250.103(a). Comparative analysis with other approved systems, equipment, and procedures is one tool that MMS uses to assess the adequacy of protection provided by alternative technology or operations. Actual operational experience is necessary with alternative compliance measures before MMS will consider them as proven technology. A departure from established requirements may also be approved by MMS, when necessary, for the proper control of a well, the facilitation of the proper development of a lease, the conservation of natural resources, or the protection of life, property, or the marine, coastal, or human environment as specified in 30 CFR 250.103(b).

New and Unusual Technologies

New and unusual technologies are identified through the EP, DWOP, or DOCD review processes. Some of these technologies are extended applications of existing technologies and interface with the environment in essentially the same way as the "old technologies." These technologies provide an equal or greater level of performance (safety and environmental protection). Such technologies are reviewed for alternative compliance or departures and do not trigger additional environmental review. Some recent examples of new technologies that do not affect the environment differently are synthetic mooring lines, subsurface safety devices, and multiplex subsea controls.

New or unusual technology means equipment and/or procedures that (1) function in a manner that potentially causes different impacts to the environment than the equipment or procedures did in the past; (2) have not been used previously or extensively in an MMS OCS Region; (3) have not been used previously under the anticipated operating conditions; or (4) have operating characteristics that are outside the performance parameters established under 30 CFR 250 Subpart B. Some new technologies differ in how they function or interface with the environment. These include equipment or procedures that have not been previously used in the Gulf OCS and so have not been assessed by MMS through technical and environmental reviews; some are new equipment and systems that have never been installed on the OCS. New technologies may be outside the framework established by MMS regulations and, thus, their performance (safety, environmental protection, efficiency, etc.) has not been addressed by MMS. The degree to which these new technologies interface with the environment and the potential impacts that may result are considered in determining the level of NEPA review that will be initiated.

Technologies continue to evolve to meet the technical, environmental, and economic challenges of deepwater development. The MMS prepared a programmatic EA to evaluate the potential effects of the deepwater technologies and operations (USDOI, MMS, 2000a). As a supplement to the EA, MMS prepared a series of technical papers that provides a summary description of the different types of structures that may be employed in the development and production of hydrocarbon resources in the deepwater areas of the Gulf of Mexico (Regg et al., 2000). The descriptions and analyses of the EA and technical papers have been used in the preparation of this EIS and are incorporated here by reference.

A recent example of new technology is the proposed use of floating, production, storage, and offloading (FPSO) systems in the Gulf of Mexico. An EIS was completed to evaluate the potential environmental impacts of the use of FPSO's in the Gulf; the final EIS was published in January 2001 (USDOI, MMS, 2001a) and the Record of Decision was made on December 31, 2001. The descriptions and analyses of the FPSO EIS have been used in the preparation of this EIS and are incorporated here by reference. The MMS also funded a comparative risk analysis to understand the potential risks associated with FPSO's (Gilbert et al., 2001).

Emergency Plans

Criteria, models, and procedures for shutdown operations and the orderly evacuation for a pending hurricane have been in place in the Gulf of Mexico OCS for more than 30 years. Operating experience from extensive drilling activities and more than 4,000 platforms during the 30-plus years of the Gulf OCS Program have demonstrated the effectiveness and safety of securing wells and evacuating a facility in advance of severe weather conditions. Preinstallation efforts, historical experience with similar systems, testing, and the actual operating experience (under normal conditions and in response to emergency situations) is to formulate the exact time needed to secure the wells/production facility and to abandon as necessary. Operators will develop site-specific curtailment/securing/evacuation plans that will vary in complexity and formality by operator and type of activity. In general terms, all plans are intended to make sure the facility (or well) is secured in advance of a pending storm or developing emergency. The operating procedures developed during the engineering, design, and manufacturing phases of the project, coupled with the results (recommended actions) from hazard analyses performed, will be used to develop the emergency action/curtailment plans. Evacuation and production curtailment must consider a combination of factors, including the well status (drilling, producing, etc.), and the type and mechanics of wellbore operations. These factors are analyzed onsite through a decisionmaking process that involves onsite facility managers. The emphasis is on making real-time, situation-specific decisions and forecasting based on available information. Details of the shut-in criteria and various alerts are addressed on a case-by-case basis.

Plans for shutting in production from the subsea wells are addressed as part of the emergency curtailment plan. The plan specifies the various alerts and shutdown criteria linked to both weather and facility performance data, with the intent to have operations suspended and the wells secured in the event of a hurricane or emergency situation. Ensuring adequate time to safely and efficiently suspend operations and secure the well is a key component of the planning effort. Clearly defined responsibilities for the facility personnel are part of the successful implementation of the emergency response effort.

For a severe weather event such as a hurricane, emergency curtailment plans would address the criteria and structured procedures for suspending operations and ultimately securing the wellbore(s) prior to weather conditions that could exceed the design operating limitations of the drilling or production unit. For drilling operations, the plan might also address procedures for disconnecting and moving the drilling unit off location after the well has been secured, should the environmental conditions exceed the floating drilling unit's capability to maintain station. Curtailment of operations consists of various stages of "alerts" indicating the deterioration of meteorological, oceanographic, or wellbore conditions. Higher alert levels require increased monitoring, the curtailment of lengthy wellbore operations, and, if conditions warrant, the eventual securing of the well. If conditions improve, operations could resume based on the limitations established in the contingency plan for the known environmental conditions. The same emergency curtailment plans would be implemented in an anticipated or impending emergency situation, such as the threat of terrorist attack.

Neither the MMS nor the Coast Guard mandates that an operator must evacuate a production facility for a hurricane; it is a decision that rests solely with the operator. The Coast Guard does require the submittal of an emergency evacuation plan that addresses the operator's intentions for evacuation of nonessential personnel, egress routes on the production facility, lifesaving and personnel safety devices, firefighting equipment, etc. As activities move farther from shore, it may become safer to not evacuate the facility because helicopter operations become inherently more risky with greater flight times. Severe weather conditions also increase the risks associated with helicopter operations. The precedent for leaving a facility manned during severe weather is established in North Sea and other operating basins.

Redundant, fail-safe, automatic shut-in systems located inside the well bore and at the sea surface, and in some instances also at the seafloor, are designed to prevent or minimize pollution. These systems are designed and tested to ensure proper operation should a production facility or well be catastrophically damaged. Testing occurs at regular intervals with predetermined performance limits designed to ensure functioning of the systems in the event of an emergency.

Permits and Applications

After EP or DOCD approval, the operator submits applications for specific activities to MMS for approval. These applications include those for drilling wells; well-test flaring; temporary well abandonment; installing a well protection structure, production platforms, satellite structures, subsea wellheads and manifolds, and pipelines; installation of production facilities; commencing production operations; platform removal and lease abandonment; and pipeline abandonment.

Wells

The MMS requirements for the drilling of wells can be found at 30 CFR 250 Subpart D. Lessees are required to take precautions to keep all wells under control at all times. The lessee must use the best available and safest technology to enhance the evaluation of abnormal pressure conditions and to minimize the potential for uncontrolled well flow.

Prior to conducting drilling operations, the operator is required to submit and obtain approval for an Application for Permit to Drill (APD). The APD requires detailed information — including project layout at a scale of 24,000:1, design criteria for well control and casing, specifications for blowout preventors, a mud program, cementing program, direction drilling plans, etc. — to allow evaluation of operational safety and pollution-prevention measures. The APD is reviewed for conformance with the engineering requirements and other technical considerations.

The MMS is responsible for conducting technical and safety reviews of all drilling, workover, and production operations on the OCS. These detailed analyses determine if the lessee's proposed operation is in compliance with all regulations and all current health, safety, environmental, and classical engineering standards. Compliance includes requirements for state-of-the-art drilling technology, production safety systems, completion of oil and gas wells, oil-spill contingency plans, pollution-control equipment, hydrogen sulfide contingency plans, and specifications for platform/structure designs. These safety, technical, and engineering reviews involve risk assessment and a thorough analysis of the hazards involved. Safety systems used for drilling, workover, and production operations on the OCS must be designed, installed, used, maintained, and tested in a manner to assure the safety and protection of the human, marine, and coastal environments. Specific requirements for sundry notices for well workovers, completions, and abandonments are detailed in 30 CFR 250 Subparts E, F, and G, respectively.

The MMS regulations at 30 CFR 250.702 address the requirements for permanent abandonment of a well on the OCS. A permanent abandonment includes the isolation of zones in the open wellbore, plugging of perforated intervals, plugging the annular space between casings (if they are open), setting a surface plug, and cutting and retrieving the casing at least 15 ft below the mudline. All plugs must be tested in accordance with the regulations. There are no routine surveys of permanently abandoned well locations. If a well is found to be leaking, MMS would require the operator of record to perform an intervention to repair the abandonment. If a well is temporarily abandoned at the seafloor, an operator must provide MMS with an annual report summarizing plans to permanently abandon the well or to bring the well into production. Part of the annual report for a temporarily abandoned well is a survey of the well location to ensure the temporary abandonment is intact and adequately restricting any reservoir fluids from migrating out of the well. All equipment such as well heads, production trees, casing, manifolds, etc., must be designed to withstand the pressures of the deepwater areas. These designs are verified by MMS through multiple levels of engineering safety reviews prior to the equipment being placed into service.

Platforms and Structures

The MMS does a technical and safety review of all proposed structure designs and installation procedures. All proposed facilities are reviewed for structural integrity. These detailed classical engineering reviews entail an intense evaluation of all operator proposals for fabrication, installation, modification, and repair of all mobile and fixed structures. The lessee must design, fabricate, install, use, inspect, and maintain all platforms and structures on the OCS to assure their structural integrity for the safe conduct of operations at specific locations. Applications for platform and structure approval are filed in accordance with 30 CFR 250.901. Design requirements are presented in detail at 30 CFR 250.904 through 250.909. The lessee evaluates characteristic environmental conditions associated with operational functions to be performed. Factors such as waves, wind, currents, tides, temperature, and the potential for marine growth on the structure are considered. In addition, pursuant to 30 CFR 250.902 and 250.903, a program has been established by MMS to assure that new structures meeting the conditions listed under 30 CFR 250.900(c) are designed, fabricated, and installed using standardized procedures to prevent structural failures. This program facilitates review of such structures and uses third-party expertise and technical input in the verification process through the use of a Certified Verification Agent. After installation, platforms and structures are required to be periodically inspected and maintained under 30 CFR 250.912.

Pipelines

Regulatory processes and jurisdictional authority concerning pipelines on the OCS and in coastal areas are shared by several Federal agencies, including DOI, DOT, COE, the Federal Energy Regulatory Commission (FERC), and the USCG. Aside from pipeline regulations, these agencies have the responsibility of overseeing and regulating the following areas: the placement of structures on the OCS and pipelines in areas that affect navigation; the certification of proposed projects involving the transportation or sale of interstate natural gas, including OCS gas; and the right of eminent domain exercised by pipeline companies. In addition, DOT is responsible for promulgating and enforcing safety regulations for the transportation in or affecting interstate commerce of natural gas, liquefied natural gas (LNG), and hazardous liquids by pipeline. This includes all offshore pipelines on State lands beneath navigable waters and on the OCS. The regulations are contained in 49 CFR 191 through 193 and 195. In a Memorandum of Understanding (MOU) between DOT and DOI dated December 10, 1996, each party's respective regulatory responsibilities are outlined. The DOT is responsible for establishing and enforcing design, construction, operation, and maintenance regulations, and for investigating accidents for all OCS transportation pipelines beginning downstream of the point at which operating responsibility transfers from a producing operator to a transporting operator. The DOI's responsibility extends upstream from the transfer point described above.

The MMS is responsible for regulatory oversight of the design, installation, and maintenance of OCS oil and gas pipelines. The MMS operating regulations for pipelines found at 30 CFR 250 Subpart J are intended to provide safe and pollution-free transportation of fluids in a manner that does not unduly interfere with other users of the OCS. Pipeline applications are usually submitted and reviewed separately from development and production plans. Pipeline applications may be for on-lease pipelines or right-of-way for pipelines that cross other lessees' leases or unleased areas of the OCS. Pipeline permit applications to MMS include the pipeline location drawing, profile drawing, safety schematic drawing, pipe design data to scale, a shallow hazard survey report, and an archaeological report.

The DOI has regulatory responsibility for all producer-operated pipelines that cross directly into State waters without first connecting to a transportation operator's common-carrier pipeline on the OCS. The DOI's responsibility extends downstream from the first production well to the last valve and associated safety equipment on the last OCS-related production system along the pipeline. The DOT's regulatory responsibility extends shoreward from the last valve on the last OCS-related production facility.

The MMS evaluates the design, fabrication, installation, and maintenance of pipelines. Proposed pipeline routes are evaluated for potential seafloor or subsea geologic hazards and other natural or manmade seafloor or subsurface features or conditions (including other pipelines) that could have an adverse impact on the pipeline or that could be adversely impacted by the proposed operations. Routes are also evaluated for potential impacts on archaeological resources and biological communities. A CER, EA, and/or EIS is prepared in accordance with applicable policies and guidelines. The MMS prepares an EA and/or an EIS on all pipeline rights-of-way that go ashore. The FWS reviews and provides comments on applications for pipelines that are near certain sensitive biological communities. No pipeline route will be approved by MMS if any bottom-disturbing activities (from the pipeline itself or from the anchors of lay barges and support vessels) encroach on any biologically sensitive areas.

The design of the proposed pipeline is evaluated for appropriate cathodic protection system to protect the pipeline from leaks resulting from the effects of external corrosion of the pipe; external pipeline coating system to prolong the service life of the pipeline; measures to protect the inside of the pipeline from the detrimental effects, if any, of the fluids being transported; the submersibility of the line (i.e., that the pipeline will remain in place on the seafloor and not have the potential to float, even if empty or filled with gas rather than liquids); proposed operating pressure of the line, and protection of other pipelines crossing the proposed route. Such an evaluation includes reviewing the calculations used by the applicant in order to determine whether the applicant properly considered such elements as the grade of pipe to be used, the wall thickness of the pipe, derating factors related to the submerged and riser portions of the pipeline, the pressure rating of any valves or flanges to be installed in the pipeline, the pressure rating of any other pipeline(s) into which the proposed line might be tied, the required pressure to which the line must be tested before it is placed in service; protective devices such as pressure sensors and remotely operated valves, the physical arrangement of those devices proposed to be installed by the applicant for the purposes of protecting the pipeline from possible overpressure conditions and for detecting and initiating a response to abnormally low-pressure conditions; and the applicant's planned compliance with regulations requiring that pipelines greater than 8 5/8 inches in diameter and installed in water depths less than 200 ft shall be buried to a depth of at least 3 ft (30 CFR 250.1003). In addition, pipelines crossing fairways require a COE permit and must be buried to a depth of at least 10 ft.

Operators are required to periodically inspect pipeline routes. Monthly overflights are conducted to inspect pipeline routes for leakage.

Applications for pipeline abandonment must also be submitted for MMS review and approval. Abandonment applications are evaluated to ensure they will render the pipeline inert and/or to minimize the potential for the pipeline becoming a source of pollution by flushing and plugging it; and minimize the likelihood that the abandoned line will become an obstruction to other users of the OCS by filling it and burying the ends.

Inspection and Enforcement

The OCSLA authorizes and requires MMS to provide for both an annual scheduled inspection and a periodic unscheduled (unannounced) inspection of all oil and gas operations on the OCS. The inspections are to assure compliance with all regulatory constraints that allowed commencement of the operation.

The primary objective of an initial inspection is to assure proper installation of mobile drilling units and fixed structures, and proper functionality of their safety and pollution prevention equipment. After operations begin, additional announced and unannounced inspections are conducted. Unannounced inspections are conducted to foster a climate of safe operations, to maintain an MMS presence, and to focus on operators with a poor performance record. These inspections are also conducted after a critical safety feature has previously been found defective. Poor performance generally means that more frequent unannounced inspections may be conducted on a violator's operation.

The annual inspection examines all safety equipment designed to prevent blowouts, fires, spills, or other major accidents. These annual inspections involve the inspection for installation and performance of all platform safety system components.

The inspectors follow the guidelines as established by the regulations, API RP 14C, and the specific MMS-approved plan. The MMS inspectors perform these inspections using a national checklist called the Potential Incident of Noncompliance (PINC) list. This list is a compilation of yes/no questions derived from all regulated safety and environmental requirements. Information PINC's can be found at http://www.mms.gov/regcompliance/inspect.htm.

The MMS administers an active civil penalties program (30 CFR 250, Subpart N). A civil penalty in the form of substantial monetary fines may be issued against any operator that commits a violation that may constitute a threat of serious, irreparable, or immediate harm or damage to life, property, or the environment. The MMS may make recommendations for criminal penalties if a willful violation occurs. In addition, the regulation at 30 CFR 250.173(a) authorizes suspension of any operation in the GOM Region if the lessee has failed to comply with a provision of any applicable law, regulation, or order or provision of a lease or permit. Furthermore, the Secretary may invoke his authority under 30 CFR 250.185(c) and cancel a lease.

Pollution Prevention, Oil-Spill Response Plans, and Financial Responsibility

Pollution prevention is addressed through proper design and requirements for safety devices to prevent continued flow from a well should a rupture in one of the pipelines or risers occur. Redundancy is provided for critical safety devices that will shut off flow from the well if, for example, a riser were to rupture. Wells, particularly subsea wells, include a number of sensors that help in detecting pressures and the potential for leaks in the production system. Safety devices are monitored and tested frequently to ensure their operation should an incident occur. Barriers are monitored to provide early warning of potential for loss containment. Contingency plans for dealing with a spill are addressed as part of the project-specific OCS development plan, which also requires MMS review and approval before development begins.

The MMS has regulations (30 CFR 250.300) to ensure that lessees do not create conditions that will pose an unreasonable risk to public health, life, property, aquatic life, wildlife, recreation, navigation, commercial fishing, or other uses of the ocean during offshore oil and gas operations. Control and removal of pollution is the responsibility and at the expense of the lessee. Operators are required to install curbs, gutters, drip pans, and drains on platform and rig deck areas in a manner necessary to collect all contaminants and debris not authorized for discharge. The rules also explicitly prohibit the disposal of equipment, cables, chains, containers, or other materials into offshore waters. Portable equipment, spools or reels, drums, pallets, and other loose items must be marked in a durable manner with the owner's name prior to use or transport over offshore waters. Smaller objects must be stored in a marked container when not in use. Operational discharges such as produced water and drilling muds and cuttings are regulated by the USEPA through the NPDES program. The MMS may restrict the rate of drilling fluid discharge or prescribe alternative discharge methods.

To ensure that safety devices are operating properly, MMS incorporates the American Petroleum Institute (API) Recommended Practice (RP) 14C into the operating regulations. API RP 14C incorporates the knowledge and experience of the oil and gas industry regarding the analysis, design, installation, and testing of the safety devices used to prevent pollution. API RP 14C presents proven practices for providing these safety devices for offshore production platforms. Proper application of these practices, along with good design, maintenance, and operation of the entire production facility, should provide an operationally safe and pollution-free production platform.

The MMS's responsibilities under OPA 90 include spill prevention in Federal and State offshore waters, review and approval of oil-spill response plans (OSRP's), inspection of oil-spill containment and cleanup equipment, and ensuring oil-spill financial responsibility. The MMS regulations (30 CFR 254) require that all owners and operators of oil handling, storage, or transportation facilities located seaward of the coastline submit an OSRP for approval. The regulation at 30 CFR 254.2 requires that an OSRP must be submitted and approved before an operator can use a facility, or the operator must certify in writing to the MMS that it is capable of responding to a "worst-case" spill or the substantial threat of such a spill. The facility must be operated in compliance with the approved OSRP or the MMS-accepted "worst-case" spill certification. Owners or operators of offshore pipelines are required to submit an OSRP for any pipeline that carries oil, condensate, or gas with condensate; pipelines carrying essentially dry gas do not require an OSRP. The OSRP describes how an operator intends to respond to an oil spill. The OSRP may be site-specific or regional. The Emergency Response Action Plan within the OSRP outlines the availability of spill containment and cleanup equipment and trained personnel. It must ensure that full-response capability can be deployed during an oil-spill incident. The OSRP includes an inventory of appropriate equipment and materials, their availability, and the time needed for deployment. All MMS-approved OSRP's must be reviewed at least every two years and all resulting modifications must be submitted to MMS within 15 days whenever

(1) a change occurs that appreciably reduces an owner/operator's response capabilities;

(2) a substantial change occurs in the worst-case discharge scenario or in the type of oil being handled, stored, or transported at the facility;

(3) there is a change in the name(s) or capabilities of the oil-spill removal organizations cited in the OSRP; or

(4) there is a change in the applicable Area Contingency Plans.

The responsible party for every covered offshore facility must demonstrate oil-spill financial responsibility (OSFR) as required by OPA 90 (30 CFR 253). A covered offshore facility is any structure and all of its components, equipment, pipeline, or device (other than a vessel or other than a pipeline or deepwater port licensed under the Deepwater Port Act of 1974) used for exploring, drilling, or producing oil, or for transporting oil from such facilities. The MMS ensures that each responsible party has sufficient funds for removal costs and damages resulting from the accidental release of liquid hydrocarbons into the environment for which the responsible party is liable.

Air Emissions

The OCSLA (43 U.S.C. 1334(a)(8)) requires the Secretary of the Interior to promulgate and administer regulations that comply with the National Ambient Air Quality Standards (NAAQS) pursuant to the Clean Air Act (CAA) (42 U.S.C. 7401 *et seq*.) to the extent that authorized activities significantly affect the air quality of any State. Under provisions of the CAA Amendments (CAAA) of 1990, the USEPA Administrator has jurisdiction and, in consultation with the Secretary of the Interior and the Commandant of the Coast Guard, established the requirements to control air pollution in OCS areas of the Pacific, Atlantic, Arctic, and eastward of 87°30′W. longitude in the GOM. The OCS area westward of 87°30′W. longitude in the Gulf is under MMS air quality jurisdiction.

For OCS air emission sources located east of 87°30′W. longitude and within 25 mi of the States' seaward boundaries, the requirements are the same as the requirements that would be applicable if the source were located in the corresponding onshore area. The USEPA requirements for these OCS areas are at 40 CFR 55, Appendix A. For emission sources located beyond the 25 mi of the States' boundaries, the sources are subject to Federal requirements for Prevention of Significant Deterioration (PSD). The regulations also establish procedures to allow the USEPA Administrator to exempt any OCS source from a control technology requirement if it is technically infeasible or poses unreasonable threat to health or safety.

For OCS air emission sources west of 87°30′W. longitude, the MMS established the regulations at 30 CFR 250 Subpart C to comply with the Clean Air Act. The regulated pollutants include carbon monoxide, suspended particulates, sulphur dioxide, nitrogen oxides, total hydrocarbons, and volatile organic compounds (as a precursor to ozone). In areas where hydrogen sulfide may be present, operations are regulated by 30 CFR 250.417. All new or supplemental EP's and DOCD's must include air emissions information sufficient to make an air quality determination. The MMS regulations provide for the collection of information about potential sources of pollution in order to determine whether projected emissions of air pollutants from a facility may result in onshore ambient air concentrations above USEPA significance levels and to identify appropriate emissions controls to prevent accidents and air quality deterioration.

Emissions data for new or modified onshore facilities directly associated with proposed OCS activities are required to be included in the development plan to enable each affected State to make a determination of the effects on its air quality.

The MMS uses a three-level hierarchy of criteria to evaluate the potential impact of offshore emission sources upon onshore receptors. The evaluation criteria are (1) exemption level, (2) significance level, and (3) maximum allowable increase. If the proposed activities exceed the criteria at the first level, they are then evaluated against the set of criteria at the next level; the same for the second to third levels.

The first step is to compare the worst-case emissions to the MMS exemption criteria. This corresponds to the USEPA screening step. Since there is no screening model suitable for use with offshore emission sources, MMS uses simple equations to calculate the screening thresholds or "exemption levels." If the emissions associated with the proposed activities are below the exemption levels, the proposed actions are exempt from further air quality review and modeling with the Offshore and Coastal Dispersal (OCD) model is not required.

The second step requires refined modeling using OCD if the exemption level is exceeded. The modeled onshore impacts are compared to MMS's codified significance levels. In the event the significance level is exceeded in the second step, the operator would be required to apply best available control technology and remodel the resulting emissions. If the resulting impact is still above the significance level, the operator must comply with the third step by demonstrating that the cumulative impact to onshore areas is below the maximum allowable increase or the operator must offset the emissions. The maximum allowable increase is determined by the PSD classification of the potentially affected onshore area. The maximum allowable increase for a Class II area is higher than for a Class I area. For large sources potentially affecting Class I areas, the MMS actively consults with the designated Federal land manager. The MMS consults with the Federal land manager for all permanent large sources affecting Class I areas, including any modification to an existing large facility that results in any increase in emissions above the previously approved levels of the PSD regulated pollutants.

It is worth noting that to date no plan has ever been submitted in the GOMR that required the need to go the third step in the review process — all MMS-approved emissions are below the MMS's significance levels. Additionally, to date, no Gulf Region plan has had to undergo Federal land manager consultation for particulate matter, and all plans that underwent Federal land manger consultation for NO_2 or SO_2 were deemed to "not significantly consume the increment."

Flaring

Flaring is the venting and/or burning of natural gas from a specially designed boom. Flaring systems are also used to vent gas during well testing or during repair/installation of production equipment. The MMS heavily regulates flaring to minimize the loss of natural gas resources. The MMS policy, in accordance with 30 CFR 250.175, is to not allow flaring or venting of natural gas on an extended basis, but regulations do provide for some limited volume, short duration (typically 2-14 days) flaring or venting upon approval by MMS. Such flaring or venting may be conducted as part of unloading/testing operations that are necessary to remove potentially damaging completion fluids from the well bore, to provide sufficient reservoir data for the operator to evaluate a reservoir and development options, and in emergency situations. Under extraordinary circumstances, special flaring approval may be granted. Substantial justification must be provided for each flaring request.

Hydrogen Sulfide Contingency Plans

The operator of a lease must request that MMS make a determination regarding the presence of hydrogen sulfide (H_2S) gas pursuant to 30 CFR 250.203, 30 CFR 250.204, and 30 CFR 250.417. The MMS classifies an area of proposed operations as (1) H_2S absent, (2) H_2S present, or (3) H_2S unknown.

All operators on the OCS involved in production of sour hydrocarbons that could result in atmospheric H_2S concentrations above 20 ppm are required to file an H_2S contingency plan. This plan must include procedures to ensure the safety of the workers on the production facility and contingencies for simultaneous drilling, well-completion, well-workovers, and production operations. The lessee/operator must take all necessary and practicable precautions to protect personnel from the toxic effects of H_2S and to mitigate the adverse effects of H_2S to property and the environment. All operators are required to adhere to the National Association of Corrosion Engineers' (NACE) *Standard Material Requirement MRO175-97 for Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment* (NACE International, 1997). These engineering standards enhance the integrity of the infrastructure used to produce the sour oil and gas. In addition, the API has also developed *Recommended Practices for Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide* (API, 1995).

The MMS issued rules governing requirements for preventing hydrogen sulfide releases, detecting and monitoring hydrogen sulfide and sulphur dioxide, protecting personnel, providing warning systems, and establishing requirements for hydrogen sulfide flaring. NTL 98-16, titled "Hydrogen Sulfide (H_2S) Requirements," provides clarification, guidance, and information on the requirements. The NTL provides guidance on sensor location, sensor calibration, respirator breathing time, measures for protection against sulfur dioxide, requirements for classifying an area for the presence of H_2S, requirements for flaring and venting of gas containing H_2S, and other issues pertaining to H_2S-related operations.

Archaeological Resources Regulation

The archaeological resources regulation at 30 CFR 250.194 grants specific authority to each MMS Regional Director to require archaeological resource surveys and reports where deemed necessary. The technical requirements of the archaeological resource surveys are detailed in NTL 98-06, issued by the MMS, Gulf of Mexico OCS Region. The regulation at 30 CFR 250.126 requires the lessee to include an archaeological report with an EP or DOCD. If the evidence suggests that an archaeological resource may be present, the lessee must either locate the site of any operation so as not to adversely affect the area where the archaeological resource may be, demonstrate that an archaeological resource does not exist, or demonstrate that archaeological resources will not be adversely affected by operations. If the lessee discovers any archaeological resource while conducting approved operations, operations must be immediately stopped and the discovery reported to the MMS Regional Director.

Coastal Zone Management Consistency Review and Appeals for Plans

Pursuant to the Coastal Zone Management Act (CZMA), a State with an approved Coastal Zone Management (CZM) plan reviews certain OCS activities to determine whether they will be conducted in a manner consistent with their approved plan. This review authority is applicable to activities described in detail in any plan for the exploration or development of any area that has been leased under the OCSLA and that affects any land or water use or natural resource within the State's coastal zone (16 U.S.C. 1456(c)(3)(B)). The MMS may not issue a permit for activities described in an EP or DOCD unless the State concurs or is conclusively presumed to have concurred that the OCS plan is consistent with its CZM plan (43 U.S.C. 1340(c) and 1351(d); 16 U.S.C. 1456(c)(3)).

The information requirements for CZM purposes are found at 30 CFR 250.203 and 250.204 and are discussed in NTL 2000-G10. Under the CZMA, each State with an approved CZM plan may require information that is different than that specifically outlined in these regulations. All of the Gulf States have approved CZM programs. Requirements for the abbreviated format of environmental information for Texas, Louisiana, Mississippi, and Alabama, and the long-form format required for activity determined to affect the State of Florida are given in Appendices H and I of NTL 2000-G10. A State CZM agency is required to ensure timely public notice of their receipt of an OCS plan that has been submitted for their CZM consistency determination (15 CFR 930.78(b) and 15 CFR 930.84(a)).

In accordance with the requirements of 15 CFR 930.76(b), the MMS, Gulf of Mexico OCS Region sends copies of an OCS plan, including the consistency certification and other necessary information, to the designated State CZM agency by receipted mail. If no State-agency objection is submitted by the end of the consistency review period, MMS shall presume consistency concurrence by the State (15 CFR 930.79(a) and (b)). Similar procedures are followed for amended, revised, and modified plans.

If a written consistency concurrence is received from the State, the MMS may then approve any permit for activities described in the OCS plan in accordance with 15 CFR 930.63(c). The MMS does not impose or enforce additional State conditions when issuing permits. The MMS can require modification of a plan if the operator has agreed to certain requirements requested by the State.

If the MMS receives a written consistency objection from the State containing all the items required in 15 CFR 930.79(c) before the expiration of the review period, the MMS will not approve any activity described in the OCS plan unless (1) the operator amends the OCS plan to accommodate the objection in accordance with 15 CFR 930.83 and concurrence is subsequently received or conclusively presumed; (2) upon appeal, the Secretary of Commerce, in accordance with 15 CFR 930.120, finds that the OCS plan is consistent with the objectives or purposes of the CZMA or is necessary in the interest of national security; or (3) the original objection is declared invalid by the courts.

Best Available and Safest Technologies

To assure that oil and gas exploration, development, and production activities on the OCS are conducted in a safe and pollution-free manner, 43 U.S.C. 1347(b) of the OCSLA, as amended, requires that all OCS technologies and operations use the best available and safest technology (BAST) that the Secretary determines to be economically feasible. Conformance to the standards, codes, and practices referenced in 30 CFR 250 is considered to be the application of BAST. These standards, codes, and practices include requirements for state-of-the-art drilling technology, production safety systems, completion of oil and gas wells, oil-spill response plans, pollution-control equipment, and specifications for platform/structure designs. The MMS conducts periodic offshore inspections, and continuously and systematically reviews OCS technologies to ensure that the best available and safest technologies are applied to OCS operations. The BAST is not required when the MMS determines that the incremental benefits are clearly insufficient to justify increased costs; however, it is the responsibility of an operator of an existing operation to demonstrate why application of a new technology would not be feasible. This requirement is applicable to equipment and procedures that, if failed, would have a significant effect on safety, health, or the environment, unless benefits clearly do not justify the cost (30 CFR 250.107(c) and (d)).

The BAST concept is addressed in the MMS, Gulf of Mexico OCS Region by a continuous effort to locate and evaluate the latest technologies and to report on these advances at periodic Regional Operations Technology Assessment Committee (ROTAC) meetings. A part of the MMS staff has an ongoing function to evaluate various vendors and industry representatives' innovations and improvements in techniques, tools, equipment, procedures, and technologies applicable to oil and gas operations (drilling, producing, completion, and workover operations). This information is provided to MMS district personnel at ROTAC meetings. The requirement for the use of BAST has, for the most part, been an evolutionary process whereby advances in equipment, technologies, and procedures have been integrated into OCS operations over a period of time. An awareness by both MMS inspectors and the OCS operators of the most advanced equipment and technologies has resulted in the incorporation of these advances into day-to-day operations. An example of such an equipment change that evolved over a period of time would be the upgrading of diverter systems on drilling rigs from the smaller diameter systems of the past to the large-diameter, high-capacity systems found on drilling rigs operating on the OCS today. Another example of a BAST-required equipment change would be the requirement to replace subsurface-controlled, subsurface safety valves with surface-controlled, subsurface safety-valve systems, which incorporate a more positive closure design and operation.

Production Facilities

The MMS's regulations governing oil and gas production safety systems are found in 30 CFR 250 Subpart H. Production safety equipment used on the OCS must be designed, installed, used, maintained, and tested in a manner to assure the safety and protection of the human, marine, and coastal environments. All tubing installations open to hydrocarbon-bearing zones below the surface must be equipped with safety devices that will shut off the flow from the well in the event of an emergency, unless the well is incapable of flowing. Surface- and subsurface-controlled safety valves and locks must conform to the requirements of 30 CFR 250.801. All surface production facilities, including separators, treaters, compressors, headers, and flowlines must be designed, installed, and maintained in a manner that provides for efficiency, safety of operations, and protection of the environment. Production facilities also have stringent requirements concerning electrical systems, flowlines, engines, and firefighting systems. The safety-system devices are tested by the lessee at specified intervals and must be in accordance with API RP 14 C Appendix D and other measures.

Personnel Training and Education

An important factor in ensuring that offshore oil and gas operations are carried out in a manner that emphasizes operational safety and minimizes the risk of environmental damage is the proper training of personnel. Under 30 CFR 250 Subpart O, the MMS has consolidated its training requirements. The goal of the regulations (30 CFR 250.1502) is to ensure that employees who work in the following areas receive approved training that will result in safe and clean operations: (1) drilling well control, (2) well-completion/well-workover well control, (3) well-servicing well control, and (4) production safety systems. The elements of each of these training classes are listed in 30 CFR 250.1520. The MMS also accredits training organizations to teach the classes (30 CFR 250 1514). The MMS specifies requirements for a written test and hands-on simulator and well test (30 CFR 250.1518 and 1519).

The mandatory Drilling Well-Control Training Program was instituted by MMS in 1979. In 1983, the mandatory Safety Device Training Program was established to ensure that personnel involved in installing, inspecting, testing, and maintaining safety devices are qualified. As a preventive measure, all offshore personnel must be trained to operate oil-spill cleanup equipment, or the lessee must retain a trained contractor(s) to operate the equipment for them. In addition, MMS offers numerous technical seminars to ensure that personnel are capable of performing their duties and are incorporating the most up-to-date safety procedures and technology in the petroleum industry. In 1994, the Office of Safety Management (OSM) created the MMS Offshore Training Institute to develop and implement an inspector training program. The institute introduced state-of-the art multimedia training to the inspector work force and has produced a series of interactive computer training modules.

Structure Removal and Site Clearance

Under MMS operating regulations and lease agreements, all lessees must remove objects and obstructions upon termination of a lease. Lessees must ensure that all objects related to their activities are removed following termination of their lease. NTL 98-26, dated November 30, 1998, establishes site clearance verification procedures that include trawling the cleared site over 100 percent of the established clearance radii by a licensed shrimper. The MMS requires lessees to submit a procedural plan for site clearance verification. Lessees are required to file reports on the results of their site clearance activities. Pipelines may be abandoned in place.

Lessees/operators must notify the MMS at least 30 days before a structure removal and provide information that includes the following: complete identification of the structure; size of the structure (number and size of legs and pilings); removal technique to be employed (if explosives are to be used, the amount and type of explosive per charge); and the number and size of well conductors to be removed. At present, if a structure removal involves the use of explosives, an EA is prepared and an Endangered Species Act Section 7 consultation is initiated with NOAA Fisheries. The NOAA Fisheries issued a "standard" Biological Opinion on July 25, 1988, which covers removal operations that meet specified criteria pertaining to the size of explosive charge used, detonation depth, and number of blasts per structure grouping. The use of explosives to cut offshore oil/gas structure legs/pilings for removal could cause injury or death to protected marine mammals and endangered sea turtles. The MMS has consulted with NOAA Fisheries and, together, the two agencies have a history of developing structure removal precautions. The MMS continues to work with NOAA Fisheries on this issue as structures are placed in deeper waters of the Gulf and as more data is gathered concerning explosive removals. The MMS, NOAA Fisheries, and lessees are cooperating in an observer/monitoring program to determine the presence of marine mammals and/or sea turtles in the vicinity of the structure removals. The NOAA Fisheries sends approved observers to every structure removal where explosives are used. The NOAA Fisheries Observer Program began in 1986. The number of documented sea turtles impacted by explosives was two during 1986-1994 (Gitschlag and Herczeg, 1994; NRC, 1996), one in 1997 (Gitschlag, personal communication, 1999), one in 1998 (Shah, personal communication, 1998), and one in 2001 (Gitschlag, personal communication, 2001). A total of six additional sea turtles have been captured and removed prior to detonation of explosives for platform removal (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997). If cetaceans are observed in the vicinity of a removal site, detonations are postponed until the animals have vacated the area.

Rigs-to-Reefs

Rigs-to-Reefs (RTR) is a catchy term for converting obsolete, nonproductive offshore oil and gas platforms to designated artificial reefs (Dauterive, 2000). Disposal of obsolete offshore oil and gas platforms is not only a financial liability for the oil and gas industry but can be a loss of productive marine habitat. The use of obsolete oil and gas platforms for reefs has proven to be highly successful. Their availability, design profile, durability, and stability provide a number of advantages over the use of traditional artificial reef materials. To capture this recyclable and valuable fish habitat, the States of Louisiana, Texas, and Mississippi in 1986, 1989, and 1999, respectively, passed enabling legislation and signed into law RTR plans for their respective States. Alabama and Florida have no RTR legislation. The State laws set up a mechanism to transfer ownership and liability of the platform from oil and gas companies to the State when the platform ceases production and the lease is terminated. The company (donor) saves money by donating a platform to the State (recipient) for a reef rather than scrapping the platform onshore. The industry then donates 50 percent of the savings to the State to run the State's artificial reef program. Since the inception of the RTR plans, more than 141 retired platforms have been donated and used for reefs in the Gulf of Mexico.

1.6. OTHER OCS-RELATED ACTIVITIES

The MMS has programs and activities that are OCS related but not specific to the leasing process or to the management of exploration, development, and production activities. These programs include both environmental and technical studies, and cooperative agreements with other Federal and State agencies for NEPA work, joint jurisdiction cooperative efforts, inspection actives, and regulatory enforcement. The MMS also participates in industry research efforts and forums.

Environmental Studies Program

An Environmental Studies Program (ESP) was established in accordance with Section 20 of the OCSLA. The program funds studies to establish information needed for assessment and management of environmental impacts on the human, marine, and coastal environments of the OCS and the coastal areas that may be affected by oil and gas development. As a part of the ESP, the Gulf of Mexico Region has funded more than 350 completed or ongoing environmental studies. The types of studies funded include

- literature reviews and baseline studies of the physical, chemical, and biological environment of the shelf;
- literature review and studies of the physical, chemical, and biological environment of deep water (>300 m);
- studies of the socioeconomic impacts along the Gulf Coast; and
- studies of the effects of oil and gas activities on the marine environment.

Information collected through these studies is used to evaluate the impacts of oil and gas activities on the Gulf of Mexico OCS.

Technical Assessment & Research Program

The Technical Assessment & Research (TA&R) Program supports research associated with operational safety and pollution prevention as well as oil-spill response and cleanup capabilities. The TA&R Program is comprised of two functional research activities: (1) operational safety and engineering research; and (2) oil-spill research. The TA&R Program has four primary objectives.

- Technical Support – Providing engineering support in evaluating industry operational proposals and related technical issues and in ensuring that these proposals comply with applicable regulations, rules, and operational guidelines and standards.
- Technology Assessment – Investigating and assessing industry applications of technological innovations and ensuring that governing MMS regulations, rules, and operational guidelines ensure the use of the best available and safest technologies (BAST) (Chapter 1.5).
- Research Catalyst – Promoting and participating in industry research initiatives in the fields of operational safety, engineering research, and oil-spill response and cleanup research.
- International Regulations – Supporting international cooperative efforts for research and development initiatives to enhance the safety of offshore oil and natural gas activities and the development of appropriate regulatory program elements worldwide.

Interagency Agreements

Cooperating Agency Agreements under NEPA

Section 1500.5(b) of the CEQ implementing regulations (40 CFR 1500.5(b)) encourages agency cooperation early in the NEPA process. A Federal agency can be a lead, joint lead, or cooperating agency. A lead agency manages the NEPA process and is responsible for the preparation of an EIS; a joint lead Agency shares these responsibilities; and a cooperating agency that has jurisdiction by law and has special expertise with respect to any environmental issue shall participate in the NEPA process upon the request of the lead agency.

When an agency is requested and agrees to become a Cooperating Agency, the cooperating and lead agencies usually enter into a Cooperating Agency Agreement. The Agreement details the responsibilities of each participating agency.

The MMS has entered into agreements with State and Federal agencies. The MMS, as lead agency, has requested other Federal agencies to enter into Cooperating Agency Agreements (e.g., the Destin Dome 56 Unit project); other agencies have requested MMS to become a cooperating agency (e.g., the Gulfstream Gas Pipeline project). The MMS has been, is, and will be involved in Cooperating Agency Agreements with USEPA, COE, Federal Energy Regulatory Commission (FERC), and the Department of Transportation. Some projects, such as major gas pipelines across Federal waters and projects under the Deepwater Port Act of 1974, can require cooperative efforts by multiple Federal and State agencies.

Memorandum of Understanding Between MMS and Coast Guard

Given the overlap in jurisdictions of MMS and the Coast Guard and the large array of regulatory provisions pertaining to activities on the OCS, MMS and the Coast Guard have established a formal Memorandum of Understanding (MOU) that delineates lead responsibilities for managing OCS activities in accordance with OCSLA and OPA 90. The MOU, dated August 1989 and updated December 1998 (and published in the *Federal Register* on January 15, 1999), is designed to minimize duplication and promote consistent regulation of facilities under the jurisdiction of both agencies.

Generally, the MOU identifies MMS as the lead agency for matters concerning the equipment and operations directly involved in the production of oil and gas. These include, among others, design and operation of risers, permanent mooring foundations of the facility, drilling and well production and services, inspection and testing of all drilling-related equipment, and platform decommissioning. Issues regarding the safe operation of the facility, its systems, and the equipment needed to support all operations on board generally fall under the jurisdiction of the Coast Guard. These include, among others, design of vessels, their seakeeping characteristics, propulsion and dynamic positioning systems, supply and lightering procedures and equipment, utility systems, safety equipment and procedures, and pollution prevention and response procedures. Both agencies will continue to be responsible for accident investigations. For incidents for which both agencies have an investigative interest in the systems involved, one agency will assume lead investigative responsibility with supporting participation provided by the other agency.

International Activities and Marine Minerals Division

The International Activities and Marine Minerals Division (INTERMAR) has a dual role in MMS. On behalf of MMS, it functions as a liaison for agency involvement in International Activities and it provides policy direction for management of minerals resources on the Federal OCS. The MMS's nonenergy minerals program in the Gulf is described in Chapter 4.1.3.2.2.

CHAPTER 2

ALTERNATIVES INCLUDING THE PROPOSED ACTION

2. ALTERNATIVES INCLUDING THE PROPOSED ACTIONS

2.1. MULTISALE NEPA ANALYSIS

This environmental impact statement (EIS) is being prepared in support of the nine areawide oil and gas lease sales in the Central and Western Planning Areas (CPA and WPA) of the Gulf of Mexico OCS (Figure 1-1). These lease sales are scheduled for 2003-2007 under the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007* (5-Year Program). An environmental assessment (EA) was prepared on the first sale in the 5-Year Program (Western Gulf Sale 184); that proposed lease sale is not included in this EIS. Federal regulations allow for several similar proposals to be analyzed in one EIS (40 CFR 1502.4). Given the similar and annual nature of these areawide lease sales, multisale EIS's are appropriate. This multisale EIS will lessen duplication and save resources. The multisale EIS is intended to focus the NEPA/EIS process on differences among the proposed sales and on significant environmental issues and recent information.

Although this EIS addresses nine proposed sale actions, each sale will have a separate decision process. This EIS will serve as a decision-support document for Sales 185 and 187, which are scheduled for 2003. The multisale approach allows the prelease process for subsequent lease sales to be completed in one year, as this EIS will serve as a base reference for the National Environmental Policy Act (NEPA) review and documentation for each of the subsequent proposed actions.

One Call for Information and Nominations (Call) and Notice of Intent to Prepare an EIS (NOI) was issued at the beginning of this multisale prelease process. One Area Identification (Area ID) was prepared for the 10 CPA and WPA lease sales scheduled under the proposed 5-Year Program. The Area ID describes the geographical areas and identifies the alternatives, mitigating measures, and issues to be analyzed in the NEPA documents for the proposed sales (specifically, the EA for Western Gulf Sale 184 and this multisale EIS for the other nine Central and Western Gulf sales).

Consultation with the public will be initiated in subsequent years. An Information Request will be issued, specifically requesting input on the scheduled sale under consideration. A NEPA review will be conducted for each subsequent sale. An EA will be prepared to determine whether or not the information and analyses in this multisale EIS are still valid for each subsequent sale under consideration. Consideration of the EA and any comments received in response to the Information Request will result in either a Finding of No New Significant Impact (FONNSI) or the determination that the preparation of a Supplemental EIS (SEIS) is warranted. Sale-specific notices will be published as usual, except that the Proposed Notice of Sale will be published after completion of the final NEPA document for each sale.

Because the EA will be prepared for a proposal that "is, or is closely similar to, one which normally requires the preparation of an EIS" (40 CFR 1501.4(e)(2)), the EA will be made available for public review for 30 days prior to making a decision on the proposed lease sale. If the EA results in a FONNSI, the EA and FONNSI will be sent to the Governors of the affected States. The availability of the EA and FONNSI will be announced in the *Federal Register*. The FONNSI will become part of the Record of Decision prepared for the decision on the Notice of Sale.

In some cases, the EA may result in a finding that it is necessary to prepare an SEIS (40 CFR 1502.9). Some of the factors that could justify an SEIS are a significant change in resource estimates, legal challenge on the EA/FONNSI, significant new information, significant new environmental issue(s), new proposed alternative(s), a significant change in the proposed action, or the previous analysis in the multisale EIS is deemed inadequate.

If an SEIS is necessary, the analysis will focus on addressing the new issue(s) or concern(s) that prompted the decision to prepare the SEIS. The SEIS will include a discussion explaining the purpose of the SEIS and incorporating the multisale EIS, a description of the proposed action and alternatives and a comparison of the alternatives, a description of the affected environment for any potentially affected resources that are the focus of the SEIS and were not described in the multisale EIS, an analysis of new impacts or changes in impacts from the multisale EIS because of new information or the new issue(s) analyzed in the SEIS, and a discussion of the consultation and coordination carried out for the new issues or information analyzed in the SEIS.

The MMS published the Call and NOI for the proposed 2003-2007 Central and Western Gulf of Mexico lease sales in the *Federal Register* on September 12, 2001. Federal, State, and local agencies, along with other interested parties, were requested to send written comments to the MMS Gulf of Mexico OCS Region on the scope of the EIS, significant issues that should be addressed, and alternatives and mitigating measures that should be considered. The comment period closed on October 12, 2001. Additional public notices were distributed via newspapers, mailouts, and the Internet. The MMS received 14 comments in response to the Call and NOI. A summary of these comments can be found in Chapter 5.

In accordance with the Council on Environmental Quality's (CEQ) regulations implementing NEPA, scoping was conducted to solicit comments on the proposed actions and to update the Gulf of Mexico's environmental information base for the Central and Western Gulf of Mexico. Scoping provides those with an interest in the OCS Program an early opportunity to participate in the events leading to the publication of the Draft EIS. Although the scoping process is formally initiated by the publication of the Call and NOI, scoping efforts and other coordination meetings are carried out in an ongoing manner. In October 2001, scoping meetings were held in Galveston and Houston, Texas; New Orleans, Louisiana; and Mobile, Alabama. A summary of the scoping comments can be found in Chapter 5. The result of the scoping effort was the identification of the alternatives, mitigating measures, and issues described below.

2.2. Alternatives, Mitigating Measures, and Issues

2.2.1. Alternatives

2.2.1.1. Alternatives for Proposed Central Gulf Sales

Alternative A - The Proposed Action(s): This alternative would offer for lease all unleased blocks within the CPA for oil and gas operations (Figure 1-1), with the following exceptions: Lund South (Area NG16-07) Blocks 172, 173, 213-217, 252-261, 296-305, and 349; Amery Terrace (Area NG15-09) Blocks 280, 281, 318-320, and 355-359; and portions of Amery Terrace (Area NG15-09) Blocks 235-238, 273-279, and 309-359, which are deferred from the proposed actions under the "Treaty Between The Government of the United States of America And The Government Of The United Mexican States on the Delimitation Of The Continental Shelf In the Western Gulf of Mexico Beyond 200 Nautical Miles." The CPA encompasses about 47.8 million acres (ac). The estimated amount of resources projected to be developed as a result of any one proposed CPA lease sale is 0.276-0.654 billion barrels of oil (BBO) and 1.590-3.300 trillion cubic feet (tcf) of gas.

Alternative B - The Proposed Action(s) Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features: This alternative would offer for lease all unleased blocks in the CPA, as described for the proposed action(s), with the exception of any unleased blocks within the 167 blocks subject to the Topographic Features Stipulation.

Alternative C - The Proposed Action(s) Excluding the Unleased Blocks Within 15 Miles of the Baldwin County, Alabama, Coast: This alternative would offer for lease all unleased blocks in the CPA, with the exception of any unleased blocks within 15 mi of the Baldwin County, Alabama, coast.

Alternative D - No Action: This alternative is equivalent to cancellation of one or more proposed CPA lease sales scheduled in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007.* The opportunity for development of the estimated oil and gas resources that could have resulted from any proposed action(s) would be precluded or postponed, and any potential environmental impacts resulting from the proposed action(s) would not occur or would be postponed.

2.2.1.2. Alternatives for Proposed Western Gulf Sales

Alternative A – The Proposed Action(s): This alternative would offer for lease all unleased blocks within the WPA for oil and gas operations (Figure 1-1), with the following exceptions: High Island Area East Addition, South Extension, Blocks A-375 and A-398 and portions of other blocks within the Flower Garden Banks National Marine Sanctuary are deferred from leasing. Mustang Island Area Blocks 793, 799, and 816 have been identified by the Navy as needed for testing equipment and for training mine warfare personnel and are deferred from the proposed actions. Sigsbee Escarpment (Area NG15-08) Blocks 11, 57, 103, 148, 149, 194, 239, 284, and 331-341; portions of Sigsbee Escarpment (Area NG15-08) Blocks 12-14, 58-60, 104-106, 150, 151, 195, 196, 240, 241, 285-298, and 342-349; and Keathley Canyon (Area NG15-05) Blocks 978-980 are deferred from the proposed actions under the "Treaty Between The Government of the United States of America And The Government Of The United Mexican

States on the Delimitation Of The Continental Shelf In the Western Gulf of Mexico Beyond 200 Nautical Miles," which took effect in January 2001. The WPA encompasses about 35.9 million ac. The estimated amount of resources projected to be developed as a result of any one proposed WPA lease sale is 0.136-0.262 BBO and 0.810-1.440 tcf of gas.

Alternative B - The Proposed Action(s) Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features: This alternative would offer for lease all unleased blocks in the WPA, as described for the proposed action(s), with the exception of any unleased blocks within the 200 blocks subject to the Topographic Features Stipulation.

Alternative C - No Action: This alternative is equivalent to cancellation of one or more proposed WPA lease sales scheduled in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007.* The opportunity for development of the estimated oil and gas resources that could have resulted from any proposed action(s) would be precluded or postponed, and any potential environmental impacts resulting from the proposed action(s) would not occur or would be postponed.

2.2.2. Mitigating Measures

In 1978, the Council on Environmental Quality (CEQ) defined mitigation as a 5-step process.

- Avoidance—The avoidance of an impact altogether by not taking a certain action or part of an action.
- Minimization—The minimizing of impacts by limiting the degree or magnitude of the action and its implementation.
- Restoration—The rectifying of the impact by repairing, rehabilitation, or restoring the affected environment.
- Maintenance—The reducing or eliminating of the impact over time by preservation and maintenance operations during the life of the action.
- Compensation—The compensation for the impact by replacing or providing substitute resources or environments.

2.2.2.1. Proposed Mitigating Measures

The potential mitigating measures included for analysis in this EIS were developed as the result of scoping efforts over a number of years for the continuing OCS Program in the Gulf of Mexico and from scoping efforts specifically for the proposed 2003-2007 Central and Western Gulf OCS lease sales. Five lease stipulations are proposed for the Central Gulf sales—the Topographic Features Stipulation; the Live Bottom (Pinnacle Trend) Stipulation; the Military Areas Stipulation; the Blocks South of Baldwin County, Alabama, Stipulation; and the Law of the Sea Convention Royalty Payment Stipulation. Four lease stipulations are proposed for the Western Gulf sales—the Topographic Features Stipulation, the Military Areas Stipulation, the Naval Mine Warfare Area Stipulation, and the Law of the Sea Convention Royalty Payment Stipulation. These measures will be considered for adoption by the Assistant Secretary of the Interior for Land and Minerals (ASLM). The analysis of any stipulations as part of Alternative A does not ensure that the ASLM will make a decision to apply the stipulations to leases that may result from any proposed lease sale, nor does it preclude minor modifications in wording during subsequent steps in the prelease process if comments indicate changes are necessary or if conditions change.

Any stipulations or mitigation requirements to be included in a lease sale will be described in the Record of Decision for that lease sale. Mitigation measures in the form of lease stipulations are added to the lease terms and are therefore enforceable as part of the lease. In addition, each exploration and development plan, as well as any pipeline applications that may result from a lease sale, will undergo a NEPA review, and additional project-specific mitigations may be applied as conditions of plan approval. The MMS has the authority to monitor and enforce these conditions, and under 30 CFR 250 Subpart N, may seek remedies and penalties from any operator that fails to comply with the conditions of permit approvals, including stipulations and other mitigating measures.

2.2.2.2. Mitigating Measures Considered But Not Analyzed in Detail

Numerous potential mitigating measures were identified through the scoping efforts for many past lease sale EIS's. The MMS funded studies to provide information to evaluate some of these potential mitigating measures. Some of these mitigating measures were adopted, or modified and adopted. Some measures were dropped from further consideration when analysis indicated that the measures were not warranted or would have been ineffective. Since the last multisale EIS, many MMS protective measures have been modified and strengthened (Chapter 2.2.2.3).

The MMS and the National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries), formerly known as the National Marine Fisheries Service (NMFS), have identified OCS-related debris, OCS-related vessel traffic, and seismic airgun noise as potential sources of "take" of marine protected species. Marine protected species may ingest or become entangled in marine debris, which results in their harm, injury, or mortality. Furthermore, collisions between OCS-related vessels and marine protected species can cause injury or mortality to animals. Because these sources of potential "take" may result from the lease sale action, the MMS, in consultation with NOAA Fisheries, developed a lease stipulation to (1) reduce trash and flotsam in the environment as generated by oil and gas activities offshore and (2) minimize the potential for vessel collisions with protected species. Marine protected species lease stipulations were included in Eastern Gulf Lease Sale 181, Central Gulf Lease Sale 182, and Western Gulf Lease Sale 184. These stipulations were developed as a result of Section 7 Consultations (Endangered Species Act) performed with NOAA Fisheries for the proposed lease sales. Although MMS anticipates that similar requirements will be developed for the WPA and CPA lease sales addressed in this EIS, the specific protective measures to be included will not be determined until NOAA Fisheries has completed their Biological Opinion (BO) for the required Section 7 Consultation.

2.2.2.3. Existing Mitigating Measures

Mitigating measures have been proposed, identified, evaluated, or developed through previous MMS lease sale NEPA review and analysis processes. Many of these mitigating measures have been adopted and incorporated into regulations and/or guidelines governing OCS exploration, development, and production activities. All plans for OCS activities go through MMS review and approval to ensure compliance with established laws and regulations. Mitigating measures must be incorporated and documented in plans submitted to MMS. Operational compliance is enforced through the MMS on-site inspection program.

Mitigating measures that are a standard part of the MMS program limit the size of charges used for explosive platform removal; require placing explosive charges at least 5 m below the mudline; ensure site clearance procedures to eliminate potential snags to commercial fishing nets; and require surveys to detect and avoid archaeological sites and biologically-sensitive areas such as pinnacles, low-relief live bottoms, and chemosynthetic communities.

Some MMS-identified mitigating measures are incorporated into OCS operations through cooperative agreements or efforts with industry and various State and Federal agencies. These include NOAA Fisheries's Observer Program to protect marine mammals and sea turtles during explosive removals, regulations on minimum helicopter altitudes to prevent disturbance of wildlife, labeling operational supplies to track possible sources of accidental debris loss, development of methods of pipeline landfall to eliminate impacts to barrier beaches, and semiannual beach cleanup events.

Most OCS revenue goes into the U.S. Treasury. A portion of the revenue goes into two special-purpose accounts—the Land and Water Conservation Fund (LWCF) and the National Historic Preservation Fund (NHPF). The LWCF was established by the Land and Water Conservation Act of 1965 to provide revenues for Federal, State, and local governments to purchase parks and recreation areas and to plan, acquire, and develop land and water resources for recreational use, habitat protection, scenic beauty, and biological diversity. From FY 1982 through FY 2000, about $16.3 billion was dispersed from OCS revenues to the LWCF. The NHPF is designed to expand and accelerate historic plans and activities through matching grant-in-aid to States and local governments and funds for the National Trust for Historic Preservation. Offshore mineral leasing provides 100 percent of the $150 million transferred to the fund annually.

The 1986 amendments to Section 8(g) of the OCS Lands Act mandated that the Federal Government share with affected coastal States 27 percent of future revenues generated from the leasing and development of oil and natural gas resources located in the Federal OCS in a zone 3 mi wide adjacent to the seaward boundary of a State's offshore waters. Through FY 2000, over $2.9 billion of 8(g) monies have been disbursed; all five Gulf Coast States receive 8(g) monies. The monies are used by the States as they deem necessary, without Federal restrictions, and may be used to mitigate coastal impacts from OCS-related activities.

2.2.3. Issues

Issues are defined by CEQ to represent those principal "effects" that an EIS should evaluate in-depth. Scoping identifies specific environmental resources and/or activities rather than "causes" as significant issues (CEQ Guidance on Scoping, April 30, 1981). The analysis in the EIS can then show the degree of change from present conditions for each issue due to the relevant actions related to the proposed actions.

Selection of environmental and socioeconomic issues to be analyzed was based on the following criteria:

- issue is identified in the CEQ regulations as subject to evaluation;
- the relevant resource/activity was identified through the scoping process or from comments on past EIS's;
- the resource/activity may be vulnerable to one or more of the impact-producing factors (IPF's) associated with the OCS Program; a reasonable probability of an interaction between the resource/activity and IPF should exist; or
- information that indicates a need to evaluate the potential impacts to a resource/activity has become available.

2.2.3.1. Issues to be Analyzed

The following issues relate to potential IPF's and the resources and activities that could be affected by OCS exploration, development, production, and transportation activities.

Petroleum Spills: Specific concerns were raised regarding the potential effects of oil spills on marine and coastal environments, marine mammals, other endangered and threatened species, commercial fishing, recreation and tourism, water quality, and wetlands. Other concerns raised over the years of scoping were fate and behavior of oil spills, availability and adequacy of oil-spill containment and cleanup technologies, oil-spill cleanup strategies, impacts of various oil-spill cleanup methods, effect of winds and currents on the transport of oil spills, effects of weathering on oil spills, toxicological effects of fresh and weathered oil, air pollution associated with spilled oil, and short-term and long-term impacts of oil on wetlands.

Drilling Fluids and Cuttings: Potential smothering of benthic communities by offshore disposal of drilling fluids and cuttings has been raised as an issue. Specific concerns related to the use and disposal of drilling fluids include potential spills of oil-based drilling fluids (OBF), onshore disposal of OBF, the fate and effects of synthetic-based drilling fluids (SBF) in the marine environment; and the potential toxic effects or bioaccumulation of trace metals in drilling fluids discharged into the marine environment.

Visual and Aesthetic Interference: The potential effects of the presence of drilling rigs and platforms, service vessels, helicopters, trash and debris, and flaring on visual aesthetics as seen by residents and visitors of the Pensacola area is an issue of great concern.

Air Emissions: The potential effects of emissions of combustion gases from platforms, drill rigs, service vessels, and helicopters have been raised as an issue. Also under consideration are the flaring of produced gases during extended well testing and the potential impacts of transport of production with associated hydrogen sulfide.

Water Quality Degradation: Issues raised related to water quality degradation were most often associated with operational discharges of drilling muds and cuttings, produced waters, and domestic wastes. Water quality issues also included concerns related to impacts from sediment disturbance, petroleum spills and blowouts, and discharges from service vessels.

Other Wastes: Other concerns include storage and disposal of trash and debris, and trash and debris on recreational beaches.

Structure and Pipeline Emplacement: Some of the issues related to structure and pipeline emplacement are bottom area disturbances from bottom-founded structures or anchoring, sediment displacement related to pipeline burial, space-use conflicts, and the vulnerability of offshore pipelines to damage that could result in hydrocarbon spills or H_2S leaks.

Platform Removals: Concerns about the abandonment of operations include how a platform is removed, potential impacts of explosive removals on marine organisms, remaining operational debris snagging fishing nets, and site clearance procedures.

OCS-Related Support Services, Activities, and Infrastructure: Concerns over activities related to the shore-base support of the Development and Production Plan include vessel and helicopter traffic and emission, construction or expansion of navigation channels or onshore infrastructure, maintenance and use of navigation channels and ports, and deepening of ports.

Sociocultural and Socioeconomic: Many concerns have focused on the potential impacts to coastal communities. Issues include impacts on employment, population fluctuations, demands on public services, effects on land use, tourism, impacts to low income or minority populations, and cultural impacts.

Coastal Zone Management: Concern has been expressed over potential conflicts with the coastal states' coastal zone management programs and with local county, parish, or community land-use plans.

OCS Oil and Gas Infrastructure Security: The MMS recognizes the increased importance of OCS oil and gas production and the need to protect offshore personnel and facilities. The MMS has taken and continues to take steps to ensure that OCS production facilities and the associated transportation network are secure. The MMS works closely with OCS operators, USCG, other Federal agencies, and local authorities to identify potential security risks and appropriate security measures that should be imposed. The MMS is also working with the Homeland Security Office in Washington, D.C., to develop OCS-wide security guidelines to enhance existing mitigation measures for the protection of OCS personnel, facilities, and equipment. The guidelines will establish protective measures for standard threat condition levels to help MMS personnel and operators respond during a crisis.

Other Issues: Many other issues have been identified. Several of these issues are subsets or variations of the issues listed above. All are taken under advisement and are considered in the analyses, if appropriate. Additional issues raised during scoping are noise from platforms, vessels, helicopters, and seismic surveys; turbidity as a result of seafloor disturbance or discharges; mechanical damage to biota and habitats; and multiple-use conflicts.

The analyses in Chapters 4.2-4.5 address the issues and concerns identified above for the following resource topics:

- Air Quality
- Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice
- Archaeological Resources (Historic and Prehistoric)
- Deepwater Benthic Communities
- Coastal Barrier Beaches and Associated Dunes
- Coastal and Marine Birds
- Commercial Fisheries
- Fish Resources and Essential Fish Habitat
- Gulf Sturgeon
- Human Resources and Land Use
- Live Bottoms (Pinnacle Trend and Topographic Features)
- Marine Mammals
- Recreational Beaches
- Sea Turtles
- Submerged Vegetation
- Water Quality (Coastal and Marine)
- Wetlands

2.2.3.2. Issues Considered but Not Analyzed

As previously noted, CEQ's regulations for implementing NEPA instruct agencies to adopt an early process (termed "scoping") for determining the scope of issues to be addressed and for identifying significant issues related to a proposed action. As part of this scoping process, agencies shall identify and eliminate from detailed study the issues that are not significant to the proposed action or have been covered by prior environmental review.

Through our scoping efforts, numerous issues and topics were identified for consideration in the EIS for the proposed 2003-2007 Central and Western lease sales. After careful evaluation and study, the following categories were considered not to be significant issues related to the proposed actions or that have been covered by prior environmental review.

Program and Policy Issues

Comments and concerns that relate to program and policy are issues under the direction of the Department of the Interior and/or MMS, and their guiding regulations, statutes, and laws. The comments and concerns related to program and policy issues are not considered to be specifically related to the proposed actions and are forwarded to the appropriate program offices for their consideration.

Use of Revenues Generated by OCS Leasing

Comments and concerns that relate to the use of revenues are issues under the direction of the Congress of the United States or the Department of the Interior, and their guiding regulations, statutes, and laws. The comments and concerns related to program and policy issues are not considered to be specifically related to the proposed actions and are forwarded to the appropriate program offices for their consideration.

2.3. PROPOSED CENTRAL GULF LEASE SALES

2.3.1. Alternative A — The Proposed Actions

2.3.1.1. Description

The proposed actions would offer for lease all unleased blocks within the CPA for oil and gas operations (Figure 1-1), with the following exceptions: Lund South Area (Area NG16-07) Blocks 172, 173, 213-217, 252-261, 296-305, and 349; and Amery Terrace Area (Area NG15-09) Blocks 235-238, 273-281, 309-320, and 355-359. The CPA encompasses about 47.8 million acres. It is estimated that a proposed action in the CPA could result in the discovery and production of 0.276-0.654 BBO and 1.590-3.300 tcf of gas.

The analyses of impacts summarized below and described in detail in Chapters 4.2.1 and 4.4.3 are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in Chapters 4.1.1, 4.1.2, and 4.4.

2.3.1.2. Summary of Impacts

Impacts on Sensitive Coastal Environments

Coastal Barrier Beaches and Associated Dunes (Chapters 4.2.1.1.1 and 4.4.3.1.1)

The 0-1 pipeline landfalls projected in support of a proposed action are not expected to cause significant impacts to barrier beaches because of the use of nonintrusive installation methods. Existing facilities originally built inland may, through natural erosion and shoreline recession, be located in the barrier beach and dune zone and contribute to erosion there. A proposed action may contribute to the continued use of such facilities.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which combined with channel jetties, generally causes minor and very localized impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. The worst of these situations is found on the sediment-starved coasts of Louisiana, where sediments are largely organic. Based on use, a proposed action would account for a very small percentage of these impacts, which would occur whether a proposed action is implemented or not.

In conclusion, a proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. A proposed action may extend the life and presence of facilities in eroding areas, which can accelerate erosion there. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

Should a spill contact a barrier beach, oiling is expected to be light and sand removal during cleanup activities minimized. No significant impacts to the physical shape and structure of barrier beaches and associated dunes are expected to occur as a result of a proposed action.

Wetlands (Chapters 4.2.1.1.2 and 4.4.3.1.2)

Loss of 0-40 ha of habitat is estimated as a result of 0-10 km of new pipelines projected as a result of a proposed action. Secondary impacts, such as continued widening of existing pipeline and navigation channels and canals and failure of mitigation structures, are also expected to affect the rate at which wetlands convert to open water.

Maintenance dredging of navigation channels and canals is expected to occur with minimal impacts; a proposed action is expected to contribute minimally to the need for this dredging. Alternative dredged-material disposal methods can be used to enhance and create coastal wetlands. By artificially keeping navigation channels open and with larger dimensions than would the region's natural hydrodynamic processes, maintenance dredging maintains tidal and storm flushing potential of inland regions at maximum capacities, as they relate to the described needs of the canal project. Without maintenance dredging, these channels would naturally fill in, reducing the channels' cross-sectional areas and their capacities to flush or drain a region when under the influences of storms and tides.

In conclusion, adverse initial impacts and more importantly secondary impacts of installation, maintenance, continued existence, and the failure of mitigation structures for pipeline and navigation canals are considered the most significant OCS-related and proposed-action-related impacts to wetlands. Although initial impacts are considered locally significant and are largely limited to where OCS-related canals and channels pass through wetlands, secondary impacts may have substantial, progressive, and cumulative adverse impacts to the hydrologic basin or subbasin in which they are found.

Offshore oil spills resulting from a proposed action are not expected to significantly damage inland wetlands; however, if an inland oil spill related to a proposed action occurs, some impact to wetland habitat would be expected. Although the impact may occur generally over coastal regions, the impact has the highest probability of occurring in the coastal regions, by and large northeast of Galveston County, in the vicinities where WPA oil is handled, and in and around Plaquemines and St. Bernard Parishes in the CPA.

Although the probability of occurrence is low, the greatest threat to wetland habitat is from an inland spill resulting from a vessel accident or pipeline rupture. While a resulting slick may cause minor impacts to wetland habitat and surrounding seagrass communities, the equipment and personnel used to clean up a slick over the impacted area may generate the greatest impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

Seagrass Communities (Chapters 4.2.1.1.3 and 4.4.3.1.3)

Most seagrass communities located between the Southwest Pass of the Mississippi River and Cape San Blas, Florida, are inland of the barrier shorelines. Pipeline construction in coastal waters would temporarily elevate turbidity in nearby submerged vegetation beds, depending upon currents. If constructed, the pipeline landfall would temporarily elevate turbidity in submerged vegetation beds near the pipeline routes. The Corps of Engineers (COE) and State permit requirements are expected to require pipeline routes that avoid beds of high-salinity, submerged vegetation and to reduce turbidity impacts to within tolerable limits. Hence, impacts to submerged vegetation by pipeline installation are projected to be very small and short term.

After bottom sediments are disturbed by pipeline installation, they will be generally more easily suspended by storms than before the disturbance. In estuaries, this increase is not projected to be a problem. Due to tidal flushing, this increased turbidity is projected to be below significant levels and to continue after storms for up to one month.

Beds of submerged vegetation within a channel's area of influence will have already adjusted to bed configurations in response to turbidity generated there. Very little, if any, damage would then occur as a result of typical channel traffic. Generally, propwash will not resuspend sediments in navigation channels beyond pre-project conditions.

Depending upon the submerged plant species involved, narrow scars in dense portions of the beds will take 1-7 years to recover. Scars through sparser areas will take 10 years or more to recover. The broader the scar, the longer the recovery period. Extensive damage to a broad area may never be corrected.

Maintenance dredging will not have a substantial impact on existing seagrass habitat given that no new channels are expected to be dredged as a result of a CPA proposed action.

Should a spill ≥1,000 bbl occur offshore from activities resulting from a proposed action, the seagrass communities with the highest probabilities of contact within 10 days would be those located within Matagorda County, Texas, for a proposed action in the WPA and within Plaquemines Parish, Louisiana, for a proposed action in the CPA.

Because of the location of most submerged aquatic vegetation, inshore spills pose the greatest threat to them. Such spills may result from either vessel collisions that release fuel and lubricants or from pipelines that rupture. If an oil slick settles into a protective embayment where seagrass beds are found, shading may cause reduced chlorophyll production; shading for more than about 2 weeks could cause thinning of leaf density. Under certain conditions, a slick could reduce dissolved oxygen in an embayment and cause stress to the bed and associated organisms due to reduced oxygen conditions. These light and oxygen problems can correct themselves once the slick largely vacates the embayment, and light and oxygen levels are returned to pre-slick conditions.

Increased water turbulence due to storms or vessel traffic will break apart the surface sheen and disperse some oil into the water column, as well as increase suspended particle concentration, which will adsorb to the dispersed oil. Typically, these situations will not cause long-term or permanent damage to the seagrass beds, although some dieback of leaves is projected for one growing season. No permanent loss of seagrass is projected to result from oil contact, unless an unusually low tidal event allows direct contact between the slick and vegetation. The greatest danger under the more probable circumstances is a reduction, for up to 2 years, of the diversity or population of epifauna and benthic fauna found in seagrass beds.

Although the probability of their occurrence is low, the greatest threat to inland, seagrass communities would be from an inland spill resulting from a vessel accident or pipeline rupture. Although a resulting slick may cause minor impacts to the bed, equipment and personnel used to clean up a slick over shallow seagrass beds may generate the greatest impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Scarring may occur if an oil slick is cleaned up over a shallow submerged aquatic vegetation bed where vessels, booms, anchors, and personnel on foot would be used and scar the bed. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

Impacts on Sensitive Offshore Resources

Pinnacle Trend (Chapters 4.2.1.2.1 and 4.4.3.2.1)

Activities resulting from a proposed action in the CPA are not expected to adversely impact the pinnacle trend environment because of implementation of the Live Bottom Stipulation. No community-wide impacts are expected. The inclusion of the Live Bottom Stipulation would minimize the potential for mechanical damage. The impacts of a proposed action are expected to be infrequent because of the few operations in the vicinity of the pinnacles and the small size and dispersed nature of many of the features. Potential impacts from blowouts, pipeline emplacement, mud and cutting discharges, and structure removals would be minimized because of the proposed Live Bottom Stipulation and the low levels of oil and gas activities anticipated in the area. The frequency of impacts on the pinnacles would be rare, and the severity should be slight because of the widespread nature of the features. Impacts from accidents involving anchor placement on pinnacles (those actually crushed or subjected to abrasions) could be severe in a few areas.

With implementation of the Live Bottom Stipulation, there would be few operations in the vicinity of the pinnacles as a result of a proposed action. Because of this and the small size and dispersed nature of many of the features, impacts from accidental events as a result of a proposed action are expected to be infrequent. No community-wide impacts are expected. Potential impacts from blowouts would be minimized because of the proposed Live Bottom Stipulation and the low levels of oil and gas activities anticipated in the area. Oil spills would not be followed by adverse impacts (e.g., high elevated decrease in live cover) because of the depth of the features and dilution of spills (by currents and the quickly rising oil). The frequency of impacts on the pinnacles would be rare, and the severity should be slight because of the widespread nature of the features.

Topographic Features (Chapters 4.2.1.2.2 and 4.4.3.2.2)

The proposed Topographic Features Stipulation could prevent most of the potential impacts on live-bottom communities from bottom-disturbing activities (structure removal and emplacement) and operational discharges. Recovery from impact incidences of operational discharges would take place within 10 years.

The proposed Topographic Features Stipulations will assist in preventing most of the potential impacts on live-bottom communities from blowouts and surface and subsurface oil spills. Recovery from incidences of impacts from blowouts would take place within 10 years.

Contact with spilled oil would cause lethal and sublethal effects in benthic organisms. The oiling of benthic organisms is not likely because the proposed Topographic Features Stipulations would keep subsurface sources of spills away from the immediate vicinity of topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for adult sessile biota, including coral colonies in the case of the Flower Garden Banks, and there would be limited incidences of mortality. The recovery of harmed benthic communities could take more than 10 years.

Chemosynthetic Deepwater Benthic Communities (Chapters 4.2.1.2.3 and 4.4.3.2.3)

Chemosynthetic communities are susceptible to physical impacts from structure placement (including templates or subsea completions), anchoring, and pipeline installation. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement.

If the presence of a high-density community were missed using existing procedures, potentially severe or catastrophic impacts could occur due to raking of the sea bottom by anchors and anchor chains, and partial or complete burial by muds and cuttings associated with pre-riser discharges or some types of riserless drilling. Variations in the dispersal and toxicity of synthetic-based drilling fluids may contribute to the potential areal extent of these impacts. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type), although it may reappear relatively quickly once the process begins, as in the case of a mussel community. Tube-worm communities may be the most sensitive of all communities because of the combined requirements of hard substrate and active hydrocarbon seepage. Mature tube-worm bushes have been found to be several hundred years old. There is evidence that substantial impacts on these communities would permanently prevent reestablishment.

A proposed action in the CPA is expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience minor impacts from drilling discharges or resuspended sediments located at more than 1,500 ft away, as required by NTL 2000-G20.

Chemosynthetic communities could be susceptible to physical impacts from a blowout depending on bottom-current conditions. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement. There is evidence that substantial impacts on these communities would permanently prevent reestablishment, particularly if hard substrate required for recolonization was buried.

Potential accidental impacts from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities located at more than 1,500 ft away from a blowout could experience minor impacts from resuspended sediments.

Nonchemosynthetic Deepwater Benthic Communities (Chapters 4.2.1.2.4 and 4.4.3.2.4)

Some impact to benthic communities from drilling and production activities would occur as a result of physical impact from structure placement (including templates or subsea completions), anchoring, and installation of pipelines regardless of their locations. Megafauna and infauna communities at or below the sediment/water interface would be impacted from the muds and cuttings normally discharged at the seafloor at the start of every new well prior to riser installation. The impact from muds and cuttings discharged at the surface are expected to be low in deep water. Drilling muds would not be expected to reach the bottom beyond a few hundred meters from the surface-discharge location, and cuttings would be dispersed. Even in situations where substantial burial of typical benthic communities occurred, recolonization from populations from neighboring substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of days for bacteria and probably less than one year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be very rare. These unique communities are distinctive and similar in nature to protected pinnacles and topographic features on the continental shelf. Any hard substrate communities located in deep water would be particularly sensitive to impacts from OCS activities. Impacts to these sensitive habitats could permanently prevent recolonization with similar organisms requiring hard substrate.

A proposed action in the CPA is expected to cause little damage to the ecological function or biological productivity of the widespread, typical deep-sea benthic communities.

Accidental events resulting from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, typical, deep-sea benthic communities. Some impact to benthic communities would occur as a result of impact from an accidental blowout. Megafauna and infauna communities at or below the sediment/water interface would be impacted by the physical disturbance of a blowout or by burial from resuspended sediments. Even in situations where substantial burial of typical benthic communities occurred, recolonization from populations from neighboring substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of hours to days for bacteria and probably less than one year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be very rare. These unique communities are distinctive and similar in nature to protected pinnacles and topographic features on the continental shelf. Any hard substrate communities located in deep water would be particularly sensitive to impacts. Impacts to these sensitive habitats could permanently prevent recolonization with similar organisms requiring hard substrate, but adherence to the provisions of NTL 2000-G-20 should prevent all but minor impacts to hard-bottom communities beyond 454 m (1,500 ft).

A proposed action in the CPA is expected to cause little damage to the ecological function or biological productivity of the widespread, typical, deep-sea benthic communities.

Accidental events resulting from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, typical, deep-sea benthic communities. Some impact to benthic communities would occur as a result of impact from an accidental blowout. Megafauna and infauna communities at or below the sediment/water interface would be impacted by the physical disturbance of a blowout or by burial from resuspended sediments.

Impacts on Water Quality

Coastal Waters (Chapters 4.2.1.3.1 and 4.4.3.3.1)

The primary impacting sources to water quality in coastal waters are point-source and nonpoint-source discharges from support facilities and vessel discharges. The impacts to coastal water quality from a proposed action in the CPA should be minimal as long as all regulatory requirements are met.

Spills <1,000 bbl are not expected to significantly impact water quality in coastal waters. Larger spills, however, could impact coastal water quality. Chemical spills and the accidental release of SBF are expected to have temporary localized impacts on water quality.

Marine Waters (Chapters 4.2.1.3.2 and 4.4.3.3.2)

During exploration and development drilling activities, the primary impacting sources to marine water quality are discharges of drilling fluids and cuttings. Impacting discharges during production activities are produced water and supply-vessel discharges. Impacts to marine waters from a proposed action in the CPA should be minimal as long as all regulatory requirements are followed.

Spills <1,000 bbl are not expected to significantly impact marine water quality. Larger spills, however, could impact marine water quality. Chemical spills, the accidental release of SBF, and blowouts are expected to have temporary localized impacts on marine water quality.

Impacts on Air Quality (Chapters 4.2.1.4 and 4.4.3.4)

Emissions of pollutants into the atmosphere from the activities associated with a proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. Emissions from proposed-action activities are not expected to have concentrations that would change onshore air-quality classifications. The OCS modeling results show that increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than the maximum increases allowed in the PSD Class I area and the PSD Class II areas.

Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. Other emissions of pollutants into the atmosphere from accidental events as a result of a proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emissions height, emission rates, and the distance of these emissions from the coastline. These emissions are not expected to have concentrations that would change onshore air quality classifications. Increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than maximum increases allowed under the PSD Class I and II program.

Impacts on Marine Mammals (Chapters 4.2.1.5 and 4.4.3.5)

Small numbers of marine mammals could be killed or injured by chance collision with service vessels and by eating indigestible debris, particularly plastic items, lost from service vessels, drilling rigs, and fixed and floating platforms. Deaths due to structure removals are not expected due to existing mitigation measures or those being developed for structures placed in oceanic waters. There is no conclusive evidence whether anthropogenic noise has or has not caused long-term displacements of, or reductions in, marine mammal populations. Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification, although the scope of effects and their magnitude are not known.

The routine activities of a proposed action is not expected to have long-term adverse effects on the size and productivity of any marine mammal species or population stock endemic to the northern Gulf of Mexico.

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact marine mammals in the Gulf of Mexico. Characteristics of impacts (i.e., acute vs. chronic impacts) depend on the magnitude, frequency, location, and date of accidents; characteristics of spilled oil; spill-response capabilities and timing; and various meteorological and hydrological factors.

Populations of marine mammals in the northern Gulf will be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes.

Impacts on Sea Turtles (Chapters 4.2.1.6 and 4.4.3.6)

Routine activities resulting from a proposed action have the potential to harm individual sea turtles. These animals could be impacted by the degradation of water quality resulting from operational discharges; noise generated by helicopter and vessel traffic, platforms, and drillships; brightly-lit platforms; explosive removals of offshore structures; vessel collisions; and jetsam and flotsam generated by service vessels and OCS facilities. Lethal effects are most likely to be from chance collisions with OCS service vessels and ingestion of plastic materials. "Takes" due to explosive removals are expected to be rare due to mitigation measures already established (e.g., NOAA Fisheries observer program) and in development. Most OCS activities are expected to have sublethal effects. Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification; there is uncertainty concerning the possible effects. Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas could cause declines in survival or fecundity, and result in either population declines, however, such declines are not expected. The routine activities of a proposed action are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or population in the Gulf of Mexico.

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact small to large numbers of sea turtles in the Gulf of Mexico, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and date of accidents, and various meteorological and hydrological factors. Populations of sea turtles in the northern Gulf will be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes.

Impacts on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice (Chapters 4.2.1.7 and 4.4.3.7)

An impact from a proposed action in the CPA on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice is possible but unlikely. Impact may result from the consumption of beach trash and debris by beach mice, efforts to clean up trash and debris, and beach restoration activities.

Given the low probability of a spill ≥1,000 bbl occurring and contacting within 10 days beaches adjacent to beach mice habitats and the necessity of storm surge for oil to reach beach mouse habitat and contact the beach mice, no direct impacts of oil spills on beach mice from the proposed action are expected to occur as a result of a proposed action in the CPA or WPA. Protective measures required under the Endangered Species Act should prevent any oil-spill response and cleanup activities from having significant impact to the beach mice and their habitat.

Impacts on Coastal and Marine Birds (Chapters 4.2.1.8 and 4.4.3.8)

The majority of effects resulting from a proposed action in the CPA on endangered/threatened and nonendangered/nonthreatened coastal and marine birds are expected to be sublethal: behavioral effects, sublethal exposure to or intake of OCS-related contaminants or discarded debris, temporary disturbances, and displacement of localized groups from impacted habitats. Chronic sublethal stress, however, is often undetectable in birds. As a result of stress, individuals may weaken, facilitating infection and disease; then, migratory species may not have the strength to reach their destination. No significant habitat impacts are expected to occur directly from routine activities resulting from a proposed action. Secondary impacts to coastal habitats will occur over the long term and may ultimately displace species from traditional sites to alternative sites.

Oil spills from a proposed action pose the greatest potential direct and indirect impacts to coastal and marine birds. Birds that are heavily oiled are usually killed. If physical oiling of individuals or local groups of birds occurs, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected. Small coastal spills, pipeline spills, and spills from accidents in navigated waterways can contact and affect the different groups of coastal and marine birds, most commonly marsh birds, waders, waterfowl, and certain shorebirds. Lightly oiled birds can sustain tissue and organ damage from oil ingested during feeding and grooming, or that is inhaled. Stress and shock enhance the effects of exposure and poisoning. Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration. Reproductive success can be affected by the toxins in oil. Indirect effects occur by fouling of nesting habitat, and displacement of individuals, breeding pairs, or populations to less favorable habitats.

Dispersants used in spill cleanup activity can have toxic effects similar to oil on the reproductive success of coastal and marine birds. The, air, vehicle, and foot traffic that takes place during shoreline clean up activity can disturb nesting populations and degrade or destroy habitat.

Impacts on the Gulf Sturgeon (Chapters 4.2.1.9 and 4.4.3.9)

Potential impacts on Gulf sturgeon may occur from resuspended sediments and OCS-related discharges, as well from nonpoint runoff from estuarine OCS-related facilities. The low toxicity of this pollution and the almost absent overlap between individual Gulf sturgeon and occurrence of contamination is expected to result in little impact of a proposed action on Gulf sturgeon. Routine activities resulting from a proposed action in the CPA are expected to have little effect on Gulf sturgeon.

The Gulf sturgeon could be impacted by oil spills resulting from a proposed action. Contact with spilled oil could cause irritation of gill epithelium and disturbance of liver function in Gulf sturgeon. The likelihood of spill occurrence and contact to the Gulf sturgeon as a result of a proposed action is very low.

Impacts on Fish Resources and Essential Fish Habitat (Chapters 4.2.1.10 and 4.4.3.10)

It is expected that coastal and marine environmental degradation from a proposed action would have little effect on fish resources or essential fish habitat (EFH). The impact of coastal and marine environmental degradation is expected to cause an undetectable decrease in fish resources or in EFH. Fish resources and EFH are expected to recover from more than 99 percent, but not all, of the expected coastal and marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation, but any loss of wetlands as EFH would be permanent.

Offshore live bottoms will not be impacted. Offshore discharges and subsequent changes to marine water quality will be regulated by NPDES permits. At the expected level of impact, the resultant influence on fish resources and EFH would be negligible and indistinguishable from natural population variations.

Activities such as pipeline trenching and OCS discharge of drilling muds and produced water would cause negligible impacts and would not deleteriously affect fish resources or EFH. At the expected level of impact, the resultant influence on fish resources would cause less than a 1 percent change in fish populations or EFH. As a result, there would be little disturbance to fish resources or EFH.

A proposed action is expected to result in less than a 1 percent decrease in fish resources and/or standing stocks or in EFH. It would require one generation for fish resources to recover from 99 percent of the impacts. Recovery from the loss of wetlands habitat would probably not occur.

Accidental events resulting from oil and gas development in CPA and WPA lease sale areas of the Gulf of Mexico have the potential to cause some detrimental effects on fisheries and fishing practices. It is expected that subsurface blowouts that may occur as a result of a proposed action would have a negligible effect on Gulf fish resources or commercial fishing. If spills due to a proposed action were to occur in open waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be sublethal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. The effect of proposed-action-related oil spills on fish resources and commercial fishing is expected to cause less than a 1 percent decrease in standing stocks of any population, commercial fishing efforts, landings, or value of those landings. Any affected commercial fishing activity will recover within 6 months. At the expected level of impact, the resultant influence on fish populations and commercial fishing activities within the CPA or WPA lease sale areas would be negligible and indistinguishable from variations due to natural causes.

It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH; however, wetland loss could occur due to a petroleum spill contacting inland areas.

Impacts on Commercial Fisheries (Chapters 4.2.1.11 and 4.4.3.11)

Activities such as seismic surveys and pipeline trenching will cause negligible impacts and will not deleteriously affect commercial fishing activities. Operations such as production platform emplacement, underwater OCS impediments, and explosive platform removal, will cause slightly greater impacts on commercial fishing. At the expected level of impact, the resultant influence on commercial fishing will be indistinguishable from variations due to natural causes. As a result, there would be very little impact to commercial fishing. A proposed action is expected to result in less than a 1 percent change in activities, in pounds landed, or in the value of landings. It will require less than 6 months for fishing activity to recover from any impacts.

Accidental events resulting from oil and gas development in CPA and WPA lease sale areas of the Gulf of Mexico have the potential to cause some detrimental effects on fisheries and fishing practices. It is expected that subsurface blowouts that may occur as a result of a proposed action would have a negligible effect on Gulf fish resources or commercial fishing. If spills due to a proposed action were to occur in open waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be sublethal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. The effect of proposed-action-related oil spills on fish resources and commercial fishing is expected to cause less than a 1 percent decrease in standing stocks of any population, commercial fishing efforts, landings, or value of those landings. Any affected commercial fishing activity will recover within 6 months. At the expected level of impact, the resultant influence on fish populations and commercial fishing activities within the CPA or WPA lease sale areas would be negligible and indistinguishable from variations due to natural causes.

Impacts on Recreational Beaches (Chapters 4.2.1.12 and 4.4.3.12)

Marine debris will be lost from time to time from operations resulting from a proposed action. The impact on Gulf Coast recreational beaches is expected to be minimal. The incremental increase in helicopter and vessel traffic is expected to add very little additional noise that may affect beach users. A proposed action is expected to result in nearshore operations that may adversely affect the enjoyment of some Gulf Coast beach uses; however, these will have little effect on the number of beach users.

It is unlikely that a spill would be a major threat to recreational beaches because any impacts would be short-term and localized. Should a spill contact a recreational beach, short-term displacement of recreational activity from the areas directly affected would occur. Beaches directly impacted would be expected to close for periods of 2-6 weeks, or until the cleanup operations were complete. Should a spill result in a large volume of oil contacting a beach or a large recreational area being contacted by an oil slick, viitation to the area could be reduced by as much as 5-15 percent for as long ass one season, but such an event should have no long-term effect on tourism.

Tarballs can lessen the enjoyment of the recreational beaches but should have no long-term effect on the overall use of beaches.

Impacts on Archaeological Resources

Historic Archaeological Resources (Chapters 4.2.1.13.1 and 4.4.3.13.1)

The greatest potential impact to a historic archaeological resource as a result of a proposed action in the CPA would result from direct contact between an offshore activity (platform installation, drilling rig emplacement, and dredging or pipeline project) and a historic shipwreck. An MMS-funded study (Garrison et al., 1989) resulted in the redefinition of the high-probability areas for the location of historic period shipwrecks. An MMS review of the historic high-probability areas is occurring at the time of this writing. The NTL for archaeological resources surveys in the Gulf of Mexico Region, NTL 2002-G01, mandates a 50-m linespacing for remote-sensing surveys of leases within the high-probability areas for historic shipwrecks.

Ferromagnetic debris has the potential to mask the magnetic signatures of historic shipwrecks.

Maintenance dredging of navigation channels may result in impacts to historic shipwrecks; however, the percentage of OCS use of these channels under a proposed action is less than 1 percent.

Most other routine activities associated with a proposed action in the CPA are not expected to impact historic archaeological resources. It is conservatively assumed that about 2 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action. It is expected that archaeological resources will be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities.

Offshore oil and gas activities resulting from a proposed action could contact a shipwreck because of incomplete knowledge on the location of shipwrecks in the Gulf. Although this occurrence is not probable, such an event would result in the disturbance or destruction of important historic archaeological information. Other factors associated with a proposed action in the CPA are not expected to affect historic archaeological resources.

Impact to a historic archaeological resource could occur as a result of an accidental spill. As indicated in Chapter 4.4.1, it is not very likely that an oil spill will occur and contact coastal historic archaeological sites from accidental events associated with a proposed action in the WPA or CPA. The major effect from an oil-spill impact would be visual contamination of a historic coastal site, such as a historic fort or lighthouse. As historic archaeological sites are protected under law, it is expected that any spill cleanup operations would be conducted in such a way as to cause little or no impacts to historic archaeological resources. These impacts would be temporary and reversible.

Prehistoric Archaeological Resources (Chapters 4.2.1.13.2 and 4.4.3.13.2)

Several impact-producing factors may threaten the prehistoric archaeological resources of the Central Gulf. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric site located on the continental shelf. The archaeological survey and archaeological clearance of sites required prior to an operator beginning oil and gas activities on a lease are expected to be highly effective (90%) at identifying possible prehistoric sites. Since the survey and clearance provide a significant reduction in the potential for a damaging interaction between an impact-producing factor and a prehistoric site, there is a very small possibility of an OCS activity contacting a prehistoric site. Should such contact occur, there would be damage to or loss of significant and/or unique archaeological information.

Onshore development as a result of a proposed action could result in the direct physical contact from new facility construction, pipeline trenching, and new navigation canal dredging. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes of the Federal, State, and local agencies involved.

A proposed action in the CPA is not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost.

Accidental events producing oil spills may threaten the prehistoric archaeological resources of the Gulf Coast. Impacts to prehistoric sites could occur as a result of an oil spill. Should a spill contact an archaeological site, damage might include loss of radiocarbon-dating potential, direct impact from oil-spill cleanup equipment, and/or looting. Previously unrecorded sites could be impacted by oil-spill cleanup operations on beaches.

As indicated in Chapter 4.4.1, it is not very likely for an oil spill to occur and contact coastal and barrier island prehistoric sites as a result of a proposed action in the WPA or CPA. The proposed actions are not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost and this impact would be irreversible.

Impacts on Human Resources and Land Use

Land Use and Coastal Infrastructure (Chapters 4.2.1.14.1 and 4.4.3.14.1)

A proposed action in the CPA would not require additional coastal infrastructure or alter the current land use of the analysis area.

Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on land use. Coastal or nearshore spills could have short-term adverse effects on coastal infrastructure requiring cleanup of any oil or chemicals spilled.

Demographics (Chapters 4.2.1.14.2 and 4.4.3.14.2)

Activities relating to a proposed CPA lease sale are expected to minimally affect the analysis area's land use, infrastructure, and demography. These impacts are projected to mirror employment effects that are estimated to be negligible to any one subarea. Baseline patterns and distributions of these factors, as described in Chapter 3.3.3, are expected to maintain. Changes in land use throughout the analysis area are expected to be contained and minimal. The OCS-related infrastructure is in place and will not change as a result of a proposed action. Current baseline estimates of population growth for the analysis area show a continuation of growth, but at a slower rate.

Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on the demographic characteristics of the Gulf coastal communities.

Economic Factors (Chapters 4.2.1.14.3 and 4.4.3.14.3)

Should a proposed CPA lease sale occur, there would be only minor economic changes in the Texas, Louisiana, Mississippi, and Alabama subareas. A proposed action is expected to generate less than a 1 percent increase in employment in any of these subareas. This demand will be met primarily with the existing population and available labor force. There would be very little to no economic stimulus in the Florida subareas.

While a proposed CPA lease sale will not significantly impact the analysis area, OCS activities from past and future OCS lease sales will continue to occur and impact the analysis area. In other words, even if a proposed action were not held, there would still be impacts from past and future OCS lease sales in the analysis area. The OCS-related impacts will continue even in the absence of a proposed action.

The opportunity costs (employment and revenues) associated with oil-spill cleanup activities is expected to be temporary and of short duration. It is not expected to exceed 1 percent of baseline employment for any subarea within the analysis area. A large oil spill resulting from the proposed actions would acutely threaten shoreline recreational beaches for up to 30 days. After that, natural processes such as weathering and dispersion significantly change the nature and form of the oil to the point that it is unlikely to be a major threat to beach recreational resources and activities.

Environmental Justice (Chapters 4.2.1.14.4 and 4.4.3.14.4)

Because of the existing extensive and widespread support system for OCS-related industry and associated labor force, the effects of a proposed action in the CPA are expected to be widely distributed and little felt. In general, who will be hired and where new infrastructure might be located is impossible to predict. Impacts related to a proposed action are expected to be economic and have a limited but positive effect on low-income and minority populations. Given the existing distribution of the industry and the limited concentrations of minority and low-income peoples, a proposed action is not expected to have a disproportionate effect on these populations.

Lafourche Parish will experience the most concentrated effects of a proposed action; however, because the parish is not heavily low-income or minority, because the Houma are not residentially segregated, and because the effects of road traffic and port expansion will not occur in areas of low-income or minority concentration, these groups will not be differentially affected. In general, the effects in Lafourche Parish are expected to be mostly economic and positive. A proposed action would help to maintain ongoing levels of activity rather than expand them. Future changes in activity levels will most likely be caused by fluctuations in oil prices and imports, and not by activities related to a proposed action. A proposed action is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people.

Considering the low likelihood of an oil spill and the nonhomogeneous population distribution along the Gulf of Mexico region, accidental spill events associated with a proposed action are not expected to have disproportionate adverse environmental or health effects on minority or low-income people.

2.3.1.3. Mitigating Measures

2.3.1.3.1. Topographic Features Stipulation

The topographic features of the Central Gulf provide habitat for coral reef community organisms (Chapter 3.2.2.2). These communities could be severely and adversely impacted by oil and gas activities resulting from the proposed actions if such activities took place on or near these communities without the Topographic Features Stipulation and if such activities were not mitigated. The DOI has recognized this problem for some years, and since 1973 stipulations have been made a part of leases on or near these biotic communities so that impacts from nearby oil and gas activities were mitigated to the greatest extent possible. This stipulation would not prevent the recovery of oil and gas resources but would serve to protect valuable and sensitive biological resources.

The Topographic Features Stipulation was formulated based on consultation with various Federal agencies and comments solicited from the States, industry, environmental organizations, and academic representatives. The stipulation is based on years of scientific information collected since the inception of the stipulation. This information includes various Bureau of Land Management/MMS-funded studies on the topographic highs in the Central Gulf; numerous stipulation-imposed, industry-funded monitoring reports; and the National Research Council (NRC) report entitled *Drilling Discharges in the Marine Environment* (1983). The location and lease status of the blocks affected by the Topographic Features Stipulation are shown on Figures 2-1 and 2-2.

The requirements in the stipulation are based on the following facts:

(a) Shunting of the drilling effluent to the nepheloid layer confines the effluent to a level deeper than that of the living reef of a high-relief topographic feature. Shunting is therefore an effective measure for protecting the biota of high-relief topographic features (Bright and Rezak, 1978; Rezak and Bright, 1981; NRC, 1983).

(b) The biological effect on the benthos from the deposition of nonshunted discharge is mostly limited to within 1,000 m of the discharge (NRC, 1983).

(c) The biota of topographic features can be categorized into depth-related zones defined by degree of reef-building activity (Rezak and Bright, 1981; Rezak et al., 1983 and 1985).

The stipulation establishes No Activity Zones at the topographic features. A zone is defined by the 85-m bathymetric contour (isobath) since, generally, the biota shallower than 85 m are more typical of the Caribbean reef biota, while the biota deeper than 85 m are similar to soft-bottom organisms found throughout the Gulf. Where a topographic feature is in water depths less than 85 m, the deepest "closing" isobath defines the No Activity Zone for that area. Within the No Activity Zones, no operations, anchoring, or structures are allowed. Outside the No Activity Zones, additional restrictive zones are established where oil and gas operations could occur, but where drilling discharges would be shunted.

The stipulation requires that all effluents within 1,000 m of banks containing an antipatharian-transitional zone be shunted to within 10 m of the seafloor. Banks containing the more sensitive and productive algal-sponge zone require a shunt zone extending 1 nautical mile (nmi) and an additional 3-nmi shunt zone for development only.

The stipulation reads as follows:

Topographic Features Stipulation

(a) No activity including structures, drilling rigs, pipelines, or anchoring will be allowed within the listed isobath ("No Activity Zone") of the banks as listed above.

(b) Operations within the area shown as "1,000-Meter Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 meters, from the bottom.

(c) Operations within the area shown as "1-Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 meters, from the bottom. (Where there is a "1-Mile Zone" designated, the "1,000-Meter Zone" in paragraph (b) is not designated.)

(d) Operations within the area shown as "3-Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids from development operations to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 meters, from the bottom.

The banks and corresponding blocks to which this stipulation may be applied in the Central Gulf are as follows:

Bank Name	Isobath (m)	Bank Name	Isobath (m)
Shelf Edge Banks		Sweet Bank[1]	85
		Bright Bank	85
McGrail Bank	85	Geyer Bank[3]	85
Bouma Bank	85	MacNeil Bank[3]	82
Rezak Bank	85	Alderdice Bank	80
Sidner Bank	85		
Rankin Bank	85	**Midshelf Banks**	
Sackett Bank[2]	85		
Ewing Bank	85	Fishnet Bank[2]	76
Diaphus Bank[2]	85	29 Fathom Bank	64
Parker Bank	85	Sonnier Bank	55
Jakkula Bank	85		

[1] Only paragraph (a) of the stipulation applies.
[2] Only paragraphs (a) and (b) apply.
[3] WPA bank with a portion of its "3-Mile Zone" in the CPA.

Effectiveness of the Lease Stipulation

The purpose of the stipulation is to protect the biota of the topographic features from adverse effects due to routine oil and gas activities. Such effects include physical damage from anchoring and rig emplacement and potential toxic and smothering effects from muds and cuttings discharges. The Topographic Features Stipulation has been used on leases since 1973, and this experience shows conclusively that the stipulation effectively prevents damage to the biota of these banks from routine oil and gas activities. Anchoring related to oil and gas activities on the sensitive portions of the topographic features has been prevented. Monitoring studies have demonstrated that the shunting requirements of the stipulations are effective in preventing the muds and cuttings from impacting the biota of the banks. The stipulation, if adopted for the proposed actions, will continue to protect the biota of the banks, specifically as discussed below.

Mechanical damage resulting from oil and gas operations is probably the single most serious impact to benthic habitat. Complying with the No Activity Zone designation of the Topographic Features Stipulation should completely eliminate this threat to the sensitive biota of WPA topographic features from activities resulting from the proposed actions. The sensitive biota within the zones provided for in the Topographic Features Stipulation will thus be protected.

Several other impact-producing factors may threaten communities associated with topographic features. Vessel anchoring and structure emplacement result in physical disturbance of benthic habitat and are the most likely activities to cause permanent or long-lasting impacts to sensitive offshore habitats. Recovery from damage caused by such activities may take 10 or more years (depending on the maturity of the impacted community). Operational discharges (drilling muds and cuttings, produced waters) may impact the biota of the banks due to turbidity and sedimentation, resulting in death to benthic organisms in large areas. Recovery from such damage may take 10 or more years (depending on the maturity of the impacted community). Blowouts may cause similar damage to benthic biota by resuspending sediments, causing turbidity and sedimentation, which could ultimately have a lethal impact on benthic organisms. Recovery from such damage may take up to 10 years (depending on the maturity of the impacted community). Oil spills will cause damage to benthic organisms if the oil contacts the organisms; such contact is unlikely except from spills from blowouts. There have been few blowouts in the Gulf of Mexico. Structure removal using explosives can result in water turbidity, redeposition of sediments, and explosive shock-wave impacts. Recovery from such damage could take more than 10 years (depending on the maturity of the impacted community). The above activities, especially bottom-disturbing activities, have the greatest potential to severely impact the biota of topographic features. Those activities having the greatest impacts are also those most likely to occur. The proposed actions, without benefit of the Topographic Features Stipulation or comparable mitigation, are expected to have a severe impact on the sensitive offshore habitats of the topographic features.

The stipulation provides different levels of protection for banks in different categories as defined by Rezak and Bright (1981). The categories and their definitions are as follows:

Category A:	zone of major reef-building activity; maximum environmental protection recommended;
Category B:	zone of minor reef-building activity; environmental protection recommended;
Category C:	zone of negligible reef-building activity, but crustose algae present; environmental protection recommended; and
Category D:	zone of no reef-building or crustose algae; additional protection not necessary.

The stipulation requires that all effluents within 1,000 m of Sackett, Fishnet, and Diaphus Banks, categorized by Rezak and Bright (1981) as Category C banks, be shunted into the nepheloid layer; the potentially harmful materials in drilling muds will be trapped in the bottom boundary layer and will not move up the banks where the biota of concern are located. Surface drilling discharge at distances greater than 1,000 m from the bank is not expected to impact the biota.

The stipulation protects the remaining banks (Category A and B banks) with even greater restrictions. Surface discharge will not be allowed within 1 nmi of these more sensitive banks. Surface discharges outside of 1 nmi are not expected to impact the biota of the banks, as adverse effects from surface discharge are limited to 1,000 m. However, it is possible that, when multiple wells are drilled from a single platform (surface location), typical during development operations, extremely small amounts of muds discharged more than 1 nmi from the bank may reach the bank. In order to eliminate the possible cumulative effect of muds discharged during development drilling, the stipulation imposes a 3-Mile Zone within which shunting of development well effluent is required.

The stipulation would prevent damage to the biota of the banks from routine oil and gas activities resulting from the proposals, while allowing the development of nearby oil and gas resources. The stipulation will not protect the banks from the adverse effects of an accident such as a large blowout on a nearby oil or gas operation.

2.3.1.3.2. Live Bottom (Pinnacle Trend) Stipulation

The Live Bottom (Pinnacle Trend) Stipulation covers the pinnacle trend area of the CPA (Figure 2-3). A small portion of the northeastern CPA, including portions of 70 lease blocks (Figure 2-3), is characterized by a pinnacle trend, which is classified as a live bottom under the stipulation. The pinnacle trend extends into the northwest portion of the Eastern Planning Area (EPA). The pinnacles are a series of topographic irregularities with variable biotal coverage, which provide structural habitat for a variety of pelagic fish. The pinnacles in the region could be impacted from physical damage of unrestricted oil and gas activities, as noted in Chapter 4.2.1.2.1. The Live Bottom (Pinnacle Trend) Stipulation is intended to protect the pinnacle trend and the associated hard-bottom communities from damage and, at the same time, provide for recovery of potential oil and gas resources.

The stipulation reads as follows:

Live Bottom (Pinnacle Trend) Stipulation

(To be included only on leases in the following blocks: Main Pass Area, South and East Addition Blocks 190, 194, 198, 219-226, 244-266, 276-290; Viosca Knoll Area Blocks 473-476, 521, 522, 564, 565, 566, 609, 610, 654, 692-698, 734, 778.)

For the purpose of this stipulation, "live bottom areas" are defined as seagrass communities; or those areas which contain biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, or corals living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; or areas whose lithotope favors the accumulation of turtles, fishes, and other fauna.

Prior to any drilling activities or the construction or placement of any structure for exploration or development on this lease, including, but not limited to, anchoring, well drilling, and pipeline and platform placement, the lessee will submit to the Regional Director (RD) a live bottom survey report containing a bathymetry map prepared utilizing remote sensing techniques. The bathymetry map shall be prepared for the purpose of determining the presence or absence of live bottoms which could be impacted by the proposed activity. This map shall encompass such an area of the seafloor where surface disturbing activities, including anchoring, may occur.

If it is determined that the live bottoms might be adversely impacted by the proposed activity, the RD will require the lessee to undertake any measure deemed economically, environmentally, and technically feasible to protect the pinnacle area. These measures may include, but are not limited to, the following:

(a) the relocation of operations; and

(b) the monitoring to assess the impact of the activity on the live bottoms.

Effectiveness of the Lease Stipulation

Through detection and avoidance, this stipulation minimizes the likelihood of mechanical damage from OCS activities associated with rig and anchor emplacement to the sessile and pelagic communities associated with the crest and flanks of such features. Since this area is subject to heavy natural sedimentation, this stipulation does not include any specific measures to protect the pinnacles from the discharge of effluents.

The sessile and pelagic communities associated with the crest and flanks of the pinnacle and hard-bottom features could be adversely impacted by oil and gas activities resulting from the proposed actions if such activities took place on or near these communities without the Live Bottom (Pinnacle Trend) Stipulation. For many years, this stipulation has been made a part of leases on blocks in the CPA on or near these biotic communities so that impacts from nearby oil and gas activities were mitigated to the greatest extent possible. This stipulation does not prevent the recovery of oil and gas resources; however, it does serve to protect valuable and sensitive biological resources.

Activities resulting from the proposed actions, particularly anchor damage to localized pinnacle areas, are expected to cause substantial damage to portions of the pinnacle trend environment because these activities are potentially destructive to the biological communities and could damage one or several individual pinnacles. The most potentially damaging of these are the impacts associated with mechanical damages that may result from anchors. However, the action is judged to be infrequent because of the limited operations in the vicinity of the pinnacles and the small size of many of the features. Minor impact is expected from large oil spills, blowouts, pipeline emplacement, muds and cuttings discharges, and structure removals. The frequency of impacts to the pinnacles is rare, and the severity is judged to be slight because of the widespread nature of the features within the pinnacle trend area. The proposed actions, without the benefit of the Live Bottom (Pinnacle Trend) Stipulation, could have an adverse impact on the pinnacle region, but such impact is expected to be of a localized nature. Impact from mechanical damage including anchors could potentially be long term if the physical integrity of the pinnacles themselves became altered.

The pinnacle trend occurs as patchy regions within the general area of the eastern portion of the CPA (Ludwick and Walton, 1957; Vittor and Associates, Inc., 1985; Brooks and Giammona, 1990). The pinnacle trend also extends into the EPA. The stipulation would require the operators to locate the individual pinnacles and associated communities that may be present in the block. The stipulation requires that a survey be done to encompass the potential area of proposed surface disturbance and that a bathymetry map depicting any pinnacles in the vicinity be prepared from the survey. (Since it is the pinnacles themselves and the habitat they provide for various species that are sensitive to impacts from oil and gas activities, photo-documentation of the identified pinnacles is not warranted.) The MMS Gulf of Mexico Regional Director, through consultation with FWS, could then decide if pinnacles in the trend would be potentially impacted and, if so, require appropriate mitigative measures.

By identifying the individual pinnacles present at the activity site, the lessee would be directed to avoid placement of the drilling rig and anchors on the sensitive areas. Thus, mechanical damage to the pinnacles is eliminated when measures required by the stipulation are imposed. The stipulation does not address the discharge of effluents near the pinnacles because the pinnacle trend is subjected to heavy natural sedimentation and is at considerable depths. The rapid dilution of drill cuttings and muds will minimize the potential of significant concentration of effluents on the pinnacles.

2.3.1.3.3. Military Areas Stipulation

A standard military warning areas stipulation has been applied to all blocks leased in military areas in the Gulf of Mexico since 1977. Figure 2-4 shows the military warning areas in the Gulf of Mexico. This stipulation would be a part of any lease resulting from the proposed actions. The stipulation reads as follows:

Military Areas Stipulation

(a) Hold and Save Harmless

Whether compensation for such damage or injury might be due under a theory of strict or absolute liability or otherwise, the lessee assumes all risks of damage or injury to persons or property, which occur in, on, or above the OCS, to any persons or to any property of any person or persons who are agents, employees, or invitees of the lessee, its agents, independent contractors, or subcontractors doing business with the lessee in connection with any activities being performed by the lessee in, on, or above the OCS, if such injury or damage to such person or property occurs by reason of the activities of any agency of the United States Government, its contractors or subcontractors, or any of its officers, agents, or employees, being conducted as a part of, or in connection with, the programs and activities of the command headquarters listed in Table 2-1.

Notwithstanding any limitation of the lessee's liability in Section 14 of the lease, the lessee assumes this risk whether such injury or damage is caused in whole or in part by any act or omission, regardless of negligence or fault, of the United States, its contractors or subcontractors, or any of its officers, agents, or employees. The lessee further agrees to indemnify and save harmless the United States against all claims for loss, damage, or injury sustained by the lessee, or to indemnify and save harmless the United States against all claims for loss, damage, or injury sustained by the agents, employees, or invitees of the lessee, its agents, or any independent contractors or subcontractors doing business with the lessee in connection with the programs and activities of the aforementioned military installation, whether the same be caused in whole or in part by the negligence or fault of the United States, its contractors, or subcontractors, or any of its officers, agents, or employees and whether such claims might be sustained under a theory of strict or absolute liability or otherwise.

(b) Electromagnetic Emissions

The lessee agrees to control its own electromagnetic emissions and those of its agents, employees, invitees, independent contractors or subcontractors emanating from individual designated defense warning areas in accordance with requirements specified by the commander of the command headquarters listed in Table 2-1 to the degree necessary to prevent damage to, or unacceptable interference with Department of Defense flight, testing, or operational activities, conducted within individual designated warning areas. Necessary monitoring control and coordination with the lessee, its agents, employees, invitees, independent contractors, or subcontractors, will be effected by the commander of the appropriate onshore military installation conducting operations in the particular warning area; provided, however, that control of such electromagnetic emissions shall in no instance prohibit all manner of electromagnetic communication during any period of time between a lessee, its agents, employees, invitees, or independent contractors, or subcontractors and onshore facilities.

(c) Operational

The lessee, when operating or causing to be operated on its behalf, boat, ship, or aircraft traffic in the individual designated warning areas, shall enter into an agreement with the commander of the individual command headquarters listed in Table 2-1, upon utilizing an individual designated warning area prior to commencing such traffic. Such an agreement will provide for positive control of boats, ships, and aircraft operating into the warning areas at all times.

Effectiveness of the Lease Stipulation

The hold harmless section of the military stipulation serves to protect the U.S. Government from liability in the event of an accident involving the lessee and military activities. The actual operations of the military and the lessee and its agents will not be affected.

The electromagnetic emissions section of the stipulation requires the lessee and its agents to reduce and curtail the use of radio, CB, or other equipment emitting electromagnetic energy within some areas. This serves to reduce the impact of oil and gas activity on the communications of military missions and reduces the possible effects of electromagnetic energy transmissions on missile testing, tracking, and detonation.

The operational section requires notification to the military of oil and gas activity to take place within a military use area. This allows the base commander to plan military missions and maneuvers that will avoid the areas where oil and gas activities are taking place or to schedule around these activities. Prior notification helps reduce the potential impacts associated with vessels and helicopters traveling unannounced through areas where military activities are underway.

This stipulation reduces potential impacts, particularly in regards to safety, but does not reduce or eliminate the actual physical presence of oil and gas operations in areas where military operations are conducted. The reduction in potential impacts resulting from this stipulation makes multiple-use conflicts most unlikely. Without the stipulation, some potential conflict is likely. The best indicator of the overall effectiveness of the stipulation may be that there has never been an accident involving a conflict between military operations and oil and gas activities.

2.3.1.3.4. Blocks South of Baldwin County, Alabama, Stipulation

This stipulation will be included only on leases on blocks south of and within 15 mi of Baldwin County, Alabama.

Blocks South of Baldwin County, Alabama, Stipulation

In order to minimize visual impacts from development operations on these blocks, lessees will contact other lessees and operators of leases in the vicinity prior to submitting a

Development Operations Coordination Document (DOCD) to determine if existing or planned surface production structures can be shared. If feasible, the DOCD should reflect the results of any resulting sharing agreement, propose the use of subsea technologies, or propose another development scenario that does not involve new surface structures. If a feasible development scenario that does not call for new surface structure(s) cannot be formulated, the DOCD should ensure that they are the minimum necessary for the proper development of the block and that they will be constructed and placed, using orientation, camouflage, or other design measures, to limit their visibility from shore. The MMS will review and make decisions on the DOCD in accordance with applicable Federal regulations and MMS policies, and in consultation with the State of Alabama (Geological Survey/Oil and Gas Board).

Effectiveness of the Lease Stipulation

For several years, the Governor of Alabama has continually indicated opposition to new leasing south and within 15 mi of Baldwin County but has requested that, if the area is offered for lease, a lease stipulation to reduce the potential for visual impacts should be applied to all new leases in this area. Prior to the decision in 1999 on the Final Notice of Sale for Sale 172, the MMS, GOM OCS Regional Director, in consultation with the Geological Survey of Alabama/State Oil and Gas Board, developed a lease stipulation to be applied to any new leases within the 15-mi area to mitigate potential visual impacts. The stipulation specifies requirements for consultation that lessees must follow when developing plans for fixed structures. The stipulation has been continually adopted in annual Central Gulf of Mexico lease sales since 1999. It has been considered satisfactorily responsive to the concern of the Governor of Alabama and is proposed at this time for adoption in each of the future Central Gulf of Mexico lease sales in the current 5-Year Program, i.e., Sales 185, 190, 194, 198, and 201.

2.3.1.3.5. Law of the Sea Convention Royalty Payment Stipulation

This stipulation will be included in leases beyond the United States (U.S.) Exclusive Economic Zone (EEZ) in the area formerly known as the Western Gap.

Law of the Sea Convention Royalty Payment Stipulation

If the U.S. becomes a party to the 1982 Law of the Sea Convention (Convention) prior to or during the life of a lease issued by the U.S. on a block or portion of a block located beyond the U.S. EEZ and subject to such conditions that the Senate may impose through its constitutional role of advice and consent, then the following royalty payment lease provisions will apply to the lease so issued, consistent with Article 82 of the Convention:

1. The Convention requires payments annually by coastal States party to the Convention with respect to all production at a site after the first five years of production at that site. Any such payments will be made by the U.S. Government and not the lessee.
2. For the purpose of this stipulation regarding payments by the lessee to the U.S., a site is defined as an individual lease whether or not the lease is located in a unit.
3. For the purpose of this stipulation, the first production year begins on the first day of commercial production (excluding test production). Once a production year begins it shall run for a period of 365 days whether or not the lease produces continuously in commercial quantities. Subsequent production years shall begin on the anniversary date of first production.
4. If total lease production during the first five years following first production exceeds the total royalty suspension volume(s) provided in the lease terms, or through application and approval of relief from royalties, the following provisions of this stipulation will not apply. If after the first five years of

production but prior to termination of this lease, production exceeds the total royalty suspension volume(s) provided in the lease terms, or through application and approval of relief from royalties, the following provisions of this stipulation will no longer apply effective the day after the suspension volumes have been produced.

5. If, in any production year after the first five years of lease production, due to lease royalty suspension provisions or through application and approval of relief from royalties, no lease production royalty is due or payable by the lessee to the U.S., then the lessee will be required to pay, as stipulated in paragraph 9 below, Convention-related royalty in the following amount so that the required Convention payments may be made by the U.S. Government as provided under the Convention:

   a. In the sixth year of production, one percent of the value of the sixth year's lease production saved, removed, or sold from the leased area;

   b. After the sixth year of production, the Convention-related royalty payment rate shall increase by one percent for each subsequent year until the twelfth year and shall remain at seven percent thereafter until lease termination.

6. If the U.S. becomes a party to the Convention after the fifth year of production from the lease, and a lessee is required, as provided herein, to pay Convention-related royalty, the amount of the royalty due will be based on the above payment schedule as determined from first production.

   For example, U.S. accession to the Convention in the tenth year of lease production would result in a Convention-related royalty payment of five percent of the value of the tenth year's lease production, saved, removed, or sold from the lease. The following year, a payment of six percent would be due, and so forth as stated above, up to a maximum of seven percent per year.

7. If, in any production year after the first five years of lease production, due to lease royalty suspension provisions or through application and approval of relief from royalties, lease production royalty is paid but is less than the payment provided for by the Convention, then the lessee will be required to pay to the U.S. Government the Convention-related royalty in the amount of the shortfall.

8. In determining the value of production from the lease if a payment of Convention-related royalty is to be made, the provisions of the lease and applicable regulations shall apply.

9. The Convention-related royalty payment(s) required under paragraphs 5 through 7 of this stipulation, if any, shall not be paid monthly but shall be due and payable to MMS on or before 30 days after the expiration of the relevant production lease year.

10. The lessee will receive royalty credit in the amount of the Convention-related royalty payment required under paragraphs 5 through 7 of this stipulation, which will apply to royalties due under the lease for which the Convention-related royalty accrued in subsequent periods as non-Convention related royalty payments become due.

11. Any lease production for which the lessee pays no royalty other than a Convention-related requirement, due to lease royalty suspension provisions or through application and approval of relief from royalties, will count against the lease's applicable royalty suspension or relief volume.

12. The lessee will not be allowed to apply or recoup any unused Convention-related credit(s) associated with a lease that has been relinquished or terminated.

Effectiveness of the Lease Stipulation

Adoption of this stipulation in future Western Gulf of Mexico lease sales in the current 5-Year Program, i.e., Sales 187, 192, 196, and 200, would ensure that blocks beyond the U.S. Exclusive Economic Zone (EEZ) in the area formerly known as the Western Gap would be offered consistent with both U.S. law (the OCSLA and the Truman Proclamation asserting U.S. dominion over our OCS to its farthest exploitable reach) and provisions of the 1982 Law of the Sea Convention, which is internally recognized, but not acceded to by the U.S. The Convention balances the extension of coastal Nation control over the natural resources of the continental margin seaward of 200 mi with a modest obligation on such Nations to share revenues from successful mineral development seaward of 200 mi. This proposed stipulation specifies royalty payment provisions that would facilitate the U.S. Government's ability to make any payment required by the Convention. It has continually been adopted for annual Western Gulf of Mexico lease sales since 2001.

2.3.2. Alternative B — The Proposed Actions Excluding the Unleased Blocks Near the Biologically Alternative B Sensitive Topographic Features

2.3.2.1. Description

This alternative would offer for lease all unleased blocks in the CPA, as described for the proposed actions, with the exception of any unleased blocks within the 167 blocks in the CPA that are subject to the Topographic Features Stipulation. As of June 6, 2002, 72 blocks of the 167 blocks were unleased. Although the blocks to be excluded contain oil and/or gas resources, this alternative would not change the resource estimate and activity ranges for the overall proposed actions. It is estimated that a proposed action in the CPA could result in the discovery and production of 0.276-0.654 BBO and 1.590-3.300 tcf of gas.

2.3.2.2. Summary of Impacts

The analyses of impacts summarized below and described in detail in Chapters 4.2.2 and 4.4.3 are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in Chapters 4.1.1, 4.1.2, and 4.4.

The difference between the potential impacts described for Alternative A and those under Alternative B is that under Alternative B no oil and gas activity would take place in the unleased blocks within the 167 blocks subject to the Topographic Features Stipulation. The assumption that the levels of activity for Alternative B are essentially the same as those projected for the proposed actions leads to the conclusion that the impacts expected to result from Alternative B would be very similar to those described under the proposed actions (Chapter 4.2.1). Therefore, the regional impact levels for all resources, except for the topographic features, would be similar to those described under the proposed actions. This alternative, if adopted, would prevent any oil and gas activity whatsoever in the affected blocks; thus, it would eliminate any potential direct impacts to the biota of those blocks from oil and gas activities, which otherwise would be conducted within the blocks.

2.3.3. Alternative C — The Proposed Actions Excluding the Unleased Blocks within 15 Miles of the Baldwin County, Alabama, Coast

2.3.3.1. Description

This alternative would offer for lease all unleased blocks in the CPA, as described for the proposed actions, with the exception of any unleased blocks within 15 mi of the coast of Baldwin County, Alabama (Figure 2-5). Although the blocks to be excluded contain oil and/or gas resources, this alternative would not change the resource estimate and activity ranges for the overall proposed actions. It is estimated that a proposed action in the CPA could result in the discovery and production of 0.276-0.654 BBO and 1.590-3.300 tcf of gas.

2.3.3.2. Summary of Impacts

The analyses of impacts summarized below and described in detail in Chapters 4.2.3 and 4.4.3 are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in Chapters 4.1.1, 4.1.2, and 4.4.

The difference between the potential impacts described for Alternative A and those under Alternative C is that under Alternative C no oil and gas activity would take place in the unleased blocks within 15 mi of the Baldwin County coast. The assumption that the levels of activity for Alternative C are the essentially the same as those projected for the proposed actions leads to the conclusion that the impacts expected to result from Alternative C would be very similar to those described under the proposed actions (Chapter 4.2.1). Therefore, the regional impact levels for all resources, except recreational beaches, would be similar to those described under the proposed actions. This alternative, if adopted, would reduce the potential aesthetic impacts to recreational beaches along the Baldwin County coast.

2.3.4. Alternative D — No Action

2.3.4.1. Description

This alternative is equivalent to cancellation of one or more proposed CPA lease sales scheduled in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007.* The opportunity for development of the estimated of 0.276-0.654 BBO and 1.590-3.300 tcf of gas could have resulted from any proposed action(s) would be precluded or postponed, and any potential environmental impacts resulting from the proposed action(s) would not occur or would be postponed.

2.3.4.2. Summary of Impacts

If Alternative D is selected, all impacts, positive and negative, associated with the proposed actions would not occur. This alternative would therefore result in no effect on the sensitive resources and activities discussed in Chapters 4.2.4 and 4.4.3. The incremental contribution of any of the proposed sales to cumulative effects would not occur, but effects from other activities, including other OCS sales, would remain. Oil-spill risk could increase due to the importation of foreign oil to replace the resources lost through cancellation of any of the proposed actions.

Strategies that could provide replacement resources for lost domestic OCS oil and gas production include a combination of energy conservation; onshore domestic oil and gas supplies; alternative energy sources; and imports of oil, natural gas, and liquefied natural gas. Market forces are assumed to be the predominant factor in determining substitutes for OCS oil and gas. Based on this, increased imports of foreign oil are assumed to be the largest replacement source. Much of this imported oil would enter the United States through the Gulf of Mexico, thus increasing the risks due to tanker spills. Potential alternative energy sources are discussed in the Final EIS for the *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002*.

2.4. Proposed Western Gulf Lease Sales

2.4.1. Alternative A — The Proposed Actions

2.4.1.1. Description

The proposed actions would offer for lease all unleased blocks within the WPA for oil and gas operations (Figure 1-1), with the following exceptions: High Island Area East Addition, South Extension, Blocks A-375 and A -376; Sigsbee Escarpment Area (Area NG15-08) Blocks 11-14, 57-60, 103-106, 148-151, 194-196, 239-241, 285-298, and 331-349; and Keathley Canyon Area (Area NG15-05) Blocks

978-980. The WPA encompasses about 35.9 million acres. The estimated amount of resources projected to be developed as a result of any one proposed WPA lease sale is 0.136-0.262 BBO and 0.810-1.440 tcf of gas.

The analyses of impacts summarized below and described in detail in Chapters 4.3.1 and 4.4.3 are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in Chapters 4.1.1, 4.1.2, and 4.4.

2.4.1.2. Summary of Impacts

Impacts on Sensitive Coastal Environments

Coastal Barrier Beaches and Associated Dunes (Chapters 4.3.1.1.1 and 4.4.3.1.1)

The 0-1 pipeline landfalls projected in support of a proposed action are not expected to cause significant impacts to barrier beaches because of the use of nonintrusive installation methods. Existing facilities originally built inland may, through natural erosion and shoreline recession, be located in the barrier beach and dune zone and contribute to erosion there. A proposed action may contribute to the continued use of such facilities.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which combined with channel jetties, generally causes minor and very localized impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. Based on use, a proposed action would account for a very small percentage of these impacts, which would occur whether a proposed action is implemented or not.

In conclusion, a proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. A proposed action may extend the life and presence of facilities in eroding areas, which can accelerate erosion there. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

Should a spill contact a barrier beach, oiling is expected to be light and sand removal during cleanup activities minimized. No significant impacts to the physical shape and structure of barrier beaches and associated dunes are expected to occur as a result of a proposed action.

Wetlands (Chapters 4.3.1.1.2 and 4.4.3.1.2)

A proposed action is projected to contribute to the construction of 0-1 new onshore pipelines in the WPA; therefore, the projected impact to wetlands from pipeline emplacement is expected to be minimal. As a secondary impact, some wetlands could potentially be converted to open water by continued widening of existing pipeline and navigational canals.

Maintenance dredging of navigation channels related to a proposed action is expected to occur with minimal impacts. Alternative dredged-material disposal methods can be used to enhance and create coastal wetlands.

Deepening an existing channel to accommodate larger service vessels may occur within the previously described environment(s) and could generate the creation of a small area of wetland that would be attributable to a proposed action.

In conclusion, adverse impacts of installation, maintenance, continued existence, and the failure of mitigation structures of pipeline and especially navigation canals are considered the most significant, proposed-action-related impacts to wetlands.

Offshore oil spills resulting from a proposed action are not expected to significantly damage inland wetlands; however, if an inland oil spill related to a proposed action occurs, some impact to wetland habitat would be expected. Although the impact may occur generally over coastal regions, the impact has the highest probability of occurring in the coastal regions, by and large northeast of Galveston County, in the vicinities where WPA oil is handled, and in and around Plaquemines and St. Bernard Parishes in the CPA.

Although the probability of occurrence is low, the greatest threat to wetland habitat is from an inland spill resulting from a vessel accident or pipeline rupture. While a resulting slick may cause minor impacts to wetland habitat and surrounding seagrass communities, equipment and personnel used to cleanup a slick over the impacted area may generate the greatest direct impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. In addition, close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

Seagrass Communities (Chapters 4.3.1.1.3 and 4.4.3.1.3)

Most seagrass communities located within a WPA proposed action are located behind the barrier islands, sparsely distributed in bays and estuaries along coastal Louisiana and Texas, including the Tamaulipas, Mexico Laguna Madre Pipeline construction in coastal waters would temporarily elevate turbidity in nearby submerged vegetation beds, depending upon currents. If constructed, the pipeline landfall would temporarily elevate turbidity in submerged vegetation beds near the pipeline routes. The COE and State permit requirements are expected to require pipeline routes that avoid beds of high-salinity, submerged vegetation and to reduce turbidity impacts to within tolerable limits. Therefore, impacts to submerged vegetation by pipeline installation are projected to be very small and short term. Petroleum reservoirs in deepwater areas could require their own pipeline landfall.

After bottom sediments are disturbed by pipeline installation, they will be generally more easily suspended by storms than before the disturbance. In estuaries, this increase is not projected to be a problem. Due to tidal flushing, this increased turbidity is projected to be below significant levels and to continue after storms for up to one month.

Beds of submerged vegetation within a channel's area of influence will have already adjusted to bed configurations in response to turbidity generated there. Very little, if any, damage would then occur as a result of typical channel traffic. Generally, propwash will not resuspend sediments in navigation channels beyond pre-project conditions.

Depending upon the submerged plant species involved, narrow scars in dense portions of the beds will take 1-7 years to recover. Scars through sparser areas will take 10 years or more to recover. The broader the scar, the longer the recovery period. Extensive damage to a broad area may never be corrected.

Maintenance dredging will not have a substantial impact on existing seagrass habitat given that no new channels are expected to be dredged as a result of a WPA proposed action.

Should a spill ≥1,000 bbl occur offshore from activities resulting from a proposed action, the seagrass communities with the highest probabilities of contact within 10 days would be those located within Matagorda County, Texas, for a proposed action in the WPA and Plaquemines Parish, Louisiana, for a proposed action in the CPA.

Because of the location of most submerged aquatic vegetation, inshore spills pose the greatest threat to them. Such spills may result from either vessel collisions that release fuel and lubricants or from pipelines that rupture. If an oil slick settles into a protective embayment where seagrass beds are found, shading may cause reduced chlorophyll production; shading for more than about 2 weeks could cause thinning of leaf density. Under certain conditions, a slick could reduce dissolved oxygen in an embayment and cause stress to the bed and associated organisms due to reduced oxygen conditions. These light and oxygen problems can correct themselves once the slick largely vacates the embayment, and light and oxygen levels are returned to pre-slick conditions.

Increased water turbulence due to storms or vessel traffic will break apart the surface sheen and disperse some oil into the water column, as well as increase suspended particle concentration, which will adsorb to the dispersed oil. Typically, these situations will not cause long-term or permanent damage to the seagrass beds, although some dieback of leaves is projected for one growing season. No permanent loss of seagrass is projected to result from oil contact, unless an unusually low tidal event allows direct contact between the slick and vegetation. The greatest danger under the more probable circumstances is a reduction, for up to 2 years, of the diversity or population of epifauna and benthic fauna found in seagrass beds.

Although the probability of their occurrence is low, the greatest threat to inland, seagrass communities would be from an inland spill resulting from a vessel accident or pipeline rupture. Although a resulting slick may cause minor impacts to the bed, equipment and personnel used to cleanup a slick over shallow seagrass beds may generate the greatest direct impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Scarring may occur if an oil slick is cleaned up over a shallow submerged aquatic vegetation bed where vessels, booms, anchors, and personnel on foot would be used and scar the bed. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

Impacts on Sensitive Offshore Resources

Topographic Features (Chapters 4.3.1.2.1 and 4.4.3.2.1)

The proposed Topographic Features Stipulation could prevent most of the potential impacts on live-bottom communities from bottom-disturbing activities (structure removal and emplacement) and operational discharges. Recovery from impact incidences of operational discharges would take place within 10 years.

The proposed Topographic Features Stipulations will assist in preventing most of the potential impacts on live-bottom communities from blowouts and surface and subsurface oil spills. Recovery from incidences of impacts from blowouts would take place within 10 years.

Contact with spilled oil would cause lethal and sublethal effects in benthic organisms. The oiling of benthic organisms is not likely because the proposed Topographic Features Stipulations would keep subsurface sources of spills away from the immediate vicinity of topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for adult sessile biota, including coral colonies in the case of the Flower Garden Banks, and there would be limited incidences of mortality. The recovery of harmed benthic communities could take more than 10 years.

Chemosynthetic Deepwater Benthic Communities Chapters 4.3.1.2.2 and 4.4.3.2.3)

Chemosynthetic communities are susceptible to physical impacts from structure placement (including templates or subsea completions), anchoring, and pipeline installation. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement.

If the presence of a high-density community were missed using existing procedures, potentially severe or catastrophic impacts could occur due to raking of the sea bottom by anchors and anchor chains and partial or complete burial by muds and cuttings associated with pre-riser discharges or some types of riserless drilling. Variations in the dispersal and toxicity of synthetic-based drilling fluids may contribute to the potential areal extent of these impacts. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type), although it may reappear relatively quickly once the process begins, as in the case of a mussel community. Tube-worm communities may be the most sensitive of all communities because of the combined requirements of hard substrate and active hydrocarbon seepage. Mature tube-worm bushes have been found to be several hundred years old. There is evidence that substantial impacts on these communities would permanently prevent reestablishment.

A proposed action in the WPA is expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience minor impacts from drilling discharges or resuspended sediments located at more than 1,500 ft away as required by NTL 2000-G20.

Chemosynthetic communities could be susceptible to physical impacts from a blowout depending on bottom-current conditions. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement. There is evidence that substantial impacts on these communities would permanently prevent reestablishment, particularly if hard substrate required for recolonization were to be buried.

Potential accidental impacts from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities located at more than 1,500 ft away from a blowout could experience minor impacts from resuspended sediments.

Nonchemosynthetic Deepwater Benthic Communities (Chapters 4.3.1.2.3 and 4.4.3.2.4)

Some impact to benthic communities from drilling and production activities would occur as a result of physical impact from structure placement (including templates or subsea completions), anchoring, and installation of pipelines regardless of their locations. Megafauna and infauna communities at or below the sediment/water interface would be impacted from the muds and cuttings normally discharged at the seafloor at the start of every new well prior to riser installation. The impact from muds and cuttings discharged at the surface are expected to be low in deep water. Drilling muds would not be expected to reach the bottom beyond a few hundred meters from the surface-discharge location, and cuttings would be dispersed. Even in situations where substantial burial of typical benthic communities occurred, recolonization from populations from neighboring substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of days for bacteria and probably less than 1 year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be very rare. These unique communities are distinctive and similar in nature to protected pinnacles and topographic features on the continental shelf. Any hard substrate communities located in deep water would be particularly sensitive to impacts from OCS activities. Impacts to these sensitive habitats could permanently prevent recolonization, with similar organisms requiring hard substrate.

A proposed action in the WPA is expected to cause little damage to the ecological function or biological productivity of the widespread, typical deep-sea benthic communities.

Accidental events resulting from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, typical, deep-sea benthic communities. Some impact to benthic communities would occur as a result of impact from an accidental blowout. Megafauna and infauna communities at or below the sediment/water interface would be impacted by the physical disturbance of a blowout or by burial from resuspended sediments.

Impacts on Water Quality

Coastal Waters (Chapters 4.3.1.3.1 and 4.4.3.3.1)

The primary impacting sources to water quality in coastal waters are point-source and nonpoint-source discharges from support facilities and vessel discharges. The impacts to coastal water quality from a proposed action in the WPA should be minimal as long as all regulatory requirements are met.

Spills <1,000 bbl are not expected to significantly impact water quality in coastal waters. Larger spills, however, could impact water quality. Chemical spills and the accidental release of SBF are expected to have temporary localized impacts on water quality.

Marine Waters (Chapters 4.3.1.3.2 and 4.4.3.3.2)

During exploration and development drilling activities, the primary impacting sources to marine water quality are discharges of drilling fluids and cuttings. Impacting discharges during production activities are produced water and supply-vessel discharges. Impacts to marine waters from a proposed action in the WPA should be minimal as long as all regulatory requirements are followed.

Spills <1,000 bbl are not expected to significantly impact marine water quality. Larger spills, however, could impact marine water quality. Chemical spills, the accidental release of SBF, and blowouts are expected to have temporary localized impacts on marine water quality.

Impacts on Air Quality (Chapters 4.3.1.4 and 4.4.3.4)

Emissions of pollutants into the atmosphere from the activities associated with a proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. Emissions from proposed-action activities are not expected to have concentrations that would change onshore air-quality classifications. The OCS modeling results show that increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than the maximum increases allowed in the PSD Class II areas.

Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. Other emissions of pollutants into the atmosphere from accidental events as a result of a proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emissions height, emission rates, and the distance of these emissions from the coastline. These emissions are not expected to have concentrations that would change onshore air quality classifications. Increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than maximum increases allowed under the PSD Class I and II program.

Impacts on Marine Mammals (Chapters 4.3.1.5 and 4.4.3.5)

Small numbers of marine mammals could be killed or injured by chance collision with service vessels and by eating indigestible debris, particularly plastic items, lost from service vessels, drilling rigs, and fixed and floating platforms. Deaths due to structure removals are not expected due to existing mitigation measures or those being developed for structures placed in oceanic waters. There is no conclusive evidence whether anthropogenic noise has or has not caused long-term displacements of, or reductions in, marine mammal populations. Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification, although the scope of effects and their magnitude are not known.

The routine activities of a proposed action is not expected to have long-term adverse effects on the size and productivity of any marine mammal species or population stock endemic to the northern Gulf of Mexico.

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact marine mammals in the Gulf of Mexico. Characteristics of impacts (i.e., acute vs. chronic impacts) depend on the magnitude, frequency, location, and date of accidents; characteristics of spilled oil; spill-response capabilities and timing; and various meteorological and hydrological factors. Populations of marine mammals in the northern Gulf will be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes.

Impacts on Sea Turtles (Chapters 4.3.1.6 and 4.4.3.6)

Routine activities resulting from a proposed action have the potential to harm sea turtles. These animals could be impacted by the degradation of water quality resulting from operational discharges; noise generated by helicopter and vessel traffic, platforms, and drillships; brightly-lit platforms; explosive removals of offshore structures; vessel collisions; and jetsam and flotsam generated by service vessels and OCS facilities. Lethal effects are most likely to be from chance collisions with OCS service vessels and ingestion of plastic materials. "Takes" due to explosive removals are expected to be rare due to mitigation measures already established (e.g., NOAA Fisheries observer program) and in development. Most OCS activities are expected to have sublethal effects. Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification; there is uncertainty concerning the possible effects. Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas could cause declines in survival or fecundity and result in either population declines; however, such declines are not expected. The routine activities of a proposed action are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or population in the Gulf of Mexico.

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact small to large numbers of sea turtles in the Gulf of Mexico, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and date of accidents, and various meteorological and hydrological factors. Populations of sea turtles in the northern Gulf will be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes.

Impacts on Coastal and Marine Birds (Chapters 4.3.1.7 and 4.4.3.8)

The majority of effects resulting from a proposed action in the WPA on endangered/threatened and nonendangered/nonthreatened coastal and marine birds are expected to be sublethal: behavioral effects, sublethal exposure to or intake of OCS-related contaminants or discarded debris, temporary disturbances, and displacement of localized groups from impacted habitats. Chronic sublethal stress, however, is often undetectable in birds. As a result of stress, individuals may weaken, facilitating infection and disease; then, migratory species may not have the strength to reach their destination. No significant habitat impacts are expected to occur directly from routine activities resulting from a proposed action. Secondary impacts to coastal habitats will occur over the long term and may ultimately displace species from traditional sites to alternative sites.

Oil spills from a proposed action pose the greatest potential direct and indirect impacts to coastal and marine birds. Birds that are heavily oiled are usually killed. If physical oiling of individuals or local groups of birds occurs, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected. Small coastal spills, pipeline spills, and spills from accidents in navigated waterways can contact and affect the different groups of coastal and marine birds, most commonly marsh birds, waders, waterfowl, and certain shorebirds. Lightly oiled birds can sustain tissue and organ damage from oil ingested during feeding and grooming, or that is inhaled. Stress and shock enhance the effects of exposure and poisoning. Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration. Reproductive success can be affected by the toxins in oil. Indirect effects occur by fouling of nesting habitat, and displacement of individuals, breeding pairs, or populations to less favorable habitats.

Dispersants used in spill cleanup activity can have toxic effects similar to oil on the reproductive success of coastal and marine birds. The, air, vehicle, and foot traffic that takes place during shoreline clean up activity can disturb nesting populations and degrade or destroy habitat.

Impacts on Fish Resources and Essential Fish Habitat (Chapters 4.3.1.8 and 4.4.3.10)

It is expected that coastal and marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of coastal and marine environmental degradation is expected to cause an undetectable decrease in fish resources or in EFH. Fish resources and EFH are expected to recover from more than 99 percent, but not all, of the expected coastal and marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation, but any loss of wetlands as EFH would be permanent.

Offshore live bottoms will not be impacted. Offshore discharges and subsequent changes to marine water quality will be regulated by NPDES permits. At the expected level of impact, the resultant influence on fish resources and EFH would be negligible and indistinguishable from natural population variations.

Activities such as pipeline trenching and OCS discharge of drilling muds and produced water would cause negligible impacts and would not deleteriously affect fish resources or EFH. At the expected level of impact, the resultant influence on fish resources would cause less than a 1 percent change in fish populations or EFH. As a result, there would be little disturbance to fish resources or EFH.

A proposed action is expected to result in less than a 1 percent decrease in fish resources and/or standing stocks or in EFH. It would require one generation for fish resources to recover from 99 percent of the impacts. Recovery from the loss of wetlands habitat would probably not occur.

Accidental events resulting from oil and gas development in CPA and WPA lease sale areas of the Gulf of Mexico have the potential to cause some detrimental effects on fisheries and fishing practices. It is expected that subsurface blowouts that may occur as a result of a proposed action would have a negligible effect on Gulf fish resources or commercial fishing. If spills due to a proposed action were to occur in open waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be sublethal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. The effect of proposed-action-related oil spills on fish resources and commercial fishing is expected to cause less than a 1 percent decrease in standing stocks of any population, commercial fishing efforts, landings, or value of those landings. Any affected commercial fishing activity will recover within 6 months. At the expected level of impact, the resultant influence on fish populations and commercial fishing activities within the CPA or WPA lease sale areas would be negligible and indistinguishable from variations due to natural causes.

It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH; however, wetland loss could occur due to a petroleum spill contacting inland areas.

Impacts on Commercial Fisheries (Chapters 4.3.1.9 and 4.4.3.11)

Activities such as seismic surveys and pipeline trenching will cause negligible impacts and will not deleteriously affect commercial fishing activities. Operations such as production platform emplacement, underwater OCS impediments, and explosive platform removal, will cause slightly greater impacts on commercial fishing. At the expected level of impact, the resultant influence on commercial fishing will be indistinguishable from variations due to natural causes. As a result, there would be very little impact to commercial fishing. A proposed action is expected to result in less than a 1 percent change in activities, in pounds landed, or in the value of landings. It will require less than 6 months for fishing activity to recover from any impacts.

Accidental events resulting from oil and gas development in CPA and WPA lease sale areas of the Gulf of Mexico have the potential to cause some detrimental effects on fisheries and fishing practices. It is expected that subsurface blowouts that may occur as a result of a proposed action would have a negligible effect on Gulf fish resources or commercial fishing. If spills due to a proposed action were to occur in open waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be sublethal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. The effect of proposed-action-related oil spills on fish resources and commercial fishing is expected to cause less than a 1 percent decrease in standing stocks of any population, commercial fishing efforts, landings, or value of those landings. Any affected commercial fishing activity will recover within 6 months. At the expected level of impact, the resultant influence on fish populations and commercial fishing activities within the CPA or WPA lease sale areas would be negligible and indistinguishable from variations due to natural causes.

Impacts on Recreational Beaches (Chapters 4.3.1.10 and 4.4.3.12)

Marine debris will be lost from time to time from operations resulting from a proposed action. The impact on Gulf Coast recreational beaches is expected to be minimal. The incremental increase in helicopter and vessel traffic is expected to add very little additional noise that may affect beach users. A proposed action is expected to result in nearshore operations that may adversely affect the enjoyment of some Gulf Coast beach uses; however, these will have little effect on the number of beach users.

It is unlikely that a spill would be a major threat to recreational beaches because any impacts would be short-term and localized. Should a spill contact a recreational beach, short-term displacement of recreational activity from the areas directly affected would occur. Beaches directly impacted would be expected to close for periods of 2-6 weeks, or until the cleanup operations were complete. Should a spill result in a large volume of oil contacting a beach or a large recreational area being contacted by an oil slick, visitation to the area could be reduced by as much as 5-15 percent for as long ass one season, but such an event should have no long-term effect on tourism.

Tarballs can lessen the enjoyment of the recreational beaches but should have no long-term effect on the overall use of beaches.

Impacts on Archaeological Resources

Historic Archaeological Resources (Chapters 4.3.1.11.1 and 4.4.3.13.1)

The greatest potential impact to a historic archaeological resource as a result of a proposed action in the WPA would result from direct contact between an offshore activity (platform installation, drilling rig emplacement, and dredging or pipeline project) and a historic shipwreck. An MMS-funded study (Garrison et al., 1989) resulted in the redefinition of the high-probability areas for the location of historic period shipwrecks. An MMS review of the historic high-probability areas is occurring at the time of this writing. The NTL for archaeological resources surveys in the Gulf of Mexico Region, NTL 2002-G01, mandates a 50-m linespacing for remote-sensing surveys of lease within the high-probability areas for historic shipwrecks.

Ferromagnetic debris has the potential to mask the magnetic signatures of historic shipwrecks.

Maintenance dredging of navigation channels may result in impacts to historic shipwrecks; however, the percentage of OCS use of these channels under a proposed action is less than 1 percent.

Most other routine activities associated with a proposed action in the WPA are not expected to impact historic archaeological resources. It is conservatively assumed that 1 percent of the OCS Program's use of projected onshore facilities will occur in support of a proposed action (Table 4-11). It is expected that archaeological resources will be protected through review and approval processes of various Federal, State, and local agencies involved in permitting onshore activities.

Offshore oil and gas activities resulting from a proposed action could contact a shipwreck because of incomplete knowledge on the location of shipwrecks in the Gulf. Although this occurrence is not probable, such an event would result in the disturbance or destruction of important historic archaeological information. Other factors associated with a proposed action in the WPA are not expected to affect historic archaeological resources.

Impact to a historic archaeological resource could occur as a result of an accidental spill. As indicated in Chapter 4.4.1, it is not very likely that an oil spill will occur and contact coastal historic archaeological sites from accidental events associated with a proposed action in the WPA or CPA. The major effect from an oil-spill impact would be visual contamination of a historic coastal site, such as a historic fort or lighthouse. As historic archaeological sites are protected under law, it is expected that any spill cleanup operations would be conducted in such a way as to cause little or no impacts to historic archaeological resources. These impacts would be temporary and reversible.

Prehistoric Archaeological Resources (Chapters 4.3.1.11.2 and 4.4.3.13.2)

Several impact-producing factors may threaten the prehistoric archaeological resources of the Western Gulf. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric site located on the continental shelf. The archaeological survey and archaeological clearance of sites required prior to an operator beginning oil and gas activities on a lease are expected to be highly effective (90%) at identifying possible prehistoric sites. Since the survey and clearance provide a significant reduction in the potential for a damaging interaction between an impact-producing factor and a prehistoric site, there is a very small possibility of an OCS activity contacting a prehistoric site. Should such contact occur, there would be damage to or loss of significant or unique archaeological information.

Onshore development as a result of a proposed action could result in the direct physical contact from new facility construction, pipeline trenching, and new navigation canal dredging. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes of the Federal, State, and local agencies involved.

A proposed action in the WPA is not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost.

Accidental events producing oil spills may threaten the prehistoric archaeological resources of the Gulf Coast. Impacts to prehistoric sites could occur as a result of an oil spill. Should a spill contact an archaeological site, damage might include loss of radiocarbon-dating potential, direct impact from oil-spill cleanup equipment, and/or looting. Previously unrecorded sites could be impacted by oil-spill cleanup operations on beaches.

As indicated in Chapter 4.4.1, it is not very likely for an oil spill to occur and contact coastal and barrier island prehistoric sites as a result of a proposed action in the WPA or CPA. The proposed actions are not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost and this impact would be irreversible.

Impacts on Human Resources and Land Use

Land Use and Coastal Infrastructure (Chapters 4.3.1.12.1 and 4.4.3.14.1)

The existing oil and gas infrastructure is expected to be sufficient to handle development associated with a proposed action. A proposed WPA lease sale would not alter the current land use of the area. Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on land use. Coastal or nearshore spills could have short-term adverse effects on coastal infrastructure requiring cleanup of any oil or chemicals spilled.

Demographics (Chapters 4.3.1.12.2 and 4.4.3.14.2)

Activities relating to a proposed WPA lease sale are expected to minimally affect the analysis area's land use, infrastructure, and demography. These impacts are projected to mirror employment effects that are estimated to be negligible to any one subarea. Baseline patterns and distributions of these factors, as described in Chapter 3.3.3, are expected to maintain. Changes in land use throughout the analysis area are expected to be contained and minimal. The OCS-related infrastructure is in place and will not change as a result of a proposed action. Current baseline estimates of population growth for the analysis area show a continuation of growth, but at a slower rate. Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on the demographic characteristics of the Gulf coastal communities.

Economic Factors (Chapters 4.3.1.12.3 and 4.4.3.14.3)

Should a proposed WPA lease sale occur, there would be only minor economic changes in the Texas, Louisiana, Mississippi, and Alabama subareas. A proposed action is expected to generate less than a 1 percent increase in employment in any of these subareas. This demand will be met primarily with the existing population and available labor force. There would be very little to no economic stimulus in the Florida subareas.

While a proposed WPA lease sale will not significantly impact the analysis area, OCS activities from past and future OCS lease sales will continue to occur and impact the analysis area. In other words, even if a proposed action were not held, there would still be impacts from past and future OCS lease sales on the analysis area. The OCS-related impacts will continue even in the absence of a proposed action. In addition, the lack of a proposed action could lead to reduced employment in affected sectors.

The opportunity costs (employment and revenues) associated with oil-spill cleanup activities is expected to be temporary and of short duration. It is not expected to exceed 1 percent of baseline employment for any subarea within the analysis area. A large oil spill resulting from the proposed actions would acutely threaten shoreline recreational beaches for up to 30 days. After that, natural processes such as weathering and dispersion significantly change the nature and form of the oil to the point that it is unlikely to be a major threat to beach recreational resources and activities.

Environmental Justice (Chapters 4.3.1.12.4 and 4.4.3.14.4)

Because of the presence of an existing extensive and widespread support system for the OCS-related industry and associated labor force, the effects of a proposed action in the WPA are expected to be widely distributed and little felt. In general, who will be hired and where new infrastructure might be located is impossible to predict. Impacts related to a proposed action are expected to be economic and have a limited but positive effect on low-income and minority populations. Given the existing distribution of the industry and the limited concentrations of minority and low-income peoples, a proposed action sale is not expected to have a disproportionate effect on these populations. A proposed action is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people.

Considering the low likelihood of an oil spill and the nonhomogeneous population distribution along the Gulf of Mexico region, accidental spill events associated with a proposed action are not expected to have disproportionate adverse environmental or health effects on minority or low-income people.

2.4.1.3. Mitigating Measures

2.4.1.3.1. Topographic Features Stipulation

The topographic features of the Western Gulf provide habitat for coral-reef-community organisms (Chapter 3.2.2.3). Oil and gas activities resulting from the proposed actions could have a severe, even lethal, impact on or near these communities if the Topographic Features Stipulation is not adopted and such activities were not otherwise mitigated. The DOI has recognized this problem for some years, and since 1973 stipulations have been made a part of leases on or near these biotic communities; impacts from nearby oil and gas activities were mitigated to the greatest extent possible. This stipulation would not prevent the recovery of oil and gas resources but would serve to protect valuable and sensitive biological resources.

The Topographic Features Stipulation was formulated based on consultation with various Federal agencies and comments solicited from the States, industry, environmental organizations, and academic representatives. The stipulation is based on years of scientific information collected since the inception of the stipulation. This information includes various Bureau of Land Management/MMS-funded studies of topographic highs in the Gulf of Mexico; numerous stipulation-imposed, industry-funded monitoring reports; and the National Research Council (NRC) report entitled *Drilling Discharges in the Marine Environment* (1983). The location and lease status of the blocks affected by the Topographic Features Stipulation are shown on Figures 2-1, 2-6, and 2-7.

The requirements in the stipulation are based on the following facts:

(a) Shunting of the drilling effluent to the nepheloid layer confines the effluent to a level deeper than that of the living components of a high-relief topographic feature. Shunting is therefore an effective measure for protecting the biota of high-relief topographic features (Bright and Rezak, 1978; Rezak and Bright, 1981; NRC, 1983).

(b) The biological effect on the benthos from the deposition of nonshunted discharge is mostly limited to within 1,000 m of the discharge (NRC, 1983).

(c) The biota of topographic features can be categorized into depth-related zones defined by degree of reef-building activity (Rezak and Bright, 1981; Rezak et al., 1983 and 1985).

The stipulation establishes No Activity Zones at the topographic features. A zone is defined by the 85-m bathymetric contour (isobath) because, generally, the biota shallower than 85 m are more typical of the Caribbean reef biota, while the biota deeper than 85 m are similar to soft-bottom organisms found throughout the Gulf. Where a bank is in water depths less than 85 m, the deepest "closing" isobath defines the No Activity Zone for that topographic feature. Within the No Activity Zones, no operations, anchoring, or structures are allowed. Outside the No Activity Zones, additional restrictive zones are established where oil and gas operations could occur, but where drilling discharges would be shunted.

The stipulation requires that all effluents within 1,000 m of banks containing an antipatharian-transitional zone be shunted to within 10 m of the seafloor. Banks containing the more sensitive and productive algal-sponge zone require a shunt zone extending 1 nmi and an additional 3-nmi shunt zone for development only.

Exceptions to the general stipulation are made for the Flower Garden Banks and the low-relief banks. Because the East and West features of the Flower Garden Banks have received National Marine Sanctuary status, they are protected to a greater degree than the other banks. The added provisions at the Flower Garden Banks require that (a) the No Activity Zone be based on the 100-m isobath instead of the 85-m isobath and be defined by the "1/4 1/4 1/4" system (a method of defining a specific portion of a block) rather than the actual isobath and (b) there be a 4-Mile Zone instead of a 1-Mile Zone in which shunting is required. Although Stetson Bank was made part of the Flower Garden Banks National Marine Sanctuary in 1996, it has not as yet received added protection that would differ from current stipulation requirements. Low-relief banks have only a No Activity Zone. A shunting requirement would be counterproductive because it would put the potentially toxic drilling muds in the same water depth range as the features associated biota that are being protected. Also, the turbidity potentially caused by the release of drilling effluents in the upper part of the water column would not affect the biota on low-relief features as they appear to be adapted to high turbidity. Claypile Bank, which is a low-relief bank that exhibits the *Millepora*-sponge community, has been given the higher priority protection of a 1,000-Meter Zone where monitoring is required.

The stipulation reads as follows:

Topographic Features Stipulation
(Western Planning Area)

(a) No activity including structures, drilling rigs, pipelines, or anchoring will be allowed within the listed isobath ("No Activity Zone") of the banks as listed below.

(b) Operations within the area shown as "1,000-Meter Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 meters, from the bottom.

(c) Operations within the area shown as "1-Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 meters, from the bottom. (Where there is a "1-Mile Zone" designated, the "1,000-Meter Zone" in paragraph (b) is not designated.) This restriction on operations also applies to areas surrounding the Flower Garden Banks National Marine Sanctuary, namely the "4-Mile Zone" surrounding the East Flower Garden Bank and the West Flower Garden.

(d) Operations within the area shown as "3-Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids from development operations to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 meters, from the bottom.

The banks and corresponding blocks to which this stipulation may be applied in the Western Gulf are as follows:

Bank Name	Isobath (m)	Bank Name	Isobath (m)
Shelf Edge Banks		**Low Relief Banks**[2]	
West Flower Garden Bank	100-120	Coffee Lump	70
(defined by ¼ ¼ ¼ system)		32 Fathom Bank	52
East Flower Garden Bank	100-130	Claypile Bank[3]	50
(defined by ¼ ¼ ¼ system)		**South Texas Banks**[4]	
MacNeil Bank	86-94	Dream Bank	78-82
Rankin Bank	85	Southern Bank	80
Geyer Bank	85	Hospital Bank	70
Elvers Bank	85	North Hospital Bank	68-70
Bright Bank[1]	85	Aransas Bank	70-72
McGrail Bank[1]	85	South Baker Bank	70-84
Rezak Bank[1]	85	Baker Bank	70-74
Sidner Bank[1]	85	**South Texas Low-Relief Banks**	
Parker Bank[1]	85	Mysterious Bank	74-86
Appelbaum Bank	85	Blackfish Ridge	70
Midshelf Banks		Big Dunn Bar	65
29 Fathom Bank	64	Small Dunn Bar	65
Stetson Bank	52		

[1]CPA bank with a portion of its "1-Mile Zone" and/or "3-Mile Zone" in the WPA.
[2]Low-Relief Mid Shelf Banks—only paragraph (a) applies.
[3]Claypile Bank—only paragraphs (a) and (b) apply. In paragraph (b), monitoring, rather than shunting, of the effluent is required at Claypile Bank to determine the effect on the biota.
[4]South Texas Banks—only paragraphs (a) and (b) apply.

Effectiveness of the Lease Stipulation

The purpose of the stipulation is to protect the biota of the topographic features from adverse effects due to routine oil and gas activities. Such effects include physical damage from anchoring and rig emplacement and potential toxic and smothering effects from muds and cuttings discharges. The Topographic Features Stipulation has been used on leases since 1973 and has effectively prevented damage to the biota of these banks from routine oil and gas activities such as anchoring. Monitoring studies have demonstrated that the shunting requirements of the stipulation are effective in preventing the muds and cuttings from impacting the biota of the banks. The stipulation, if adopted for the proposed actions, will continue to protect the biota of the banks, specifically as discussed below.

The stipulation provides different levels of protection for banks in different categories as defined by Rezak and Bright (1981). The categories and their definitions are as follows:

Category A: zone of major reef-building activity; maximum environmental protection recommended;

Category B: zone of minor reef-building activity; environmental protection recommended;

Category C: zone of negligible reef-building activity, but crustose algae present; environmental protection recommended; and

Category D: zone of no reef-building or crustose algae; additional protection not necessary.

Mechanical damage resulting from oil and gas operations is probably the single most serious impact to benthic habitat. Complying with the No Activity Zone designation of the Topographic Features Stipulation should completely eliminate this threat to the sensitive biota of WPA topographic features from activities resulting from the proposed actions.

Several other impact-producing factors may threaten communities associated with topographic features. Vessel anchoring and structure emplacement result in physical disturbance of benthic habitat and are the most likely activities to cause permanent or long-lasting impacts to sensitive offshore habitats. Recovery from damage caused by such activities may take 10 or more years (depending on the maturity of the impacted community). Operational discharges (drilling muds and cuttings, produced waters) may impact the biota of the banks due to turbidity and sedimentation, resulting in death to benthic organisms in large areas. Recovery from such damage may take 10 or more years (depending on the maturity of the impacted community). Blowouts may cause similar damage to benthic biota by resuspending sediments, causing turbidity and sedimentation, which could ultimately have a lethal impact on benthic organisms. Recovery from such damage may take up to 10 years (depending on the maturity of the impacted community). Oil spills will cause damage to benthic organisms if the oil contacts the organisms; such contact is unlikely except from spills from blowouts. There have been very few blowouts in the Gulf. Structure removal using explosives can result in water turbidity, redeposition of sediments, and explosive shock-wave impacts. Recovery from such damage could take more than 10 years (depending on the maturity of the impacted community). The above activities, especially bottom-disturbing activities, have the greatest potential to severely impact the biota of topographic features. Those activities having the greatest impacts are also those most likely to occur. The proposed actions, without benefit of the Topographic Features Stipulation or comparable mitigation, are expected to have a severe impact on the sensitive offshore habitats of the topographic features.

The biota of low-relief banks and the turbidity of the water are such that protective measures to restrain drilling discharges are not warranted for these features.

The stipulation provides an added measure of protection for Claypile Bank, requiring both No Activity and 1,000-Meter Zones. Claypile Bank is the only low-relief bank that is known to contain the *Millepora*-sponge community. This assemblage is categorized by Rezak and Bright (1981) as a Category B community (minor reef-building activity) worthy of increased protection; therefore, monitoring will be required within the 1,000-Meter Zone. Any impacts from drilling will thereby be documented so that further protective measures could be taken. Due to the low relief of the bank (5 m), shunting would be counterproductive.

The stipulation requires that all drill cuttings and drilling fluids within 1,000 m of high-relief topographic features categorized by Rezak and Bright (1981) as Category C banks (negligible reef-building activity) be shunted into the nepheloid layer; the potentially harmful materials in drilling muds would be trapped in the bottom boundary layer and would not move up the banks where the biota of concern are located. Surface drilling discharge at distances greater than 1,000 m from the bank is not expected to adversely impact the biota.

The stipulation protects the remaining banks (Category A and B banks—major and minor reef building) with even greater restrictions. (Appelbaum Bank is categorized as Category C; however, it contains the algal-sponge community, which is indicative of Category A banks. Therefore, it carries a Category A bank stipulation.) Surface discharge will not be allowed within 1 nmi of these more sensitive banks. Surface discharges outside of 1 nmi are not expected to adversely impact the biota of the banks. However, when multiple wells are drilled from a single platform (surface location), typical during development operations, extremely small amounts of muds discharged more than 1 nmi from the bank may reach the bank. In order to eliminate the possible cumulative effect of muds discharged from numerous wells outside of 1 nmi, the stipulation imposes a 3-Mile Zone within which shunting of development effluent is required. The stipulation results in increased protection to the East and West features of the Flower Garden Banks. Shunting would be required within a 4-Mile Zone.

The surface discharge of drilling muds and cuttings resulting from exploratory wells within the 3-Mile Zone is not expected to reach or affect the biological resources located within the No Activity Zone for three main reasons: (1) the biological effect on the benthos from the deposition of nonshunted discharge is mostly limited to within 1,000 m of the discharge (NRC, 1983); (2) exploration usually requires the drilling of one to four wells per site as opposed to more than five in the case of development; and (3) a significantly lower volume of exploration drilling discharges is expected per site since development usually requires the drilling of several additional wells over greater distances to reach potential reservoirs. The requirement to shunt drilling discharges within the 3-Mile Zone during development drilling is in response to the strong recommendation by FWS.

The stipulation would prevent damage to the biota of the banks from routine oil and gas activities resulting from the proposed actions, while allowing the development of nearby oil and gas resources. The stipulation would not protect the banks from adverse effects of an accident such as a large blowout on a nearby oil or gas operation.

2.4.1.3.2. Military Areas Stipulation

A standard military warning areas stipulation has been applied to all blocks leased in military areas in the Gulf of Mexico since 1977. Figure 2-5 shows the military warning areas in the Gulf of Mexico. This stipulation would be a part of any lease resulting from the proposed actions. The stipulation reads as follows:

Military Areas Stipulation

(a) Hold and Save Harmless

Whether compensation for such damage or injury might be due under a theory of strict or absolute liability or otherwise, the lessee assumes all risks of damage or injury to persons or property, which occur in, on, or above the OCS, to any persons or to any property of any person or persons who are agents, employees, or invitees of the lessee, its agents, independent contractors, or subcontractors doing business with the lessee in connection with any activities being performed by the lessee in, on, or above the OCS, if such injury or damage to such person or property occurs by reason of the activities of any agency of the United States Government, its contractors or subcontractors, or any of its officers, agents, or employees, being conducted as a part of, or in connection with, the programs and activities of the command headquarters listed in Table 2-1.

Notwithstanding any limitation of the lessee's liability in Section 14 of the lease, the lessee assumes this risk whether such injury or damage is caused in whole or in part by any act or omission, regardless of negligence or fault, of the United States, its contractors or subcontractors, or any of its officers, agents, or employees. The lessee further agrees to indemnify and save harmless the United States against all claims for loss, damage, or injury sustained by the lessee, or to indemnify and save harmless the United States against all claims for loss, damage, or injury sustained by the agents, employees, or invitees of the lessee, its agents, or any independent contractors or subcontractors doing business with the lessee in connection with the programs and activities of the aforementioned military installation, whether the same be caused in whole or in part by the negligence or fault of the United States, its contractors, or subcontractors, or any of its officers, agents, or employees and whether such claims might be sustained under a theory of strict or absolute liability or otherwise.

(b) Electromagnetic Emissions

The lessee agrees to control its own electromagnetic emissions and those of its agents, employees, invitees, independent contractors or subcontractors emanating from individual designated defense warning areas in accordance with requirements specified by the commander of the command headquarters listed in Table 2-1 to the degree necessary to prevent damage to, or unacceptable interference with Department of Defense flight, testing, or operational activities, conducted within individual designated warning areas. Necessary monitoring control and coordination with the lessee, its agents, employees, invitees, independent contractors, or subcontractors, will be effected by the commander of the appropriate onshore military installation conducting operations in the particular warning area; provided, however, that control of such electromagnetic emissions shall in no instance prohibit all manner of electromagnetic communication during any period of time between a lessee, its agents, employees, invitees, or independent contractors, or subcontractors and onshore facilities.

(c) Operational

The lessee, when operating or causing to be operated on its behalf, boat, ship, or aircraft traffic in the individual designated warning areas, shall enter into an agreement with the commander of the individual command headquarters listed in Table 2-1, upon utilizing an individual designated warning area prior to commencing such traffic. Such an agreement will provide for positive control of boats, ships, and aircraft operating into the warning areas at all times.

Effectiveness of the Lease Stipulation

The hold harmless section of the military stipulation serves to protect the U.S. Government from liability in the event of an accident involving the lessee and military activities. The actual operations of the military and the lessee and its agents will not be affected.

The electromagnetic emissions section of the stipulation requires the lessee and its agents to reduce and curtail the use of radio, CB, or other equipment emitting electromagnetic energy within some areas. This serves to reduce the impact of oil and gas activity on the communications of military missions and reduces the possible effects of electromagnetic energy transmissions on missile testing, tracking, and detonation.

The operational section requires notification to the military of oil and gas activity to take place within a military use area. This allows the base commander to plan military missions and maneuvers that will avoid the areas where oil and gas activities are taking place or to schedule around these activities. Prior notification helps reduce the potential impacts associated with vessels and helicopters traveling unannounced through areas where military activities are underway.

This stipulation reduces potential impacts, particularly in regards to safety, but does not reduce or eliminate the actual physical presence of oil and gas operations in areas where military operations are conducted. The reduction in potential impacts resulting from this stipulation makes multiple-use conflicts most unlikely. Without the stipulation, some potential conflict is likely. The best indicator of the overall effectiveness of the stipulation may be that there has never been an accident involving a conflict between military operations and oil and gas activities.

2.4.1.3.3. Naval Mine Warfare Area Stipulation

This stipulation will apply to Mustang Island Area, East Addition, Blocks 732, 733, and 734. (Mustang Island Area, East Addition, Block 733 was leased in August 1994.) The Navy has identified these blocks as needed for testing equipment and for training mine warfare personnel. The MMS and the Navy have entered into a formal agreement (signed June 20, 1994, by the MMS and July 15, 1994, by the Navy) that these blocks could be offered for lease with a special stipulation.

The stipulation reads as follows:

Naval Mine Warfare Area Stipulation

(a) The placement, location, and planned periods of operation of surface structures on this lease during the exploration stage are subject to approval by the Regional Director (RD), Minerals Management Service, Gulf of Mexico Region, after the review of the operator's Exploration Plan (EP). Prior to approval of the EP, the RD will consult with the Commander, Mine Warfare Command, in order to determine the EP's compatibility with scheduled military operations. No permanent structures nor debris of any kind shall be allowed in the area covered by this lease during exploration operations.

(b) To the extent possible, sub-seafloor development operations for resources subsurface to this area should originate outside the area covered by this lease. Any above-seafloor development operations within the area covered by this lease must be compatible with scheduled military operations as determined by the Commander, Mine Warfare Command. The lessee will consult with and coordinate plans for above-seafloor development activities (including abandonment) with the Commander, Mine Warfare Command. The Development Operations Coordination Document (DOCD) must contain the locations of any permanent structures, fixed platforms, pipelines, or anchors planned to be constructed or placed in the area covered by this lease as part of such development operations. The DOCD must also contain the written comments of the Commander, Mine Warfare Command on the proposed activities. Prior to approval of the DOCD, the RD will consult with the Commander in order to determine the DOCD's compatibility with scheduled military operations.

For more information consultation, and coordination, the lessee must contact:

Commander, Mine Warfare Command
325 Fifth Street, SE, Corpus Christi, Texas 78419-5032
Telephone: (512) 939-4895

Effectiveness of the Lease Stipulation

The Naval Mine Warfare Area Stipulation will eliminate potential impacts from multiple-use conflicts on these blocks.

For exploration activities, the stipulation requires consultation with the Commander, Mine Warfare Command, prior to approval of any EP. Prior coordination will determine the compatibility of the proposed exploration operations with scheduled military operations and help mitigate potential impacts between surface structures and scheduled military activities.

For development activities, the stipulation requires that both sub-seafloor and above-seafloor development operations must be compatible with scheduled military operations. Consultation and coordination prior to approval of any DOCD will help mitigate potential impacts between development operations and military activities on these blocks.

2.4.1.3.4. Law of the Sea Convention Royalty Payment Stipulation

This stipulation will be included in leases beyond the United States (U.S.) Exclusive Economic Zone (EEZ) in the area formerly known as the Western Gap.

Law of the Sea Convention Royalty Payment Stipulation

If the U.S. becomes a party to the 1982 Law of the Sea Convention (Convention) prior to or during the life of a lease issued by the U.S. on a block or portion of a block located beyond the U.S. EEZ and subject to such conditions that the Senate may impose through its constitutional role of advice and consent, then the following royalty payment lease provisions will apply to the lease so issued, consistent with Article 82 of the Convention:

1. The Convention requires payments annually by coastal States party to the Convention with respect to all production at a site after the first five years of production at that site. Any such payments will be made by the U.S. Government and not the lessee.
2. For the purpose of this stipulation regarding payments by the lessee to the U.S., a site is defined as an individual lease whether or not the lease is located in a unit.
3. For the purpose of this stipulation, the first production year begins on the first day of commercial production (excluding test production). Once a production year begins it shall run for a period of 365 days whether or not the lease produces continuously in commercial quantities. Subsequent production years shall begin on the anniversary date of first production.
4. If total lease production during the first five years following first production exceeds the total royalty suspension volume(s) provided in the lease terms, or through application and approval of relief from royalties, the following provisions of this stipulation will not apply. If after the first five years of production but prior to termination of this lease, production exceeds the total royalty suspension volume(s) provided in the lease terms, or through application and approval of relief from royalties, the following provisions of this stipulation will no longer apply effective the day after the suspension volumes have been produced.
5. If, in any production year after the first five years of lease production, due to lease royalty suspension provisions or through application and approval of relief from royalties, no lease production royalty is due or payable by the lessee to the U.S., then the lessee will be required to pay, as stipulated in paragraph 9 below, Convention-related royalty in the following amount so that the required Convention payments may be made by the U.S. Government as provided under the Convention:
    a. In the sixth year of production, one percent of the value of the sixth year's lease production saved, removed, or sold from the leased area;
    b. After the sixth year of production, the Convention-related royalty payment rate shall increase by one percent for each subsequent year until the twelfth year and shall remain at seven percent thereafter until lease termination.
6. If the U.S. becomes a party to the Convention after the fifth year of production from the lease, and a lessee is required, as provided herein, to pay Convention-related royalty, the amount of the royalty due will be based on the above payment schedule as determined from first production.

For example, U.S. accession to the Convention in the tenth year of lease production would result in a Convention-related royalty payment of five percent of the value of the tenth year's lease production, saved, removed, or sold from the lease. The following year, a payment of six percent would be due, and so forth as stated above, up to a maximum of seven percent per year.

7. If, in any production year after the first five years of lease production, due to ease royalty suspension provisions or through application and approval of relief from royalties, lease production royalty is paid but is less than the payment provided for by the Convention, then the lessee will be required to pay to the U.S. Government the Convention-related royalty in the amount of the shortfall.
8. In determining the value of production from the lease if a payment of Convention-related royalty is to be made, the provisions of the lease and applicable regulations shall apply.
9. The Convention-related royalty payment(s) required under paragraphs 5 through 7 of this stipulation, if any, shall not be paid monthly but shall be due and payable to MMS on or before 30 days after the expiration of the relevant production lease year.
10. The lessee will receive royalty credit in the amount of the Convention-related royalty payment required under paragraphs 5 through 7 of this stipulation, which will apply to royalties due under the lease for which the Convention-related royalty accrued in subsequent periods as non-Convention related royalty payments become due.
11. Any lease production for which the lessee pays no royalty other than a Convention-related requirement, due to lease royalty suspension provisions or through application and approval of relief from royalties, will count against the lease's applicable royalty suspension or relief volume.
12. The lessee will not be allowed to apply or recoup any unused Convention-related credit(s) associated with a lease that has been relinquished or terminated.

Effectiveness of the Lease Stipulation

Adoption of this stipulation in future Western Gulf of Mexico lease sales in the current 5-Year Program, i.e., Sales 187, 192, 196, and 200, would ensure that blocks beyond the U.S. Exclusive Economic Zone (EEZ) in the area formerly known as the Western Gap would be offered consistent with both U.S. law (the OCSLA and the Truman Proclamation asserting U.S. dominion over our OCS to its farthest exploitable reach) and provisions of the 1982 Law of the Sea Convention, which is internally recognized, but not acceded to by the U.S. The Convention balances the extension of coastal Nation control over the natural resources of the continental margin seaward of 200 mi with a modest obligation on such Nations to share revenues from successful mineral development seaward of 200 mi. This proposed stipulation specifies royalty payment provisions that would facilitate the U.S. Government's ability to make any payment required by the Convention. It has continually been adopted for annual Western Gulf of Mexico lease sales since 2001.

2.4.2. Alternative B — The Proposed Actions Excluding the Unleased Blocks Near the Biologically Sensitive Topographic Features

2.4.2.1. Description

This alternative would offer for lease all unleased blocks in the WPA, as described for the proposed actions, with the exception of any unleased blocks within the 200 blocks in the WPA that are subject to the Topographic Features Stipulation. As of June 6, 2002, 118 blocks of the 200 blocks were unleased. Although the blocks to be excluded contain oil and/or gas resources, this alternative would not change the resource estimate and activity ranges for the overall proposed actions. It is estimated that a proposed action in the WPA could result in the discovery and production of 0.136-0.262 BBO and 0.810-1.440 tcf of gas.

2.4.2.2. Summary of Impacts

The analyses of impacts summarized below and described in detail in Chapters 4.3.2 and 4.4.3 are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in Chapters 4.1.1, 4.1.2, and 4.4.

The difference between the potential impacts described for Alternative A and those under Alternative B is that under Alternative B no oil and gas activity would take place in the unleased blocks within the 200 blocks subject to the Topographic Features Stipulation. The assumption that the levels of activity for Alternative B are essentially the same as those projected for the proposed actions leads to the conclusion that the impacts expected to result from Alternative B would be very similar to those described under the proposed actions (Chapter 4.3.1). Therefore, the regional impact levels for all resources, except for the Topographic Features, would be similar to those described under the proposed actions. This alternative, if adopted, would prevent any oil and gas activity whatsoever in the affected blocks; thus, it would eliminate any potential direct impacts to the biota of those blocks from oil and gas activities, which otherwise would be conducted within the blocks.

2.4.3. Alternative C — No Action

2.4.3.1. Description

This alternative is equivalent to cancellation of one or more proposed WPA lease sales scheduled in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007.* The opportunity for development of the estimated of 0.136-0.262 BBO and 0.810-1.440 tcf of gas could have resulted from any proposed action(s) would be precluded or postponed, and any potential environmental impacts resulting from the proposed action(s) would not occur or would be postponed.

2.4.3.2. Summary of Impacts

If Alternative C is selected, all impacts, positive and negative, associated with the proposed actions would not occur. This alternative would therefore result in no effect on the sensitive resources and activities discussed in Chapters 4.3.1 and 4.4.3. The incremental contribution of any of the proposed sales to cumulative effects would not occur, but effects from other activities, including other OCS sales, would remain. Oil-spill risk could increase due to the importation of foreign oil to replace the resources lost through cancellation of any of the proposed actions.

Strategies that could provide replacement resources for lost domestic OCS oil and gas production include a combination of energy conservation; onshore domestic oil and gas supplies; alternative energy sources; and imports of oil, natural gas, and liquefied natural gas. Market forces are assumed to be the predominant factor in determining substitutes for OCS oil and gas. Based on this, increased imports of foreign oil are assumed to be the largest replacement source. Much of this imported oil would enter the United States through the Gulf of Mexico, thus increasing the risks due to tanker spills. Potential alternative energy sources are discussed in the Final EIS for the *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002*.

CHAPTER 3

DESCRIPTION OF THE AFFECTED ENVIRONMENT

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1. Physical Environment

3.1.1. Air Quality

The Clean Air Act established the National Ambient Air Quality Standards (NAAQS); the primary standards are to protect public health and the secondary standards are to protect public welfare. New NAAQS for ozone and particulate matter took effect on September 16, 1997. The current NAAQS (40 CFR 50.12 and 62 FR 138, July 18, 1997) are shown in Table 3-1. The Clean Air Act Amendments of 1990 established classification designations based on regional monitored levels of ambient air quality. These designations impose mandated timetables and other requirements necessary for attaining and maintaining healthful air quality in the U.S. based on the seriousness of the regional air quality problem.

When measured concentrations of regulated pollutants exceed standards established by the NAAQS, an area may be designated as a nonattainment area for a regulated pollutant. The number of exceedances and the concentrations determine the nonattainment classification of an area. There are five classifications of nonattainment status: marginal, moderate, serious, severe, and extreme (Clean Air Act Amendments, 1990).

The Federal OCS waters attainment status is unclassified. The OCS areas are not classified because there is no provision for any classification in the Clean Air Act for waters outside of the boundaries of State waters. Only areas within State boundaries are to be classified either attainment, nonattainment, or unclassifiable. Operations west of 87.5^o W. longitude fall under MMS jurisdiction for enforcement of the Clean Air Act. The OCS waters east of 87.5^o W. longitude are under the jurisdiction of USEPA. Figure 3-1 presents the air quality status in the Gulf Coast as of August 2001. All air-quality nonattainment areas reported in Figure 3-1 are for ozone nonattainment. No graphics depicting the boundaries (projected from historical data) of ozone areas of influence, areas at risk, or areas of violation along the U.S. Gulf of Mexico coast were available at the time of publishing this EIS. It is expected that the number of areas of violation will increase under the new 8-hr ozone NAAQS as compared to the number of areas under the old 1-hr standard. As of August 2001, the new 8-hr ozone standard had not yet been fully implemented because of pending court action.

Pollutant levels in coastal areas of Texas reported in the *Air Monitoring Report, 1991* (Texas Air Control Board, 1994) were nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur dioxide (SO_2), particulate matter (PM_{10}), and ozone (O_3). The State of Texas is considered to be in attainment for the pollutants SO_2 and NO_2. Exceedances of the national standards for CO and PM_{10} have only been measured in the interior of the state. Thus, there have been no exceedances of the NAAQS for SO_2, NO_2, CO, and PM_{10} in Texas coastal areas (also see USEPA, 2001). The following Texas coastal counties are classified as nonattainment for ozone: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Jefferson, Hardin, and Orange (USEPA, 2001).

Measurements of pollutant concentrations in Louisiana are presented in the *Air Quality Data Annual Report, 1996* (Louisiana Dept. of Environmental Quality, 1996). Louisiana is considered to be in attainment of the NAAQS for CO, SO_2, NO_2, and PM_{10} (also see USEPA, 2001). As of August 2001, six Louisiana coastal zone parishes have been tentatively designated nonattainment for ozone: Iberville, Ascension, Lafourche, East Baton Rouge, West Baton Rouge, and Livingston (USEPA, 2001). Ozone measurements (Louisiana Dept. of Environmental Quality, written communication, 1997) between 1989 and 1997 show that the number of days exceeding the national standards are declining.

Air quality data for 1993 were obtained from the Alabama Department of Environmental Management for PM_{10}, NO_2, and O_3. The data shows that Mobile County is in attainment of the NAAQS for all criteria pollutants. There have been no exceedances of the NAAQS for SO_2, NO_x, CO, and PM_{10} in the State of Alabama (USEPA, 2001).

The State of Florida has no nonattainment areas in its coastal counties (USEPA, 2001). Relative to onshore air quality in Escambia County, USEPA's Aerometric Information Retrieval System was accessed for ambient air monitoring data of SO_2, O_3, and PM_{10} for the years 1995 through 1997. During this period, the following exceedances of applicable standards were recorded: no measurements of SO_2; three measurements of O_3 (one in 1995 and two in 1996); and no measurements of PM_{10}. If the proposed, new, 8-hr ozone standard is imposed using the 1996-1998 data, Escambia County would be in violation. Indeed, during the 1998 summer season, there were a number of ozone alerts.

Prevention of Significant Deterioration (PSD) Class I air quality areas, designated under the Clean Air Act, are afforded the greatest degree of air quality protection and are protected by stringent air quality standards that allow for very little deterioration of their air quality. The PSD maximum allowable pollutant increase for Class I areas are as follows: 2.5 $\mu g/m^3$ annual increment for NO_2; 25 $\mu g/m^3$ 3-hr increment, 5 $\mu g/m^3$ 24-hr increment, and 2 $\mu g/m^3$ annual increment for SO_2; and 8 $\mu g/m^3$ 24-hr increment and 5 $\mu g/m^3$ annual increment for PM_{10}. The CPA includes the Breton National Wildlife Refuge and National Wilderness Area south of Mississippi, which is designated as a PSD Class I area. The U.S. Fish and Wildlife Service (FWS) has responsibility for protecting wildlife, vegetation, visibility, and other sensitive resources called air-quality-related values in this area. The FWS has expressed concern that the NO_2 and SO_2 increments for the Breton National Wilderness Area have been consumed. There is no PSD Class I air quality area in the WPA.

Ambient air quality is a function of the size, distribution, and activities directly related with population in association with the resulting economic development, transportation, and energy policies of the region. Meteorological conditions and topography may confine, disperse, or distribute air pollutants. Assessments of air quality depend on multiple variables such as the quantity of emissions, dispersion rates, distances from receptors, and local meteorology. Due to the variable nature of these independent factors, ambient air quality is an ever-changing dynamic process.

3.1.2. Water Quality

For the purposes of this EIS, water quality is the ability of a waterbody to maintain the ecosystems it supports or influences. In the case of coastal and marine environments, the quality of the water is influenced by the rivers that drain into the area, the quantity and composition of wet and dry atmospheric deposition, and the influx of constituents from sediments. Besides the natural inputs, human activity can contribute to water quality through discharges, run-off, burning, dumping, air emissions, and spills. Also, mixing or circulation of the water can either improve the water through flushing or be the source of factors contributing to the decline of water quality.

Evaluation of water quality is done by direct measurement of factors that are considered important to the health of an ecosystem. The primary factors influencing coastal and marine environments are temperature, salinity, oxygen, nutrients, pH, pathogens, and turbidity or suspended load. Trace constituents such as metals and organic compounds can affect water quality. Altering the ecosystem through changes in any of these parameters can result in the destruction of specific species, support of undesirable or exotic species, and possibly mass mortality. The effects can either be localized or widespread.

The region under consideration is divided into coastal and marine waters for the following discussion. Coastal waters, as defined by MMS, include all the bays and estuaries from the Rio Grande River to the Florida Bay (Figure 3-2). Marine water as defined in this document includes both State offshore water and Federal OCS waters, which includes everything outside any barrier islands to the Exclusive Economic Zone. The inland extent is defined by the Coastal Zone Management Act.

3.1.2.1. Coastal Waters

Along the U.S. Gulf Coast lies one of the most extensive estuary systems in the world, which extends from the Rio Grande River to Florida Bay (Figure 3-2). Estuaries represent a transition zone between the freshwater of rivers and the higher salinity waters offshore. These bodies of water are influenced by freshwater and sediment influx from rivers and the tidal actions of the oceans. The primary variables that influence coastal water quality are water temperature, total dissolved solids (salinity), suspended solids (turbidity), and nutrients. An estuary's salinity and temperature structure is determined by hydrodynamic mechanisms governed by the interaction of marine and terrestrial influences, including tides, nearshore circulation, freshwater discharges from rivers, and local precipitation. Gulf Coast estuaries exhibit a general east to west trend in selected attributes of water quality associated with changes in regional geology, sediment loading, and freshwater inflow.

Estuaries provide habitat for plants, animals, and humans. Marshes, mangroves, and seagrasses surround the Gulf Coast estuaries, providing food and shelter for shorebirds, migratory waterfowl, fish, invertebrates (e.g., shrimp, crabs, and oysters), reptiles, and mammals. Estuarine-dependent species constitute more than 95 percent of the commercial fishery harvests from the Gulf of Mexico. Several major cities are located along the coast, including Houston, New Orleans, Mobile, and Tampa. Tourism supplies an estimated $20 billion to the economy each year (USEPA, 1999). Shipping and marine transport is an important industry, with 7 of the top 10 busiest ports in the U.S., in terms of total tonnage, located in Gulf estuaries.

Estuarine ecosystems are impacted by humans, primarily via upstream withdrawals of water for agricultural, industrial, and domestic purposes; contamination by industrial and sewage discharges and agricultural runoff carrying pesticides and herbicides; and habitat alterations (e.g., construction and dredge and fill operations). Drainage from more than 55 percent of the conterminous U.S. enters the Gulf of Mexico, primarily from the Mississippi River. Texas, Louisiana, and Alabama ranked first, second, and fourth in the nation in 1995 in terms of discharging the greatest amount of toxic chemicals (USEPA, 1999). The Gulf of Mexico region ranks highest of all coastal regions in the U.S. in the number of wastewater treatment plants (1,300), number of industrial point sources (2,000), percent of land use devoted to agriculture (31%), and application of fertilizer to agricultural lands (62,000 tons of phosphorus and 758,000 tons of nitrogen) (USDOC, NOAA, 1990).

A recent assessment of the ecological condition of Gulf of Mexico estuaries was published by the USEPA (1999). The assessment describes the general ecology and summarizes the "health" of all the Gulf estuarine systems. Sources of the data include the USEPA's Environmental Monitoring and Assessment Program for Estuaries (EMAP-E), the NOAA Estuarine Eutrophication Survey (USDOC, NOAA, 1997a), and 305(b) reports from each state. A classification scheme based on designated beneficial uses was developed. Estuaries are classified primarily by aquatic life support, fish consumption, or recreation and whether they are fully, partially, or not supporting of these uses. From 1996 305(b) data, 78 percent of Gulf estuaries were surveyed with 35 percent of the surveyed estuaries designated as impaired. Factors resulting in impairment were pathogen indicators (e.g., fecal coliform) and eutrophication indicators (e.g., nutrients, organic enrichment, and low dissolved oxygen).

3.1.2.2. Marine Waters

The marine water, within the area of interest, can be divided into three regions: the continental shelf west of the Mississippi River, the continental shelf east of the Mississippi River, and deepwater (> 400 m). For this discussion, the continental shelf includes the upper slope to a water depth of 400 m. While the various parameters measured to evaluate water quality do vary in marine waters, one parameter, pH, does not. The buffering capacity of the marine system is controlled by carbonate and bicarbonate, which maintains the pH at 8.2.

Continental Shelf West of the Mississippi River

The Mississippi and Atchafalaya Rivers are the primary sources of freshwater, sediment, and pollutants to the continental shelf west of the Mississippi (Murray, 1997). The drainage basin that feeds the rivers covers 55 percent of the contiguous United States. While the average river discharge from the Mississippi River exceeds the input of all other rivers along the Texas-Louisiana coast by a factor of 10, during low-flow periods, the Mississippi River can have a flow less than all the other rivers combined (Nowlin et al., 1998). A turbid surface layer of suspended particles is associated with the freshwater plume. A nepheloid layer composed of suspended clay material from the underlying sediment is always present on the shelf. The river system supplies nitrate, phosphate, and silicate to the shelf. During summer months, the low-salinity water from the Mississippi River spreads out over the shelf, resulting in a stratified water column. While surface oxygen concentrations are at or near saturation, hypoxia, defined as oxygen concentrations less than 2 milligrams per liter (mg/l) O_2, is observed in bottom waters during the summer months.

The zone of hypoxia on the Louisiana-Texas shelf is one of the largest areas of low oxygen in the world's coastal waters (Murray, 1997). The oxygen-depleted bottom waters occur seasonally and are affected by the timing of the Mississippi and Atchafalaya River discharges carrying nutrients to the surface waters. This, in turn, increases the carbon flux to the bottom, which, under stratified conditions, results in oxygen depletion to the point of hypoxia (<2 mg/l O_2). The hypoxic conditions last until local wind-driven circulation mixes the water again. The area of hypoxia stretches over 17,000 km^2 at its peak and was observed as far away as Freeport, Texas. Increased nutrient loading since the turn of the 19th century correlates with the increased extent of hypoxic events (Eadie et al., 1992), supporting the theory that hypoxia is related to the nutrient input from the Mississippi and Atchafalaya River systems.

Shelf waters off the coast of Louisiana are contaminated with trace organic pollutants including polynuclear aromatic hydrocarbons (PAH), herbicides, chlorinated pesticides, and polychlorinated biphenyls (PCB's), and trace inorganic (metals) pollutants. Of particular note is the pervasive distribution of the herbicide Atrazine (Murray, 1997). The source of these contaminants is the river water that feeds into the area.

Continental Shelf East of the Mississippi River

Water quality on the continental shelf from the Mississippi River Delta to Tampa Bay is influenced by river discharge, run-off from the coast, and eddies from the Loop Current. The Mississippi River accounts for 72 percent of the total discharge onto the shelf (SUSIO, 1975). The outflow of the Mississippi River generally extends only 75 km (45 mi) to the east of the river mouth (Vittor and Associates, Inc., 1985) except under extreme flow conditions. The Loop current intrudes in irregular intervals onto the shelf, and the water column can change from well mixed to highly stratified very rapidly. Discharges from the Mississippi River can be easily entrained in the Loop Current. The flood of 1993 influenced the entire northeastern Gulf shelf with some Mississippi River water transported to the Atlantic Ocean through the Florida Straits (Dowgiallo, 1994). Hypoxia is rarely observed on the Mississippi-Alabama shelf, although low dissolved oxygen values of 2.93-2.99 mg/l were observed during the MAMES cruises (Brooks, 1991).

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

A three-year, large-scale marine environmental baseline study conducted from 1974 to 1977 in the eastern Gulf of Mexico resulted in an overview of the Mississippi, Alabama, Florida (MAFLA) OCS environment to 200 m (SUSIO, 1977; Dames and Moore, 1979). Analysis of water, sediments, and biota for hydrocarbons indicated that the MAFLA area is pristine, with some influence of anthropogenic and petrogenic hydrocarbons from river sources. Analysis of trace metal contamination for the nine trace metals analyzed (barium, cadmium, chromium, copper, iron, lead, nickel, vanadium, and zinc) also indicated no contamination. A decade later, the continental shelf off Mississippi and Alabama was revisited (Brooks, 1991). Bottom sediments were analyzed for high-molecular-weight hydrocarbons and heavy metals. High-molecular-weight hydrocarbons can come from natural petroleum or recent biological production as well as input from anthropogenic sources. In the case of the Mississippi-Alabama shelf, the source of petroleum hydrocarbons and terrestrial plant material is the Mississippi River. Higher levels of hydrocarbons were observed in the late spring, which coincides with increased river influx. The sediments, however, are washed away later in the year, as evidenced by low hydrocarbon values in winter months. Contamination from trace metals was not observed (Brooks, 1991).

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

More recent investigations of the continental shelf east of the Mississippi River confirm previous observations that the area is highly influenced by river input of sediment and nutrients (Jochens et al., in preparation). Hypoxia was not observed on the shelf during the three years of the study.

Deepwater

Limited information is available on the deepwater environment. Water at depths greater than 1,400 m is relatively homogeneous with respect to temperature, salinity, and oxygen (Nowlin, 1972; Pequegnat, 1983; Gallaway et al., 1988). Of importance, as pointed out by Pequegnat (1983), is the flushing time of the Gulf of Mexico. Oxygen in deepwater must originate from the surface and be mixed into the deepwater by some mechanism. If the replenishment of the water occurs over a long period of time, the addition of hydrocarbons through the discharge from oil and gas activities could lead to low oxygen and potentially hypoxic conditions in the deepwater of the Gulf of Mexico. The time scales and mechanism for maintaining the high oxygen levels in the deep Gulf are unknown.

Limited analyses of trace metals and hydrocarbons for the water column and sediments exist (Trefry, 1981; Gallaway et al., 1988). Hydrocarbon seeps are extensive throughout the continental slope and contribute hydrocarbons to the surface sediments and water column, especially in the Central Gulf (Sassen et al., 1993a and b). MacDonald et al. (1993) observed 63 individual seeps using remote sensing and submarine observations. Estimates of the total volume of seeping oil vary widely from 29,000 bbl/yr (MacDonald, 1998) to 520,000 bbl/yr (Mitchell et al., 1999). These estimates used satellite data and an assumed slick thickness. In addition to hydrocarbon seeps, other fluids leak from the underlying sediments into the bottom water along the slope. These fluids have been identified to have three origins: (1) seawater trapped during the settling of sediments; (2) dissolution of underlying salt diapirs; and (3) deep-seated formation waters (Fu and Aharon, 1998; Aharon et al., 2001). The first two fluids are the source of authigenic carbonate deposits while the third is rich in barium and is the source of barite deposits such as chimneys.

3.2. BIOLOGICAL RESOURCES

3.2.1. Sensitive Coastal Environments

The coastal environments discussed here are those barrier beaches, wetlands, and submerged vegetation that might be impacted by activities resulting from the proposed actions. Geographically, the discussion covers coastal areas that range from the State of Tamaulipas, Mexico, through Alabama in the U.S. Several geologic subareas are found along this coast. Although seemingly similar biological environments occur in each of those subareas, they vary significantly. For that reason, the following environmental descriptions of this coast are organized into four geologic subareas. Those areas are (1) the barrier island complex of northern Tamaulipas, Mexico, and southern Texas; (2) the Chenier Plain of eastern Texas and western Louisiana; (3) the Mississippi River Delta complex of southeastern Louisiana; and (4) the barrier-island and Pleistocene-plain complex of Mississippi and Alabama.

The landmasses in these areas are relatively low. Some form broad flat plains with gradually, sloping topographies. Tides there are diurnal and micro-tidal (Table 3-2). Tidal influences can be seen 25-40 mi inland in some areas of Louisiana, Texas, and Alabama, due to large bay complexes, channelization, and low topographies. Wind-driven tides are often dominant over the minimal gravity tides that occur there.

3.2.1.1. Coastal Barrier Beaches and Associated Dunes

The U.S. Gulf shoreline from the Mexican border to Florida is about 1,500 km long. Ocean-wave intensities around the Gulf are generally low to moderate. These shorelines are usually sandy beaches that can be divided into several interrelated environments. Generally, beaches consist of a shoreface, foreshore, and backshore. The shoreface slopes downward and seaward from the low-tidal water line, under the water. The nonvegetated foreshore slopes up from the ocean to the beach berm-crest. The backshore is found between the beach berm-crest and the dunes, and it may be sparsely vegetated. The berm-crest and backshore may occasionally be absent due to storm activity.

The dune zone of a barrier landform can consist of a single low dune ridge, several parallel dune ridges, or a number of curving dune lines that may be stabilized by vegetation. These elongated, narrow landforms are composed of wind-blown sand and other unconsolidated, predominantly coarse sediments.

Sand dunes and shorelines conform to environmental conditions found at its site. These conditions usually include waves, currents, wind, and human activities. When Gulf waters are elevated by storms, waves are generally larger and can overwash lower coastal barriers, creating overwash fans or terraces behind and between the dunes. With time, opportunistic plants will re-establish on these flat, sand terraces, followed by the usual vegetative succession for this area. Along more stable barriers, where overwash is rare, the vegetative succession in areas behind the dunes is generally complete. Vegetation in these areas of broad flats or coastal strands consists of scrubby woody vegetation, marshes, and maritime forests. Saline and freshwater ponds may be found among the dunes and on the landward flats. Landward, these flats may grade into wetlands and intertidal mud flats that fringe the shore of lagoons, islands, and embayments. In areas where no bay or lagoon separates barrier landforms from the mainland, the barrier vegetation grades into scrub or forest habitat of the mainland.

Larger changes to barrier landforms are primarily due to storms, subsidence, deltaic cycles, longshore currents, and human activities. Barrier landform configurations continually adjust, accreting and eroding, in response to prevailing and changing environmental conditions. Landform changes can be seasonal and cyclical, such as seen with the onshore movement of sand during the summer and offshore movement during the winter, which is due to seasonal meteorological and wave-energy differences. Non-cyclical changes in landforms can be progressive, causing landform movement landward, seaward, or laterally along the coast.

Lateral movement of barrier landforms is of particular importance. As headlands and beaches erode, their sediments are transported offshore or laterally along the shoreline. Eroding headlands typically extend sand spits that may encape marshes or previously open, shallow Gulf waters. By separating inshore waters from Gulf waters and slowing the dispersal of freshwater into the Gulf, movements of barrier landforms contribute to the area and diversity of estuarine habitat along a coast. Most barrier islands around the Gulf are moving laterally to some degree. Where this occurs, the receding end of the island is typically eroding; the leading end accretes. These processes may be continuous or cyclic.

Accumulations and movements of sediments that make up barrier landforms are often described in terms of regressive and transgressive sequences. Although transgressive landforms dominate around the Gulf of Mexico, both transgressive and regressive barriers occur there. A regressive sequence deposits terrestrial sediments over marine deposits, building land into the sea, as would be seen during deltaic land-building processes. Regressive barriers have high and broad dune profiles. These thick accumulations of sand may form parallel ridges.

A transgressive sequence moves the shore landward, allowing marine deposits to form on terrestrial sediments. Transgressive coastal landforms around the Gulf have low profiles and are characterized by narrow widths; low, sparsely vegetated, and discontinuous dunes; and numerous, closely spaced, active washover channels. Landward movement or erosion of a barrier shoreline may be caused by any combination of subsidence, sea-level rise, storms, channels, groins, seawalls, and jetties. These influences are discussed under the cumulative activities scenario (Chapter 4.1.3.3). Movement of barrier systems is not a steady process because the passage rates and intensities of cold fronts and tropical storms, as well as intensities of seasons, are not constant (Williams et al., 1992).

Texas and Mexican Barrier Island Complex

The Gulf coastline of Texas is about 590 km long. The State of Tamaulipas, in northeastern Mexico, has a Gulf shoreline of about 378 km. The barrier islands of both areas are mostly accreted sediments that were reworked from river deposits, previously accreted Gulf shores, bay and lagoon sediments, and exposed seafloors (White et al., 1986). This reworking continues today as these barrier beaches and islands move generally to the southwest (Price, 1958). During the period of about 1850-1975, net coastal erosion occurred in the following three groups of counties in Texas: (1) Cameron, Willacy, and southern Kenedy; (2) northern Matagorda, Brazoria, and southern Galveston; and (3) Jefferson, Chambers, and far northern Galveston (Morton, 1982). These generalized trends seem to be continuing.

Elevations of Galveston Island and Bolivar Peninsula beach ridges generally range from 1.5 to 3 m above sea level (Fisher et al., 1972). The beaches of Galveston Island and Bolivar Peninsula are locally eroding or accreting. Accreting shorelines have a distinct beach berm and a wide back beach. Eroding beaches are relatively narrow, and the beach berm and back beach may be absent. Construction of seawalls and jetties on Galveston Island have contributed to erosion there, as discussed further in Chapter 4.1.3.3.

Padre Island is moderately regressive. It is typically 1.5-3 m above sea level and occasionally overwashed by hurricane surges. On the northern portion, some dunes may rise 6-9 m and the dune ridge is generally continuous. On the southern portion, the dune ridge is a series of short discontinuous segments. The dry winds and arid nature of this southern portion destabilize sand dunes. Sand flats and coppice dunes occupy the southern portion of the island. Any activity that reduces the sparse vegetation cover of this area initiates erosion. Vegetation on Padre Island is generally sparse, becoming more sparse on its southern portion. The vegetation largely consists of grasses and scrubby, woody growth (Brown et al., 1977; Smith, in press).

Exceptions to the above are the once regressive Matagorda Peninsula and Rio Grande Headland. The Matagorda Peninsula accreted as the Brazos-Colorado River Delta. Later, the peninsula became transgressive and the sediments were reworked to form flanking arcs of barrier sand spits. Washover channels cut the westward arc of the peninsula, forming barrier islands. The Rio Grand Headland has also become transgressive and sand spits formed to its north and south. Today, longshore drift is southerly at these sites. Their northern spits are now eroding and their southern spits are accreting.

The Chenier Plain

The Chenier Plain of eastern Texas and western Louisiana began developing about 2,800 years ago. During that period, Mississippi River Delta sediments were intermittently eroded, reworked, and carried into the Chenier Plain area by storms and coastal currents. This deposition gathered huge volumes of mud and sand, forming a shoreface that slopes very gently, almost imperceptibly, downward for a very long distance offshore. This shallow mud bottom is viscous and elastic, which generates hydrodynamic friction (Bea et al., 1983). Hence, wave energies along the barrier shorelines of the Chenier Plain are greatly reduced, causing minimal longshore sediment transport along the Chenier Plain (USDOI, GS, 1988). More recently, this shoreline has been eroding as sea level rises, converting most of this coast to transgressive shorelines.

Today, the Red River and about 30 percent of the Mississippi River are diverted to the Atchafalaya River. The diversions have increased the sediment load in the longshore currents, which generally move slowly westward along the coast.

The barrier beaches of the Chenier Plain are generally narrow, low, and sediment starved due to the natures of coastal currents and the shoreface. Here and there, beach erosion has exposed relic marsh terraces that were buried by past overwash events. West of about Fence Lake, Texas, the beach is fairly typical, being composed of shelly sand; although, it is no more than 200 ft wide. Its shoreface sediments are similar (Fisher et al., 1973).

East of Fence Lake, the shoreface contains discontinuous mud deposits among muddy sands. During low tides, extensive mudflats are exposed east and west of Fence Lake. The beach in this area is much narrower and becomes a low escarpment, where wave action cuts into the salt marsh (Fisher et al., 1973). In the vicinity of Louisiana's Constance Beach and Peveto, the rapidly eroding beach may be as much as 60 ft wide, where it exists. In this vicinity, erosion threatens Louisiana State Highway 82 and a few houses. In these more rapidly eroding areas, the beach is replaced by rip-rap and bulkheads (Mann and Thompson, 2001). In 1988, the U.S Geological Survey reported that general shoreline retreat along the Chenier Plain had been three or more meters per year. Since then, a series of offshore wave breaks have been placed from Constance Beach to Holly Beach, Louisiana, to reduce erosion and to retain sediments. These circumstances are discussed in greater detail in Chapter 4.1.3.3.

The dune ridges of the Chenier Plain's shoreline are generally well vegetated. Their elevations along the Texan segment are generally less than 5 ft (Fisher et al., 1973). Transects taken along the beach in the vicinity of Oceanview Beach to Holly Beach indicate that the dune ridge ranged between 7 and 12 ft National Geodetic Vertical Depth (NGVD). For comparison, the high-water shoreline position during October 1992 through July 1994 was estimated to be fairly stable, at about 3.5 ft NGVD (Byrnes and McBride, 1995).

The Mississippi River Delta Complex

Most barrier shorelines of the Mississippi River Delta in Louisiana are transgressive and trace the seaward remains of a series of five abandoned deltas. The Mississippi River is channelized through the Belize Delta, more commonly known as the Birdfoot Delta. Channelization isolated the river from most of this sixth delta, except near the distributary mouths. There, a small fraction of the river's sediment load is contributed to longshore currents for building and maintaining barrier shores. The bulk of river sediments are deposited in deep water, where they cannot be reworked and contribute to the longshore sediment drift. Most of southeastern Louisiana's barrier beaches are composed of medium to coarse sand.

The shorefaces of the Mississippi River Delta complex generally slope very gently seaward, which reduces wave energies at the shorelines. Mud flats are exposed during very low tidal events. The slope here is not as shallow as that found off the Chenier Plain. The steepest shoreface of the delta is found at the Caminada-Moreau Coast, where the greatest rates of erosion are seen. At this site, the long shore currents split to the east and west, which removes sand from the area without replenishing the area (Wolfe et al., 1988; Wetherell, 1992; Holder and Lugo-Fernandez, 1993).

Regressive shorelines do occur in Louisiana's deltaic region. The diversion of the Red River and about 30 percent of the Mississippi River to the Atchafalaya River has allowed transport of large volumes of sediment into shallow Atchafalya Bay. There, inland deltas are forming at the mouths of that river and Wax Lake Outlet, which are discussed more fully under Chapter 3.2.1.2. Recent satellite photography of these deltas reveal that dredge-disposal islands were constructed off Point au Fer in very shallow water (3-5 ft) at the mouth of Atchafalaya Bay. These islands and the surrounding shallows are the foundations for a future barrier shoreline in this area, if the Atchafalaya River Delta continues to build seaward as expected.

Smaller shoreline regressions also occur as a result of jetties located on the eastern end of Grand Isle, the western end of Caminada-Moreau Beach, Empire navigational canal, and elsewhere. The circumstances of these situations are discussed more completely in Chapter 3.2.1.2.

Most dune zones of the Mississippi River Delta contain low, single-line dune ridges that may be sparsely to heavily vegetated. Generally in this area, the vegetation on a dune ridge gets denser as the time between storms lengthens. The dune zone of the Chandeleur Islands is larger and more complex. Boyd and Penland (1988) reported that elevations of the Chandeleur Islands ranged between less than 1 m and 8 m MSL (above mean sea level). Since then, the hurricanes of the 1990's greatly lowered these elevations, which are slowly recovering. In 1997 the Chandeleur Islands contained about 1,930 ha of land, most of which was beach and dune complex (USDOI, GS, 1998).

Boyd and Penland (1988) reported that 52 percent of the Caminada-Moreau Coast had a vegetated, dune ridge of less than 1 m MSL and that the elevation of the remaining length ranges up to 3 m MSL. The mean water-level threshold for overwashing 75 percent of that beach is 1.42 m MSL. They estimated that this threshold is achieved about 15 times a year, on average. Mean water elevations exceeding 2.5 m MSL occur once every 2 years (Richie and Penland, 1985).

Boyd and Penland (1988) estimated that storms raise mean water levels 1.73-2.03 m above mean sea level 10-30 times per year. Under those conditions, the following would be over washed: 67 percent of Timbalier Island; 100 percent of Isles Dernieres and the Barataria Bay Barriers (excluding Grand Isle); and 100, 89, and 64 percent of the southern, central, and northern portions of the Chandeleur Islands, respectively.

Shell Key is an emerged barrier feature that varies greatly from the others around the Delta. It is located south of Marsh Island, Louisiana, at the mouth of Atchafalaya Bay, and is composed almost entirely of oyster-shell fragments. It is found amid extensive shell reefs, which are part of the Shell Keys National Wildlife Refuge. This dynamic, minimally vegetated island builds and wanes with passing storms. In 1992 and 1999, Hurricane Andrew and Hurricane Francis reduced the island to little more than a shoal that largely submerges under storm tides. The shallow, submerged shell reefs around Shell Key also serve as barrier features. Located on the other side of the bay's mouth and to the southeast, the Point au Fer Shell Reefs were commercially dredged for shells, and no longer exist (USDOI, FWS, 2001; Schales and Soileau, personal communication, 2001)

Mississippi and Alabama Coasts

The Dog Keys define the Mississippi Sound of Mississippi and Alabama. Mississippi has about 54.6 km of barrier beaches on these islands (USDOI, FWS, 1999). Dauphin Island represents about another 12 km. This relatively young group of islands was formed 3,000-4,000 years ago as a result of shoal-bar accretion (Otvos, 1979). They are separated by wide passes with deep channels. Shoals are typically adjacent to these barriers. Generally, these islands are regressive and stable in size as they migrate westwardly in response to the predominantly westward-moving longshore currents.

These islands generally have high beach ridges and prominent sand dunes. Although overwash channels do not commonly occur, the islands may be overwashed during strong storms. The islands are well vegetated among and behind the dunes and around ponds. Southern maritime climax forests of pine and palmetto are found behind some of their dune fields.

Dauphin Island, Alabama, is the exception to the above description. It is essentially a low-profile transgressive barrier island, except for a small, eroding, Pleistocene core at its eastern end. The western end is a Holocene spit that is characterized by small dunes and many washover fans, exposed marsh deposits, and tree stumps exposed in the surf zone.

Pelican Island, Alabama, is a vegetated sand shoal, located Gulfward of Dauphin Island. Southeasterly of that island is Sand Island, which is little more than a shoal. These barrier islands are parts of Mobile Bay's ebb-tidal delta. As such, they continually change shape under storm and tidal pressures. Their sands generally move northwesterly into the longshore drift, nourishing beaches down drift. These sediments may also move landward during flood tides (Hummell, 1990).

The Gulf Shores region of Alabama extends from Mobile Point eastward to the Florida boundary, a distance of about 50 km (Smith, 1984). It has the widest beaches and largest dune system among the barrier beaches discussed.

3.2.1.2. Wetlands

According to the U.S. Dept. of the Interior (Dahl, 1990; Henfer et al., 1994), during the mid-1980's, 4.4 percent of Texas (3,083,860 ha) (Henfer et al., 1994), 28 percent of Louisiana (3,557,520 ha), 14 percent of Mississippi (17,678,730 ha), and 8 percent of Alabama (1,073,655 ha) were considered wetlands. During the prior 10 years, these states' wetland areas decreased by 1.6-5.6 percent.

Wetland habitats found along the Central and Western Gulf Coast include fresh, intermediates, brackish, and saline marshes; mud and sand flats; and forested wetlands of mangrove swamps, cypress-tupelo swamps, and bottomland hardwoods. Coastal wetland habitats occur as bands around waterways and as broad expanses. Saline and brackish habitats support sharply delineated, segregated stands of single plant species. Fresh and very low salinity environments support more diverse and mixed communities of plants. The plant species that occur in greatest abundance vary greatly around the Gulf. For those reasons, interested readers are referred to ecological characterization and inventory studies conducted by the FWS, in cooperation with other agencies; the Texas Bureau of Economic Geology; and other researchers (Gosselink et al., 1979; Gosselink, 1984; Smith, 1984; Fisher et al., 1972 and 1973; Brown et al., 1976 and 1977; Stout et al., 1981).

The importance of coastal wetlands to the coastal environment has been well documented. See the above listed characterization and inventory studies. High organic productivity and efficient nutrient recycling are characteristic of coastal wetlands. They provide habitat for a great number and wide diversity of resident plants, invertebrates, fishes, reptiles, birds, and mammals. Marsh environments are particularly important nursery grounds for many economically important fish and shellfish juveniles. The marsh edge, where marsh and open water come together, is particularly important for its higher productivity and greater concentrations of organisms. Emergent plants produce the bulk of the energy that supports salt-marsh dependent animals. Freshwater-marsh environments generally contain a much higher diversity of plants and animals than do those of saline marshes.

Gulf coastal wetlands also support the largest fur harvest in North America, producing 40-65 percent of the nation's yearly total in Louisiana (Olds, 1984). Gulf coastal wetlands support over two-thirds of the Mississippi Flyway wintering waterfowl population and much of North America's puddle duck population.

Texas Barrier Islands and Tamaulipas Coastal Wetlands

Landward of the barrier beaches of Texas, estuarine marshes largely occur as continuous and discontinuous bands around bays, lagoons, and river deltas. Broad expanses of emergent wetland vegetation do not commonly occur south of Baffin Bay because of the arid climate and hypersaline waters. In the vicinity of southern Padre Island, marshes are minimal and unstable, compared to the more northern Gulf. In Tamaulipas, marshes behind the barrier islands are even less abundant than seen in the vicinity of Padre Island. Dominant salt-marsh plants in southern regions include more salt-tolerant species such as *Batis maritima* and glasswort (*Salicornia sp.*).

Brackish marshes occur in less saline, inland areas and are divided into frequently and infrequently flooded marshes. Infrequently flooded marshes contain an assemblage of plants that are much more tolerant of dry conditions. Freshwater marshes in Texas occur inland above tidally delivered saline waters, in association with streams, lakes, and catchments. Broken bands of black mangroves (*Avicennia germinans*) also occur in this area (Brown et al., 1977; White et al., 1986; Smith, in press).

Wind-tidal flats of mud and sand are mostly found around shallow bay margins and in association with shoals. As one goes farther south from Corpus Christi and into Tamaulipas, flats increasingly replace lagoonal and bay marshes. Laguna Madre of Texas is divided into northern and southern parts by the wind-tidal flats of the Land-Cut Area, just south of Baffin Bay. The Intracoastal Waterway is dredged through this area, as are a series of well access channels. Dredging has caused topographic and vegetative changes among the flats of Laguna Madre.

Frequently flooded flats usually remain moist and may have mats of blue-green algae and an area-specific assemblage of invertebrates. Infrequently flooded flats are at higher elevations where only tides that are driven by strong wind can flood them. These are better drained and much dryer. Higher tidal flats remain barren because of the occasional saltwater flooding and subsequent evaporation that raises salt concentrations in the soil. This inhibits most plant growth; some salt-marsh plants that are tolerant of dry conditions may be found there. Some higher flats are nontidal, barren fan deltas and barren channel margins along streams. The salt concentrations of these soils are often elevated also (Brown et al., 1977; White et al., 1986; Smith, in press).

Inland beaches of sand and shells are found along the shores of bays, lagoons, and tidal streams. The structure of these beaches is similar to but much narrower and smaller in scale than barrier beaches. Compared to the sand beaches, shell features are typically stacked to higher elevations by storm waves and are generally more stable.

Few freshwater swamps and bottomland hardwoods occur in the general vicinity of OCS-related service bases and navigational channels of the Texas barrier island area. In the southern third of this area, they are nonexistent (Brown et al., 1977; White et al., 1986).

Chenier Plain

Beginning about 2,800 years ago and as sea level dropped during the last ice age, sediments from the Mississippi River and its delta were intermittently reworked and deposited by storms and coastal currents, forming the Chenier Plain between Port Bolivar, Texas, and Atchafalaya Bay in Louisiana. As the area filled in, a series of shell and sand ridges were formed parallel or oblique to the present-day Gulf Coast and were later abandoned as sea level continued to fall. Mudflats formed between the ridges when localized hydrologic and sedimentation patterns favored deposition there. This intermittent deposition isolated entrenched valleys from the Gulf, forming large lakes such as Sabine, Calcasieu, White, Grand, and others (Gosselink et al., 1979; Fisher et al., 1973). As a result, few tidal passes are found along this coast as compared to central Texas and eastern Louisiana. This reduces the tidal movement of saline waters.

Because of the structure of the Chenier Plain and its beaches, salt marshes are not as widely spread there as elsewhere in the northern Gulf. Generally in this area, salt marshes front the Gulf directly and are frequently submerged by tides and storms. Hence, they are considered high-energy environments, as compared to most vegetated wetlands.

Brackish and intermediate salinity marshes are dominant in estuarine areas of the Chenier Plain. They are tidal, although wind-driven tides are more influential and occasionally inundate these areas. Since salinity in this area ranges broadly, these habitats support a mix of salt and salt-tolerant freshwater plants, although marsh-hay cordgrass is generally dominant. These habitats are the most extensive and productive in coastal Louisiana.

Plant communities of freshwater marshes are among the most diverse of sensitive coastal environments. Annuals have a much greater presence in freshwater marshes than in estuarine areas. Dominance often changes from season to season as a result of year-round seed-germination schedules. Freshwater wetlands are extensive in the Chenier Plain due to the abundant rainfall and runoff coupled with the ridge system that retains freshwater and restricts the inflow of saline waters. Tidal influences are generally minimal in these areas, although strong storms may inundate the area. Hence, detritus is not as readily exported and accumulates there, supporting additional plant growth. Freshwater marsh plants are generally more buoyant than estuarine plants. In areas where detritus collects thickly, marsh plants may form floating marshes, referred to as "flotants." Flotants generally occur in very low-energy environments. They are held together by surrounding shorelines and a weave of slowly deteriorating plant materials and living roots.

Forested wetlands are not very common in the Chenier Plain. They only occur in the flood plain regions of major streams, along the northern margin of this area. There, cypress-tupelo swamps grade through stands of blackwillow to bottomland hardwoods.

Mississippi River Delta Complex

Mississippi River Delta Complex forms a plain that is composed of a series of overlapping riverine deltas that have extended onto the continental shelf over the past 6,000 years. Wetlands on this deltaic plain are the most extensive of those within this EIS's area of attention.

Sparse stands of black mangrove are found here and there, in the highest salinity areas of the Barataria and Terrebonne Basins. Extensive salt and brackish marshes are found throughout the southern half of the plain and east of the Mississippi River. Further inland, extensive intermediate and fresh water marshes are found. East of the Mississippi River and south of Lake Pontchartrain, Louisiana, very few intermediate and freshwater wetlands were found until the Caernarvon Freshwater Diversion was intermittently put into action in 1993. In freshwater areas, cypress-tupelo swamps are found flanking the natural levees and in areas that are impounded by dredged materials, levees, or roads. Bottomland hardwoods are found on the numerous natural levees and in drained levee areas

Except for leveed areas and the delta and basin of the Atchafalaya River, all of these deltas are generally experiencing succession towards wetter terrestrial and deeper water habitats. This is due to deltaic abandonment and human actions and their ensuing erosion. Most of these wetlands are built upon highly organic soils, which are easily eroded, compacted, and oxidized. These problems are discussed in Chapter 4.1.3.3.

Two active deltas are found in this area. The more active is in Atchafalaya Bay, at the mouths of the Atchafalaya River and its distributary, Wax-lake Outlet. Because the Red River and about thirty percent of the Mississippi River have been diverted to the Atchafalaya River, large volumes of sediment are being delivered to that shallow bay. As a result, extensive freshwater marshes, swamps, and bottomland hardwoods are found in this river basin. Relatively few estuarine marshes are found there.

The less active delta is at the mouth of the Mississippi River, which is referred to as the Belize or Birdfoot Delta. The Mississippi River has been channelized through most of this delta, which greatly reduced the volume of sediments that it contributes to the delta and longshore currents near the mouths of its distributaries. A few man-made diversions have been installed that are designed to deliver water rather than sediments to this delta. See Chapter 4.1.3.3 for a fuller description of these circumstances.

Mississippi and Alabama

Estuarine marshes around Mississippi Sound and associated bays occur in discontinuous bands. The most extensive wetland areas in Mississippi occur in the eastern Pearl River delta near the western border of the State and in the Pascagoula River delta area near the eastern border of the State. Mississippi's wetlands seem to be more stable than those in Louisiana and Alabama, perhaps reflecting the more stable substrate, more active and less disrupted sedimentation patterns in wetland areas, and the occurrence of only minor canal dredging and development.

Alabama has approximately 118,000 ac of coastal wetlands, of which approximately 75,000 ac are forested, 4,400 ac are freshwater marsh, and 35,400 ac are estuarine marsh (Wallace, 1996). Most coastal wetlands in Alabama occur on the Mobile River delta or along the northern Mississippi Sound.

3.2.1.3. Seagrass Communities

Three million hectares of submerged seagrass beds are estimated to exist in exposed, shallow coastal waters of the northern Gulf of Mexico. An additional 166,000 ha are found in protected, natural embayments and are not considered exposed to OCS impacts. The area off Florida, in the Eastern Planning Area, contains approximately 98.5 percent of all coastal seagrasses in the northern Gulf of Mexico; Texas and Louisiana contain approximately 0.5 percent. Mississippi and Alabama have the remaining 1 percent of seagrass beds.

Seagrass beds grow in shallow, relatively clear and protected waters with predominantly sand bottoms. Their distribution depends on an interrelationship among a number of environmental factors that include temperature, water depth, turbidity, salinity, turbulence, and substrate suitability. Primarily because of low salinity and high turbidity, robust seagrass beds and the accompanying high diversity of marine species are found only within a few scattered, protected locations in the Western and Central Gulf of Mexico. Inshore seagrasses provide important habitat for immature shrimp, black drum, spotted sea trout, juvenile southern flounder, and several other fish species; and they provide a food source for several species of wintering waterfowl.

Seagrasses in the WPA are widely scattered beds in shallow, high-salinity coastal lagoons and bays. The most extensive seagrass beds are found in both the Upper and Lower Laguna Madre along the Texas coast, as well as Baffin Bay. In the Texas Laguna Madre, seagrass meadows are the most common submerged habitat type. Although permanent meadows of perennial species occur in nearly all bay systems along the Texas Gulf Coast, most of the State's seagrass cover (79%) is found in the Laguna Madre (Pulich, 1998), with seagrasses currently covering about 243 km^2 in the upper portion of the Laguna Madre (Quammen and Onuf, 1993). Seagrasses are largely excluded from bays north of Pass Cavallo where rainfall and inflows are high and salinity's average less than 20 ppt, as well as the upper, fresher portions of most estuaries. Seagrasses in the Laguna Madre constitute a unique resource that cannot be duplicated elsewhere on the Texas coast (Withers, 2001). Lower-salinity, submerged beds of aquatic vegetation are found inland and discontinuously in coastal lakes, rivers, and the most inland portions of some coastal bays.

The turbid waters and soft, highly organic sediments of Louisiana's estuaries and offshore areas limit widespread distribution of higher salinity seagrass beds. Consequently, only a few areas in offshore Louisiana, mostly in Chandeleur Sound, support seagrass beds. In Mississippi and Alabama, seagrasses occur within the Mississippi Sound.

The distribution of seagrass beds in coastal waters of the Western and Central Gulf have diminished during recent decades. Primary factors believed to be responsible include dredging, dredged material disposal, trawling, water quality degradation, hurricanes, a combination of flood protection levees that have directed freshwater away from wetlands, saltwater intrusion that moved growing conditions closer inland, and infrequent freshwater diversions from the Mississippi River into coastal areas during flood stage.

3.2.2. Continental Shelf Benthic Resources

Seafloor (benthic) habitats, including live-bottom areas, topographic features, and deepwater benthic communities, are essential components of the overall offshore community assemblage in the Gulf of Mexico. The benthic resources of the continental shelf are discussed in Chapter 3.2.2.. Deepwater benthic resources are discussed in Chapter 3.2.3.

The pelagic offshore water-column biota contains primary producers (phytoplankton and bacteria—90 percent of the phytoplankton in the northern Gulf of Mexico is constituted by diatoms), secondary producers (zooplankton), and consumers (larger marine species including fish, reptiles, cephalopods, crustaceans, and marine mammals). The zooplankton consists of holoplankton (organisms for which all life stages are spent in the water column, including protozoans, gelatinous zooplankton, copepods, chaetognaths, polychaetes, and euphausids) and meroplankton (mostly invertebrate and vertebrate organisms for which larval stages are spent in the water column, including polychaetes, echinoderms, gastropods, bivalves, and fish larvae and eggs). Planktonic primary producers drift with currents, whereas zooplankton moves by swimming. The species diversity, standing crop, and primary productivity of offshore phytoplankton are known to fluctuate much less than their coastal counterparts as the offshore phytoplankton are less subject to changes of salinity, nutrient availability, vertical mixing, and zooplankton predation. In general, the diversity of pelagic planktonic species generally decreases with decreased salinity, and biomass decreases with distance from shore. Temperature, salinity, and nutrient availability limit the geographical and vertical ranges of plankton and consumers. The fish species of the Gulf are temperate, with incursions of subtropical Caribbean faunas. Gulf fish species exhibit seasonal distribution and abundance fluctuations that are probably largely related to oceanographic conditions.

Another essential component of the offshore environment is the neuston, which is composed of organisms living at the air-seawater interface. Significant components of the neuston are copepods, floating *Sargassum* algae (also known as "*Sargassum* mats"), and the organisms associated with the

Sargassum. As many as 100 different animal species can be found in the floating *Sargassum* in the Gulf. These species include mostly hydroids and copepods, but also contain fish, crabs, gastropods, polychaetes, bryozoans, anemones, and sea spiders. The majority of these organisms depend on the presence of the *Sargassum* algae. *Sargassum* alga rafts potentially constitute long-term havens for young sea turtles, which drift with these floating ecosystems as they feed off their living organisms, possibly for several years.

Shelf phytoplankton and zooplankton are more abundant, more productive, and seasonally more variable than the deep Gulf plankton. This is related to salinity changes, greater nutrient availability, increased vertical mixing, and different zooplankton predation in the shelf environment.

The benthos of the shelf has both floral and faunal components; floral representatives include bacteria, algae, and seagrasses. The abundance of benthic algae is limited by the scarcity of suitable substrates and light penetration. In exceptionally clear waters, benthic algae, especially coralline red algae, are known to grow in water depths to at least 180 m. Rezak et al. (1983) recorded algae from submarine banks off Louisiana and Texas. Offshore seagrasses are not conspicuous in the Central and Western Gulf; however, fairly extensive beds may be found in estuarine areas behind the barrier islands throughout the Gulf.

Benthic fauna include infauna (animals that live in the substrate, including mostly burrowing worms, crustaceans, and mollusks) and epifauna (animals that live on or are attached to the substrate; mostly crustaceans, as well as echinoderms, mollusks, hydroids, sponges, and soft and hard corals). Shrimp and demersal fish are closely associated with the benthic community. Substrate is the single most important factor in the distribution of benthic fauna (densities of infaunal organisms increase with sediment particle size) (Defenbaugh, 1976), although temperature and salinity are also important in determining the extent of faunal distribution. Depth and distance from shore also influence the benthic faunal distribution (Defenbaugh, 1976). Lesser important factors include illumination, food availability, currents, tides, and wave shock. Indeed, the density of offshore infaunal organisms has been found to be greater during the spring and summer as compared to the winter (Brooks, 1991).

In general, the vast majority of bottom substrate available to benthic communities in the Central and Western Gulf consists of soft, muddy bottoms; the benthos here is dominated by polychaetes. Benthic habitats on the continental shelf at most risk to potential impacts from oil and gas operations are topographic features and the pinnacle trend, live-bottom communities (Chapter 3.2.2).

3.2.2.1. Continental Slope and Deep Sea

The continental slope is a transitional environment influenced by processes of both the shelf and the abyssal (deep sea) Gulf (>975 m). This transitional character applies to both the pelagic and the benthic realms.

The deep-sea area (>800 m) of the northern Gulf of Mexico is much less known than the shelf (<150 m). Observed biotal differences in the deep ecosystem of the Gulf justify referring to the Western Gulf (which includes both the WPA and CPA) as the "true" Gulf and to the Eastern Gulf (which includes the EPA) as a divergence of the "Tropical Western Atlantic" (Pequegnat, 1983; LGL Ecological Research Associates, Inc. and Texas A&M University, 1986).

The highest values of surface primary production are found in the upwelling area north of the Yucatan Channel and in the DeSoto Canyon region. In general, the Western Gulf is more productive in the oceanic region than is the Eastern Gulf. It is generally assumed that all the phytoplankton is consumed by the zooplankton, except for brief periods during major plankton blooms. The zooplankton then egests a high percentage of their food intake as feces that sink toward the bottom. Most of the herbivorous zooplankton are copepods, calanoids being the dominant group (Pequegnat, 1983).

Compared to the shelf, there is less plankton on the slope and in the deep Gulf. In addition, some of the planktonic species are specifically associated with either the slope or the deep sea. The biomass of plankton does not appear to be affected by seasonal changes. Some east-west variations noted among diatom species have been attributed to the effects of different watermasses, i.e., normal Gulf waters versus those influenced by the Mississippi River (Pequegnat, 1983).

The topographic and physical oceanographic conditions at East Breaks in the Western Gulf support nutrient-rich upwelling, which may significantly contribute to recreational billfishing in the area (as reported by the National Marine Fisheries Service (NMFS)) as well as the year-round presence of large pelagic filter feeders such as whale sharks and manta rays (observations from East Breaks production platforms 110 and 165).

The 450-m isobath defines the truly deep-sea fauna. The aphotic zone at and beyond these depths (below the euphotic zone and extending to within a meter off the bottom) represents a huge mass of water. In these sunlight-deprived waters, photosynthesis cannot occur, and processes of food consumption, biological decomposition, and nutrient regeneration occur in cold and dark waters. The lowermost layer containing the last meter of water off the bottom and the bottom itself constitute the benthic zone. This zone is a repository of sediments where nutrient storage and regeneration take place in association with the solid and semisolid substrate (Pequegnat, 1983).

Most of the benthic fauna found on the deep slope and abyssal plain are endemic to those depths and have been grouped into seven faunal assemblages by Pequegnat (1983) and confirmed by LGL Ecological Research Associates, Inc. and Texas A&M University (1986):

> The Shelf/Slope Transition Zone (150-450 m) is a very productive part of the benthic environment. Demersal fish are dominant, many reaching their maximum populations in this zone. Asteroids, gastropods, and polychaetes are common.
>
> The Archibenthal Zone has two subzones. The Horizon A Assemblage is located between 475 and 750 m. Although less abundant, the demersal fish are a major constituent of the fauna, as are gastropods and polychaetes. Sea cucumbers are more numerous. The Horizon B Assemblage, located at 775-950 m, represents a major change in the number of species of demersal fish, asteroids, and echinoids, which reach maximum populations here. Gastropods and polychaetes are still numerous.
>
> The Upper Abyssal Zone is located between 975 and 2,250 m. Although the number of species of demersal fish drops, the number that reach maximum populations dramatically increases. This indicates a group uniquely adapted to the environment. Sea cucumbers exhibit a major increase, and gastropods and sponges reach their highest species numbers here.
>
> The Mesoabyssal Zone, Horizon C (2,275-2,700 m) exhibits a sharp faunal break. The number of species reaching maximum populations in the zone drops dramatically for all taxonomic groups.
>
> The Mesoabyssal Zone, Horizon D Assemblage (2,725-3,200 m) coincides with the lower part of the steep continental slope in the Western Gulf. Since the Central Gulf is dominated at these depths by the Mississippi Trough and Mississippi Fan, the separation of Horizon C and D assemblages is not as distinct in the Central Gulf. The assemblages differ in species constitution.
>
> The Lower Abyssal Zone (3,225-3,850 m) is the deepest of the assemblages. Megafauna is depauperate. The zone contains an assemblage of benthic species not found elsewhere.

3.2.2.2. Live-Bottom (Pinnacle Trend) Resources

The northeastern portion of the Central Gulf of Mexico exhibits a region of topographic relief, known as the “pinnacle trend,” at the outer edge of the Mississippi-Alabama shelf between the Mississippi River and DeSoto Canyon. The pinnacles appear to be carbonate reefal structures in an intermediate stage between growth and fossilization (Ludwick and Walton, 1957). The region contains a variety of features from low-relief rocky areas to major pinnacles, as well as ridges, scarps, and relict patch reefs. The heavily indurated pinnacles provide a surprising amount of surface area for the growth of sessile invertebrates and attract large numbers of fish. Additional hard-bottom features are located nearby on the continental shelf, outside the actual pinnacle trend.

The features of the pinnacle trend offer a combination of topographic relief, occasionally in excess of 20 m, and hard substrate for the attachment of sessile organisms and, therefore, have a greater potential to support significant live-bottom communities than surrounding areas on the Mississippi-Alabama Shelf. This potential to support live-bottom communities has made these features a focus of concern and discussion. The species composition of the pinnacle trend has been compared to the Antipatharian Zone and Nepheloid Zone described by Rezak and Bright (1978) and Rezak (CSA, 1985). The following description of the pinnacle-trend region is found in the Mississippi-Alabama Continental Shelf Ecosystems Study: Data Summary and Synthesis, as described by Brooks (1991).

> Biological assemblages dominated by tropical hard bottom organisms and reef fishes occupy a variety of topographic features that exist between 53 and 110 m in the northeastern Gulf of Mexico between the Mississippi River and DeSoto Canyon. The origins of the carbonate features vary. Some are small, isolated, low to moderate [relief] reefal features or outcrops of unknown origin. Some appear to be hard substrates exposed by erosion during sea level still-stands along late Pleistocene shorelines. Others appear to be small reefs that existed near these shorelines. The largest reefal features appear to have been offshore reefs. The structure of the summits of some reefs may also have been modified by Holocene erosional events following their initial period of growth (namely, the flat-topped reefs). Most appear to be deteriorating under the influence of bioerosional processes. Hard bottoms and associated organisms are evident on at least two salt domes within 50 km of the Mississippi River Delta.
>
> The hermatypes that contributed to the development of these structures probably included coralline algae, reef-building corals, bryozoans, foraminiferans, and molluscs, among others. Present-day production of calcium carbonate is probably limited to an impoverished calcareous alga population on features cresting above 78 m (shallower in most areas). Features below this depth can most likely be considered completely drowned reefs.
>
> Present-day biological assemblages on features in the Northeastern Gulf are dominated by suspension feeding invertebrates. Populations are depauperate on features of low topography, those in habitats laden with fine sediments, and at the base of larger features (where resuspension of sediments limits community development). On larger features the diversity and development of communities appears to depend on habitat complexity; that is, the number of habitat types available to hard bottom organisms, and to some extent, the distance from the Mississippi River Delta. On reefs containing extensive reef flats on their summits, there are rich assemblages distinguished by a high relative frequency of sponges, gorgonian corals (especially sea fans), crinoids, and bryozoans. Due to the generally accordant depth of flat-topped reefs (62-63 m), coralline algae are also in abundance. Other organisms on reef flats include holothurians, basket stars, and myriads of fish (mostly, *Holanthias martinicensis* [roughtongue bass*], Hemanthias aureorubens* [streamer bass], *Rhomboplites aurorubens* [vermilion snapper]). On reefs lacking this reef flat habitat, as well as on reef faces of flat-topped features, the benthic community is characterized by a high relative abundance of ahermatypic corals (both solitary and colonial scleractinians). Other frequently observed organisms on these rugged, often vertical reef faces include crinoids, gorgonians, sea urchins, and basket stars. Among other species, dense schools of *H. martinicensis*, *H. aureorubens* (streamer bass) and *Paranthias furcifer* (creole-fish) often occupy their summits.
>
> Biological abundance and species diversity increase in relation to the amount of solid substrate exposed and to the variety of habitats available. Thus, low biological abundance and diversity characterize low relief features 2 m high. Features of intermediate relief (2-6 m high) may exhibit low or high abundance and diversity depending upon habitat complexity. High relief features (>6 m) have dense and diverse biotas whose composition varies with habitat type (i.e., flat reef tops vs. ragged reef sides). Depth in the water column appears not to play a major role in determining species composition except in the case of coralline algae, which have not been encountered

> below a depth of 78 m. Since most of the major species are suspension feeders, susceptibility to sedimentation does appear to limit species composition. Areas closest to the Mississippi River Delta are most affected, and this influence extends eastward for up to 115 km (70 miles) from the Delta. Living hermatypic corals have not been observed on topographic features of the Mississippi-Alabama shelf.

In assessing the overall health of the pinnacle trend live bottoms; Brooks (1991) concludes the following:

> Human impact in these environments appears to be minimal. Discarded debris or lost fishing gear (such as longlines), though present at many sites, was not abundant, and therefore poses little threat to the environment. Cables and lines can affect shallower reef communities, but probably have little impact at these depths once they become tangled on or lodged against reef structures. Fishing pressure on these relatively small features may reduce the population of the larger, commercially important species, and may explain the frequency of smaller individuals of unprofitable species on heavily fished reefs.

Continental Shelf Associates, Inc. (CSA, 1992a) investigated another portion of the Mississippi-Alabama continental shelf west and north of the areas investigated by Brooks. Three types of hard-bottom features were identified for biological characterization:

(1) pinnacle features present in approximately 80- to 90-m water depths;

(2) deepwater pinnacles and associated hard bottom located in approximately 110- to 130-m water depths; and

(3) suspected low relief, hard-bottom features in the central and eastern portions of the upper Mississippi-Alabama shelf in water depths shallower than 75 m. Although the CSA biological investigations were fairly limited, they did study several significant topographic features.

Shinn et al. (1993) investigated an exploratory drill site in Main Pass Block 255. The drill site was located at 103-m water depth and was adjacent to a 4- to 5-m high rock pinnacle. The pinnacle feature had been impacted by drill muds and cuttings approximately 15 months prior to the investigation.

In 1994, DelMar Operating Inc. re-investigated the disturbed site in Main Pass Block 255. Their findings (DelMar Operating, Inc., 1994) are summarized below:

> Locally the 330 ft (100 m) isobath appears to be the lower limit of any exposed carbonate material, regionally, the 390 ft (120 m) isobath appears to be the lower limit regardless of pinnacle or mesa-like characteristics. Associated with the mesa-like features are carbonate RLM [reef-like mounds]. These RLM are typically less than 20 ft in length, 3 ft in height, and 4 ft in breadth.
>
> Throughout the area north and east of the existing template, the slope trends are locally interrupted by several RLM. The most significant seafloor feature in the site-specific area is the carbonate material at the edge of the mesa-like feature and the moderate slope break that it defines. Within this zone, several RLM can be identified sitting above the general local bathymetric trend. Current analysis of the RLM and the mesa-like features located throughout the region indicate that all of these features are believed to be more common than originally mapped.

A four-year study (1996-2000) characterizing and monitoring carbonate mounds on the Mississippi/Alabama outer continental shelf (OCS) (Table 3-3) was recently completed by Continental Shelf Associates, Inc. and the Geochemical and Environmental Research Group (GERG) of Texas A&M University (TAMU) for the U.S. Geological Survey (USGS), Biological Resources Division (CSA and GERG, 2001). Five of the nine sites investigated during the four-year project are located in the Central

Planning Area of the Gulf of Mexico and could potentially be affected by this combined lease sale (Table 3-3); the remaining 4 sites are outside the lease sale area and will not be affected.

The five areas investigated by CSA and GERG that are included in this multisale EIS are described as follows:

- Site 5 includes high relief with a tall, flattop mound near its center and a lower mound at its southwestern edge; a horseshoe shaped (100-m base diameter), medium-profile, flattop structure, with 8-m maximum relief and a base depth of 77 m (Figure 3-3). A fine sediment veneer occurred on all horizontal rock surfaces and was particularly evident on the top of the feature, filling all depressions. This pinnacle feature is known as Double-Top Reef and belongs to the shallow pinnacle trend in the central and northeastern Gulf of Mexico.

  There are distinct assemblages of organisms in different locations on these features. Organisms found on top of the large feature were family *Stenogorgiinae, Swiftia exserta*, *Stichopathes lutkeni*, *Antipathes* spp., *Bebryce cinera/grandis*, *Ctenocella* (*Ellisella*) spp., *Hypnogorgia pendula*, and other unidentified gorgonian corals. Hermatypic as well as ahermatypic corals were sparsely distributed on the top interior probably due to heavy accumulations of fine sediments. *Rhizopsammia manuelensis* was the dominant species on almost all surfaces of the smaller mounds associated with the feature. Other species found on the vertical face of the main feature and adjacent mounds included *Madracis/Oculina* sp., *Madrepora carolina*, *Antipathes* spp., and *Stichopathes lutkeni*. Also present were the sea urchins *Stylocidaris affinis* and *Diadema antillarum*, a few unidentified sponge species, and small colonies of bryozoans.

- Site 6 is a low-relief site covering part of a large, carbonate hardground consisting of extensive areas of low-relief rock features. The features range up to about 1 m in height on a relatively flat seafloor and covered with a thin layer of fine sediments.

  There was a low-diversity biological community observed on these low-relief features. The most noticeable taxa include *Bebryce cinerea/grandis*, *Thesea* spp., *Ctenocella* (*Ellisella*) spp., *Antipathes*, and *Stichopates lutkeni*. *Rhizopsammia manuelensis* was relatively common on the few features with more than 1 m of relief, and *Madracis/Oculina* sp. and *Madrepora carolina* were also occasionally observed.

- Site 7 is a high-relief site located on a large, flat top mound. Known as "Alabama Alps," this pinnacle feature forms the northwestern terminus of a northwest to southeast aligned ridge and pinnacle arc paralleling the shelf edge (Figure 3-3) (USDOI, MMS, 2000a). The sides of the feature range from nearly vertical walls stepping down to the seafloor to large attached monolithic structures that decrease in height farther from the site center. Along the western side of the site, there are numerous large rock overhangs and ledges several meters wide and deep, with some tilted at acute angles. Large, distinct sediment-filled depressions and channels were observed along the southern edge of the monitoring site.

  There is a distinct difference between the community on the flat top of the structure and that associated with the sloping sides and flanks. Biota observed on the top of the feature include *Bebryce cineriea/grandis*, *Ctenocella* (*Ellisella*) spp., *Nicella* spp., crinoids, *Antipathes* spp., *Stichopathes lutkeni*, coralline algae, several species of sponges; *Astrocyclus caecilia*, and *R. manuelensis*. The occurrence of R. manuelensis on the top of Site 7 may be due to the less uniform topography at this site. The species does not appear in the areas of lowest relief atop the feature. On the edges, sides, and adjacent rock structures, *R. manuelensis* is the dominant epibiota, with crinoids, *Antipathes* spp., *Stichopathes lutkeni*, coralline algae (down to approximately 76 m), *Madracis/Oculina* sp., the unidentified solitary scleractinian, and several sponges also observed. Along the exposed edges of the large rock overhangs, *Madracis/Oculina* sp. and unidentified scleractinian were abundant. In the areas of scattered shell and rubble surrounding the feature are crinoids, with small colonies of *Antipathes* spp. also in evidence.

- Site 8 is a medium-relief site with a rugged mound near its center and numerous crevices and overhangs associated with the feature. The mound is slightly elongated, approximately 40 m in north-south extent and 15 m in east-west extent, with a smaller mound located nearby to the east. The relief of the smaller mound is 7-8 m above the surrounding seafloor. The entire feature is covered by silt with areas of thicker deposits on horizontal surfaces and in depressions and crevices.

  Rhizopsammia manuelensis was evident on the entire structure from just above the base to the top, with lower densities observed on horizontal surfaces with a heavier silt accumulation. Other observed epibiota included the *Ctenocella* (*Ellisella*) spp., *Hypnogorgia pendula*, *Nicella* spp., *Thesea* spp., *Antipathes* spp., *Stichopathes lutkeni*, and *Madrepora carolina*. There is no obvious zonation of any of these taxa except for higher abundances of *Hypnogorgia pendula* occurring near the top of the feature. The arrow crabs, *Stenohynchus seticornis* and *Astrocyclus caecilia*, crinoids, and the sea urchins *Diadema antillarum* and *Stylocidaris affinis* were also observed on the mounds. The species colonizing the lower relief mounds appear similar in composition to those on the primary feature.

- Site 9 is low relief consisting of low subcircular mounds, generally 0.5-2 m in height with diameters of 5-20 m. There are a few features with up to 5-m relief with ledges, overhangs, and crevices. A few outcrops are much larger with heights up to 5 m and diameters greater than 10 m. Many of the medium to large structures are flattened and greatly undercut with wide overhangs and vertical holes down through the mounds. The bases of the features are covered with silt up to a height of about 0.5 m. Some areas of low rock are completely covered and the buried hard substrate is only apparent from the gorgonian fans and whips protruding through the silt.

  Biota on the lower relief structures includes *Bebryce cinerea/grandis, Hypnogorgia pendula*, *Nicella* spp., *Swiftia exserta*, *Thesea* spp., *Ctenocella* (*Ellisella*) spp., *Antipathes* spp., *Madrepora carolina*, and occasional crinoids. *Ctenocella* (*Ellisella*) spp. had substantially higher abundances at this site than the other surveyed sites especially on the low-relief rock outcrops. Some smaller mounds (1 m in height) had few colonies of *R. manuelensis*; however, the larger mounds had very high numbers of *R. manuelensis* on the upper 2-3 m of the structure, along with larger octocoral fans.

3.2.2.3. Topographic Features

The shelf edge, shelf, and mid-shelf of the Western and Central Gulf are characterized by topographic features that are inhabited by hard-bottom benthic communities. The habitat created by the topographic features is important for the following reasons:

(1) they support hard-bottom communities of high biomass, high diversity, and high numbers of plant and animal species;

(2) they support, either as shelter or food, or both, large numbers of commercially and recreationally important fishes;

(3) they are unique to the extent that they are small, isolated areas of such communities in vast areas of much lower diversity;

(4) they provide a relatively pristine area suitable for scientific research (especially the East and West Flower Garden Banks); and

(5) they have an aesthetically intrinsic value.

Figure 3-4 depicts the location of 39 known topographic features in the Gulf of Mexico; 23 in the WPA and 16 in the CPA.

Benthic organisms on these features are mainly limited by temperature and light (lack of); extreme water temperature and light intensity are known to stress corals. Temperatures lower than 16 °C reduce coral growth, while temperatures in excess of 32 °C will impede coral growth and induce coral bleaching (loss of symbiotic zooxanthellae). While intertidal corals are adapted to high light intensity, most corals become stressed when exposed to unusually high light levels. Furthermore, although corals will grow or survive under low light level conditions, they do best submerged in clear, nutrient-poor waters. Light penetration in the Gulf is limited by several factors including depth and events of prolonged turbidity. Hard substrates favorable to colonization by coral communities in the northern Gulf are found on outer shelf, high-relief features. These substrates are found above the nepheloid layer, are off the muddy seafloor, and are bathed most of the year in nutrient-poor waters. The East and West Flower Garden Banks are examples of such suitable substrates. From 1990 to 1995, horizontal Secchi disk water turbidity over the coral reef has been estimated at 46 m during the summer, and water temperature ranged from 19 to 30 °C at a 20-m depth (Gittings, personal communication, 1996).

The banks of the Gulf of Mexico have been identified and classified into seven distinct biotic zones (Table 3-4) (modified/updated from Rezak et al., 1983 and 1985); however, none of the banks contain all seven zones. The zones are divided into the following four categories depending upon the degree of reef-building activity in each zone.

Zones of Major Reef Building and Primary Production

Diploria-Montastraea-Porites Zone

This zone is characterized by 18-20 hermatypic coral species and is found predominantly at the East and West Flower Garden Banks. The dominant species/groups of the zone in order of dominance are the *Montastraea annularis complex* (this group includes *M. franksii*, *M. faveolata*, and *M. annularis*), *Diploria strigosa*, *Porites asteroides, Colpophyllia natans,* and *Montastraea cavernosa* (Dokken et al., in preparation). Coralline algae are abundant in areas, which adds substantial amounts of calcium carbonate to the substrate. In addition to the coralline algae, there is a considerable amount of bare reef rock, which fluctuates in percent cover with the appearance of a red-turf like algae, at both banks. Red turf algae (primarily Order Ceramiales) is the dominant algal group at the East and West Flower Garden Banks and has increased in percent cover substantially over the last several years. Dokken et al. (in preparation) reported algal percent cover at both banks was significantly greater during 1999 than 1998. Percent coral cover in this zone is estimated at 59.0 percent and 54.6 percent at the East and West Banks, respectively (Dokken et al., in preparation).

Typical sport and commercial fish observed in this zone include various grouper species, amberjack, barracuda; red, gray, and vermillion snapper; cottonwick; and porgy. There is also a diverse group of tropical reef fish species found on these banks, including creole fish; queen, stoplight, red band, and princess parrot fish; rock beauty; blue tang, and the whitespotted filefish, just to name a few. There are over 175 tropical reef species that reside within the high-diversity zone at the Flower Garden Banks (Dennis and Bright, 1988; Pattengill, 1998). This high-diversity *Diploria/Montastraea/Porites* Zone is found only at the East and West Flower Garden Banks in water depths less than 36 m.

Madracis and Fleshy Algal Zone

The *Madracis* Zone is dominated by the small branching coral *Madracis mirabilis*, which produces large amounts of carbonate sediment. In places, large (possibly ephemeral) populations of turf-like algae dominate the *Madracis* gravel substratum (Algal Zone). The *Madracis* Zone appears to have a successional relationship with the *Diploria-Montastraea-Porites* Zone. *Madracis* colony remains build up the substrate and allow the successional species to grow. The zone occurs at the East and West Flower Garden Banks on peripheral components of the main reefal structure between 28 and 46 m.

Stephanocoenia-Millepora Zone

The *Stephanocoenia-Millepora* Zone is inhabited by a low-diversity coral assemblage of 12 hermatypic corals and can be found at the Flower Garden, McGrail, and Bright Banks. The eight most conspicuous corals in order of dominance are *Stephanocoenia michelinii, Millepora alcicornis*, *Montastraea cavernosa*, *Colpophyllia natans*, *Diploria strigosa*, *Agaricia agaricites*, *Mussa angulosa*, and *Scolymia cubensis*. The assemblages associated with this zone are not well known; coralline algae is the most conspicuous organism in the zone. Additionally, reef fish populations are less diverse; but the Atlantic spiny oyster (*Spondylus americanus*) appears numerous. The depth range of this zone is between 36 and 52 m.

Algal-Sponge Zone

The Algal-Sponge Zone covers the largest area among the reef-building zones. The dominant organisms of the zone are the coralline algae, which are the most important carbonate-nodule producers. The alga nodules range from 1 to 10 cm in size, cover 50-80 percent of the bottom, and generally occur between 55 and 85 m. The habitat created by the alga nodules supports communities that are probably as diverse as the coral-reef communities. Most of the leafy algae found on the banks occur in this zone and contribute large amounts of food to the surrounding communities. Calcareous green algae (*Halimeda* and *Udotea)* and several species of hermatypic corals are major contributors to the substrate. Deepwater alcyonarians are abundant in the lower Algal-Sponge Zone. Sponges, especially *Neofibularia nolitangere,* are conspicuous. Echinoderms are abundant and also add to the carbonate substrate. Small gastropods and pelecypods are also abundant. Gastropod shells are known to form the center of some of the algal nodules. Characteristic fish of the zone are yellowtail reef fish, sand tilefish, cherubfish, and orangeback bass.

Partly drowned reefs are a major biotope of the Algal-Sponge Zone. They are defined as those reefal structures covered with living crusts of coralline algae with occasional boulders of hermatypic corals. In addition to the organisms typical to the rest of the Algal-Sponge Zone, the partly drowned reefs are also inhabited by large anemones, large comatulid crinoids, basket stars, limited crusts of *Millepora*, and infrequent small colonies of other hermatypic species. The relief and habitat provided by the carbonate structures also attract a variety of fish species, especially yellow tail reef fish and blue and queen angelfish.

Zone of Minor Reef Building

Millepora-Sponge Zone

The *Millepora*-Sponge Zone occupies depths comparable to the *Diploria-Montastraea-Porites* Zone on the claystone-siltstone substrate of the Texas-Louisiana midshelf banks. One shelf-edge carbonate bank, Geyer Bank, also exhibits the zone but only on a bedrock prominence. Crusts of the hydrozoan coral, *Millepora alcicornis*, sponges, and other epifauna occupy the tops of siltstone, claystone, or sandstone outcrops in this zone. Scleractinian corals and coralline algae are rarely observed.

Transitional Zone of Minor to Negligible Reef Building

Antipatharian Zone

This transitional zone is not distinct but blends in with the lower Algal-Sponge Zone. It is characterized by an abundance of antipatharian whips growing with the algal-sponge assemblage. With increased water depth, the assemblages of the zone become less diverse, characterized by antipatharians, comatulid crinoids, few leafy or coralline algae, and limited fish (yellowtail redfish, queen angelfish, blue angelfish, and spotfin hogfish). Again, the depth of this zone differs at the various banks but generally extends to 90 m.

Zone of No Reef Building

Nepheloid Zone

High turbidity, sedimentation, and resuspension occur in this zone. Rocks or drowned reefs are covered with a thin veneer of sediment and epifauna are scarce. The most noticeable are comatulid crinoids, octocoral whips and fans, antipatharians, encrusting sponges, and solitary ahermatypic corals. The fish fauna is different and less diverse than those of the coral reefs or partly drowned reefs. These fish species include red snapper, spanish flag, snowy grouper, bank butterflyfish, scorpionfishes, and roughtongue bass. This zone occurs on all banks, but its depth differs at each bank. Generally, the Nepheloid Zone begins at the limit of the Antipatharian Zone and extends to the surrounding soft bottom.

Banks of the Gulf of Mexico

Shelf-Edge Banks		Midshelf Banks		South Texas Banks
Western	Central	Western	Central	Western Only
East Flower Garden Bank	Bright Bank	Claypile Lump	Sonnier Bank	Big Dunn Bar
West Flower Garden Bank	McGrail Bank	32 Fathom Bank	Fishnet Bank	Small Dunn Bar
Geyer Bank	Alderdice Bank	29 Fathom Bank	29 Fathom Bank	Blackfish Ridge
Rankin Bank	Rankin Bank	Stetson Bank		Mysterious Bank
Elvers Bank	Rezak Bank	Coffee Lump		Baker Bank
MacNeil Bank	Sidner Bank			Aransas Bank
Appelbaum Bank	Ewing Bank			Southern Bank
				North Hospital Bank
				Hospital Bank
				South Baker Bank
				Dream Bank

Figures 3-5 and 3-6 illustrate the topographic relief associated with several of the more developed features, i.e., the East and West Flower Garden Banks and Stetson Bank.

Shelf-Edge Banks

The shelf-edge banks of the Western and Central Gulf generally exhibit the *Diploria-Montastraea-Porites* zonation that is exhibited at the East and West Flower Garden Banks at comparable depths. However, Geyer Bank (37-m crest), which is within the depth of the high-diversity, coral-reef zone, does not exhibit the high-diversity characteristics. Instead, Geyer Bank has a well-developed *Millepora*-Sponge Zone, which is typically the defining characteristic of midshelf banks found elsewhere in the Gulf of Mexico.

Midshelf Banks

Five midshelf banks contain the *Millepora*-Sponge Zone: Sonnier, 29 Fathom, and Fishnet Banks in the Central Gulf; and Stetson and Claypile Banks in the Western Gulf. The nepheloid layer often enfolds Claypile Bank, considered a low-relief bank with only 10 m of relief. Therefore, the level of development of the *Millepora*-Sponge community is lowest at Claypile Bank. Two other midshelf banks in the Western Gulf (32 Fathom Bank and Coffee Lump) are also low-relief banks with less than 10 m of relief.

Stetson Bank is isolated from other banks by waters over 50 m and lies near the northern physiological limit for the advanced development of reef-building, hermatypic corals. The species composition is markedly different from that of other tropical reefs including the Flower Garden Banks. However, in addition to the *Millepora*-Sponge characteristics at Stetson Bank, there are sparsely distributed reef- and nonreef-building coral species found. *Madracis decactus*, *Agaricia fragilis*, (ahermatypic corals), *Stephenocoenia michelinii*, and *Diploria strigosa* (hermatypic corals) are among the most dominant coral species found at Stetson Bank. In addition to Stetson's unique landscape and topographic features (Figure 3-6), there is a large distribution of marine life residing at the bank. Over 140 species of reef and schooling fishes, 108 mollusks, and 3 predominant echinoderms are reported. Due to its vertical orientation, Stetson attracts a number of pelagic species that move back and forth across the continental shelf utilizing various banks, including the Flower Gardens, for seasonal feeding, mating, and as nursery ground. These large pelagic animals include species such as manta and devil rays and the filter-feeding whale shark.

Figure 3-7 shows the 1-Mile and 3-Mile Zones around Sonnier Bank as examples of the protective zonation that would be established by the Topographic Features Stipulation proposed for these proposed lease sales.

South Texas Banks

The South Texas banks are geographically/geologically distinct from the shelf-edge banks. Several of the South Texas banks are also low-relief banks. These banks exhibit a reduced biota and have relatively low relief, few hard-substrate outcrops, and a thicker sediment cover than the other banks.

It has been suggested that four other South Texas features in the Western Gulf be considered as sensitive offshore topographic features: Phleger, Sebree, and Big and Small Adam Banks. Phleger Bank (a shelf-edge bank) crests at 122 m, deeper than the lower limit of the No Activity Zones (85 m [100 m in the case of the Flower Gardens]). The depth of the bank precludes the establishment of the Antipatharian Zone so that even though the bank is in clear water, the biota is typical of the nepheloid zone. The bank appears to be predominantly covered with sand, with scattered rock outcrops of approximately 1-2 m in diameter and 1 m in height. The sand substrate is devoid of sessile benthic organisms, although the rock outcrops support a number of epifaunal species such as cup-shaped and encrusting sponges, octocorals, and crinoids. Roughtongue bass were observed in video surveys to be the dominant fish species on this bank.

Sebree Bank, located in 36.5 m of water, is a low-relief feature of approximately 3 m in relief and is located in an area subject to high sedimentation. Clusters of the scleractinian coral, *Oculina diffusa*, have been observed on the rocky outcrops of this bank. This species tends to thrive in habitats exhibiting low light and high sedimentation. It forms twisted, rather low-relief colonies, and does not create reefs or distinctive assemblages of reefal species. The bank attracts abundant nektonic species, including red snapper and other commercially and recreationally important finfish (Tunnell, 1981). Findings in the August 1993 cooperative dive effort on Sebree Bank by MMS, the State of Texas, and Texas A&M University at Corpus Christi (Dokken et al., 1993) were generally consistent with those reported by Tunnell (1981).

Dokken et al. (1993) compared the nepheloid dominated, low-diversity community of Sebree Bank with the nepheloid zone community described by Rezak et al. (1985). Rezak and Bright (1981) devised an environmental priority index to rate the sensitivity of topographic features in the northern Gulf of Mexico:

A. South Texas midshelf relict Pleistocene carbonate reefs bearing turbidity tolerant Antipatharian Zone and Nepheloid Zone (surrounding depths of 60-80 m, crests 56-70 m).

B. North Texas-Louisiana midshelf, Tertiary-outcrop banks bearing clear-water, *Millepora*-Sponge Zone and turbid-water-tolerant Nepheloid Zone (surrounding depths of 50-62 m, crests 18-40 m.

C. North Texas-Louisiana midshelf banks bearing turbidity-tolerant assemblages approximating the Antipatharian Zone (surrounding depths of 65-78 m, crests 52-66 m).

D. North Texas-Louisiana shelf-edge, carbonate banks bearing clear-water coral reefs and Algal-Sponge Zones, transitional assemblages approximating the Antipatharian Zone and Nepheloid Zone (surrounding depths of 84-200 m, crests 15-75 m).

E. Eastern Louisiana shelf-edge, carbonate banks bearing poorly developed elements of the Algal-Sponge Zone, transitional Antipatharian Zone assemblages, and Nepheloid Zone (surrounding depths of 100-110 m, crests 67-73 m).

They categorized similar features containing nepheloid zone communities as Class D banks, where protection is not recommended. Since Sebree Bank is located within a shipping fairway, it is relatively well protected from physical impacts (anchoring or drilling disturbance). While they did not specifically discuss Sebree Bank, based on five ranking criteria, similar nepheloid zone communities were given the lowest rating of all the topographic features.

Big and Small Adam Banks are also low-relief features subject to sedimentation. Rezak and Bright (1981) categorized these features as Class D banks, where protection is not recommended. Although the banks may contain the Antipatharian Zone, this designation is speculative (Rezak et al., 1983). Big and Small Adam Banks were given the lowest ratings of those topographic features discussed by Rezak and Bright (1981), based on their criterion for environmental priority rankings.

3.2.3. Deepwater Benthic Communities

Chemosynthetic communities are remarkable in that they utilize a carbon source independent of photosynthesis and the sun-dependent photosynthetic food chain that supports all other life on earth. Although the process of chemosynthesis is entirely microbial, chemosynthetic bacteria and their production can support thriving assemblages of higher organisms through symbiosis. The first discovery of deep-sea chemosynthetic communities including higher animals was unexpectedly made at hydrothermal vents in the eastern Pacific Ocean during geological explorations (Corliss et al., 1979). The principal organisms included tube worms, clams, and mussels that derive their entire food supply from symbiotic chemosynthetic bacteria, which obtain their energy needs from chemical compounds in the venting fluids. Similar communities were first discovered in the Eastern Gulf of Mexico in 1983 at the bottom of the Florida Escarpment in areas of "cold" brine seepage (Paull et al., 1984). The fauna here was found to be generally similar to vent communities including tube worms, mussels, and rarely, vesicomyid clams.

Two groups fortuitously discovered chemosynthetic communities in the Central Gulf of Mexico concurrently in November 1984. During investigations by Texas A&M University to determine the effects of oil seepage on benthic ecology (until this investigation, all effects of oil seepage were assumed to be detrimental), bottom trawls unexpectedly recovered extensive collections of chemosynthetic organisms including tube worms and clams (Kennicutt et al., 1985). At the same time, LGL Ecological Research Associates was conducting a research cruise as part of the multiyear MMS Northern Gulf of Mexico Continental Slope Study (LGL Ecological Research Associates, Inc. and Texas A&M University, 1986). Bottom photography (processed on board the vessel) resulted in clear images of vesicomyid clam chemosynthetic communities. Photography during the same LGL/MMS cruise also documented tube-worm communities *in situ* in the Central Gulf of Mexico for the first time (not processed until after the cruise; Boland, 1986) prior to the initial submersible investigations and firsthand descriptions of Bush Hill in 1986 (Rosman et al., 1987a; MacDonald et al., 1989).

Distribution

There is a clear relationship between known hydrocarbon discoveries at great depth in the Gulf slope and chemosynthetic communities, hydrocarbon seepage, and authigenic minerals including carbonates at the seafloor (Sassen et al., 1993a and b). While the hydrocarbon reservoirs are broad areas several kilometers beneath the Gulf, chemosynthetic communities occur in isolated areas with thin veneers of sediment only a few meters thick.

The northern Gulf of Mexico slope includes a stratigraphic section more than 10 km thick and has been profoundly influenced by salt movement. Mesozoic source rocks from Upper Jurassic to Upper Cretaceous generate oil in most of the Gulf slope fields (Sassen et al., 1993a and b). Migration conduits supply fresh hydrocarbon materials through a vertical scale of 6-8 km toward the surface. The surface expressions of hydrocarbon migration are referred to as seeps. Geological evidence demonstrates that hydrocarbon and brine seepage persists in spatially discrete areas for thousands of years. The time scale for oil and gas migration (combination of buoyancy and pressure) from source systems is on the scale of millions of years (Sassen, 1997). Seepage from hydrocarbon sources through faults towards the surface tends to be diffused through the overlying sediment, carbonate outcroppings, and hydrate deposits so the corresponding hydrocarbon seep communities tend to be larger (a few hundred meters wide) than chemosynthetic communities found around the hydrothermal vents of the Eastern Pacific (MacDonald, 1992). There are large differences in the concentrations of hydrocarbons at seep sites.

The widespread nature of Gulf of Mexico chemosynthetic communities was first documented during contracted investigations by the Geological and Environmental Research Group (GERG) of Texas A&M University for the Offshore Operators Committee (Brooks et al., 1986). The occurrence of chemosynthetic organisms dependent on hydrocarbon seepage has been documented in water depths as shallow as 290 m (Roberts et al., 1990) and as deep as 2,200 m (MacDonald, 1992). This depth range specifically places chemosynthetic communities in the deepwater region of the Gulf of Mexico, which is defined as water depths greater than 305 m (1,000 ft). Chemosynthetic communities are not found on the continental shelf. At least 45 communities are now known to exist in 43 OCS blocks (Figure 4-1 and Table 3-8). Although a systematic survey has not been done to identify all chemosynthetic communities in the Gulf, there is evidence indicating that many more such communities may exist. The depth limits of discoveries probably reflect the limits of exploration (lack of submersibles capable of depths over 1,000 m). MacDonald et al. (1993 and 1996) have analyzed remote-sensing images from space that reveal the presence of oil slicks across the north-central Gulf of Mexico. Results confirmed extensive natural oil seepage in the Gulf, especially in water depths greater than 1,000 m. A total of 58 additional potential locations were documented where seafloor sources were capable of producing perennial oil slicks (MacDonald et al., 1996). Estimated seepage rates ranged from 4 to 70 bbl/day compared to less than 0.1 bbl/day for ship discharges (both normalized for 1,000 mi^2 (3,430 km^2)). This evidence considerably increases the area where chemosynthetic communities dependent on hydrocarbon seepage may be expected.

The densest aggregations of chemosynthetic organisms have been found at water depths of around 500 m and deeper. The best known of these communities was named Bush Hill by the investigators who first described it (MacDonald et al., 1989). It is a surprisingly large and dense community of chemosynthetic tube worms and mussels at a site of natural petroleum and gas seepage over a salt diapir in Green Canyon Block 185. The seep site is a small knoll that rises about 40 m above the surrounding seafloor in about 580-m water depth.

Stability

According to Sassen (1997) the role of hydrates at chemosynthetic communities has been greatly underestimated. The biological alteration of frozen gas hydrates was first discovered during the recent MMS study "Stability and Change in Gulf of Mexico Chemosynthetic Communities." It is hypothesized (MacDonald, 1998) that the dynamics of hydrate alteration could play a major role as a mechanism for regulation of the release of hydrocarbon gases to fuel biogeochemical processes and could also play a substantial role in community stability. Recorded bottom-water temperature excursions of several degrees in some areas such as the Bush Hill site (4-5 °C at 500-m depth) are believed to result in dissociation of hydrates, resulting in an increase in gas fluxes (MacDonald et al., 1994). Although not as destructive as the volcanism at vent sites of the mid-ocean ridges, the dynamics of shallow hydrate formation and movement will clearly affect sessile animals that form part of the seepage barrier. There is potential of a catastrophic event where an entire layer of shallow hydrate could break free of the bottom and result in considerable impact to local communities of chemosynthetic fauna. At deeper depths (>1,000 m), the bottom-water temperature is colder (by approximately 3 °C) and undergoes less fluctuation. The formation of more stable and probably deeper hydrates influences the flux of light hydrocarbon gases to the surface, thus influencing the surface morphology and characteristics of chemosynthetic communities. Within complex communities such as Bush Hill, oil seems less important than previously thought (MacDonald, 1998).

Through taphonomic studies (death assemblages of shells) and interpretation of seep assemblage composition from cores, Powell (1995) reported that, overall, seep communities were persistent over periods of 500-1,000 years. Some sites retained optimal habitat over geological time scales. Powell reported evidence of mussel and clam communities persisting in the same sites for 500-4,000 years. Powell also found that both the composition of species and trophic tiering of hydrocarbon seep communities tend to be fairly constant across time, with temporal variations only in numerical abundance. He found few cases in which the community type changed (from mussel to clam communities, for example) or had disappeared completely. Faunal succession was not observed. Surprisingly, when recovery occurred after a past destructive event, the same chemosynthetic species reoccupied a site. There was little evidence of catastrophic burial events, but two instances were found in mussel communities in Green Canyon Block 234. The most notable observation reported by Powell (1995) was the uniqueness of each chemosynthetic community site.

Precipitation of authigenic carbonates and other geologic events will undoubtedly alter surface seepage patterns over periods of 1-2 years, although through direct observation, no changes in chemosynthetic fauna distribution or composition were observed at seven separate study sites (MacDonald et al., 1995). A slightly longer period (12 years) can be referenced in the case of Bush Hill, the first community described *in situ* in 1986. No mass die-offs or large-scale shifts in faunal composition have been observed (with the exception of collections for scientific purposes) over the 12-year history of research at this site.

Biology

MacDonald et al. (1990) has described four general community types. These are communities dominated by Vestimentiferan tube worms (*Lamellibrachia c.f. barhami* and *Escarpia* n.sp.), mytilid mussels (Seep Mytilid Ia, Ib, and III, and others), vesicomyid clams (*Vesicomya cordata* and *Calyptogena ponderosa*), and infaunal lucinid or thyasirid clams (*Lucinoma* sp. or *Thyasira* sp.). These faunal groups tend to display distinctive characteristics in terms of how they aggregate, the size of aggregations, the geological and chemical properties of the habitats in which they occur and, to some degree, the heterotrophic fauna that occur with them. Many of the species found at these cold seep communities in the Gulf are new to science and remain undescribed. As an example, at least six different species of seep mussels have been collected but none is yet described.

Individual lamellibranchid tube worms, the longer of two taxa found at seeps (the other is an *Escarpia*-like species but probably a new genus) can reach lengths of 3 m and live hundreds of years (Fisher et al., 1997). Growth rates determined from recovered marked tube worms have been variable, ranging from no growth of 13 individuals measured one year to a maximum growth of 20 mm per year in a *Lamellibrachia* individual. Average growth rate was 2.5 mm/yr for the *Escarpia*-like species and 7.1 mm/yr for lamellibrachids. These are slower growth rates than those of their hydrothermal vent relatives, but *Lamellibrachia* individuals can reach lengths 2-3 times that of the largest known hydrothermal vent species. Individuals of *Lamellibrachia* sp. in excess of 3 m have been collected on several occasions, representing probable ages in excess of 400 years (Fisher, 1995). Vestimentiferan tube worm spawning is not seasonal and recruitment is episodic.

Growth rates for methanotrophic mussels at cold seep sites have recently been reported (Fisher, 1995). General growth rates were found to be relatively high. Adult mussel growth rates were similar to mussels from a littoral environment at similar temperatures. Fisher also found that juvenile mussels at hydrocarbon seeps initially grow rapidly, but the growth rate drops markedly in adults; they grow to reproductive size very quickly. Both individuals and communities appear to be very long lived. These methane-dependent mussels have strict chemical requirements that tie them to areas of the most active seepage in the Gulf of Mexico. As a result of their rapid growth rates, mussel recolonization of a disturbed seep site could occur relatively rapidly. There is some early evidence that mussels also have some requirement of a hard substrate and could increase in numbers if suitable substrate is increased on the seafloor (Fisher, 1995).

Unlike mussel beds, chemosynthetic clam beds may persist as a visual surface phenomenon for an extended period without input of new living individuals because of low dissolution rates and low sedimentation rates. Most clam beds investigated by Powell (1995) were inactive. Living individuals were rarely encountered. Powell reported that over a 50-year timespan, local extinctions and recolonization should be gradual and exceedingly rare.

Extensive mats of free-living bacteria are also evident at hydrocarbon seep sites. These bacteria may compete with the major fauna for sulfide and methane energy sources and may also contribute substantially to overall production (MacDonald, 1998). The white, nonpigmented mats were found to be an autotrophic sulfur bacteria *Beggiatoa* species, and the orange mats possessed an unidentified nonchemosynthetic metabolism (MacDonald, 1998).

Preliminary information has been presented by Carney (1993) concerning the nonchemosynthetic animals (heterotrophs) found in the vicinity of hydrocarbon seeps. Heterotrophic species at seep sites are a mixture of species unique to seeps (particularly molluscs and crustacean invertebrates) and those that are a normal component from the surrounding environment. Carney reports a potential imbalance that could occur as a result of chronic disruption. Because of sporadic recruitment patterns, predators could gain an advantage, resulting in exterminations in local populations of mussel beds.

Detection

Chemosynthetic communities cannot be reliably detected directly using geophysical techniques; however, hydrocarbon seeps that allow chemosynthetic communities to exist modify the geological characteristics in ways that can be remotely detected. These known sediment modifications include (1) precipitation of authigenic carbonate in the form of micronodules, nodules, or rock masses; (2) formation of gas hydrates; (3) modification of sediment composition through concentration of hard chemosynthetic organism remains (such as shell fragments and layers); (4) formation of interstitial gas bubbles or hydrocarbons; and (5) formation of depressions or pockmarks by gas expulsion. These features give rise to acoustic effects such as wipeout zones (no echoes), hard bottoms (strongly reflective echoes), bright spots (reflection enhanced layers), or reverberant layers (Behrens, 1988; Roberts and Neurauter, 1990). Potential locations for most types of communities can be determined by careful interpretation of these various geophysical modifications, but to date, the process remains imperfect and confirmation of living communities requires direct visual techniques.

As part of the recent MMS study, "Stability and Change in Gulf of Mexico Chemosynthetic Communities," Sager (1997) characterized the geophysical responses of seep areas that support chemosynthetic communities so that a protocol can be refined to use geophysical remote-sensing techniques to locate chemosynthetic communities reliably. One objective is to use geophysical mapping techniques to reduce the seafloor area that may require searching by much slower and expensive near-bottom techniques. An additional study involving groundtruthing of geophysical characteristics and observed chemosynthetic communities, which is currently underway (2000-2002), will also improve predicative capabilities.

3.2.4. Marine Mammals

Twenty-nine species of marine mammals are known to occur in the Gulf of Mexico (Davis et al., 2000). The Gulf's marine mammals (Table 3-36) are represented by members of the taxonomic order Cetacea, which is divided into the suborders Mysticeti (i.e., baleen whales) and Odontoceti (i.e., toothed whales, dolphins, and their allies), as well as the order Sirenia, which include the manatee and dugong. Within the GOM, there are 28 species of cetaceans (7 mysticete and 21 odontocete species) and 1 sirenian species, the manatee (Jefferson et al., 1992).

Prior to 1973, the California sea lion (*Zalophus californianus*) was sometimes reported in Gulf waters (Gunter, 1977). These animals were likely escapees or released from sea life parks located in the region. It appears the animals did not form stable feral colonies, since extensive aerial and shipboard surveys conducted in the Gulf during the last 10 years have not resulted in any sightings of this species. A California sea lion was photographed in November 1991 at the Marine Research Station at Holguin, Cuba (Laist, personal communication, 2001). The animal was captured two years earlier in a bay on the Caribbean coast of Cuba.

3.2.4.1. Nonendangered and Nonthreatened Species

Two of the seven species of mysticetes known to occur in the Gulf are not presently listed as endangered or threatened. With the exception of the sperm whale, none of the odontocetes known to occur in the Gulf are currently listed as endangered or threatened.

Cetaceans — Mysticetes

Bryde's Whale (Balaenoptera edeni)

The Bryde's whale (*Balaenoptera edeni*) is the second smallest of the balaenopterid whales; it is generally confined to tropical and subtropical waters (i.e., between lat. 40°N. and lat. 40°S.) (Cummings, 1985). Unlike some baleen whales, it does not have a well-defined breeding season in most areas; thus, calving may occur throughout the year. The Bryde's whale feeds on small pelagic fishes and invertebrates (Leatherwood and Reeves, 1983; Cummings, 1985; Jefferson et al., 1993).

There are more records of Bryde's whale than of any other baleen whale species in the northern Gulf of Mexico. It is likely that the Gulf represents at least a portion of the range of a dispersed, resident population of Bryde's whale (Jefferson and Schiro, 1997). Bryde's whale in the northern Gulf, with few exceptions, have been sighted along a narrow corridor near the 100-m (328-ft) isobath (Davis and Fargion, 1996; Davis et al., 2000). Most sightings have been made in the DeSoto Canyon region and off western Florida, though there have been some in the west-central portion of the northeastern Gulf. Group sizes range from one to seven animals. Abundance estimates are 29 and 25 individuals from ship and aerial surveys of the EPA slope, respectively, and 22 individuals for the oceanic northern Gulf (Davis et al., 2000). These data suggest that the northern Gulf may represent at least a portion of the range of a dispersed, resident population of Bryde's whale (Jefferson and Schiro, 1997; Davis et al., 1998a and 2000).

Minke Whale (Balaenoptera acutorostrata)

The minke whale *(Balaenoptera acutorostrata*) is a small rorqual that is widely distributed in tropical, temperate, and polar waters. Minke whales may be found offshore but appear to prefer coastal waters. Their diet consists of invertebrates and fishes (Leatherwood and Reeves, 1983; Stewart and Leatherwood, 1985; Jefferson et al., 1993; Würsig et al., 2000).

At least three geographically isolated populations are recognized: North Pacific, North Atlantic, and Southern Hemisphere. The North Atlantic population migrates southward during winter months to the Florida Keys and the Caribbean Sea. There are 10 reliable records of minke whales in the Gulf of Mexico and all are the result of strandings (Jefferson and Schiro, 1997). Most records from the Gulf have come from the Florida Keys, although strandings in western and northern Florida, Louisiana, and Texas have been reported (Jefferson and Schiro, 1997). Sightings data suggest that minke whales either migrate into Gulf waters in small numbers during the winter or, more likely, that sighted individuals represent strays from low-latitude breeding grounds in the western North Atlantic (Jefferson and Schiro, 1997; Davis et al., 1998a and 2000).

Cetaceans — Odontocetes

Pygmy and Dwarf Sperm Whales (Family Kogiidae)

The pygmy sperm whale *(Kogia breviceps*) and its congener, the dwarf sperm whale *(K. sima*), are medium-sized toothed whales that feed on cephalopods and, less often, on deep-sea fishes and shrimps (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Caldwell and Caldwell, 1989). Hence, they inhabit oceanic waters in tropical to warm temperate zones (Jefferson and Schiro, 1997). They appear to be most common in waters over the continental slope and along the shelf edge. Little is known of their natural history, although a recent study of *Kogia* in South Africa has determined that these two species attain sexual maturity much earlier and live fewer years than other similarly sized toothed whales (Plön and Bernard, 1999).

Kogia have been sighted throughout the Gulf in waters that vary broadly in depth and seafloor topographies (Mullin et al., 1991; Davis et al., 1998a and 2000). The GulfCet I study reported these animals in waters with a mean bottom depth of 929 m (Davis et al., 1998a). *Kogia* have been sighted over the continental shelf, but there is insufficient evidence that they regularly inhabit continental shelf waters. *Kogia* sightings were made during GulfCet aerial surveys (1992-1997) in all waters between the 100-m and 2,000-m isobaths. Data also indicate that *Kogia* may associate with frontal regions along the shelf break and upper continental slope, areas with high epipelagic zooplankton biomass (Baumgartner, 1995). During the GulfCet II study, *Kogia* were widely distributed in the oceanic northern Gulf, including slope waters of the eastern Gulf. *Kogia* frequently strand on the coastline of the northern Gulf, more often in the eastern Gulf (Jefferson and Schiro, 1997). Between 1984 and 1990, 22 pygmy sperm whales and 10 dwarf sperm whales stranded in the Gulf of Mexico.

Because dwarf and pygmy sperm whales are difficult to distinguish from one another, sightings of either species are often categorized as *Kogia* sp. The difficulty in sighting pygmy and dwarf sperm whales is exacerbated by their avoidance reaction towards ships and their change in behavior towards approaching survey aircraft (Würsig et al., 1998). Therefore, combined estimated abundance are 66 and 188 individuals from ship and aerial surveys of the slope of the eastern Gulf, respectively, and 733 individuals for the oceanic northern Gulf (Davis et al., 2000).

Beaked Whales (Family Ziphiidae)

Two genera and four species of beaked whales occur in the GOM. These encompass (1) three species of the genus *Mesoplodon* (Sowerby's beaked whale [*M. biden*s], Blainville's beaked whale [*M. densirostri*s], and Gervais' beaked whale [*M. europaeu*s]) and (2) one species of the genus *Ziphiu*s; Cuvier's beaked whale *(Ziphius cavirostri*s). Morphological similarities among species in the genus *Mesoplodon* make identification of free-ranging animals difficult. Generally, beaked whales appear to prefer oceanic waters, although little is known of their respective life histories. Stomach content analyses suggest that these whales feed primarily on deepwater cephalopods, although they also consume some mesopelagic fishes and deepwater benthic invertebrates (Leatherwood and Reeves, 1983; Heyning, 1989; Mead, 1989; Jefferson et al., 1993).

In the northern Gulf, beaked whales are broadly distributed in waters greater than 1,000 m over lower slope and abyssal landscapes (Davis et al., 1998a and 2000). Group sizes of beaked whales observed in the northern Gulf comprise 1-4 individuals per group (Mullin et al., 1991; Davis and Fargion, 1996; Davis et al., 2000). Abundance estimates of mesoplodonts (Gervais', Blainville's, and Sowerby's beaked whales) are 0 and 59 individuals from ship and aerial surveys over the slope of the eastern Gulf, respectively, and 150 individuals for the oceanic northern Gulf (Davis et al., 2000). However, these estimates may include an unknown number of Cuvier's beaked whales. The species-specific abundance of Gervais', Blainville's, or Sowerby's beaked whale was not estimated due to the difficulty of identifying these species at sea. Abundance estimates for Cuvier's beaked whales are 0 and 22 individuals from ship and aerial surveys of the slope of the eastern Gulf, respectively, and 159 individuals for the oceanic northern Gulf (Davis et al., 2000).

Sightings data indicate that Cuvier's beaked whale is probably the most common beaked whale in the Gulf (Jefferson and Schiro, 1997; Davis et al., 1998a and 2000). Würsig et al. (2000) indicates that there are 18 documented strandings of Cuvier's beaked whales in the Gulf. The Gervais' beaked whale is probably the most common mesoplodont in the northern Gulf, as suggested by stranding records (Jefferson and Schiro, 1997). Würsig et al. (2000) states that there are four verified stranding records of Blainville's beaked whales from the Gulf. Additionally, one beaked whale sighted during GulfCet II was determined to be a Blainville's beaked whale (Davis et al., 2000). Sowerby's beaked whale is represented in the Gulf by only a single record, a stranding in Florida; this record is considered extralimital since this species normally occurs much farther north in the North Atlantic (Jefferson and Schiro, 1997).

Dolphins (Family Delphinidae)

All remaining species of nonendangered and nonthreatened cetaceans found in the Gulf are members of the taxonomically diverse family Delphinidae. Most delphinids, with exceptions of the bottlenose dolphin and the Atlantic spotted dolphin, inhabit oceanic waters of the Gulf.

Atlantic Spotted Dolphin (Stenella frontalis)

The Atlantic spotted dolphin (*Stenella frontalis*) is endemic to the Atlantic Ocean within tropical to temperate zones. Surveys in the northern Gulf documented the Atlantic spotted dolphin primarily over the continental shelf and shelf edge in waters that were less than 250 m in depth, although some individuals were sighted along the slope in waters of up to approximately 1,000 m (3,280 ft) (Würsig et al., 2000). Mills and Rademacher (1996) found the principal depth range of the Atlantic spotted dolphin to be much shallower at 15-100 m water depth. Griffin and Griffin (1999) found Atlantic spotted dolphins on the eastern Gulf continental shelf in waters greater than 20 m (30 km from the coast). A satellite-tagged Atlantic spotted dolphin was found to prefer shallow water habitat and make short dives (Davis et al., 1996). Atlantic spotted dolphins are sighted more frequently in areas east of the Mississippi River (Mills and Rademacher, 1996). Perrin et al. (1994a) relate accounts of brief aggregations of smaller groups of Atlantic spotted dolphins (forming a larger group) off the coast of northern Florida. While not well substantiated, these dolphins may demonstrate seasonal nearshore-offshore movements that appear to be influenced by prey availability and water temperature (Würsig et al., 2000). Abundance estimates are 1,827 and 1,096 individuals from ship and aerial surveys, respectively, of the shelf of the eastern Gulf (Davis et al., 2000). Abundance estimates are 1,055 and 1,800 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf, and 528 individuals for the oceanic northern Gulf (Davis et al., 2000). They are known to feed on a wide variety of fishes, cephalopods, and benthic invertebrates (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Perrin et al., 1994a). This species has been seen feeding in a coordinated manner on clupeid fishes in the northern Gulf, and in one instance, offshore the Florida Panhandle (Fertl and Würsig, 1995).

Bottlenose Dolphin (Tursiops truncatus)

The bottlenose dolphin *(Tursiops truncatu*s) is a common inhabitant of the continental shelf and upper slope waters of the northern Gulf. It is the most widespread and common cetacean observed in the northern Gulf. Sightings of this species in the northern Gulf are rare beyond approximately the 1,200-m (3,937-ft) isobath (Mullin et al., 1994a; Jefferson and Schiro, 1997; Davis et al., 2000). There appears to be two ecotypes of bottlenose dolphins, a coastal form and an offshore form (Hersh and Duffield, 1990; Mead and Potter, 1990). The coastal or inshore stock(s) is genetically isolated from the offshore stock (Curry and Smith, 1997). Genetic data also support the concept of relatively discrete bay, sound, and estuary stocks (Waring et al., 1999). In the northern Gulf of Mexico, bottlenose dolphins appear to have an almost bimodal distribution: a shallow water (16-67 m) and a shelf break (about 250 m) region. These regions may represent the individual depth preferences of the coastal and offshore forms (Baumgartner, 1995). Little is known of the behavior or ranging patterns of offshore bottlenose dolphins. Recently, two bottlenose dolphins that had stranded in Florida were fitted with satellite transmitters; these animals exhibited much more mobility than has been previously documented for this species (Wells et al., 1999a). One dolphin was stranded in northwestern Florida and was released in the Gulf of Mexico off central-west Florida. This dolphin moved around Florida northward to off Cape Hatteras, North Carolina, linking two regions previously considered inhabited by different continental shelf stocks. The second dolphin stranded off the Atlantic coast of Florida and moved into waters more than 5,000 m deep, much deeper than the previously held concept of bottlenose dolphin movements. This dolphin also traveled well outside of U.S. waters, which suggests the need for a different management approach than for dolphin remaining within U.S. waters. These records demonstrate the range previously reported for the offshore stock of bottlenose dolphins inhabiting the waters off the southeastern United States is larger than previously thought, and underscore the difficulties of defining pelagic stocks. Abundance estimates are 1,056 and 1,824 individuals from ship and aerial surveys, respectively, of the shelf in the eastern Gulf (Davis et al., 2000). Abundance estimates are 1,025 and 3,959 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf, and 3,040 individuals for the oceanic northern Gulf. Abundance estimates for various Gulf bays, sounds, and estuaries are found listed in Waring et al. (1999). Best estimates by Würsig et al. (2000) for bottlenose dolphins in the northern Gulf of Mexico is 78,000. Bottlenose dolphins are opportunistic feeders, taking a wide variety of fishes, cephalopods, and shrimp (Davis and Fargion, 1996; Jefferson and Schiro, 1997; Wells and Scott, 1999). Mating and calving occurs primarily from February through May.

Clymene Dolphin (Stenella clymene)

The Clymene dolphin *(Stenella clymen*e) is endemic to the Atlantic Ocean and found only in tropical and subtropical waters (Perrin and Mead, 1994). Data suggest that Clymene dolphins are widespread within deeper Gulf waters (i.e., shelf edge and slope) (Davis et al., 2000; Würsig et al., 2000). The Clymene dolphin represents a significant component of the northern Gulf of Mexico cetacean assemblage (Mullin et al., 1994b). However, the few records of the Clymene dolphin in the northern Gulf in the past were probably a result of this species' recently clarified taxonomic status and the tendency for observers to confuse it with other species (Jefferson and Schiro, 1997). Sightings made during GulfCet surveys indicate the Clymene dolphin to be widely distributed in the western oceanic Gulf during spring and in the northeastern Gulf during summer and winter. Also, most sightings tended to occur in the central portion of the study area, west of the Mississippi Delta and east of Galveston Bay. Clymene dolphins have been sighted in water depths of 612-1,979 m (Davis et al., 1998a). The Clymene dolphin was shown to have a relationship with the depth of the 15°C isotherm, demonstrating a preference for waters where this isotherm shoals (most probably relating to productivity) (Baumgartner, 1995). Abundance estimates are 0 and 2,292 from ship and aerial surveys, respectively, of the continental slope of the eastern Gulf and 10,093 for the oceanic northern Gulf (Davis et al., 2000). This species appears to feed on fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Mullin et al., 1994c), although knowledge of feeding habits is limited to stomach contents (small fish and squid) of two individuals (Perrin et al., 1981). The Clymene dolphin was observed employing a coordinated feeding strategy on schooling fish in the northern Gulf (Fertl et al., 1997).

False Killer Whale (Pseudorca crassidens)

The false killer whale (*Pseudorca crassidens*) occurs in oceanic waters of tropical and warm temperate zones (Odell and McClune, 1999). Most sightings have been made in waters exceeding 200 m, although there have been sightings from over the continental shelf (Davis and Fargion, 1996). Although sample sizes are small, most false killer whale sightings have been east of the Mississippi River (Mullin and Hansen, 1999). Abundance estimates are 311 and 150 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf and 817 individuals for the oceanic northern Gulf (Davis et al., 2000). False killer whales primarily eat fish and cephalopods, but they have been known to attack other toothed whales (Leatherwood and Reeves, 1983; Jefferson et al., 1993).

Fraser's Dolphin (Lagenodelphis hosei)

The Fraser's dolphin (*Lagenodelphis hosei*) has a pantropical distribution (Perrin et al., 1994b) in oceanic waters and in areas where deep water approaches the coast. Fraser's dolphins feed on fishes, cephalopods, and crustaceans (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Jefferson and Schiro, 1997). This species was previously known to occur in the northern Gulf of Mexico based on a mass stranding in the Florida Keys in 1981 (Hersh and Odell, 1986). From 1992 to 1996, there were at least three strandings in Florida and Texas (Würsig et al., 2000). GulfCet ship-based surveys led to sightings of two large herds (greater than 100 individuals) and first-time recordings of sounds produced by these animals (Leatherwood et al., 1993). Fraser's dolphins have been sighted in the western and eastern Gulf at depths of around 1,000 m (3,281 ft) (Leatherwood et al., 1993; Davis and Fargion, 1996; Jefferson and Schiro, 1997; Davis et al., 2000).

Killer Whale (Orcinus orca)

The killer whale (*Orcinus orca*) is a cosmopolitan species that occurs in all oceans and seas (Dahlheim and Heyning, 1999). Generally, they appear to inhabit coastal, cold temperate and subpolar zones. Most killer whale sightings in the northern Gulf have been in waters greater than 200 m deep, although there are sightings made from over the continental shelf (Davis and Fargion, 1996). Killer whales are found almost exclusively in a broad area of the north-central Gulf (Jefferson and Schiro, 1997; O'Sullivan and Mullin, 1997; Mullin and Hansen, 1999). There was a sighting in May 1998 of killer whales in DeSoto Canyon (Ortega, personal communication, 1998). Abundance estimates were 0 for both ship and aerial surveys for the slope of the eastern Gulf and 68 individuals for the oceanic northern Gulf (Davis et al., 2000). Thirty-two individual killer whales have been photo-identified in the Gulf; some individuals have a wide temporal and spatial distribution (some with a linear distance between sightings of more than 1,100 km) (O'Sullivan and Mullin, 1997). It is not known whether killer whales in the northern Gulf remain within the Gulf or range more widely (Würsig et al., 2000). Worldwide, killer whales feed on marine mammals, marine birds, sea turtles, cartilaginous and bony fishes, and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). An attack by killer whales on a group of pantropical spotted dolphins was observed during one of the GulfCet surveys (O'Sullivan and Mullin, 1997).

Melon-headed Whale (Peponocephala electra)

The melon-headed whale *(Peponocephala electra*) is a deepwater, pantropical species (Perryman et al., 1994) that feeds on cephalopods and fishes (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Mullin et al., 1994a; Jefferson and Schiro, 1997). Sightings of this species in the northern Gulf have been primarily in continental slope waters west of the Mississippi River (Jefferson and Schiro, 1997; Davis et al., 1998a and 2000; Mullin and Hansen, 1999). The first two records of this species occurrence in the Gulf are recent strandings, one in Texas in 1990, and the other in Louisiana in 1991 (Barron and Jefferson, 1993). GulfCet surveys resulted in many sightings of melon-headed whales, suggesting that this species is a regular inhabitant of the Gulf of Mexico (e.g., Mullin et al., 1994a). The abundance for the oceanic northern Gulf is estimated to be 1,734 individuals (Davis et al., 2000).

Pantropical Spotted Dolphin (Stenella attenuata)

The pantropical spotted dolphin *(Stenella attenuat*a) is distributed in tropical and subtropical marine waters of the world (Perrin and Hohn, 1994). It is the most common cetacean in the oceanic northern Gulf (Mullin et al., 1994c; Davis and Fargion, 1996; Davis et al., 2000). Pantropical spotted dolphins are typically found in waters deeper than 1,200 m deep (Mullin et al., 1994c; Davis et al., 1998a and 2000) but have been sighted over the continental shelf (Mullin et al., 1994c). Baumgartner (1995) did not find that pantropical spotted dolphins had a preference for any one habitat type; he suggested that this species might use prey species in each distinct habitat (e.g., within the Loop Current, inside a cold-core eddy, or along the continental slope). This ability may contribute to this species' success and abundance in the northern Gulf. Abundance estimates are 7,432 and 13,649 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf and 46,625 individuals for the oceanic northern Gulf (Davis et al., 2000). It feeds on epipelagic fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993).

Pygmy Killer Whale (Feresa attenuata)

The pygmy killer whale (*Feresa attenuata*) occurs in tropical and subtropical waters throughout the world (Ross and Leatherwood, 1994), although little is known of its biology or ecology. Its diet includes cephalopods and fishes, though reports of attacks on other dolphins have been reported (Leatherwood and Reeves, 1983; Jefferson et al., 1993). The pygmy killer whale does not appear to be common in the Gulf; most records are of strandings (Jefferson and Schiro, 1997). Fourteen strandings have been documented from southern Florida to south Texas. Four ship sightings occurred during the GulfCet surveys, once off the south Texas coast in November and three in the spring in the west-central portion of the GulfCet study area. Sightings of this species have been at depths of 500-1,000 m (1,641-3,281 ft) (Jefferson and Schiro, 1997; Davis et al., 1998a and 2000). Abundance estimates are 0 and 218 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf and 175 individuals for the oceanic northern Gulf (Davis et al., 2000).

Risso's Dolphin (Grampus griseus)

The Risso's dolphin (*Grampus griseus*) is a pantropical species that inhabits deep oceanic and continental slope waters of tropical and warm temperate zones (Kruse et al., 1999). Risso's dolphins in the northern Gulf have been frequently sighted along the shelf edge, along the upper slope, and most commonly, over or near the 200-m water isobath just south of the Mississippi River in recent years (Würsig et al., 2000). A strong correlation between Risso's dolphin distribution and the steeper portions of the upper continental slope is most likely the result of cephalopod distribution along the continental slope (Baumgartner, 1997; Davis et al., 2000). Risso's dolphins have been sighted over the continental shelf at water depths less than 200 m (Mullin et al., 1994c; Davis et al., 1998a). Strandings and GulfCet sightings have occurred in all seasons in the Gulf of Mexico, and it is likely that Risso's dolphins occur year round in the Gulf. Abundance estimates are 679 and 1,317 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf and 3,040 individuals for the oceanic northern Gulf (Davis et al., 2000). Risso's dolphins feed primarily on squid and secondarily on fishes and crustaceans (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Baumgartner, 1997; Würsig et al., 2000).

Rough-toothed Dolphin (Steno bredanensis)

The rough-toothed dolphin (*Steno bredanensis*) occurs in tropical to warm temperate marine waters globally (Miyazaki and Perrin, 1994). Sightings in the northern Gulf occur primarily over the deeper waters (950-1,100 m) off the continental shelf (Mullin et al., 1994c; Davis et al., 1998a). Most sightings of the rough-toothed dolphin have been west of the Mississippi River (Mullin and Hansen, 1999); however, a mass stranding of 62 rough-toothed dolphins occurred near Cape San Blas, Florida, on December 14, 1997. Four of the stranded dolphins were rehabilitated and released; three carried satellite-linked transmitters (Wells et al., 1999b). Water depth at tracking locations of these individuals averaged 195 m. Data from the tracked individuals, in addition to sightings at Santa Rosa Beach on December 28-29, 1998 (Rhinehart et al., 1999), suggest a regular occurrence of this species in the northern Gulf. Abundance estimates are 16 and 165 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf and 453 individuals for the oceanic northern Gulf (Davis et al., 2000). This species feeds on cephalopods and fishes (Leatherwood and Reeves, 1983; Jefferson et al., 1993).

Short-finned Pilot Whale (Globicephala macrorhynchus)

The short-finned pilot whale (*Globicephala macrorhynchus*) is found in warm temperate to tropical marine waters of the world, generally in deep offshore areas (Bernard and Reilly, 1999). Based on historical records (mostly strandings), the short-finned pilot whale would be considered one of the most common offshore cetaceans in the northern Gulf (Jefferson and Schiro, 1997). However, the short-finned pilot whale has only occasionally been sighted during recent surveys in the northern Gulf. One potential explanation for the preponderance of pilot whales in the older records were misidentifications of other "blackfish" (e.g., false killer, killer, pygmy killer, and melon-headed whales)(Jefferson and Schiro, 1997). In the northern Gulf, it is most commonly sighted along the continental slope at depths of 250-2,000 m (Jefferson and Schiro, 1997; Davis et al., 1998a and 2000). Short-finned pilot whales have been sighted almost exclusively west of the Mississippi River (Mullin and Hansen, 1999). There was one sighting of short-finned pilot whales in the slope in the eastern Gulf during GulfCet II, in the extreme western part of the study area (Davis et al., 2000). Stranding records have declined dramatically over the past decade, which contributes to the evidence (though not conclusively) that this population may be declining in the Gulf. Abundance estimates are 0 and 160 individuals from ship and aerial surveys, respectively, of the slope of the eastern Gulf and 1,471 individuals for the oceanic northern Gulf (Davis et al., 2000). Squid are the predominant prey, with fishes being consumed occasionally.

Spinner Dolphin (Stenella longirostris)

The spinner dolphin *(Stenella longirostris*) occurs worldwide in tropical oceanic waters (Perrin and Gilpatrick, 1994; Jefferson and Schiro, 1997). In the northern Gulf, most sightings of spinner dolphins have been east of the Mississippi River at depths of 500-1,800 m (1,641-5,906 ft) (Jefferson and Schiro, 1997; Mullin and Hansen, 1999; Davis et al., 2000). The distribution of spinner dolphins was shown to be related with the depth of the 15°C isotherm, thereby demonstrating a preference for waters where this isotherm shoals (most probably relating to productivity) (Baumgartner, 1995). Spinner dolphins have mass stranded on two occasions in the Gulf, each time on the Florida coast. Abundance estimates were 5,319 and 8,670 individuals from ship and aerial surveys, respectively, over the slope in the eastern Gulf and 11,251 individuals in the oceanic northern Gulf (Davis et al., 2000). Spinner dolphins appear to feed on fishes and cephalopods (Würsig et al., 2000).

Striped Dolphin (Stenella coeruleoalba)

The striped dolphin *(Stenella coeruleoalba*) occurs in tropical and subtropical oceanic waters (Perrin et al., 1994c). Sightings in the northern Gulf occur primarily over the deeper waters beyond the continental shelf (Jefferson and Schiro, 1997; Davis et al., 2000; Würsig et al., 2000). The striped dolphin appears to prefer waters where the 15°C isotherm shoals (most probably relating to productivity) (Baumgartner, 1995). Abundance estimates are 416 and 2,198 individuals from ship and aerial surveys, respectively, over the slope of the eastern Gulf and 4,381 individuals for the oceanic northern Gulf (Davis et al., 2000). Striped dolphins feed primarily on small mid-water squid and fishes (especially lanternfish).

3.2.4.2. Endangered and Threatened Species

Five mysticete (or baleen) whales (the northern right, blue, fin, sei, and humpback), one odontocete (or toothed) whale (the sperm whale), and one sirenian (the West Indian manatee) occur in the Gulf of Mexico and are listed as endangered. The sperm whale is common in oceanic waters of the northern Gulf and is a resident species, while the baleen whales are considered rare or extralimital (Würsig et al., 2000). The West Indian manatee *(Trichechus manatus*) inhabits only coastal marine, brackish, and freshwater areas.

Cetaceans — Mysticetes

Blue Whale (Balaenoptera musculus)

The blue whale (*Balaenoptera musculus*) is the largest animal known. It feeds almost exclusively on concentrations of zooplankton (Yochem and Leatherwood, 1985; Jefferson et al., 1993). The blue whale occurs in all major oceans of the world; some blue whales are resident, some are migratory (Jefferson et al., 1993; USDOC, NMFS, 1998). Those that migrate move to feeding grounds in polar waters during spring and summer, after wintering in subtropical and tropical waters (Yochem and Leatherwood, 1985). Records of the blue whale in the northern Gulf consist of two strandings on the Texas coast (Lowery, 1974). There appears to be little justification for considering the blue whale to be a regular inhabitant of the Gulf of Mexico (Jefferson and Schiro, 1997).

Fin Whale (Balaenoptera physalus)

The fin whale (*Balaenoptera physalus*) is an oceanic species that occurs worldwide in marine waters and is most commonly sighted where deep water approaches the coast (Jefferson et al., 1993). Fin whales feed on concentrations of zooplankton, fishes, and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). The fin whale makes seasonal migrations between temperate waters, where it mates and calves, and polar feeding grounds that are occupied during summer months. Their presence in the northern Gulf is considered rare (Würsig et al., 2000). Sightings in the northern Gulf have typically been made in oceanic waters, chiefly in the north-central region of the Gulf (Mullin et al., 1991). There are seven reliable reports of fin whales in the northern Gulf, indicating that fin whales are not abundant in the Gulf of Mexico (Jefferson and Schiro, 1997). Sparse sighting data on this species suggest that individuals in the northern Gulf may be extralimital strays from their western Atlantic population (Jefferson and Schiro, 1997; Würsig et al., 2000).

Humpback Whale (Megaptera novaeangliae)

The humpback whale (*Megaptera novaeangliae*) occurs in all oceans, feeding in higher latitudes during spring, summer, and autumn, and migrating to a winter range over shallow tropical banks, where they calve and presumably conceive (Jefferson et al., 1993). Humpback whales feed on concentrations of zooplankton and fishes using a variety of techniques that concentrate prey for easier feeding (Winn and Reichley, 1985; Jefferson et al., 1993). There have been occasional reports of humpback whales in the northern Gulf off Florida: a confirmed sighting of a humpback whale in 1980 in the coastal waters off Pensacola (Weller et al., 1996); two questionable records of humpback whale sightings from 1952 and 1957 off the coast of Alabama (Weller et al., 1996); a stranding east of Destin, Florida, in mid-April 1998 (Mullin, personal communication, 1998); and a confirmed sighting of six humpback whales in May 1998 in DeSoto Canyon (Ortega, personal communication, 1998). Most recently, a lone humpback whale was photographed at Main Pass 281 in December 2001. Humpback whales sighted in the Gulf of Mexico may be extralimital strays during their breeding season or during their migrations (Würsig et al., 2000). The time of the year (winter and spring) and the small size of the animals involved in many sightings suggest the likelihood that these records are of inexperienced yearlings on their first return migration northward (Weller et al., 1996).

Northern Right Whale (Eubalaena glacialis)

The northern right whale (*Eubalaena glacialis*) inhabits primarily temperate and subpolar waters. Northern right whales range from wintering and calving grounds in coastal waters of the southeastern United States to summer feeding, nursery, and mating grounds in New England waters and northward to the Bay of Fundy and the Scotian Shelf. Five major congregation areas have been identified for the western North Atlantic right whale (southeastern United States coastal waters, Great South Channel, Cape Cod Bay, Bay of Fundy, and Scotian Shelf). The distribution of approximately 85 percent of the winter population and 33 percent of the summer population is unknown. During the winter, a portion of the population moves from the summer foraging grounds to the calving/breeding grounds off Florida, Georgia, and South Carolina. Right whales forage primarily on subsurface concentrations of zooplankton such as calanoid copepods by skim feeding with their mouths agape (Watkins and Schevill, 1976; Leatherwood and Reeves, 1983; Jefferson et al., 1993).

The northern right whale is one of the world's most endangered whales. The coastal nature and slow swimming speed of the northern right whale makes it especially vulnerable to human activities (USDOC, NMFS, 1991a). Based on a census of individual whales identified using photo-identification techniques, the western North Atlantic population size was estimated to be 295 individuals in 1992 (Waring et al., 1999). Confirmed historical records of northern right whales in the Gulf of Mexico consist of a single stranding in Texas (Schmidly et al., 1972) and a sighting off Sarasota County, Florida (Moore and Clark, 1963; Schmidly, 1981). The northern right whale is not considered a resident (year-round or seasonal) of the Gulf of Mexico; existing records probably represent extralimital strays from the wintering grounds of this species off the southeastern United States from Georgia to northeastern Florida (Jefferson and Schiro, 1997).

Sei Whale (Balaenoptera borealis)

The sei whale (*Balaenoptera borealis*) is an oceanic species that is not often seen close to shore (Jefferson et al., 1993). They occur in marine waters from the tropics to polar regions, but are more common in mid-latitude temperate zones (Jefferson et al., 1993). Sei whales feed on concentrations of zooplankton, small fishes, and cephalopods (Gambell, 1985; Jefferson et al., 1993). The sei whale is represented in the northern Gulf by only four reliable records (Jefferson and Schiro, 1997). One stranding was reported for the Florida Panhandle and three strandings were in eastern Louisiana (Jefferson and Schiro, 1997). This species' occurrence in the northern Gulf is considered most likely to be accidental.

Cetaceans — Odontocetes

Sperm Whale (Physeter macrocephalus)

The sperm whale (*Physeter macrocephalus*) inhabits marine waters from the tropics to the pack-ice edges of both hemispheres, although generally only large males venture to the extreme northern and southern portions of their range (Jefferson et al., 1993). In general, sperm whales seem to prefer certain areas within each major ocean basin, which historically have been termed "grounds" (Rice, 1989). As deep divers, sperm whales generally inhabit oceanic waters, but they do come close to shore where submarine canyons or other geophysical features bring deep water near the coast (Jefferson et al., 1993). Sperm whales prey on cephalopods, demersal fishes, and benthic invertebrates (Rice, 1989; Jefferson et al., 1993).

The sperm whale is the only great whale that is considered to be common in the northern Gulf (Fritts et al., 1983; Mullin et al., 1991; Davis and Fargion, 1996; Jefferson and Schiro, 1997). Sighting data suggest a northern Gulfwide distribution over slope waters. Congregations of sperm whales are commonly found in waters over the shelf edge in the vicinity of the Mississippi River delta in waters that are 500-2,000 m (1,641-6,562 ft) in depth (Mullin et al., 1994c; Davis and Fargion, 1996; Davis et al., 2000). Sperm whale sightings in the northern Gulf chiefly occur in waters with a mean seafloor depth of 1,105 m (Davis et al., 1998a). Mesoscale biological and physical patterns in the environment are important in regulating sperm whale habitat use (Griffin, 1999). Baumgartner (1995) noted that sperm whales avoided warm features characterized by a depressed 15°C isotherm and warm water at 100 m water depth; the highest sighting rates occurred in a cooler watermass characterized by intermediate to cool temperatures at 100 m and a moderately shallow 15°C isotherm. Sperm whales were found in waters with the steepest sea surface temperature gradient; sperm whales may forage along thermal fronts associated with eddies (Davis et al., 1998a). The GulfCet II study found that most sperm whales were concentrated along the slope in or near cyclones (Davis et al., 2000). Low-salinity, nutrient-rich water from the Mississippi River may contribute to enhanced primary and secondary productivity in the north-central Gulf, and thus provide resources that support the year-round presence of sperm whales south of the delta.

Consistent sightings in the region indicate that there is a resident population of sperm whales in the northern Gulf consisting of adult females, calves, and immature individuals (Mullin et al., 1994a; Davis and Fargion, 1996; Sparks et al., 1996; Jefferson and Schiro, 1997; Davis et al., 2000). Also, recent sightings were made in 2000 and 2001 of solitary mature male sperm whales in the DeSoto Canyon area (Lang, personal communication, 2001). Minimum population estimates of sperm whales in the entire Gulf totaled 411 individuals, as cited in the NMFS stock assessment report for 1996 (Waring et al., 1997). Subsequent abundance estimates of sperm whales in the "oceanic northern GOM" survey area totaled 387 individuals (Davis et al., 2000). Sperm whales in the Gulf are currently considered a separate stock from those in the Atlantic and Caribbean (Waring et al., 1997).

Distributions of Cetaceans within Offshore Waters of the Northern Gulf of Mexico

Factors influencing the spatial and temporal distribution and abundance of cetaceans may be environmental, biotic, or anthropogenic. Environmental factors encompass physiochemical, climatological, or geomorphological parameters. Biotic factors include the distribution and abundance of prey, inter- and intra-specific competition, reproduction, natural mortality, catastrophic events (e.g., die offs), and predation (Davis et al., 1998a). Anthropogenic factors include historical hunting pressure (on some populations or species), pollution, habitat loss and degradation, vessel traffic, recreational and commercial fishing, oil and gas development and production, seismic exploration and other manmade sources of noise in the sea.

Within the northern Gulf, many of the aforementioned environmental and biotic factors are strongly influenced by various hydrological circulation patterns. River discharge, wind stress, and the Loop Current generally drive these patterns. The major river system in this area is the Mississippi-Atchafalaya. Most of the river discharge into the northern Gulf is transported west and along the coast. Circulation on the continental shelf is largely wind-driven, with localized effects from fresh water (i.e., riverine) discharge. Beyond the shelf, the Loop Current in the eastern Gulf chiefly drives mesoscale circulation. Meanders of the Loop Current create warm-core anticyclonic eddies (anticyclones) once or twice annually that migrate westward. The anticyclones in turn spawn cold-core cyclonic eddies (cyclones). Together, anticyclones and cyclones govern the circulation of the continental slope in the central and western Gulf. The Loop Current and anticyclones are dynamic features that transport large quantities of high-salinity, nutrient-poor water across the near-surface waters of the northern Gulf. Cyclones, in contrast, contain high concentrations of nutrients and stimulate localized production. The combination of added nutrients into the northern Gulf from river outflow and mesoscale circulation features enhances productivity, and consequently the abundance of various species of fishes and cephalopods that cetaceans prey upon in the northern Gulf. The dynamics of these oceanographic features in turn affect the spatial and temporal distribution of prey species and ultimately influence cetacean diversity, abundance, and distribution (Mullin et al., 1994a; Davis et al., 2000).

Studies conducted during the GulfCet I program demonstrated a correlation of cetacean distribution patterns with certain geomorphic features such as seafloor depth or topographic relief. These studies suggested that seafloor depth was the most important variable in habitat partitioning among cetacean species in the northern Gulf (Baumgartner, 1995; Davis et al., 1998a). For example, GulfCet I surveys, along with other surveys (such as the subsequent GulfCet II program) and opportunistic sightings of cetaceans within the U.S. Gulf of Mexico, found that only the Atlantic spotted dolphin and the coastal form of the bottlenose dolphin were common inhabitants of the continental shelf. The remaining species of cetaceans known to regularly occur in the Gulf (with possible exception of the Bryde's whale) were sighted on the continental slope (Mullin et al., 1994a; Jefferson, 1995; Davis et al., 1998a and 2000). During the GulfCet II program, the most commonly sighted cetaceans on the continental slope were bottlenose dolphins (pelagic form), pantropical spotted dolphins, Risso's dolphins, and dwarf/pygmy sperm whales. The most abundant species on the slope were pantropical spotted and spinner dolphins.

Sperm whales sighted during GulfCet II surveys were found almost entirely in the north-central and northeastern Gulf, and near the 1,000-m (3,281-ft) isobath on the continental slope (Davis et al., 2000).

An objective of the GulfCet II program was to correlate a number of environmental parameters such as selected hydrographic features with cetacean sighting data in an effort to characterize cetacean habitats in the Gulf (Davis et al., 2000). From GulfCet II surveys, sightings of cetaceans along the slope were concentrated in cyclones where production (in this case, measured chlorophyll concentration) was elevated; increased primary production within these cyclonic features enhances secondary production, including preferred prey items. Sightings of these oceanic species, however, were much less frequent in water depths greater than 2,000 m (6,562 ft) and in anticyclones. Sperm whales tended to occur along the mid-to-lower slope, near the mouth of the Mississippi River and, in some areas, in cyclones and zones of confluence between cyclones and anticyclones. From these data, it was suggested that the greater densities of cetaceans sighted along the continental slope, rather than abyssal areas, of the northern Gulf, probably result from localized conditions of enhanced productivity, especially along the upper slope, and as a result of the collisions of mesoscale eddies with the continental margin (Davis et al., 2000).

In the north-central Gulf, the relatively narrow continental shelf south of the Mississippi River delta may be an additional factor affecting cetacean distribution, especially in the case of sperm whales (Davis et al., 2000). Outflow from the Mississippi River mouth transports large volumes of low salinity, nutrient-rich water southward across the continental shelf and over the slope. River outflow may also be entrained within the confluence of a cyclone-anticyclone eddy pair and transported beyond the continental slope. In either case, this input of nutrient-rich water leads to a localized deepwater environment with enhanced productivity and may explain the presence of a resident population of sperm whales within 50 km (31 mi) of the Mississippi River delta in the vicinity of the Mississippi Canyon.

Temporal variability in the distribution of cetaceans in the northern Gulf may also be dependent upon the extent of river discharge and the presence and dynamic nature of mesoscale hydrographic features such as cyclones. Consequently, the distribution of cetacean species will change in response to the movement of prey species associated with these hydrographic features. GulfCet I and II survey data determined that most cetacean species routinely or commonly sighted in the northern Gulf apparently occur in these waters throughout the year. However, seasonal abundance of certain species or species assemblages in slope waters may vary at least regionally (Baumgartner, 1995; Davis et al., 1998a and 2000).

Sirenians

West Indian Manatee (Trichechus manatus)

The West Indian manatee (*Trichechus manatus*) is the only sirenian known to occur in tropical and subtropical coastal waters of the southeastern U.S., Gulf of Mexico, Caribbean Sea, and the Atlantic coast of northern and northeastern South America (Reeves et al., 1992; Jefferson et al., 1993; O'Shea et al., 1995). There are two subspecies of the West Indian manatee: the Florida manatee *(T. m. latirostri*s), which ranges from the northern Gulf of Mexico to Virginia; and the Antillean manatee *(T. m. manatu*s), which ranges from northern Mexico to eastern Brazil, including the islands of the Caribbean Sea.

During warmer months, manatees are common along the west coast of Florida from the Everglades National Park northward to the Suwannee River in northwestern Florida and less common farther westward. In winter, the population moves southward to warmer waters. The winter range is restricted to smaller areas at the southern tip of Florida and to waters near localized warm-water sources, such as power plant outfalls and natural springs in west-central Florida. Crystal River, in Citrus County, is typically the northern limit of the manatee's winter range on the Gulf Coast. Manatees are found at a few small sites farther north. There are 13 winter-aggregation sites on the Florida west coast for manatees (USDOI, FWS, 2001). The major sites are (1) Crystal and Homasassa Rivers (natural springs) (Citrus County), (2) Tampa Electric Company Big Bend Power Plant (Hillsborough County), (3) Florida Power Corporation Bartow Power Plant (Pinellas County), (4) Florida Power & Light Company Fort Myers Power Plant (Lee County), and (5) Port of the Islands Marina (Collier County). The number of manatees, and probably the proportion of the manatee population, using localized warm-water refuges has increased appreciably (MMC, 1999). It is not known to what extent the increasing use of refuges in the Tampa Bay area is due to manatee population growth and/or redistribution of the manatees formerly wintering in southern Florida. Manatees are uncommon along the Florida Panhandle and are infrequently found (strandings and sightings) as far west as Louisiana and Texas (Powell and Rathbun, 1984; Rathbun et al., 1990; Schiro et al., 1998). Several sightings of two different animals were documented in the bays of the Texas Coastal Bend region (centered at Corpus Christi, Texas) during September and November 2001 (Beaver, personal communication, 2001).

Aerial surveys to estimate manatee populations are conducted during colder months when manatees aggregate at warm-water refuges in Florida. There are approximately 1,300 manatees on the Gulf Coast of Florida (Ackerman, personal communication, 1999). One manatee that died in Louisiana waters was determined to be from Tampa Bay, Florida; this determination was based on a photoidentification rematch (Schiro et al., 1998). The manatees occasionally appearing in south Texas waters might be strays from Mexico rather than Florida (Powell and Rathbun, 1984). Few manatees are known to occur along the northeastern coast of Mexico close to Texas (Lazcano-Barrero and Packard, 1989); manatees in south Texas and northern Mexico are probably stragglers from central Mexico. Manatees found in east Texas probably come from Florida.

The Antillean manatee subspecies in Mexico occurs along much of the southeastern Mexican coast from Nautla, Veracruz, to the Belize border and south to Brazil, but it is still reasonably abundant in three principal areas in southeast Mexico: vast wetland systems in the states of Tabasco and Chiapas, the bays and coastal springs along the northern and eastern coasts of the state of Quintana Roo, and the rivers near Alvarado in the state of Veracruz (Lefebvre et al., 1989). A study of manatees in Mexico near the Belize border in Quintana Roo estimates about 200 animals (Ackerman, personal communication, 1999). There are no population estimates for manatees in Mexico on the west side of the Yucatan Peninsula (Campeche) and near the Texas border (Ackerman, personal communication, 1999). There is also no evidence of manatees traveling between Cuba and Florida; it is assumed that the deep Florida Straits are a barrier to regular dispersal.

Two important aspects of manatee physiology influence their behavior and distribution: nutrition and metabolism. Manatees are herbivores that feed opportunistically on a wide variety of submerged, floating, and emergent vegetation (USDOI, FWS, 2001). Distribution of the manatee is limited to low-energy, inshore habitats supporting the growth of seagrasses (Hartman, 1979). Manatees have an unusually low metabolic rate and a high thermal conductance that leads to energetic stresses in winters, which are ameliorated by migrations to warmer areas and aggregations in warm water refugia (Hartman, 1979; O'Shea et al., 1995; Deutsch et al., 1999). Manatees primarily use open coastal (shallow nearshore) areas, estuaries, and are also found far up freshwater tributaries. Shallow grass beds with access to deep channels are preferred feeding areas in coastal and riverine habitats (USDOI, FWS, 2001). Manatees often use secluded canals, creeks, embayments, and lagoons, particularly near the mouths of coastal rivers and sloughs, for feeding, resting, mating, and calving (USDOI, FWS, 2001). Notwithstanding their association with coastal areas, a manatee was documented offshore at several OCS work barges where it was grazing on algae growing on the vessel's sides and bottom. Multiple sightings of the animal were made in October 2001 and occurred in waters exceeding 1,500 m in depth south of Mobile Bay, Alabama. Natural and artificial freshwater areas are sought by manatees occurring in estuarine and brackish areas (USDOI, FWS, 2001) for drinking. Florida manatees can exist for some time without freshwater, but it is believed that they must have access to freshwater periodically to survive (Reynolds and Odell, 1991). It is important that adequate freshwater sources be a component of manatee conservation strategies. Manatee protection has focused on protecting essential manatee habitats (seagrass beds have declined substantially in most parts of the State), as well as reducing direct causes of human-related mortality, injury, and disturbance.

3.2.5. Sea Turtles

Of the seven or eight extant species of sea turtles, five are known to inhabit the waters of the Gulf of Mexico (Pritchard, 1997): the green turtle, the loggerhead, the hawksbill, the Kemp's ridley, and the leatherback (Table 3-37).

As a group, sea turtles possess elongated, paddle-like forelimbs that are modified for swimming and shells that are streamlined (Márquez-M., 1990; Ernst et al., 1994; Pritchard, 1997). Sea turtles spend nearly all of their lives in the water and only depend on land (specifically sandy beaches) as nesting habitat. They mature slowly and are long-lived. Generally, their distributions are primarily circumtropical, although various species differ widely in their seasonal movements, geographical ranges, and behavior. There are also considerable differences in behavior among populations of the same species (Márquez-M., 1990).

Most sea turtles exhibit differential distributions among their various life stages — hatchling, juvenile, and adult (Márquez-M., 1990; Musick and Limpus, 1997; Hirth, 1997). After evacuating a nest and reaching the sea, hatchling turtles swim away from the nesting beach until they encounter zones of watermass convergence and/or sargassum rafts that are rich in prey and provide refuge (USDOC, NMFS and USDOI, FWS, 1991a and b; USDOC, NMFS and USDOI, FWS, 1992; Hirth, 1997). Most then undergo a passive migration, drifting pelagically within prevailing current systems such as oceanic gyres. After a period of years (the number varies among species), juveniles actively move into developmental habitats, which vary by species of sea turtle and are typically located in neritic waters. The term "habitat" is frequently used to communicate two very different perspectives of the concept of "home." When properly used, the term "habitat" actually refers to the "home area" utilized by a single species, population, or even individuals, and should convey both functionality and geographic area. The term is often misused to convey a biotic community that a species sometimes associates with; the correct term for this is "biotope." Examples of biotopes that sea turtles might inhabit as older juveniles include estuaries, bays, and nearshore waters. When approaching maturity, subadult juvenile turtles move into adult foraging areas, which vary among species or populations, and are geographically distinct from their juvenile developmental habitats (Musick and Limpus, 1997). Biotopes that adult sea turtles might forage in include coral reefs, bays, estuaries, nearshore waters, infralittoral, circalittoral, and oceanic waters.

All sea turtle species inhabiting the Gulf of Mexico are listed as either endangered or threatened under the Endangered Species Act of 1973 (Pritchard, 1997). Green, Kemp's ridley, leatherback, and hawksbill sea turtles are currently listed as endangered; the loggerhead sea turtle is currently listed as threatened.

Hard-shell Sea Turtles (Family Cheloniidae)

Green Sea Turtle (Chelonia mydas)

The green sea turtle (*Chelonia mydas*) is the largest hard-shelled sea turtle; adults commonly reach 100 cm in carapace length and 150 kg in weight (USDOC, NMFS, 1990). The green sea turtle is commonly found in tropical and subtropical marine waters with extralimital occurrences generally between latitude 40 ^{o}N. and latitude 40 ^{o}S. (USDOC, NMFS and USDOI, FWS, 1991a; Hirth, 1997). In U.S. Atlantic waters, green sea turtles are found around the U.S. Virgin Islands, Puerto Rico, and Atlantic and Gulf Coasts of the U.S. from Texas to Massachusetts. Areas in Texas and Florida figured heavily in the commercial fishery for green sea turtles at the end of the last century (Hildebrand, 1982).

Green sea turtles primarily occur in coastal waters, where they forage on seagrasses, algae, and associated organisms (Carr and Caldwell, 1956; Hendrickson, 1980). Some green sea turtles may move through a series of "developmental" feeding habitats as they grow (Hirth, 1997). Small pelagic green sea turtles are omnivorous. Adult green sea turtles in the Caribbean and Gulf of Mexico are herbivores, feeding primarily on seagrasses and, to a lesser extent, on algae and sponges. The adult feeding habitats are beds of seagrasses and algae in relatively shallow, protected waters; juveniles may forage in areas such as coral reefs, emergent rocky bottom, sargassum mats, and in lagoons and bays. Areas that are known as important feeding areas for green sea turtles in Florida include the Indian River, Florida Bay, Homosassa River, Crystal River, and Cedar Key (USDOC, NMFS, 1990). Green sea turtles in the Western Gulf are primarily restricted to the Texas coast where seagrass meadows and algae-laden jetties provide them developmental habitat, especially during warmer months (Landry and Costa, 1999). Movements between principal foraging areas and nesting beaches can be extensive, with some populations regularly conducting transoceanic migrations (USDOC, NMFS and USDOI, FWS, 1991a; Ernst et al., 1994; Hirth, 1997).

Statewide in Florida, nesting has been reported for greens as early as April 28 and as late as October 3 (Meylan et al., 1995). Most nesting by green turtles in recent decades for Florida has been recorded on the southeast coast. There are historic and recent records of green turtle presence in southwest Florida (summary in Meylan et al., 1995). In the Florida Panhandle, nesting has been recorded at Eglin Air Force Base in Okaloosa County (Meylan et al., 1995). The number of nests in Florida appears to be increasing, but whether this upward trend is due to an increase in the number of nests or is a result of more thorough monitoring of the nesting beaches is uncertain (USDOC, NMFS, 1990; Meylan et al., 1995).

Hawksbill Sea Turtle (Eretmochelys imbricata)

The hawksbill (*Eretmochelys imbricata*) is a small- to medium-sized sea turtle that occurs in tropical to subtropical waters of the Atlantic, Pacific, and Indian Oceans. The species is widely distributed in the Caribbean Sea and western Atlantic Ocean. In the continental U.S., the hawksbill has been recorded in coastal waters of each of the Gulf States and along the Atlantic coast from Florida to Massachusetts (USDOC, NMFS, 1993), although sightings north of Florida are rare (Hildebrand, 1982). They are considered to be the most tropical of all sea turtle species and the least commonly reported sea turtle species occurring in the Gulf (Márquez-M., 1990; Hildebrand, 1995).

Coral reefs are generally recognized as the resident foraging habitat for both juveniles and adults. Adult hawksbills feed primarily on sponges (Carr and Stancyk, 1975; Meylan, 1988) and demonstrate a high degree of selectivity, feeding on a relatively limited number of sponge species, primarily demosponges (Ernst et al., 1994).

Texas and Florida are the only states in the U.S. where hawksbills are sighted with any regularity (USDOC, NMFS, 1993). Stranded hawksbills have been reported in Texas (Hildebrand, 1982; Amos, 1989) and in Louisiana (Koike, 1996); these tend to be either hatchlings or yearlings. A hawksbill was captured accidentally in a purse seine net just offshore Louisiana (Rester and Condrey, 1996). Hawksbills found stranded in Texas are believed to originate from nesting beaches in Mexico (Landry and Costa, 1999). Northerly currents may carry immature hawksbills away from their natal beaches in Mexico northward into Texas (Amos, 1989; Collard and Ogren, 1990). Offshore at the Flower Garden Banks National Marine Sanctuary, seven sightings of the hawksbill were made between 1994 and 2000 (Hickerson, 2000). Hickerson (2000) determined that Stetson Bank, a midshelf bank that is part of the Flower Garden Banks National Marine Sanctuary, is more suitable habitat to the hawksbill sea turtle than either the East or West Flower Garden Bank. More recently, scientific divers at Stetson Bank observed an adult hawksbill sea turtle during the warmer months of 2001 (Hickerson et al., personal communication, 2001).

The hawksbill turtle is a solitary nester. Nesting within the continental U.S. is limited to southeastern Florida and the Florida Keys. Nesting by hawksbills in Florida is considered rare. Statewide, nesting has been reported as early as June 6 and as late as October 31 (Meylan et al., 1995). Juvenile hawksbills show evidence of residency on specific foraging grounds, although hawksbill migrations are possible (USDOC, NMFS and USDOI, FWS, 1993). Some populations of adult hawksbills undertake reproductive migrations between foraging grounds and nesting beaches (Márquez-M., 1990; Ernst et al., 1994). The hawksbill is presently listed as an endangered species.

Kemp's Ridley Sea Turtle (Lepidochelys kempi)

The Kemp's ridley (*Lepidochelys kempi*) is the smallest sea turtle species and occurs chiefly in the Gulf of Mexico. It may also be found along the northwestern Atlantic coast of North America as far north as Newfoundland. It is the most imperiled of the world's sea turtles. The Gulf of Mexico's population of nesting females has dwindled from an estimated 47,000 in 1947 to a current nesting population of approximately 4,200 females (Shaver, personal communication, 2001). A population crash that occurred between 1947 and the early 1970's may have been the result of both intensive annual harvest of the eggs and mortality of juveniles and adults in trawl fisheries (NRC, 1990). The recovery of the Kemp's ridley from the threat of extinction has been forestalled primarily by mortality associated with the commercial shrimp fishery (USDOI, FWS and USDOC, NMFS, 1992).

In the northern Gulf, Kemp's ridleys are most abundant in coastal waters from Texas to west Florida (Ogren, 1989; Márquez-M., 1990 and 1994; Rudloe et al., 1991). Kemp's ridleys display strong seasonal fidelity to tidal passes and adjacent beachfront environs of the northern Gulf (Landry and Costa, 1999). There is little prolonged utilization of waters seaward of the 50-m isobath by this species (Renaud, 2001). Adult Kemp's ridley turtles usually occur only in the Gulf, but juvenile and immature individuals sometimes range between tropical and temperate coastal areas of the northwestern Atlantic and Gulf (Márquez-M., 1990). Juveniles are more common than adults along the East Coast of the U.S., from Florida to New England and especially off Florida and Georgia. Within the Gulf, juvenile and immature Kemp's ridleys have been documented along the Texas and Louisiana coasts, at the mouth of the Mississippi River, and along the west coast of Florida, as quoted in stranding reports, (Ogren, 1989; Márquez-M., 1990).

The primary nesting area utilized by the Kemp's ridley sea turtle is near Rancho Nuevo, along the northeastern coast of Mexico in the state of Tamaulipas (USDOI, FWS and USDOC, NMFS, 1992, Márquez-M. et al., 2001), although secondary nest areas have also been reported in other areas of Mexico, Texas (specifically south Texas), Florida, and South Carolina (USDOI, FWS and USDOC, NMFS, 1992; Ernst et al., 1994; Márquez-M. et al., 2001). Eggs are laid annually, and following the nesting season, the adults disperse towards two feeding grounds: one northwest toward Florida and the other southeast to the Campeche Bank off the Yucatan Peninsula of Mexico. Some adult female Kemp's ridley sea turtles tagged at Rancho Nuevo have been recorded off Louisiana and Mississippi (Márquez-M., 1994). Two adult females bearing flipper tags applied at the Rancho Nuevo nesting beach were recaptured at Calcasieu and Sabine Passes, Louisiana. These post-nesting females may have been in transit to shallow Gulf foraging areas to begin conditioning for their next reproductive cycle (Landry and Costa, 1999). Post-nesting females have also been tagged in Texas, and 17 of the 18 animals tagged with satellite transmitters between 1997 and 2001 were discovered to spend time in waters along at least one of the Gulf States (Shaver, personal communication, 2001). Only one post-nesting female that was tagged with a satellite transmitter in Texas moved south to Mexican waters (Shaver, personal communication, 2001). Juveniles, subadults, and adults are common off Big Gulley, an offshore area east of Mobile Bay, Alabama, where they have been sometimes captured in trawls since the mid-1970's (Carr, 1980; Ogren, 1989; Márquez-M., 1994). Some of the smallest Kemp's ridley sea turtles have been found off Wakulla and Franklin Counties, Florida (Ogren, 1989). Two sightings of Kemp's ridley turtles were reported over the continental shelf in the Eastern Gulf during GulfCet II surveys (Davis et al., 2000).

Nesting in the U.S. occurs annually on Padre and Mustang Islands in south Texas from May to August (Thompson, 1988). A multiagency program initiated in 1978 to establish a secondary nesting colony in south Texas supplemented natural nesting. From 1948 through 1998, 45 Kemp's ridley nests on the Texas coast were documented (Shaver and Caillouet, 1998). Only 11 Kemp's ridley nests were found in Texas from 1979 to 1995 (Shaver, 1995). The first documented nesting of living-tagged Kemp's ridley in 1996 is the first documentation of any sea turtle nesting at an experimental imprinting site and outside of captivity after being released from a head-starting program (Shaver, 1996a and b). During the 1998 nesting season, 13 confirmed Kemp's ridley nests were found on the Texas coast (Shaver and Caillouet, 1998). A record 16 Kemp's ridley nests were found on Texas beaches during 1999. Twelve nests were documented in Texas during 2000; however, only eight Kemp's ridley nests were located in Texas during the 2001 nesting season (Shaver, personal communication, 2001).

The first confirmed nesting in the U.S. of a Kemp's ridley turtle that had previously nested in Mexico occurred in 1998 (Shaver and Caillouet, 1998). Kemp's ridleys that nest in south Texas today are likely a mixture of returnees from the experimental imprinting and head-starting project and others from the wild stock. Kemp's ridley sea turtles have been also documented nesting in Alabama and Florida, although less frequently than on Texas beaches. In 1998, one nest was confirmed in Alabama on Bon Secour National Wildlife Refuge (Baldwin County) (MacPherson, personal communication, 2000). In the same year, another nesting site was confirmed on Gulf Islands National Seashore (GINS) (Perdido Key Area, Escambia County, Alabama) (Nicholas, personal communication, 2000). Kemp's ridley turtles have occasionally nested in Florida. There are two reports for Pinellas County, Florida: one on Madeira Beach in 1989 (Meylan et al., 1990) and the second on Clearwater Beach in 1994 (Anonymous, 1994). There were two nests for Volusia County on the southeast coast of Florida (May 14 and June 1, 1996) (Johnson et al., 2000). The Kemp's ridley sea turtle nesting and hatching season for northwest Florida beaches extends from May 1 through October 31. For the one confirmed nest on GINS, the nest was laid on May 31 and eggs hatched on August 3, for an incubation period of 64 days (Nicholas, personal communication, 2000). Two adult female Kemp's ridleys found at Padre Island were satellite tagged to document post-nesting movements (Shaver, personal communication, 1998). Both females moved northward, spending most of their time in Louisiana waters; one female moved as far as western Florida, the other stayed in the vicinity of Louisiana.

Hatchlings appear to disperse offshore and are sometimes found in sargassum mats (Collard and Ogren, 1990). Two juvenile Kemp's ridleys released through the headstart program of the National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries), formerly known as NMFS, were found drifting in sargassum: one was found 46.3 km south of Mobile, Alabama; the other 4.6 km off Horseshoe and Pepperfish Keys on the north-central Gulf Coast of Florida (Manzella et al., 1991). During the pelagic life history stage, the Kemp's ridley sea turtle is dependent on currents, fronts, and gyres to determine their distribution. Hatchling and small juvenile habitats are hardly known due to lack of information. Some young turtles stay within the Gulf, whereas others are carried by currents out of the Gulf into the Gulf Stream current and up to the northeastern U.S. The latter migrate south and enter the Gulf as they approach maturity. With growth, the turtles actively move to shallow coastal waters, especially off western Louisiana and eastern Texas or off northwestern Florida, where feeding on benthos occurs. The north and northeast portions of the northern Gulf are considered foraging habitat for juveniles, subadults, and post-nesting females (Ogren, 1989; Rudloe et al., 1991). The Kemp's ridleys inhabiting the upper Texas and Louisiana coastal waters utilize sandy and muddy bottoms, feeding on portunids and other crabs (Ogren, 1989; Shaver, 1991), and possibly on bycatch generated by the shrimp fishery (Landry and Costa, 1999). Other Kemp's ridleys move to Cedar Key, Florida, an area where they also prey on portunid crabs. This is an area where seagrass communities are common, and also where Kemp's ridleys penetrate bays and estuaries (Carr and Caldwell, 1956; Lutcavage and Musick, 1985; Landry, personal communication, 2000). Strandings of Kemp's ridleys on Texas beaches indicate that they are mostly from Mexico (Shaver, personal communication, 1998).

Loggerhead Sea Turtle (Caretta caretta)

The loggerhead (*Caretta caretta*) is a large sea turtle that inhabits temperate and tropical marine waters of the Atlantic, Pacific, and Indian Oceans. This species is wide-ranging throughout its range and is capable of living in varied habitat types for a relatively long time (Márquez-M., 1990; USDOC, NMFS and USDOI, FWS, 1991b; Ernst et al., 1994). Loggerheads feed primarily on benthic invertebrates but are capable of feeding on a wide range of food items (Ernst et al., 1994). The loggerhead is the most abundant species of sea turtle occurring in U.S. waters of the Atlantic, from Florida to Cape Cod, Massachusetts. The loggerhead is probably the most common sea turtle species in the northern Gulf (e.g., Fritts et al., 1983; Fuller and Tappan, 1986; Rosman et al., 1987b; Lohoefener et al., 1990) and is currently listed as a threatened species.

In the western North Atlantic, there are at least four loggerhead nesting subpopulations: the Northern Nesting Subpopulation (North Carolina to northeast Florida, about 29° N. latitude); the South Florida Nesting Subpopulation (29° N. latitude to Naples); the Florida Panhandle Nesting Subpopulation (Eglin Air Force Base and the beaches near Panama City); and the Yucatán Nesting Subpopulation (northern and eastern Yucatán Peninsula, Mexico) (Byles et al., 1996). Based upon the returns of tags applied at nesting beaches, non-nesting adult females from the South Florida Subpopulation are distributed throughout the Bahamas, Greater Antilles, Yucatán, Eastern Gulf of Mexico, and southern Florida (Meylan, 1982). Non-nesting adult females from the Northern Subpopulation occur occasionally in the northeastern Gulf (Meylan, 1982). Limited tagging data suggest that adult females nesting in the Gulf of Mexico remain in the Gulf (Meylan, 1982). Little information is available on adult male distribution; however, they have been observed year-round in south Florida (Byles et al., 1996). Little is known about seasonal movements of loggerheads in the Gulf (Byles et al., 1996). The largest nesting concentration in the U.S. is on the southeast Florida coast from Volusia to Broward Counties. Statewide in Florida, nesting has been reported for loggerheads as early as March 16 and as late as October 16 (Meylan et al., 1995).

Loggerheads are the most common nesting sea turtle in northwest Florida and account for over 99 percent of the nests. The loggerhead sea turtle nesting and hatching season for northwest Florida beaches generally extends from about May 1 through October 31. The earliest nest was documented on April 27 and the latest nest on November 1. Nest incubation ranges from about 49 to 95 days. On the Gulf Coast of Florida, the most nesting by loggerheads occurs from Pinellas through Monroe Counties (southwest Florida) and from Escambia through Franklin Counties (northwest Florida). Data gathered in surveys along the Florida Gulf Coast (1998-2000 seasons) indicate that approximately 87 percent of the loggerhead nests reported were made in the southwest counties and approximately 13 percent were in northwest counties (Patrick, personal communication, 2001; Brost, personal communication, 2001). The greatest abundance of loggerhead nests found per region was in Sarasota and Charlotte Counties (southwest Florida), and Bay, Gulf, and Franklin Counties (northwest Florida).

On the Central Gulf Coast, limited monitoring of nesting activity has been conducted. A total of 107 loggerhead nests were documented during the 1999 and 2000 nesting seasons on the Bon Secour National Wildlife Refuge to Mobile Bay (Swilling, personal communication, 2001). Loggerhead nesting was reported at Biloxi, Mississippi, in 1991 (South and Tucker, personal communication, 1991). It is unknown whether the nesting sea turtles in Alabama, Mississippi, and Louisiana are genetically distinct subpopulations or genetically similar to the Florida Panhandle Subpopulation (Bowen et al., 1993).

Nesting in Texas occurs primarily on North and South Padre Islands, although occurrences are recorded throughout coastal Texas (Hildebrand, 1982).

Based on aerial survey results, western North Atlantic loggerheads are distributed about 54 percent in the southeast U.S. Atlantic, 29 percent in the northeast U.S. Atlantic, 12 percent in the eastern Gulf of Mexico, and 5 percent in the western Gulf of Mexico (Byles et al., 1996). Aerial surveys indicate that loggerheads are largely abundant in water depths less than 100 m (Shoop et al., 1981; Fritts et al., 1983). During the GulfCet aerial surveys, loggerheads were sighted throughout the northern Gulf continental shelf waters near the 100-m isobath (Davis et al., 2000). Loggerheads were also sighted over very deep waters (>1,000 m). Sightings indicate that loggerhead distribution is not as coastal-associated as that of Kemp's ridley and green sea turtles (Landry and Costa, 1999). Loggerheads have also been sighted seaward of the shelf break in the northeast U.S. (Shoop and Kenney, 1992). Loggerhead abundance in continental slope waters of the eastern Gulf increased appreciably during winter (Davis et al., 2000). It is not clear why adult loggerheads would occur in oceanic waters, unless they were traveling between foraging sites in distant and separate areas on the continental shelf or seeking warmer waters during winter (Davis et al., 2000). Shoop et al. (1981) suggested that loggerheads in oceanic waters off the Atlantic coast of the U.S. were probably in transit to other areas. Witzell and Azarovitz (1996) suggested that some turtles may move offshore in winter to seek warm-core eddies.

Loggerheads have been found to be abundant in Florida waters (Fritts and Reynolds, 1981; Fritts et al., 1983; Davis et al., 2000). Underwater surveys made near artificial reefs and a sunken offshore platform near Panama City, Florida, noted 17 sightings of sea turtles. All turtles sighted were loggerheads, usually resting in a shallow pit in the sand at a place where the artificial reef formed a sheltering overhang (Rosman et al., 1987b). In the Central Gulf, loggerheads are very abundant just offshore Breton and Chandeleur Islands (Lohoefener et al., 1990). Individual subadult loggerheads tagged with satellite transmitters at the Flower Garden Banks near the shelf-edge off Texas were found to persist there over several years (Hickerson, 2000).

Juvenile and subadult loggerheads are omnivorous, foraging on pelagic crabs, molluscs, jellyfish, and vegetation captured at or near the surface (Dodd, 1988; Plotkin et al., 1993). Adult loggerheads forage on benthic invertebrates (Dodd, 1988). The banks off central Louisiana and near the Mississippi Delta are also important marine turtle feeding areas (Hildebrand, 1982). Subadult loggerheads utilize the Flower Garden Banks near the shelf-edge off Texas as feeding habitat during all seasons (Hickerson, 2000). Genetic evidence has suggested that at least two of the subpopulations intermingle on the foraging grounds of the U.S. Atlantic coast (Byles et al., 1996).

Leatherback Sea Turtle (Family Dermochelyidae)

Leatherback Sea Turtle (Dermochelys coriacea)

The leatherback (*Dermochelys coriacea*) is the largest and most distinctive sea turtle. This species possesses a unique skeletal morphology, most evident in its flexible, ridged carapace, and in cold water maintains a core body temperature several degrees above ambient. They also have unique deep-diving abilities (Eckert et al., 1986). This species is the most wide-ranging sea turtle, undertaking extensive migrations from the tropics to boreal (cold-temperate regions of the northern latitudes) waters (Morreale et al., 1996; Hughes et al., 1998). Though considered oceanic, leatherbacks will occasionally enter bays and estuaries (Hoffman and Fritts, 1982; Knowlton and Weigle, 1989; Shoop and Kenney, 1992). Using satellite telemetry, it was recently determined that female leatherback turtles migrating through the Pacific Ocean are using similar and in some cases virtually identical pathways or ocean corridors to travel (Morreale et al., 1996). Leatherbacks feed primarily on gelatinous zooplankton such as jellyfish, siphonophores, and salps (Brongersma, 1972), although they may ingest some algae and vertebrates (Ernst et al., 1994). Leatherbacks' stomach contents have been analyzed and data suggest that they may feed at the surface, at depth within deep scattering layers, or on the benthos. Florida is the only site in the continental U.S. where leatherbacks regularly nest (USDOC, NMFS and USDOI, FWS, 1992b; Ernst et al., 1994; Meylan et al., 1995). The leatherback is currently listed as an endangered species.

Sightings of leatherbacks are common in oceanic waters of the northern Gulf of Mexico (Leary, 1957; Fritts et al., 1983; Lohoefener et al., 1988 and 1990; Collard, 1990; Davis et al., 2000). Based on a summary of several studies, Davis and Fargion (1996) concluded that the primary habitat of the leatherback in the northwestern Gulf is oceanic waters (>200 m). In contrast, the overall densities of leatherbacks in the Eastern Gulf on the shelf and on the slope were similar (Davis et al., 2000). It has been suggested that the region from Mississippi Canyon east to DeSoto Canyon appears to be an important habitat area for leatherbacks (Davis and Fargion, 1996). Most of the sightings of leatherbacks during the GulfCet surveys occurred slightly north of DeSoto Canyon (Davis and Fargion, 1996; Davis et al., 2000). The nearly disjunct summer and winter distributions of leatherback sightings over the continental slope in the Eastern Gulf during GulfCet II indicate that specific areas may be important to this species either seasonally or for short periods of time. These specific locations are most probably correlated with oceanographic conditions and resulting concentrations of prey. Large numbers of leatherbacks in waters off the northeast U.S. have been associated with concentrations of jellyfish (Shoop and Kenney, 1992). Similar sightings with high jellyfish abundance have been made in the Gulf: 100 leatherbacks were sighted just offshore Texas, while 7 were seen at a watermass boundary in the Eastern Gulf (Leary, 1957; Collard, 1990). Other clustered sightings of leatherbacks have been reported for the northern Gulf: 8 leatherbacks were sighted one day in DeSoto Canyon (Davis and Fargion, 1996), 11 during one day just south of the Mississippi River Delta (Lohoefener et al., 1990), and 14 during another day in DeSoto Canyon (Lohoefener et al., 1990).

Leatherback nesting is concentrated on coarse-grain beaches in the tropical latitudes (Pritchard, 1971). Analysis of haplotype frequencies has revealed that nesting populations of leatherbacks are strongly subdivided globally, despite the leatherback's highly migratory nature (Dutton et al., 1999). Those findings provisionally support the natal homing hypothesis for leatherbacks. Leatherbacks nest annually in U.S. territories within the Caribbean, principally at St. Croix (U.S. Virgin Islands) and Isla Culebra (Puerto Rico) (USDOC, NMFS and USDOI, FWS, 1992). Critical habitat for the leatherback includes the waters adjacent to Sandy Point, St. Croix. Additionally, leatherback sea turtles nest on beaches in Georgia and Florida. Based on an average of 5-7 nests per female per season observed at other rookeries, Meylan et al. (1995) estimated there to be 16-31 individual leatherbacks nesting annually in small numbers on the east coast of Florida.

On the Gulf Coast of Florida, documented leatherback nests are rare. One leatherback nest was reported between Phillips Inlet and Destin in September 1962 (Yerger, 1965). Another leatherback nest was documented in 1974 on St. Vincent Island, Franklin County. From 1993 to 2000, only 15 nests were reported—10 in Franklin County, 3 in Okaloosa County, 1 each in Gulf and Escambia Counties (Brost, personal communication, 2001). The greatest number of nests documented in any one season occurred in 2000, when leatherback nesting was confirmed (including successful hatching) of one nest on Gulf Islands National Seashore (Ft. Pickens Unit, Escambia County) and two nests on Eglin Air Force Base (Okaloosa Island, Okaloosa County).

Nesting occurs from February through July from Georgia to the U.S. Virgin Islands. The leatherback sea turtle nesting and hatching season for northwest Florida beaches extends from May 1 through October 31. For confirmed nesting, the earliest nest was documented on April 29 and the latest nest documented on June 19. Documented nest incubation in northwest Florida ranges from about 63 to 84 days (Brost, personal communication, 2001; Miller, personal communication, 2001; Nicholas, personal communication, 2001). Statewide in Florida, nesting has been reported for leatherbacks as early as February 22 (Meylan et al., 1995). Although the number of leatherback sea turtles nesting on Florida beaches is small relative to those nesting in St. Croix and Puerto Rico, it is the only nesting habitat regularly utilized by this endangered species in the continental U.S.

Distributions of Sea Turtles in the Offshore Waters of the Northern Gulf of Mexico

Surveys conducted during the GulfCet I and II studies represent the most recent assessments of sea turtle distribution and abundance within the oceanic northern Gulf (Davis et al., 1998a and 2000). During these surveys, only three species of sea turtles were sighted: loggerheads, Kemp's ridleys, and leatherbacks.

The GulfCet I and II surveys found the abundance of sea turtles in the northern Gulf of Mexico to be considerably higher over the continental shelf and within the eastern Gulf, east of Mobile Bay (Lohoefener et al., 1990; Davis et al., 2000). Kemp's ridleys were sighted only along the shelf. Sightings of loggerheads were also considerably higher over the continental shelf than the continental slope. However, there were sightings of loggerheads in waters exceeding 1,000 m in depth. The importance of oceanic habitat to loggerheads was not clear from these surveys, though it was suggested that turtles may move through these waters to distant foraging sites or while seeking warmer waters during winter (Davis et al., 2000). From historic sighting data, leatherbacks appear to utilize both shelf and slope habitat areas in the northern Gulf (Fritts et al., 1983; Collard, 1990; Davis et al., 1998a). GulfCet I and II studies suggested that the region from Mississippi Canyon to DeSoto Canyon, especially near the shelf edge, may be important habitat for leatherbacks (Davis et al., 2000).

Seasonally, loggerheads were widely distributed across the continental shelf during both summer and winter, though their abundance over the continental slope was considerably higher during winter surveys than summer (Davis et al, 2000). Temporal variability in leatherback distribution and abundance suggest that specific areas may be important to this species, either seasonally or for short periods of time. Overall, leatherbacks occurred in substantial numbers during both summer and winter surveys, and the high variability in the relative numbers of individual leatherbacks sighted within specific areas suggest that their distribution patterns were irruptive in nature (Davis et al., 2000).

3.2.6. Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

Hall (1981) recognizes 16 subspecies of field mouse (*Peromyscus polionotus*), 8 of which are collectively known as beach mice. Of Gulf Coast subspecies, the Alabama, Choctawhatchee, St. Andrew, and Perdido Key, beach mice occupy restricted habitats in the mature coastal dunes of Florida and Alabama. All four mice are listed as endangered: the Alabama subspecies in Alabama, and the Perdido Key, St. Andrew, and Choctawhatchee subspecies in Florida (USDOI, FWS, 1987). Populations have fallen to levels approaching extinction. For example, in the late 1980's, estimates of total remaining beach mice were less than 900 for the Alabama beach mouse, about 80 for the Perdido Key beach mouse, and about 500 for the Choctawhatchee beach mouse. The Alabama, Perdido Key, and Choctawhatchee beach mice were listed as endangered in the 1980's. The St. Andrew beach mouse was not listed as endangered until 1998; it is the only listed subspecies without designated critical habitat. Continued monitoring of populations of all subspecies along the Gulf Coast between 1985 and the present indicates that approximately 52 km (32.3 mi) of coastal dune habitat are now occupied by the four listed subspecies (1/3 of historic range). Beach mice were listed because of the loss of coastal habitat from human development. The reduced distribution and numbers of beach mice have continued because of multiple habitat threats over their entire range (coastal development and associated human activities, military activities, coastal erosion, and weather). The *Federal Register* (1985a) cites habitat loss as the primary cause for declines in populations of beach mice. Development of beachfront real estate along coastal areas and catastrophic alteration by hurricanes are the primary contributors to loss of habitat. Destruction of Gulf Coast sand dune ecosystems for commercial and residential development has destroyed about 60 percent of original beach mouse habitat.

The inland extent of beach mouse habitat may vary depending on the configuration of the sand dune system and the vegetation present. There are commonly several rows of dunes paralleling the shoreline and within these rows there are generally three types of microhabitat. The first microhabitat is the frontal dunes, which are sparsely vegetated with widely scattered coarse grasses including sea oats (*Uniola paniculata*), bunch grass (*Andropogon maritimus*), and beach grass (*Panicum amarum* and *P. repens*), and with seaside rosemary (*Ceratiola ericoides*), beach morning glory (*Ipomoea stolonifera*), and railroad vine (*I. Pes-caprae*). The second microhabitat is the frontal dune grasses, a lesser component on the higher rear scrub dunes, which support growth of slash pine (*Pinus elliotti*), sand pine (*P. clausa*), and scrubby shrubs and oaks, including yaupon (*Ilex vomitoria*), marsh elder (*Iva sp*.), scrub oak (*Quercus myrtifolia*), and sand-live oak (*Q. virginiana* var. *maritima*). The third microhabitat is the interdunal areas, which contain sedges (*Cyperus sp*.), rushes (*Juncus scirpoides*), and salt grass (*Distichlis spicata)*.

Beach mice are restricted to the coastal barrier sand dunes along the Gulf. Optimal overall beach mouse habitat is currently thought to be comprised of a heterogeneous mix of interconnected habitats including primary dunes, secondary dunes, scrub dunes, and interdunal areas. Beach mice dig burrows mainly in the primary, secondary, and interior scrub dunes where the vegetation provides suitable cover. Most beach mouse surveys conducted prior to the mid-1990's were in primary and secondary dunes because the investigators assumed that these habitats are the preferred habitat of beach mice. A limited number of surveys in scrub dunes and other interior habitat resulted in less knowledge of the distribution and relative abundance there. In coastal environments, the terms "scrub" and "scrub dune" refer to habitat or vegetation communities adjacent to and landward of primary and secondary dune types where scrub oaks are visually dominant. Interior habitat can include vegetation types such as grass-like forbs (forbs are the herbs other than grasses). There is substantial variation in scrub oak density and cover within and among scrub dunes throughout ranges of beach mice. The variation, an ecological gradient, is represented by scrub oak woodland with a relatively closed canopy at one end of a continuum. At the other extreme of the gradient, scrub dunes are relatively open with patchy scrub ridges and intervening swales or interdunal flats dominated by herbaceous plants.

Beach mice feed nocturnally in the dunes and remain in burrows during the day. Their diets vary seasonally but consist mainly of seeds, fruits, and insects (Ehrhart, 1978; Moyers, 1996). Changes in the availability of foods result in changes in diets between seasons and account for variability of seasonal diets between years. Autumn diets of beach mice consist primarily of seeds and/or fruits of sea oats, evening primrose (*Oenothera humifusa*), bluestem (*Schizachyrium maritimum*), and dune spurge (*Chamaesyce ammannioides*). Sea oats and beach pea (Galactia sp.) dominate winter diets. Spring diets primarily consist of dune toadflax (*Linaria floridana*), yaupon holly (*Ilex vomitoria)*, seashore elder (*Iva imbricata*), and greenbrier (*Smilax sp.*). Summer diets are dominated by evening primrose, insects, dune toadflax, and ground cherry (*Physalis augustifolia*) (Moyers, 1996). Management practices designed to promote recovery of dune habitat, increase food sources, and enhance habitat heterogeneity may aid in recovery of beach mouse populations.

In wild populations, beach mice have an average life span of about nine months. Males and females reach adulthood and are able to reproduce at approximately 35 days of age. Females can nurse one litter while pregnant with another litter. From captive colonies we know that litter size is 1-8 with an average of four. Young are weaned in 2-3 weeks and are generally on their own 1-2 weeks later.

Hurricanes are a natural environmental phenomenon affecting the Gulf Coast, and beach mice have evolved and persisted in coastal dune habitats since the Pleistocene. Hurricanes are part of a repeated cycle of destruction, alteration, and recovery of dune habitat. The extensive coastal dune habitat that existed along the Gulf Coast before the fairly recent commerical and residential development allowed beach mice to survive even the most severe hurricane events to repopulate dune habitat as it recovered. Beach mice are affected by the passage of hurricanes along the northwest Florida and Alabama Gulf Coast. Since records on hurricane intensity began in 1885, a total of 32 hurricanes have struck northwest Florida within the historic ranges of the four Gulf Coast beach mouse subspecies (Williams and Duedall, 1997; Doehring et al., 1994; Neumann et al., 1993). In addition, since 1899, a total of 11 hurricanes have hit the coast of Alabama.

Hurricanes generally produce damaging winds, storm tides and surges, and rain that erode barrier-island, peninsular, and mainland beaches and dunes. Following hurricanes, the dune system begins a slow natural repair process that may take 3-20 years, depending on the magnitude of dune loss (Salmon et al., 1982). During this period, sea oats and pioneer dune vegetation become established, collecting sand and building dunes. As the dunes grow and become stable, other successional dune vegetation colonizes the area (Gibson and Looney, 1994), and beach mouse food sources and habitats are reestablished. The rate of recovery of food supplies for beach mice is variable with some areas adversely affected for an extended period of time by a hurricane and post-hurricane conditions.

Tropical storms periodically devastate Gulf Coast sand dune communities, dramatically altering or destroying habitat, and either drowning beach mice or forcing them to concentrate on high scrub dunes where they are exposed to predators. How a hurricane affects beach mice depends primarily on its characteristics (winds, storm surge, rainfall), the time of year (midsummer is the worst), and where the eye crosses land (side of hurricane—clockwise or counterclockwise), population size, and storm impacts to habitat and food sources. The interior dunes and related access corridors may be essential habitats for beach mice following survival of a hurricane. For the three subspecies that have critical habitat areas (Alabama, Perdido Key, and Choctawhatchee beach mice), the major constituent elements that are known to require special management considerations or protection are dunes and interdunal areas and associated grasses and shrubs that provide food and cover (USDOI, FWS, 1985a and b).

Beach mice have existed in an environment subject to recurring hurricanes, but tropical storms and hurricanes are now considered to be a primary factor in the beach mouse's decline. It is only within the last 20-30 years that the combination of habitat loss to beachfront development, isolation of remaining habitat blocks and beach mouse populations, and destruction of remaining habitat by hurricanes have increased the threat of extinction of several subspecies of beach mice.

Reasons for Current Status

Beachfront development continues to be the greatest threat. The combinations of habitat loss to beachfront development, isolation of remaining habitat blocks and beach mouse populations, and destruction of remaining habitat by hurricanes has increased the threat of extinction of several subspecies of beach mice. Habitat reduction and fragmentation have affected the ability of beach mice to quickly recover following tropical storms and have become a major threat to the recovery of the three subspecies.

3.2.7. Coastal and Marine Birds

3.2.7.1. Nonendangered and Nonthreatened Species

The offshore waters, coastal beaches, and contiguous wetlands of the northern Gulf of Mexico are populated by both resident and migratory species of coastal and marine birds. They are herein separated into five major groups: diving birds, shorebirds, marsh birds, wading birds, and waterfowl. Many species are mostly pelagic, and therefore rarely sighted nearshore. The remaining species are found within coastal and inshore habitats and are more susceptible to potential deleterious effects resulting from OCS-related activities (Clapp et al., 1982). Recent surveys indicate that Louisiana and Texas are among the primary states in the southern and southeastern U.S. for nesting colony sites and total number of nesting coastal and marine birds (Martin and Lester, 1991; Martin, 1991). Fidelity to these nesting sites varies from year to year along the Gulf Coast. Site abandonment along the northern Gulf Coast has often been attributed to habitat alteration and excessive human disturbance (Martin and Lester, 1991).

Diving birds are a diverse group. There are three main groups of diving birds: cormorants and anhingas (Pelecaniformes), loons (Gaviiformes), and grebes (Podicipediformes). Nesting diving birds on the Gulf include cormorants.

Gulls, terns, and black skimmers make up the gull/tern group. Of these, colonies of laughing gulls, eight species of terns, and black skimmers nest in the Gulf (Martin and Lester, 1991; Pashley, 1991).

Shorebirds are those members of the order Charadriiformes generally restricted to coastline margins (beaches, mudflats, etc.). Gulf of Mexico shorebirds comprise five taxonomic families—Jacanidae (jacanas), Haematopodidae (oystercatchers), Recurvirostridae (stilts and avocets), Charadriidae (plovers), and Scolopacidae (sandpipers, snipes, and allies) (Hayman et al., 1986). An important characteristic of almost all shorebird species is their strongly developed migratory behavior, with some shorebirds migrating from nesting places in the far north to the southern part of South America (Terres, 1991). Both spring and fall migrations take place in a series of "hops" to staging areas where birds spend time feeding heavily to store up fat for the sustained flight to the next staging area; many coastal habitats along the Gulf of Mexico are critical for such purposes. Along the central Gulf Coast, 44 species of shorebirds have been recorded; only 6 nest in the area, the remaining are wintering residents and/or "staging" transients (Pashley, 1991). Although variations occur between species, most shorebirds begin breeding at one to two years of age and generally lay 3-4 eggs per year. They feed on a variety of marine and freshwater invertebrates and fish, and small amounts of plant life.

Collectively, the following families of wading birds have representatives in the northern Gulf: Ardeidae (herons and egrets), Ciconiidae (storks), Threskiornithidae (ibises and spoonbills), and Gruidae (cranes). Wading birds are those birds that have adapted to living in shallow water. They have long legs that allow them to forage by wading into shallow water, while their long bills, usually accompanied by long necks, are used to probe under water or to make long swift strokes to seize fish, frogs, aquatic insects, crustaceans, and other prey (Terres, 1991). The term "marsh bird" is a general term for a bird that lives in or around marshes and swamps. Seventeen species of wading birds in the Order Ciconiiformes are currently known to nest in the U.S., and all except the wood stork nest in the northern Gulf coastal region (Martin, 1991). Within the central Gulf Coast region, Louisiana supports the majority of nesting wading birds. Great egrets are the most widespread nesting species in the central Gulf region (Martin, 1991), while little blue herons, snowy egrets, and tricolored herons constitute the greatest number of coastal nesting pairs in the western Gulf Coast (Texas Parks and Wildlife Department, 1990). Members of the Rallidae family (rails, moorhens, gallinules, and coots) have compact bodies, and therefore, they are labeled marsh birds and not wading birds. They are also elusive and rarely seen within the low vegetation of fresh and saline marshes, swamps, and rice fields (Bent, 1926; National Geographic Society, 1983; Ripley and Beehler, 1985).

Waterfowl belong to the taxonomic order Anseriformes and include swans, geese, and ducks. A total of 36 species are regularly reported along the north-central and western Gulf Coast, consisting of 1 swan, 5 geese, 11 surface-feeding (dabbling) ducks and teal, 5 diving ducks (pochards), and 14 others (including the wood duck, whistling ducks, sea ducks, the ruddy duck, and mergansers) (Clapp et al., 1982; National Geographic Society, 1983; Madge and Burn, 1988). Many species usually migrate from wintering grounds along the Gulf Coast to summer nesting grounds in the north. Waterfowl migration pathways have traditionally been divided into four parallel north-south paths, or “flyways,” across the North American continent. The Gulf of Mexico coast serves as the southern terminus of both Central (Texas) and Mississippi (Louisiana, Mississippi, and Alabama) flyways. Waterfowl are highly social and possess a diverse array of feeding adaptations related to their habitat (Johnsgard, 1975).

3.2.7.2. Endangered and Threatened Species

The following coastal and marine bird species that inhabit or frequent the north-central and western Gulf of Mexico coastal areas are recognized by FWS as either endangered or threatened: piping plover, whooping crane, bald eagle, brown pelican, and least tern.

Piping Plover

The piping plover (*Charadrius melodus*) is a migratory shorebird that is endemic to North America. The piping plover breeds on the northern Great Plains, in the Great Lakes, and along the Atlantic Coast (Newfoundland to North Carolina); and winters on the Atlantic and Gulf of Mexico coasts from North Carolina to Mexico and in the Bahamas West Indies. The final rule on critical habitat of piping plover was published July 10, 2001; there are 20 units of critical habitat in western Florida south to Tampa Bay, 3 areas in Alabama, 15 in Mississippi, 7 in Louisiana, and 37 in Texas (66 FR 132, pp. 36037-36086). Critical wintering habitat includes the land between mean lower low water and any densely vegetated habitat, which is not used by the piping plover. It has been hypothesized that specific wintering habitat, which includes coastal sand flats and mud flats in close proximity to large inlets or passes, may attract the largest concentrations of piping plovers because of a preferred prey base and/or because the substrate coloration provides protection from aerial predators due to chromatic matching, or camouflage (Nicholls and Baldassarre, 1990). This species remains in a precarious state given its low population numbers, sparse distribution, and continued threats to habitat throughout its range. Of the birds located on the U.S. wintering grounds during censuses of 1991 and 1996, about 89 percent were found on the Gulf Coast and 8 percent on the Atlantic Coast. Along the Gulf Coast, the highest numbers of wintering plovers occur along the Texas coast (1,333) (Haig and Plissner, 1993). Piping plovers begin arriving on the wintering grounds in July and keep arriving through September. Behavioral observations of piping plovers on the wintering grounds suggest that they spend the majority of their time foraging. Primary prey for wintering plovers includes polychaete marine worms, various crustaceans, insects, and sometimes bivalve mollusks. They peck prey from on top of or just beneath the sediment. Foraging usually is on moist or wet sand, mud, or fine shell. In some cases, a mat of blue-green algae may cover this substrate. When not foraging, plovers can be found in aggressive encounters, roosting, preening, bathing, and moving among available habitat locations. The habitats used by wintering birds include beaches, mud flats, sand flats, algal flats, and washover passes (areas where breaks in the sand dunes result in an inlet). Wintering plovers are dependent on a mosaic of habitat patches and move among these patches depending on local weather and tidal conditions. In late February, piping plovers begin leaving the wintering grounds to migrate back to their breeding sites. Northward migration peaks in late March, and by late May most birds have left the wintering grounds. The migration of the piping plover is poorly understood.

Whooping Crane

The whooping crane (*Grus americana*) is an omnivorous, wading bird. The whooping crane formerly ranged from summer breeding grounds within the central Canadian provinces and northern prairie states to southern coastal wintering grounds from central Mexico to the Carolinas (Bent, 1926). Whooping cranes currently exist in three wild populations and at five captive locations (USDOI, FWS, 1994). The only self-sustaining wild population nests in the Northwest Territories and adjacent areas of Alberta, Canada, primarily within the boundaries of Wood Buffalo National Park (WBNP). These birds winter in coastal marshes and estuarine habitats along the Gulf of Mexico coast at Aransas National Wildlife Refuge (ANWR), Texas, and represent the majority of the world's population of free-ranging whooping cranes. Another wild flock was created with the transfer of wild whooping crane eggs from nests in the WBNP to be reared by wild sandhill cranes in an effort to establish a migratory, Rocky Mountains Population (USDOI, FWS, 1994). This population summers in Idaho, western Wyoming, and southwestern Montana and winter in the middle Rio Grande Valley, New Mexico. The third wild population is the first step in an effort to establish a nonmigratory population in Florida (USDOI, FWS, 1994). The December 1993 wild population was estimated at 160; the captive population contained 101 birds (USDOI, FWS, 1994).

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) is the only species of sea eagle that regularly occurs on the North American continent (USDOI, FWS, 1984). Its range extends from central Alaska and Canada to northern Mexico. The bulk of the bald eagle's diet is fish, though bald eagles will opportunistically take birds, reptiles, and mammals (USDOI, FWS, 1984). The historical nesting range of the bald eagle within the Southeast United States included the entire coastal plain and shores of major rivers and lakes. The current range is limited, with most breeding pairs occurring in Florida and Louisiana, and some in South Carolina, Alabama, and east Texas. One hundred twenty nests have been found in Louisiana; only 3 nests occurred within 5 mi of the coast (Patrick, written communication, 1997). The bald eagle was listed as endangered in 1967 in response to the declines due to DDT and other organochlorines that affected the species' reproduction (USDOI, FWS, 1984). Recovery may be slowed by human disturbance if it affects the abundance of preferable trees for nesting and perching. Preferred perch trees may be relatively large in diameter, height, surrounding percent forest cover, surrounding size of block of forest, height of surrounding canopy above the ground, height of perch above surrounding canopy, and size of the angle of open flight path to the perch (Buehler et al., 1992; Chandler et. al., 1995). For preferred nest trees, important features may be proximity to water (usually within 1/2 mile), a clear flight path to a close point on the water, an open view of the surrounding area and proximity to preferable perch trees. In July 1995, the FWS reclassified the bald eagle from endangered to threatened in the lower 48 states (*Federal Register*, 1995b).

Brown Pelican

The brown pelican (*Pelicanus occidentalis*) is one of two pelican species in North America. It feeds entirely upon fishes captured by plunge diving in coastal waters. Organochlorine pesticide pollution apparently contributed to the endangerment of the brown pelican. Organochlorines like DDT accumulate up the food web and reach their highest concentrations in predators such as the brown pelican. The pesticides interfere with calcium metabolism, causing reduced calcification of egg shells, and potentially allowing the eggs to be crushed under the weight of an incubating parent. In recent years, there has been a marked increase in brown pelican populations within the former range of the species. The population of brown pelicans and their habitat in Alabama, Florida, Georgia, North and South Carolina, and points northward along the Atlantic Coast were removed from the endangered species list in 1985; however, within the remainder of the range, which includes coastal areas of Texas, Louisiana, and Mississippi, where populations are not secure, the brown pelican remains listed as endangered (*Federal Register*, 1985b). Ten thousand nests and an estimated 25,000 adults were found in Louisiana (Patrick, written communication, 1997). The Louisiana Department of Wildlife and Fisheries submitted a request in March 1994 to the FWS to officially remove the eastern brown pelican from the endangered species list in Louisiana (Louisiana Dept. of Wildlife and Fisheries, 1994).

Least Tern

The least tern (*Sterna antillarum*) is the smallest North American tern. Three subspecies of New World least terns were recognized by the American Ornithologists' Union (1957). These are the interior least tern (*Sterna antillarum athalossus*), the eastern or coastal least tern (*S. antillarum antillarum*), and the California least tern (*S. antillarum browni*). According to *Federal Register* (1985b), "Because of the taxonomic uncertainty of least tern subspecies in eastern North America, the [Fish and Wildlife] Service decides not to specify the subspecies in this final rule. Instead the Service designates as endangered the population of least terns (hereinafter referred to as interior least tern) occurring in the interior of the United States." Least terns within 50 mi of the Gulf Coast are not are listed as endangered and will not be further analyzed here.

3.2.8. Gulf Sturgeon

The Gulf sturgeon (*Acipenser oxyrinchus desotoi*) is the only listed threatened fish species in the Gulf of Mexico. In 1991, the Gulf sturgeon was listed as threatened. Subsequently, a recovery plan was developed to ensure the preservation and protection of Gulf sturgeon spawning habitat (USDOI, FWS, and Gulf States Marine Fisheries Commission, 1995). The decline of the Gulf sturgeon is believed to be due to overfishing and habitat destruction, primarily the damming of coastal rivers and the degradation of water quality (Barkuloo, 1988).

A subspecies of the Atlantic sturgeon, the Gulf sturgeon is anadromous, with immature and mature fish participating in freshwater migrations. Gill netting and biotelemetry have shown that subadults and adults spend 8-9 months each year in rivers and 3-4 of the coolest months in estuaries or Gulf waters. Sturgeon less than about two years old remain in riverine habitats and estuaries throughout the year (Clugston, 1991). According to Wooley and Crateau (1985), the present range of the Gulf sturgeon is probably from the Suwanee River in west-central Florida to eastern Louisiana. Extant occurrences of the fish have been reported near Galveston Island in southeast Texas (one specimen) east to Charlotte Harbor in southwest Florida (5 fish) (USDOI, FWS and Gulf States Marine Fisheries Commission, 1995). Gulf sturgeon population sizes are largely unknown throughout the species' range, but estimates have been completed recently for the Suwannee, Apalachicola, and West Pearl Rivers, and the first year of a 3-year study has been completed on the Choctawhatchee River. Surveys have not been conducted yet on the remaining river systems that historically contained Gulf sturgeon. Gulf sturgeon historically spawned in major rivers of Alabama, Mississippi, and the Florida northern Gulf Coast. Until recently only two spawning sites were known, both in the Suwannee River in Florida. Eggs have now been discovered in six locations within the Choctawhatchee River system in Florida and Alabama (Fox and Hightower, 1998). In spring, large subadults and adults that migrate from the estuaries or the Gulf into major river passes feed primarily on lancelets, brachiopods, amphipods, polychaetes, and globular molluscs. Small sturgeon that remain in river passes during spring feed on amphipods, shrimp, isopods, oligochaetes, and aquatic insect larvae (Clugston, 1991). During the riverine stage, adults cease feeding, undergo gonadal maturation, and migrate upstream to spawn. Spawning occurs in freshwater reaches of the river, over coarse substrate in deep areas or holes with hard bottoms and where some current is present (Sulak and Clugston, 1998; Fox et al., 2000). Females lay large numbers of eggs. A large female was reported to have the capability of producing of 275,000-475,000 eggs (Chapman at al., 1993). These eggs are adhesive and will attach to rocks, vegetation, or other objects. They hatch in about 1 week depending upon the temperature of the water.

Fisheries scientists interrupt migrating Gulf sturgeon in the rivers and estuaries by capture with nets suspended from floats in the rivers and river mouths. Gill nets with mesh wide enough not to close the very large opercula are used. No capture or tracking is feasible in the open Gulf just when the fish migrate into it because cold fronts come every 2-3 days, with up to 9-ft seas. Conditions are dangerous for the size of vessel required, and the paths traveled in the open Gulf cannot be followed beyond the estuaries. Thus, the offshore winter distribution of Gulf sturgeon relative to the location of the activities under the proposed action is unknown. However, there have been no reported catches of this species in Federal waters (Sulak, personal communication, 1997).

Tagging studies suggest that Gulf sturgeon exhibit a high degree of river fidelity. Stabile et al. (1996) analyzed Gulf sturgeon populations from eight drainages along the Gulf of Mexico for genetic diversity. He noted significant differences among Gulf sturgeon stocks and suggested that they displayed region-specific affinities and may exhibit river-specific fidelity. Stabile et al. (1996) identified five regional or river-specific stocks (from west to east): (1) Lake Pontchartrain and Pearl River, (2) Pascagoula River, (3) Escambia and Yellow Rivers, (4) Choctawhatchee River, and (5) Apalachicola, Ochlockonee, and Suwannee Rivers.

Sturgeon are bottom suction feeders that have ventrally located, highly extrusible mouths. The sturgeon head is dorsoventrally compressed with eyes dorsal so benthic food under the sturgeon's mouth will not be visible. However, they have taste barbels, like catfish, to detect prey. The barbels are also useful for feeding in high-order streams when they are muddy. However, Gulf sturgeon are common in clear water streams also. The barbels may locate food at night when visibility of prey is low from any direction. Fishes that forage by taste are opportunistic feeders because smell is much more discriminating than taste. Another adaptation of sturgeon to mainstem rivers and offshore waters is mobility (an adaptation to the large habitat scale). High fecundity (egg number) facilitates wide dispersal, a major adaptation to the high variance of habitat quality resulting from diverse habitats and dynamic nature of mainstems of watersheds. A major threat to sturgeon populations in various species worldwide is damming of the mainstem rivers.

3.2.9. Fisheries

3.2.9.1. Fish Resources

Ichthyoplankton

Most fishes inhabiting the Gulf of Mexico, whether benthic or pelagic as adults, have pelagic larval stages. For various lengths of time (10-100 days depending on the species), these pelagic eggs and larvae become part of the planktonic community. Variability in survival and transport of pelagic larval stages is thought to be an important determinant of future year-class strength in adult populations of fishes and invertebrates (Underwood and Fairweather, 1989; Doherty and Fowler, 1994). For this reason, larval fishes and the physical and biological factors that influence their distribution and abundance have received increasing attention from marine ecologists. In general, the distribution of fish larvae depends on spawning behavior of adults, hydrographic structure and transport at a variety of scales, duration of the pelagic period, behavior of larvae, and larval mortality and growth (Leis, 1991).

Ichthyoplankton sampling at a regional scale in the Gulf of Mexico began in the early 1970's with routine surveys for king and Spanish mackerel larvae (Wollam, 1970; Dwinell and Futch, 1973). Houde et al. (1979) conducted major surveys of ichthyoplankton in the Eastern Gulf of Mexico from 1972 to 1974. They sampled 483 stations located on a grid extending from 24º 30′ N. latitude to 29º 30′ N. latitude and from depths of 10-200 m (33-656 ft). Finucane et al. (1977) collected eggs and ichthyoplankton from areas off the Texas continental shelf over a three-year period (1975-1977) as part of the South Texas Outer Continental Shelf Studies. They sampled between Port Isabel and Matagorda Bay, Texas, covering an area of approximately 100 by 300 km. In 1977, the first comprehensive surveys of the Southeastern Area Monitoring and Assessment Program (SEAMAP) began collecting larval fishes in the Gulf of Mexico from a grid of sampling stations encompassing the entire northern Gulf of Mexico (Sherman et al., 1983; Richards et al., 1984; Kelley et al., 1986). More recently, larval fish researchers have been sampling well-defined hydrographic features such as the Mississippi River discharge plume (Govoni et al., 1989; Grimes and Finucane, 1991) and the Loop Current frontal boundary (Richards et al., 1989 and 1993). These studies have used real-time physical oceanographic data to guide sampling near the hydrographic features of interest. For the aforementioned surveys, most investigators sampled ichthyoplankton using towed bongo (water column) and neuston (sea surface) nets and occasionally discrete depth nets, with mesh sizes ranging from 0.333 to 1.00 mm (Ditty et al., 1988). Taxonomic resolution in most published studies is at the family level.

Richards (1990) estimates that there are 200 families with more than 1,700 species whose early life stages may occur in the Gulf of Mexico. In addition to the resident fauna, many eggs, larvae, and juveniles may be advected into the Gulf from the Caribbean Sea via the Loop Current. In their study of the Loop Current front, Richards et al. (1993) identified 237 taxa representing 100 families. They considered this a remarkable family-level diversity when compared with previous surveys made in the Gulf of Mexico and other oceans. The diversity was attributed to a mix of fauna from tropical and warm temperate oceanic, mesopelagic, and coastal demersal and pelagic species. The larval sampling surveys by Houde et al. (1979) yielded over 200 taxa from 91 families in the Eastern Gulf of Mexico. Ditty et al. (1988) summarized information from over 80 ichthyoplankton studies from the northern Gulf of Mexico (north of 26º N) and reported 200 coastal and oceanic fishes from 61 families. Preliminary SEAMAP cruises collected 137 genera and species from 91 families (Sherman et al., 1983). The most abundant families collected in the Eastern Gulf by Houde et al. (1979) were clupeids (herrings), gobiids (gobies), bregmacerotids (codlets), carangids (jacks), synodontids (lizardfishes), myctophids (lanternfishes), serranids (seabasses), ophidiids (cusk eels), and labrids (wrasses). These families contributed 64 percent of the total taxa collected by Houde et al. (1979). Finucane et al. (1977) reported the most dominant taxa from their south Texas collections occurred in the myctophids (lanternfishes) followed by the sciaenids (drums) and scombrids (mackerels and tunas). Sherman et al. (1983) compared the rank order of the 21 most abundant families overall and by quadrant (northeast, northwest, southeast, southwest) taken during early SEAMAP cruises (Table 3-6).

Species such as Atlantic croaker, spot, and Gulf menhaden migrate to the outer shelf during winter months to spawn. Consequently, larvae of these species are often numerically dominant during winter months. Many families have numerous species within them, such as engraulids, searobins (Triglidae), tonguefishes (Cygnoglossidae), and pufferfishes (Tetradontiidae). Species from these families were collected during all months.

Many taxa were only collected over waters within certain depth ranges (Table 3-7). Species found exclusively in water depths shallower than 25 m (82 ft) were mostly inshore demersal species such as Atlantic bumper (*Caranx ruber*), spotted seatrout (*Cynoscion nebulosus*), pigfish (*Orthopristis chrysoptera*), and black drum (*Pogonias cromis*). At depths >100 m (>328 ft), several clupeids (*Brevoortia patronus*, *Opisthonema oglinum*, and *Sardinella aurita*), several serranids (*Centropristis striata*, *Diplectrum formosum*, and *Serraniculus pumilio*), Atlantic croaker (*Micropogon undulatus*), and spot (*Bairdiella chrysura*) were most common in collections. Two tunas (*Auxis* sp. and *Euthynnus alletteratus*), blue runner (*Caranx crysos*), round herring (*Etrumeus teres*), red barbier (*Hemanthias vivanus*), red snapper (*Lujanus campechanus*), king mackerel (*Scomberomorus cavalla*), and rough scad (*Trachurus lathami*) were collected only over water depths of 50-200 m (164-656 ft). Wide-ranging epipelagic species such as skipjack tuna (*Euthynnus pelamis*), sailfish (*Istiophorus platypterus*), and Atlantic swordfish (*Xiphias gladius*) were collected only in water depths exceeding 150 m (492 ft).

Two of the most important hydrographic features in the Gulf of Mexico are the Mississippi River discharge plume and the Loop Current. A series of investigations have shown that ichthyoplankton aggregate at the frontal zone of the Mississippi River discharge plume (Govoni et al., 1989; Grimes and Finucane, 1991; Govoni and Grimes, 1992). Grimes and Finucane (1991) sampled larval fishes, chlorophyll *a*, and zooplankton along transects traversing the discharge plume. Total ichthyoplankton catch per tow, individual surface chlorophyll *a* values, and zooplankton volumes were all considerably greater in frontal waters than adjacent shelf or plume waters. They found that when comparing catches of ichthyoplankton among shelf, frontal, and plume samples that frontal samples contained a higher average number of fish larvae than either plume or shelf waters. Hydrodynamic convergence and the continually reforming turbidity fronts associated with the discharge plume probably accounted for the concentration of larval fishes at the front. These investigators hypothesized that frontal waters provide feeding and growth opportunities for larvae. Bothids, carangids, engraulids, exocoetids, gobiids, sciaenids, scombrids, synodontids, and tetraodontids were the nine most frequently caught taxa in the plume/shelf samples off the Mississippi River Delta (Grimes and Finucane, 1991).

Richards et al. (1989 and 1993) examined the distribution of larval fishes along eight transects across the Loop Current boundary, as defined from satellite imagery of sea surface temperature. Most of the samples were off the continental shelf in water depths exceeding 200 m (656 ft). Although 100 fish families were identified, only 25 families were represented by >0.5 individuals/sample. Of these, the lanternfishes were most abundant. A cluster analysis of the 25 most-abundant families resolved three assemblages: oceanic, shelf, and frontal. The oceanic assemblage consisted of mesopelagic families such as hachetfishes (sternoptichyids), lanternfishes (myctophids), and bristlemouths (gonostomatids). The shelf group was subdivided into three groups including demersal taxa (e.g., sciaenids and bothids), coastal pelagic taxa (e.g., carangids and scombrids), and widely dispersing reef species (e.g., labrids, scarids, and scorpaenids). The frontal group consisted of both oceanic and shelf taxa. These studies suggest that water temperature is a major influence on the structure of larval fish assemblages (Richards et al., 1993).

All of the studies previously mentioned were conducted in the open Gulf of Mexico in shelf or oceanic waters. One survey by Ruple (1984) concentrated on the surf zone ichthyoplankton along a barrier island beach offshore Mississippi. Over the course of a year, Ruple (1984) sampled inner and outer surf zone regions and collected almost 40,000 larval fishes represented by 69 taxa. The most abundant taxa collected from the outer surf zone were anchovies (Engraulidae), Atlantic bumper, and tonguefishes. From the inner surf zone, engraulids, spot, Gulf menhaden, and hogchoker were most abundant. Seasonal peaks in abundance occurred at the outer surf zone stations during May and June and at the inner surf zone stations during December. The importance of the surf zone as habitat for larval fishes was not clear, but it appeared as though many of the larvae collected were large in size and may have been intercepted during their shoreward migration into Mississippi Sound where they would normally take up residence as benthic juveniles.

Larval fishes are highly dependent on zooplankton until they can feed on larger prey. In the northern Gulf of Mexico, the diets of Atlantic croaker, Gulf menhaden, and spot consist mainly of copepods and copepod nauplii, larval bivalves, pteropods, and the dinoflagellate *Prorocentrum* sp. (Govoni et al., 1989).

Fishes

Finfish

The Gulf of Mexico supports a great diversity of fish resources that are related to variable ecological factors, including salinity, primary productivity, and bottom type. These factors differ widely across the Gulf of Mexico and between the inshore and offshore waters. Characteristic fish resources are associated with the various environments and are not randomly distributed. High densities of fish resources are associated with particular habitat types. Most finfish resources are linked both directly and indirectly to the vast estuaries that ring the Gulf of Mexico. Finfish are directly estuary dependent when the population relies on low-salinity brackish wetlands for most of their life history, such as during the maturation and development of larvae and juveniles. Even the offshore demersal species are indirectly related to the estuaries because they influence the productivity and food availability on the continental shelf (Darnell and Soniat, 1979; Darnell, 1988). Approximately 46 percent of the southeastern United States wetlands and estuaries important to fish resources are located within the Gulf of Mexico (Mager and Ruebsamen, 1988). Consequently, estuary-dependent species of finfish and shellfish dominate the fisheries of the central and north-central Gulf.

The life history of estuary-dependent species involves spawning on the continental shelf; transporting eggs, larvae, or juveniles to the estuarine nursery grounds; growing and maturing in the estuary; and migrating of the young adults back to the shelf for spawning. After spawning, the adult individuals generally remain on the continental shelf. Movement of adult estuary-dependent species is essentially onshore-offshore with no extensive east-west or west-east migration.

Estuary-related species of commericial importance include menhaden, shrimps, oyster, crabs, and sciaenids. Estuary communities are found from east Texas through Louisiana, Mississippi, Alabama, and northwestern Florida. Darnell et al. (1983) and Darnell and Kleypas (1987) found that the density distribution of fish resources in the Gulf was highest nearshore off the central coast. For all seasons, the greatest abundance occurred between Galveston Bay and the Mississippi River. The abundance of fish resources in the far Western and Eastern Gulf of Mexico is patchy. The high-salinity bays of the Western Gulf contain no distinctive species, only a greatly reduced component of the general estuary community found in lower salinities (Darnell et al., 1983).

Estuaries and rivers of the Gulf of Mexico export considerable quantities of organic material, thereby enriching the adjacent continental shelf areas (Grimes and Finucane, 1991; Darnell and Soniat, 1979). Populations from the inshore shelf zone (7-14 m) are dominated seasonally by Atlantic croaker, spot, drum, silver seatrout, southern kingfish, and Atlantic threadfin. Populations from the middle shelf zone (27-46 m) include sciaenids but are dominated by longspine porgies. The blackfin searobin, Mexican searobin, and shoal flounder are dominant on the outer shelf zone (64-110 m).

The degradation of inshore water quality and loss of Gulf wetlands as nursery areas are considered significant threats to fish resources in the Gulf of Mexico (Christmas et al., 1988; Horst, 1992a). Loss of wetland nursery areas in the north-central Gulf is believed to be the result of channelization, river control, and subsidence of wetlands (Turner and Cahoon, 1988). Loss of wetland nursery areas in the far Western and Eastern Gulf is believed to be the result of urbanization and poor water management practices (USEPA, 1989a).

Gulf menhaden and members of the Sciaenidae family such as croaker, red and black drum, and spotted sea trout are directly dependent on estuaries during various phases of their life history. The occurrence of dense schools, generally by members of fairly uniform size, is an outstanding characteristic that facilitates mass production methods of harvesting menhaden. The seasonal appearance of large schools of menhaden in the inshore Gulf waters from April to November dictates the menhaden fishery (Nelson and Ahrenholz, 1986). Larval menhaden feed on pelagic zooplankton in marine and estuarine waters. Juvenile and adult Gulf menhaden become filter-feeding omnivores that primarily consume phytoplankton, but also ingest zooplankton, detritus, and bacteria. As filter-feeders, menhaden form a basal link in estuarine and marine food webs and, in turn, are prey for many species of larger fish (Vaughan et al., 1988).

Sciaenids are opportunistic carnivores whose food habits change with size. Larval sciaenids feed selectively on pelagic zooplankton, especially copepods. Juveniles feed upon invertebrates, changing to a primarily fish diet as they mature (Perret et al., 1980; Sutter and McIlwain, 1987; USDOC, NOAA, 1986).

Reeffish species occur in close association with natural or manmade materials on the seafloor. Live-bottom areas of low or high vertical relief partition reefal areas from surrounding sand/shell hash/mud bottom. A number of important reeffish species share the common life history characteristics of offshore spawning and transport of larvae inshore to settle in estuaries and seagrass meadows where they spend an obligatory nursery phase before recruiting to adult stocks offshore. Among these fishes are both winter and summer spawners, with gag (*Mycteroperca micolepis*) and grey snapper (*Lutjanus griseus*), respectively, being good examples. Gag have become a particularly significant species in the Eastern Gulf where spawning aggregations have been studied over a significant period. Gag spawn in February and March in a defined area west of the Florida Middle Ground, and larvae are transported inshore to settle in seagrass meadows 30-50 days later. Two new reserves have been designated (described in Chapter 3.3.1) in this area where fishing activities have been prohibited. Juveniles remain in the seagrass nursery areas until October or November when they recruit to adult stocks offshore.

Other reeffish species are considered nonestuary dependent such as the red snapper, which remain close to underwater structure. Red snapper feed along the bottom on fishes and benthic organisms such as crustaceans and mollusks. Juveniles feed on zooplankton, small fish, crustaceans, and mollusks (Bortone and Williams, 1986; USDOC, NOAA, 1986).

Many of the commercially important fish species in the Gulf of Mexico are believed to be in decline due to overfishing (USDOC, NMFS, 2001a). Continued fishing at the present levels is likely to result in eventual failure of certain fisheries. Competition between large numbers of fishermen, between fishing operations employing different methods, and between commercial and recreational fishermen for a given resource may reduce standing populations. Fishing techniques such as trawling, gill netting, or purse seining, when practiced nonselectively, may reduce the standing stocks of the desired target species as well as substantially affect fish resources other than the target. Standing stocks of some traditional fisheries, such as shrimp, shark, and tuna, have declined in the past and have required additional management restrictions resulting in some successes (Goodyear and Phares, 1990; USDOC, NMFS, 1999a; Rothschild et al., 1997; Schirripa and Legault, 1997). Recruitment is by far the most important, yet the least understood, factor contributing to changes in the numbers of harvestable Gulf fish. Natural phenomena such as weather, hypoxia, and red tides may reduce standing populations. Finally, hurricanes may affect fish resources by destroying oyster reefs and changing physical characteristics of inshore and offshore ecosystems (Horst, 1992a).

Shellfish

To a greater degree, estuaries determine the shellfish resources of the Gulf of Mexico. Life history strategies are influenced by tides, lunar cycles, maturation state, and estuarine temperature changes. Very few individuals live more than a year, and most are less than six months old when they enter the extensive inshore and nearshore fishery. Year-to-year variations in shellfish populations are frequently as high as 100 percent and are most often a result of extremes in salinity and temperature during the period of larval development. Shellfish resources in the Gulf range from those located only in brackish wetlands to those found mainly in saline marsh and inshore coastal areas. Life history strategies reflect estuary relationships, ranging from total dependence on primary productivity to opportunistic dependence on benthic organisms. Gulf shellfish resources are an important link in the estuary food chain between benthic and pelagic organisms (Darnell et al., 1983; Darnell and Kleypas, 1987; Turner and Brody, 1983).

Up to 15 species of penaeid shrimp can be expected to use the coastal and estuarine areas in the Gulf of Mexico. Brown, white, and pink shrimp are the most numerous. Pink shrimp have an almost continuous distribution throughout the Gulf but are most numerous on the shell, coral sand, and coral silt bottoms off southern Florida. Brown and white shrimp occur in both marine and estuarine habitats. Adult shrimp spawn offshore in high salinity waters; the fertilized eggs become free-swimming larvae. After several molts they enter estuarine waters as postlarvae. Wetlands within the estuary offer both a concentrated food source and a refuge from predators. After growing into juveniles the shrimp larvae leave the saline marsh to move offshore where they become adults. The timing of immigration and emigration, spatial use of a food-rich habitat, and physiological and evolutionary adaptations to tides, temperature, and salinity differ between the two species (Muncy, 1984; Turner and Brody, 1983; USDOC, NOAA, 1986).

About eight species of portunid (swimming) crabs use the coastal and estuarine areas in the Gulf of Mexico. Blue crabs (*Callinectes sapidus*) are the only species, however, that is located throughout the Gulf and comprises a substantial fishery. They occur on a variety of bottom types in fresh, estuarine and shallow offshore waters. Spawning grounds are areas of high salinity such as saline marshes and nearshore waters.

Vast intertidal reefs constructed by sedentary oysters are prominent biologically and physically in estuaries of the Gulf of Mexico. Finfishes, crabs, and shrimp are among the animals using the intertidal oyster reefs for refuge and also as a source of food, foraging on the many reef-dwelling species. Reefs, as they become established, modify tidal currents and this, in turn, affects sedimentary patterns. Further, the reefs contribute to the stability of bordering marsh (Kilgen and Dugas, 1989). Additional information on shellfish and their life histories can be found in GMFMC (1998).

Pelagics

Pelagic fishes occur throughout the water column from the beach to the open ocean. Water-column structure (temperature, salinity, and turbidity) is the only partitioning of this vast habitat. On a broad scale, pelagic fishes recognize different watermasses based upon physical and biological characteristics. Three ecological groups, delineated by watermass, will be discussed individually:

- coastal pelagic species;
- oceanic pelagic species; and
- mesopelagic species.

Coastal pelagic species occur in waters from the shoreline to the shelf edge. Oceanic species occur mainly in oceanic waters offshore from the shelf break; however, some species venture onto the shelf with watermass (e.g., Loop Current) intrusions. Mesopelagic fishes occur below the oceanic species group in the open ocean, usually at depths of 200-1,000 m (656-1,280 ft) depending upon absolute water depth.

For coastal pelagic fishes, commercial fishery landings are one of the best sources of information because these species are an important component of nearshore net and hook-and-line fisheries. Some smaller nektonic fishes occupying the surf zone along exposed beaches have been collected with seines (Naughton and Saloman, 1978; Ross, 1983). Information on the distribution and abundance of oceanic species comes from commercial longline catches and recreational fishing surveys. In addition, NMFS has conducted routine surveys of the Gulf of Mexico billfishery since 1970 (Pristas et al., 1992). Mesopelagic species are not harvested commercially but have been collected in special, discrete-depth nets that provide some quantitative data on relative abundance (Bakus et al., 1977; Hopkins and Lancraft, 1984; Hopkins and Baird, 1985; Gartner et al., 1987).

Recently, additional restrictions have been placed on the harvest of some sharks. Effective July 1, 2000, it is prohibited to retain, possess, sell, or purchase the following sharks: white, basking, sand tiger, bigeye sand tiger, dusky, bignose, Galapagos, night, Caribbean reef, narrowtooth, Caribbean sharpnose, smalltail, Atlantic angel, longfin, mako, bigeye thresher, sevengill, sixgill, and bigeye sixgill.

Coastal Pelagics

The major coastal pelagic families occurring in the region are Carcarhinidae (requiem sharks), Elopidae (ladyfish), Engraulidae (anchovies), Clupeidae (herrings), Scombridae (mackerels and tunas), Carangidae (jacks and scads), Mugilidae (mullets), Pomatomidae (bluefish), and Rachycentridae (cobia). Coastal pelagic species traverse shelf waters of the region throughout the year. Some species form large schools (e.g., Spanish mackerel), while others travel singly or in smaller groups (e.g., cobia). The distribution of most species depends upon water-column structure, which varies spatially and seasonally.

Some coastal pelagic species show an affinity for vertical structure and are often observed around natural or artificial structures, where they are best classified as transients rather than true residents. This is particularly true for Spanish sardine, round scad, blue runner, king mackerel, and cobia (Klima and Wickham, 1971; Chandler et al., 1985).

Some coastal pelagic species are found along high-energy sandy beaches from the shoreline to the swash zone (Ross, 1983). An estimated 44-76 species, many of them coastal pelagics, occur in the surf zone assemblage. Surveys have shown a high degree of dominance, with 4-10 species accounting for 90 percent of the numbers collected. In the northern Gulf of Mexico, pelagic species such as scaled sardine, Florida pompano, and various anchovies are among the numerically dominant species in seine collections (Ross, 1983). Surf zone fish assemblages show considerable seasonal structuring in the northern Gulf of Mexico (Naughton and Saloman, 1978; Ross and Modde, 1981). The lowest abundance of all species occurs in winter, with peak numbers found during summer and fall. Larger predatory species (particularly bluefish, Spanish mackerel, and blue runner) may be attracted to large concentrations of anchovies, herrings, and silversides that congregate in the surf zone.

Coastal pelagic fishes can be divided into two ecological groups. The first group includes larger predatory species such as king and Spanish mackerel, bluefish, cobia, jacks, and little tunny. These species typically form schools, undergo migrations, grow rapidly, mature early, and exhibit high fecundity. The second group exhibits similar life history characteristics, but the species are smaller in body size and are planktivorous. This group is composed of Gulf menhaden, thread herring, Spanish sardine, round scad, and anchovies. Species in the second group are preyed upon by the larger species in the first group; thus, the two are ecologically important in energy transfer in the nearshore environment (Saloman and Naughton, 1983 and 1984).

Commercial purse seine fisheries generate high landings of several coastal pelagic species in the region. The Gulf menhaden fishery produces the highest fishery landings in the U.S. (USDOC, NMFS, 2001b). Menhaden form large, surface-feeding schools in waters near the Mississippi Delta from April through September. Fishermen take advantage of this schooling behavior, capturing millions of pounds each year with large purse nets. Other coastal pelagic species contributing high commercial landings are round scad and ladyfish.

Most of the large-bodied, predatory coastal pelagic species are important to commercial or recreational fisheries. King and Spanish mackerel, cobia, and jacks are sought by the charter and head-boat fisheries in the region. King mackerel occurring in the shelf waters of the region may actually come from two distinct populations (Johnson et al., 1994). The eastern population migrates from near the Mississippi Delta eastward, then southward around the Florida peninsula, wintering off southeastern Florida (Sutter et al., 1991). The western population travels to waters off the Yucatan Peninsula during winter. In summer, both populations migrate to the northern Gulf of Mexico, where they intermix to an unknown extent (Johnson et al., 1994). Spanish mackerel, cobia, bluefish, jack crevalle, and coastal sharks are migratory, but their routes have not been studied.

Oceanic Pelagics

Common oceanic pelagic species include tunas, marlins, sailfish, swordfish, dolphins, wahoo, and mako sharks. In addition to these large predatory species, there are halfbeaks, flyingfishes, and driftfishes (Stromateidae). Lesser-known oceanic pelagics include opah, snake mackerels (Gempylidae), ribbonfishes (Trachipteridae), and escolar.

Oceanic pelagic species occur throughout the Gulf of Mexico, especially at or beyond the shelf edge. Oceanic pelagics are reportedly associated with mesoscale hydrographic features such as fronts, eddies, and discontinuities. Fishermen contend that yellowfin tuna aggregate near sea-surface temperature boundaries or frontal zones; however, Power and May (1991) found no correlation between longline catches of yellowfin tuna and sea-surface temperature (defined from satellite imagery) in the Gulf of Mexico. The occurrence of bluefin tuna larvae in the Gulf of Mexico associated with the Loop Current boundary and the Mississippi River discharge plume is evidence that these species spawn in the Gulf of Mexico (Richards et al., 1989). Many of the oceanic fishes associate with drifting *Sargassum*, which provides forage areas and/or nursery refugia.

Mesopelagics

Mesopelagic fish assemblages in the Gulf of Mexico are numerically dominated by myctophids (lanternfishes), with gonostomatids (bristlemouths) and sternoptychids (hachetfishes) common but less abundant in collections. These fishes make extensive vertical migrations during the night from mesopelagic depths (200-1,000 m or 656-3,280 ft) to feed in higher, food rich layers of the water column (Hopkins and Baird, 1985). Mesopelagic fishes are important ecologically because they transfer substantial amounts of energy between mesopelagic and epipelagic zones over each diel cycle.

Hopkins and Lancraft (1984) collected 143 mesopelagic fishes from the Eastern Gulf of Mexico during 12 cruises from 1970 to 1977. Most of their collections were made near 27º N, 86º W. Lanternfishes were most common in the catches made by Bakus et al. (1977) and Hopkins and Lancraft (1984). Bakus et al. (1977) analyzed lanternfish distribution in the western Atlantic Ocean and recognized the Gulf of Mexico as a distinct zoogeographic province. Species with tropical and subtropical affinities were most prevalent in the Gulf of Mexico lanternfish assemblage. This was particularly true for the Eastern Gulf, where Loop Current effects on species distribution were most pronounced. Gartner et al. (1987) collected 17 genera and 49 species of lanternfish in trawls fished at discrete depths from stations in the South, Central, and Eastern Gulf. The most abundant species in decreasing order of importance were *Ceratoscopleus warmingii*, *Notolychus valdiviae*, *Lepidophanes guentheri*, *Lampanyctus alatus*, *Diaphus dumerili*, *Benthosema suborbitale*, and *Myctophum affine*. Ichthyoplankton collections from oceanic waters yielded high numbers of mesopelagic larvae as compared with larvae of other species (Richards et al., 1989). Lanternfishes generally spawn year-round, with peak activity in spring and summer (Gartner, 1993).

3.2.9.2. Essential Fish Habitat

The Essential Fish Habitat Program in the Gulf of Mexico

As outlined in Chapter 1.3, the Magnuson Fishery Conservation and Management Act of 1976, as amended through 1998, places new requirements on any Federal agency regarding essential fish habitat (EFH). The MMS must now describe how actions under their jurisdiction may affect EFH. All Federal agencies are encouraged to include EFH information and assessments within NEPA documents.

An EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Because of the wide variation of habitat requirements for all life history stages (as described above), EFH for the Gulf of Mexico includes all estuarine and marine waters and substrates from the shoreline to the seaward limit of the U.S. Exclusive Economic Zone (EEZ).

The NOAA Fisheries also recommends that Fishery Management Plans identify habitat areas of particular concern (HAPC's). The general types of HAPC include the following: nearshore areas of intertidal and estuarine habitats that may provide food and rearing for juvenile fish and shell fish managed by the Fishery Management Council (FMC); offshore areas with substrates of high habitat value or vertical relief, which serve as cover for fish and shell fish; and marine and estuary habitat used for migration, spawning, and rearing of fish and shellfish. Marine sanctuaries and national estuary reserves have been designated in the area managed by the Gulf of Mexico FMC and are considered to be HAPC's that meet the above general guidelines. These HAPC's are the Flower Garden Banks National Marine Sanctuary, Weeks Bay National Estuarine Research Reserve, and Grand Bay, Mississippi.

The requirements for an EFH description and assessment are as follows: (1) description of the proposed action; (2) description of the action agency's approach to protection of EFH and proposed mitigation, if applicable; (3) description of EFH and managed and associated species in the vicinity of the proposed action; and (4) analysis of the effects of the proposed and cumulative actions on EFH, the managed species, and associated species. Chapters 1 and 2 contain descriptions of the proposed actions. Chapters 1.5 and 2.2.2 discuss MMS's approach to the preservation of EFH with specific mitigations. Chapter 3.2.1 details coastal areas that are considered EFH including wetlands and areas of submerged vegetation. Chapter 3.2.2 describes live-bottom formations and their biotic assemblages, which are considered EFH. Below is a discussion of managed species and additional mitigating factors. Chapters 4.2.1.10 and 4.3.1.8 contain the impact analysis of the proposed actions on EFH. Chapter 4.4.3.10 contains the impact analysis for accidental spills on EFH. Chapter 4.5.10 contains the impact analysis of cumulative actions.

Managed Species

The Gulf of Mexico Fishery Management Council (GMFMC) currently describes Fishery Management Plans (FMP's) for the following species. These species or species complexes are brown shrimp (*Penaeus aztecus)*, pink shrimp (*Penaeus duorarum)*, white shrimp (*Penaeus setiferus*), royal red shrimp (*Pleoticus robustus*), red drum (*Sciaenops ocellata*), black grouper (*Mycteroperca bonaci*), red grouper (*Epinephelus morio*), gag grouper (*Mycteroperca microlepis*), scamp (*Mycteroperca phenax*), red snapper *(Lutjanus campechanus*), gray snapper (*Lutjanus griseus*), yellowtail snapper (*Ocyurus chrysurus*), lane snapper (*Lujanus syngagris*), vermilion snapper (*Rhomboplites aurorubens*), gray triggerfish (*Balistes capriscus*), greater amberjack (*Seriola dumerili*), lesser amberjack (*Seriola fasciata*), tilefish (Branchiostegidae), king mackerel (*Scomberomorus cavalla*), Spanish mackerel (*Scomberomorus maculatus*), bluefish (*Pomatomus saltatrix*), cobia (*Rachycentron canadum*), dolphin (*Coryphaena hippurus*), little tunny (*Euthynnus alleteratus*), stone crab (*Menippe spp*.), spiny lobster (*Panulirus spp*.), and coral (Anthoza). None of the stocks managed by the GMFMC are endangered or threatened.

Occurrence of these managed species, along with major adult prey species and relationships with estuary and bay systems in the Eastern Gulf of Mexico, is outlined in Table 3-8. Detailed presentations of species abundance, life histories, and habitat associations for all life history stages are presented in the Generic Amendment for Essential Fish Habitat by the GMFMC (1998).

Tuna (Scombridae), billfish (Istiophoridae), swordfish (Xiphiidae), and sharks (Squaliformes) are under the direct management of NOAA Fisheries and are not included as Fishery Management Council managed species. The EFH areas for these highly migratory species (HMS) are described in separate FMP's, including the FMP for Atlantic tunas, swordfish, and sharks (USDOC, NMFS, 1999a) and the Atlantic billfish FMP Amendment 1 (USDOC, NMFS, 1996a). These separately managed species include albacore tuna (*Thunnus alalunga*), bigeye tuna (*Thunnus obesus*), bluefin tuna (*Thunnus thynnus*), skipjack tuna (*Euthynnus pelamis*), yellowfin tuna (*Thunnus albacares*), swordfish (*Xiphias gladius*), a suite of 32 shark species (Squaliformes), and billfish (Istiophoridae) species including the blue marlin (*Makaira nigricans*), white marlin (*Tetrapturus albidus*), sailfish *Istiophorus platypterus*), and longbill spearfish (*Tetrapturus pfluegeri*). The Central and Western Gulf were reviewed for the occurrence of EFH for the 42 species above. Essentially all of these species were determined to have at least one life history stage occurring in or near the area. The GMFMC (1998) did not indicate EFH for spiny lobster (*Panulirus spp*.) or yellowtail snapper (*Ocyurus chrysurus*) in the sale areas, but both these species are known to occur on topographic features such as the Flower Garden Banks and Sonnier Bank in the CPA.

As described by NMFS documents (USDOC, NMFS, 1999a and b), the current status of the scientific knowledge of these species is such that habitat preferences are largely unknown or are difficult to determine. As in the case with shark species, it is difficult to define the habitat of sharks of this temperate zone in the Gulf of Mexico because most species are highly migratory, using diverse habitats in apparently nonspecific or poorly understood ways. Temperature is a primary factor affecting the distribution of sharks, and their movement in coastal waters are usually correlated with unpredictable seasonal changes in water temperature. Similar to the species managed by the GMFMC described above, the occurrence of these 14 species managed by NOAA Fisheries, along with major prey species, is outlined in Table 3-9. Bay and estuary relationships are not cited in the FMP's except in one instance of the bull shark where estuary areas are used as a nursery area. As additional life history information is developed, additional use of inshore and estuary area may be included as EFH in the future.

Some of these 14 highly migratory species occur beyond the 200-m water depth contour. Many of these highly migratory species such as billfishes are associated with upwelling areas where canyons cause changes in current flow (upwelling) and create areas of higher productivity.

The GMFMC's *Generic Amendment for Addressing Essential Fish Habitat Requirements* (GMFMC, 1998) identifies threats to EFH and makes a number of general and specific habitat preservation recommendations for pipelines and oil and gas exploration and production activities within State waters and OCS areas.

The general recommendations for State waters and wetlands are as follows:

(1) Exploration and production activities should be located away from environmentally sensitive areas such as oyster reefs, wetlands, seagrass beds, endangered species habitats, and other productive shallow water areas. Use of air boats instead of marsh buggies should be implemented whenever possible.

(2) Upon cessation of drilling or production, all exploration/production sites, access roads, pits and facilities should be removed, backfilled, plugged, detoxified, revegetated and otherwise restored to their original condition.

(3) A plan should be in place to avoid the release of hydrocarbons, hydrocarbon-containing substances, drilling muds, or any other potentially toxic substance into the aquatic environment and the surrounding area. Storage of these materials should be in enclosed tanks whenever feasible or, if not, in lined mud pits or other approved sites. Equipment should be maintained to prevent leakage. Catchment basins for collecting and storing surface runoff should be included in the project design.

Individual States, the COE, and the USEPA have review and permit authority over oil and gas development and production within State waters. All oil and gas activities in coastal or wetland areas must adhere to numerous conservation measures before receiving permits from these agencies. In order to minimize potential coastal impacts from OCS-related activities, the MMS has numerous safety, inspection, and spill response requirements in place to prevent an accidental release of hydrocarbons from either happening at all or from reaching land (Chapters 1.5, 4.4.1 and 4.4.2).

The *Generic Amendment* lists a number of measures that may be recommended in association with exploration and the production activities located close to hard banks and banks containing reef-building coral on the continental shelf. These recommendations are:

(1) Drill cuttings should be shunted through a conduit and discharged near the seafloor, or transported ashore, or to a less sensitive, NOAA Fisheries-approved offshore locations.

(2) Drilling and production structures, including pipelines, generally should not be located within one mile of the base of a live reef.

(3) All pipelines placed in waters less than 300 ft deep should be buried to a minimum of 3 ft beneath the seafloor, where possible. Pipeline alignments should be located along routes that minimize damage to marine and estuarine habitat. Buried pipelines should be examined periodically for maintenance of adequate earthen cover.

(4) In anchorage areas, all abandoned structures must be cut off 25 ft below the mud line. If explosives are to be used, NOAA Fisheries should be contacted to coordinate marine mammal and endangered species concerns.

(5) All natural reefs and banks, as well as artificial reef areas, should be avoided.

The *Generic Amendment* makes an additional specific recommendation regarding OCS oil and gas activities under review and permit authority by MMS and USEPA. Specifically, for the conservation of EFH, activities should be conducted so that petroleum-based substances such as drilling mud, oil residues, produced waters, or other toxic substances are not released into the water or onto the seafloor. The MMS lease sale stipulations and regulations already incorporated many of the suggested EFH conservation recommendations. Lease sale stipulations are considered to be a normal part of the OCS operating regime in the Gulf of Mexico. Compliance with stipulations from lease sales is not optional; application of a stipulation(s) is a condition of the lease sale. In addition, MMS may attach mitigating measures to an application (exploration, drilling, development, production, pipeline, etc.) and issue an NTL.

The MMS Topographic Features and Live Bottom (Pinnacle Trend) Stipulations were formulated more than 20 years ago and were based on consultation with various Federal agencies and comments solicited from State, industry, environmental organizations, and academic representatives. These stipulations address conservation and protection of essential fish habitat/live-bottoms areas. The stipulations include exclusion of oil and gas activity (structures, drilling, pipelines, production, etc.) on or near live-bottom areas (both high-relief and low-relief), mandatory shunting near high-relief features, relocation of operations including pipelines away from essential fish habitat/live bottoms, and possible monitoring to assess the impact of the activity on the live bottoms.

Mitigating measures that are a standard part of the MMS OCS Program limit the size of explosive charges used for platform removal; require placing explosive charges at least 15 ft below the mudline; establish No Activity and Modified Activity Zones around high-relief live bottoms; and require remote-sensing surveys to detect and avoid biologically sensitive areas such as low-relief live bottoms, pinnacles, and chemosynthetic communities.

In consideration of existing mitigation measures, lease stipulations, and a submitted EFH Assessment document, MMS entered into a Programmatic Consultation agreement with NMFS on July 1, 1999, for petroleum development activities in the CPA and WPA. The NMFS considered an EFH Assessment describing OCS development activities, an analysis of the potential effects, MMS's views on those effects, and proposed mitigation measures as acceptable and meeting with the requirements of EFH regulations at 50 CFR Subpart K, 600.920(g). For the 1999 Programmatic Consultation, NMFS made the following additional recommendations (as numbered within the NMFS letter of agreement):

(5) When the Live Bottom (Pinnacle Trend) Stipulation is made a part of a pipeline laying permit, MMS shall require that: No bottom-disturbing activities, including anchors from a pipeline laying barge, may be located within 100 ft of any pinnacle trend feature with vertical relief greater than or equal to 8 ft.

(6) When the Topographic Features Stipulation is made a part of a permit that proposes to use a semi-submersible drilling platform, MMS shall require that: No bottom-disturbing activities, including anchors or cables from a semisubmersible drilling platform, may occur within 500 ft of the No Activity Zone boundary.

(7) When the Topographic Features Stipulation is made a part of a permit that proposes exploratory drilling operations, MMS shall require that: Exploratory operations that drill more than two wells from the same surface (surface of the seafloor) location at any one or continuous time and within the 3-Mile Restricted Activity Zone must meet the same requirements as a development operation (i.e., drilling discharges must be shunted to within 10 m of the seafloor).

(8) When the Topographic Features Stipulation is required for any proposed permit around Stetson Bank, now a part of the Flower Gardens Banks National Marine Sanctuary (FGBNMS), the protective requirements of the East and West Flower Garden Banks shall be enforced.

(9) Where there is documented damage to EFH under the Live Bottom (Pinnacle Trend) or Topographic Features lease stipulation, MMS shall coordinate with the NMFS Assistant Regional Administrator, Habitat Conservation Division, Southeast Region for advice. Based on the regulations at 30 CFR Subpart N, 250.200, "Remedies and Penalties," the Regional Director of the MMS may direct the preparation of a case file in the event that a violation of a lease provision (including lease stipulations) causes serious, irreparable, or immediate harm or damage to life (including fish and other aquatic wildlife) or the marine environment. The conduct of such a case could lead to corrective or mitigative actions.

(10) The MMS shall provide NMFS with yearly summaries describing the number and type of permits issued in the Western and Central Planning Areas, and permits for activities located in the Live Bottom (Pinnacle Trend) and Topographic Features blocks for that year. Also, the summaries shall include a report of any mitigation actions taken by MMS for that year in response to environmental damage to EFH.

The MMS has accepted and adopted these six additional EFH conservation recommendations. Although the 1999 Programmatic Consultation agreement and associated EFH recommendations refer specifically to the CPA and WPA, the same mitigation measures and lease stipulations will be evaluated by NOAA Fisheries as part of the EFH Assessment contained in this multisale EIS for both planning areas. This will be the first multisale NEPA document including an EFH consultation with NOAA Fisheries.

Mitigating Factors

As discussed above, the Gulf of Mexico Fishery Management Council's EFH preservation recommendations for oil and gas exploration and production activities are specified and are currently being followed by MMS as mitigating actions to EFH. The MMS regulations and lease sale stipulations already incorporate many of the suggested EFH conservation recommendations. In some cases MMS works with other Federal agencies to mitigate effects in an area. In addition, MMS may attach mitigating measures as a condition of approval of an OCS plan or application (exploration, drilling, development, production, pipeline, etc.).

The subsurface portions of any structures in the areas of the proposed lease sales will act as reef material and a focus for many reef-associated species. Fisheries Management Plans specifically describe the use of artificial reefs as EFH. The EFH draft from the South Atlantic Fishery Management Council (1998) describes how manmade reefs are deployed to provide fisheries habitat in a location that provides measurable benefit to man. When manmade reefs are constructed, they provide new primary hard substrate similar in function to newly exposed hard bottom, with the additional benefit of substrate extending from the bottom to the surface. Reef structures of high profile seem to yield generally higher densities of managed and nonmanaged pelagic and demersal species than a more widespread, lower profile natural hard bottom or reef (South Atlantic Fishery Management Council, 1998). The benefits of artificial reefs created by the installation of energy production platform structures are well documented in Gulf waters of the coast of Texas and Louisiana. See Appendix 9.4 for additional information on artificial reefs and the Rigs-to-Reefs development.

3.3. Socioeconomic Activities

3.3.1. Commercial Fishing

The Gulf of Mexico provides nearly 21 percent of the commercial fish landings in the continental U.S. on an annual basis. The most recent, complete information on landings and value of fisheries for the U.S. was compiled by NMFS for 1999. During 1999, commercial landings of all fisheries in the Gulf totaled over 1.9 billion pounds, valued at about $776 million (USDOC, NMFS, 2001b).

Menhaden, with landings of about 1.5 billion pounds and valued at $78.5 million, was the most important Gulf species in quantity landed during 1999. Landings have increased by 488.8 million pounds (40%) in the Gulf States compared to 1998. Shrimp, with landings of nearly 242 million pounds and valued at about $478 million, was the most important Gulf species in value landed during 1999. The 1999 Gulf oyster fishery accounted for nearly 67 percent of the national total with landings of 14 million pounds of meats, valued at about $28 million. The Gulf blue crab fishery accounted for 24 percent of the national total with landings of 45 million pounds, valued at about $32 million (USDOC, NMFS, 2001b).

Texas' total commercial landings in 1999 were nearly 93 million pounds valued at close to $221 million. Shrimp was the most valuable species group landed with all species combined coming to a total weight of over 73 million pounds valued at over $193 million. In addition, during 1999, the following species each accounted for landings valued at over $2 million: Eastern oyster, blue crab, black drum, and red snapper (USDOC, NMFS, 2001b).

Nearshore and offshore waters east of the Mississippi River Delta support a diverse assemblage of valuable fishery resources. These resources, in turn, support important commercial fisheries for the region. Coastal fishes of commercial importance to the northeastern Gulf include sheepshead, red snapper, scad, ladyfish, sardines, spotted seatrout, grouper, and mullet. Pelagic fishes of commercial importance make seasonal movements up and/or down the west Florida coast and back and forth between nearshore and offshore waters. Pelagic fishes of commercial importance include Spanish and king mackerel, amberjack, and several species of tuna. Important invertebrates landed along the west coast of Florida include American oyster, blue crab, and four species of shrimp (pink, white, brown, and rock).

Louisiana's total commercial landings in 1999 were 1.5 billion pounds, valued at $294 million. Shrimp was the most important fishery landed, with about 121 million pounds valued at $171 million. In addition, during 1999, the following species each accounted for landings valued at over $1 million: Atlantic menhaden, black drum, blue crab, Eastern oyster, red snapper, and swordfish (USDOC, NMFS, 2001b).

Mississippi's total commercial landings in 1999 were 267.5 million pounds, valued at $48.3 million. Shrimp was the most important fishery landed, with 14.5 million pounds valued at $34 million. In addition, during 1999, the following three species each accounted for landings valued at over $250,000: Atlantic menhaden, blue crab, and striped mullet (USDOC, NMFS, 2001b).

Alabama's total commercial fishery landings for 1999 were 27 million pounds, valued at $50.4 million. Shrimp was the most important fishery, with about 17.7 pounds landed valued at about $44.6 million. In addition, during 1999, the following two species each accounted for landings valued at over $750 thousand: blue crab and striped mullet (USDOC, NMFS, 2001b).

Total commercial landings for the west coast of Florida in 1999 were 90.2 million pounds, valued at $164.4 million. Shrimp was the most important fishery landed, with 16.0 million pounds valued at $ 39.6 million. In addition, during 1999, the following species each accounted for landings valued at over $5 million: Quahog clam (from aquaculture), blue crab, stone crabs, red grouper, striped mullet, and Caribbean spiny lobster (USDOC, NMFS, 2001b).

In April 1997, Continental Shelf Associates (CSA, 1997a) completed a study characterizing recreational and commercial fishing east of the Mississippi Delta for the period 1983-1993. A synopsis of some of the conclusions concerning commercial fisheries for the region from 1983 to 1993 is included below (CSA, 1997a), although the study emphasized the panhandle area of Florida.

Baitfishes accounted for the highest commercial landings in the region during the period 1983-1993. Menhaden contributed the greatest proportion of the entire finfish landings; however, the Florida Panhandle landings for menhaden are orders of magnitude lower than those reported in Louisiana and Mississippi. The baitfish fishery showed signs of overfishing (fishing effort increased, landings decreased) or at least great stress. If user demand continues as it has over the 1983-1993 period, a collapse in the bait fishery is a distinct possibility.

Coastal pelagic fishes, including king and Spanish mackerel, cobia, and jacks, are an important group to the commercial fisheries of the northeastern Gulf. The ladyfish or tenpounder accounted for the highest portion of the coastal pelagic landings. Gill nets and purse nets are the primary gear type used for coastal pelagic fishes. The Florida Panhandle is probably the most important fishing area for this species in the entire Gulf of Mexico (Joyce, 1983). Coastal pelagic landings fell during the period of 1983-1993. This is to be expected since both nominal and real income of the fishers is rising at rapid pace, thereby inducing more fishers and vessels into this fishery. The increase in fishing effort places stress on the coastal pelagic fishery resource, which eventually leads to overfishing.

Ranking third in landings over the period 1983-1993, behind the baitfishes and coastal pelagic fishes, were reef fishes. This species group were sought after by more fishers and included many more species than the other groups. The reef fishery also generated the highest valued finfish landings for the region. Hook-and-line, bottom longline, and traps were the most important gear types used to catch reef fishes in the northeastern Gulf of Mexico waters. Reef fishing for snappers, groupers, gray triggerfish, and amberjacks takes place in offshore shelf waters (20-200 m) over natural or artificial bottom. Certain deepwater reef fishes such as snowy, yellowedge, and warsaw groupers are fished exclusively in waters off the shelf break. Reef fishes, along with coastal pelagic fishes, are the most sought after groups by fishermen from Alabama and Florida who venture over to the oil and gas platforms off the adjacent States. The reef fish fishery showed a decline during the early years of 1983-1993 but finished the period on the rise. According to the GMFMC (1995), this may be explained by the overfishing of red snapper in the early 1980's and recent recovery in the stocks of this species due to various fishery management measures to protect this population. The rise in reef fish landings during the 1990's may also be due to a switch in fishing effort from red snapper to vermilion snapper, which became the most frequently landed reef fish during the period. Both these species have been experiencing intense fishing pressure from fishermen in Alabama and Florida regions within the past several years.

Oceanic pelagic fishes were not landed in high quantities relative to other finfish groups during 1983-1993; however, they were very valuable, ranking second to reef fishes in average dollar value of landings. The most important species, yellowfin tuna and swordfish, were caught primarily by surface longline in oceanic waters offshore of the shelf break. Because these fisheries operate in the open Gulf, catches responsible for landings in a specific State could have been made in waters outside the region. The demand for oceanic pelagic fishes accelerated very rapidly over the 1983-1986 period and leveled off over the remainder of the study period remaining rather static in terms of catch, price, and dockside value from 1987 to 1993.

The remaining group of finfishes landed by commercial fishers in the northeastern Gulf—the demersal fishes—was taken almost exclusively from inland (estuarine) waters. The primary gear types used in this fishery are purse nets and gill nets. For the period 1983-1993, striped mullet was the key species in the demersal landings, followed by spotted seatrout. These species were caught mostly by gill nets, and the number of fishing trips made annually was high compared with the other net fisheries. The mullet fishery is relatively valuable, due in part to the recent increases in demand for the roe in foreign markets. Most coastal counties in Alabama and the Florida Panhandle reported sizeable landings of striped mullet. Important variables impacting fishery landings include fishing pressure, management measures, loss of habitat, and pollution. Many of the demersal species are estuarine-dependent so the quality of the estuarine habitats is critical to maintaining catch levels. Little data is available on trends in various pollutants that could impact the juvenile and adult segments of the population in the vast system of northeastern Gulf estuaries. However, the trend from 1983 to 1993 for demersal species shows that the landings stabilized with an increase in value toward the latter part of the period. Several members of this species group, including red drum, striped mullet, and spotted seatrout, were subject to legislation during the period.

The dominant invertebrate species groups in the northeastern Gulf fisheries were shrimp, oysters, and blue crab. These three species groups were almost exclusively fished in inland (estuarine) waters. Little shrimping is done in shelf waters offshore Alabama or Florida. Some shrimping (royal red shrimp) does occur in DeSoto Canyon and in Louisiana, Mississippi, Alabama (primarily brown shrimp with some white shrimp catches), and Florida State waters (primarily pink shrimp). The value of shrimp landings exceeded that of all other fish or invertebrate species group. Shrimp were caught with otter trawls, butterfly nets, and beam trawls.

Blue crab was an important component of the invertebrate fishery. Blue crab was caught mostly by trap, but a small proportion of blue crab landings was contributed by the shrimp trawl fishery. The value of the blue crab landings was considerably less than the value of the shrimp landings. The blue crab catch in Mississippi and Alabama is an important part of the U.S. supply of this food commodity; therefore, changes in this catch greatly impact prices. However, price analysis for the period 1983-1993 shows that crab catches appear to be suffering from overfishing or environmental variables, and this is making it difficult for crab fishing to be profitable no matter what the capital outlay.

Oyster landings ranked third in weight and second in value behind shrimps for Alabama and northwest Florida. Oysters were harvested with tongs, a traditional method that is labor intensive, but allows for more a sustainable fishery than would be possible if more efficient means were to be used. The most common factor limiting the harvesting of oysters is high coliform counts or bacterial levels forming in bays and inlets, especially where the water is confined or receives limited flushing into the Gulf of Mexico. Oyster are plagued by marketing problems in that the public is increasingly aware of public health problems associated with eating oysters. The static nature of the fishing effort and technology in the oyster industry from 1983 to 1993 is consistent with a lack of productivity. The static character makes it difficult for oyster fishermen to increase profits despite increased fishing effort.

Important finfish groups landed at ports in Alabama and along Florida's northwest coast include snapper, porgies, mullet, baitfish, jacks, triggerfish, grouper, tuna, and other pelagics. Important shellfish groups landed at ports in Alabama and along Florida's northwest coast include shrimp, oysters, and crab. In July 1995, the State of Florida enacted a ban upon the use of entanglement nets (gill and purse nets but not trawls) in State waters (14.5 km offshore on the Gulf of Mexico side of the state). This law has caused a substantial drop in the landings of baitfishes, coastal pelagic, and demersal fishes throughout the Florida Panhandle.

Many commercial species harvested from Federal waters of the Gulf of Mexico are considered to be at or near an overfished condition. Continued fishing at the present levels may result in rapid declines in commercial landings and eventual failure of certain fisheries. Commercial landings of traditional fisheries, such as red snapper, vermilion snapper, spiny lobster, jewfish, and mackerel, have declined over the past decade despite substantial increases in fishing effort. Commercial landings of fisheries such as shark, black drum, and tuna, have increased exponentially in the recent years, and those fisheries are thought to be in need of conservation (Grimes et al., 1992; USDOC, NMFS, 1997).

Most recently, gag grouper joined vermilion snapper on the 1998 NMFS report's list of species "approaching overfishing" in the Gulf. Five other species — red snapper, Nassau grouper, jewfish, king mackerel, and red drum — were listed in the report as overfished in the Gulf. Shrimp stocks, the primary cash catch in the Gulf States, remain strong according to the report. The status of another 48 Gulf fishery species is described as "unknown," but at least one-third of U.S. marine fishery stocks are considered overfished (USDOC, NMFS, 1997). The number of species considered to be overfished will likely continue to rise under new, more stringent requirements of the Magnuson-Stevens Fisheries Management and Conservation Act (See Chapter 1.3 for details on the Act.).

Nearly all species substantially contributing to the Gulf of Mexico's commercial catches are estuarine dependent. The degradation of inshore water quality and loss of Gulf wetlands as nursery areas are considered significant threats to commercial fishing (USEPA, 1992 and 1994; Christmas et al., 1988; Gulf States Marine Fisheries Commission, 1988). Natural catastrophes may change the physical characteristics of offshore, nearshore, and inshore ecosystems and destroy gear and shore facilities. Hurricane Andrew, in August 1992, caused extensive damage to Gulf wetlands and killed at least $7.8 million worth of saltwater finfish and $3.5 million worth of oysters. Commercial fishery losses were estimated at $54 million for the months of September and October 1992 alone (Horst, 1992a). Over $10 million in damages to fisheries product, seafood plants, and vessels were incurred (USDOC, NMFS, 1994a). Hurricane Opal in October 1995 caused extensive damage to offshore fishing grounds in the northeastern Gulf. Examination of artificial reefs off the Florida Panhandle one year after the passage of Hurricane Opal revealed storm-related deterioration and destruction of fishing reefs (Maher, written communication, 1996).

The Gulf of Mexico shrimp fishery is the most valuable in the U.S., accounting for 69 percent of the total domestic production (USDOC, NMFS, 2001b). Three species of shrimp—brown, white, and pink—dominate the landings by weight. The status of the stocks are as follows: (1) brown shrimp yields are at or near the maximum sustainable levels; (2) white shrimp yields are beyond maximum sustainable levels with signs of overfishing occurring; and (3) pink shrimp yields are at or beyond maximum sustainable levels.

The shrimp fishery is facing a number of additional problems: too many vessels given available yields of shrimp; imports of less expensive shrimp from foreign countries, accounting for 35 percent of the value of total edible imports in 1999 (USDOC, NMFS, 2000); continued decline in ex-vessel price of domestic shrimp; other related fishing needs; increases in fuel prices; excessive costs of marine casualty insurance; regulations regarding the use of turtle excluder devices and by-catch devices; excessive bycatch of finfish; and conflicts with other targeted fisheries (Gulf States Marine Fisheries Commission, 1988; Louisiana Dept. of Wildlife and Fisheries, 1994; USDOC, NMFS, 1996). Without the use of by-catch reduction devices, it has been estimated that for every pound of shrimp landed, several pounds of valuable finfish are killed and discarded as bycatch (Sports Fishing Institute, 1989). In an attempt to lessen anticipated conflicts between commercial fishing for shrimp, spiny lobster, and stone crab, the GMFMC has closed areas in the Eastern Gulf to shrimp trawling during the traditional trap fishing seasons for lobster and stone crab.

The red drum fishery was closed to all harvest in Federal waters of the Gulf of Mexico on January 1, 1988. Stock assessment concluded that red drum were heavily fished prior to moving offshore to spawn and that those fish less than 12 years of age were poorly represented in the offshore spawning population. Continued harvest of adults from Federal waters would further reduce spawning stock and increase the risk of a collapse of the red drum fishery (USDOC, NMFS, 1989). The red drum fishery has remained closed through 2001.

Red and vermilion snapper resources in the Gulf of Mexico are believed to be severely overfished from both directed and bycatch fisheries. Red snapper is the most important species off the Central Gulf Coast in the reef fish complex managed under an FMP in terms of value and historical landings. Vermilion snapper is the second most important snapper species off the Florida west coast after yellowtail snapper. Both red and vermilion snapper are presently considered to be in worse condition than was the red drum when that fishery was closed to all further harvest in Federal waters (Goodyear and Phares, 1990; Horst, 1992b; USDOC, NMFS, 1989).

The major concern of the stone crab fishery is whether harvest has reached or exceeded maximum sustainable yield. Until recently, the fishery has been expanding in terms of increasing catch within traditional fishing areas, as well as previously unfished or underfished regions. However, the total harvest has declined steadily over the past several years. The GMFMC is considering limitations on the number of fishermen and traps in the stone crab fishery.

The coastal pelagic FMP addresses a number of species. Two of the more important species are king and Spanish mackerels. Both species have been extensively overfished in the past and are now under a managed rebuilding program. The commercial fishery for king mackerel is closed in the western Gulf when a quota of 1.01 million pounds is reached. From the early 1980's to 1990's, there has been a marked absence of a strong year-class of king mackerel. Spawning stock biomass has exhibited gains. There is concern about the possible need for two management units for king mackerel within the Gulf of Mexico and about the impact of the increasing Mexican fishery. Spanish mackerel stocks are showing positive signs of recovery. Spawning stock biomass and recruitment appear to be increasing. Both commercial and recreational bag limits were increased in June 2000 by the GMFMC. Most of the Spanish mackerel catch is taken off Florida. Capture of 50-80 percent of the yearly commercial allocation within a period of three weeks by southeast Florida fishermen has raised questions of conflict with recreational fishermen who believe their allocation should be increased.

Commercial landings of swordfish have increased steadily over the past several years with serious implications for the future. The percentage of older fish and spawning biomass has declined significantly. The GMFMC is developing a number of alternatives to better manage this resource.

Blue marlin and white marlin are believed to be at or near the point of full exploitation. There is concern about the increasing mortality of marlin as bycatch associated with the escalating yellowfin tuna longline fishery (Sports Fishing Institute, 1989). The tuna fishing industry has expanded at an alarming rate in the Gulf of Mexico over the past five years. Tuna are now included under the Magnuson Fishery Conservation and Management Act of 1976 (MFCMA), and the GMFMC can begin to manage the tuna fishing industry and address the marlin bycatch issue.

The taking of stony corals or gorgonian sea fans is prohibited. Fishing for soft coral octocorals is presently below the limits of maximum yield. There are major concerns about the butterfish fishery in that butterfish trawlers allegedly destroy coral reef habitat and take a large number of snappers and groupers as bycatch. In addition, a newly formed fishery of "live rock" for the ornamental trade is receiving attention due to the allegation that "live rock" fishing may purposefully or inadvertently include the harvest of stony coral. Amendment 2 to the FMP for coral and coral reefs specifically addresses the concerns of "live rock" harvest in the Gulf of Mexico (GMFMC, 1994). The coral/live rock resources were originally managed jointly by the Gulf and South Atlantic Fishery Management Councils (SAFMC). This changed in 1995 when the Councils separated their management of this group. The SAFMC passed a further amendment to the SAFMC Coral FMP in 1995 that established a separate fishery management plan for "live rock." The FMP restrictions apply only to the Atlantic coast of Florida and not to the Gulf of Mexico. No amendments for "live rock" management have been issued by the GMFMC since 1994.

The present concern with the condition of the black drum fishery stems directly from the closure of the red drum fishery. Almost immediately after closure, black drum and sheepshead were accepted as a substitute for red drum within the commercial market. The intensive fishing effort for red drum was switched to black drum and sheepshead without need to change fishing gear or technique. As a result, stocks of these two fish species are believed to be fast approaching a seriously depleted condition. Louisiana, Mississippi, and Alabama have instituted interim management measures in State waters to reduce black drum catches while an FMP is developed and implemented (Horst, 1993).

A strong market for shark has resulted in soaring catches over the past several years, though the value is low. Shark stocks are unable to sustain the present heavy fishing pressure, and without management, the fishery is expected to collapse within the near future. The GMFMC requested that Gulf States consider management measures within State waters and issued an FMP for both coastal and pelagic sharks (Justen, 1992).

Today, most of the effort expended on understanding what controls fishery populations focuses on the effects of fishing. Although most population models used in fisheries management take into account natural mortality, fishing mortality is the only variable that can be accurately estimated and controlled. Thus, while management focuses almost exclusively on controlling fishing effort, the success of any management scheme is dependent on understanding factors other than fishing that influence or regulate population abundance. Recent proposals by NOAA Fisheries are examples of attempts to conserve fish populations by increasing constraints on fishing efforts (GMFMC, 2000).

Grouper species can be overfished because they aggregate in great numbers, year after year in the same locations during spawning; during that time the males are especially susceptible to being caught. The NOAA Fisheries hopes to spare the spawning population by using closed seasons and Marine

Protected Areas (MPA's) as a management tool. But while the concept has its benefits, fishermen are also wary about the number of fishing grounds that could become off-limits to them if MPA's become numerous. The question is: Are MPA's the panacea for fisheries management woes or just a valuable alternative to other management techniques? Two MPA's have been designated of the west Florida shelf that are now closed to all fishing except for pelagics. They are named the Madison and Swanson site (115 nmi^2), south of Panama City, Florida, and Steamboat Lumps (104 nmi^2), west of Tarpon Springs, Florida. The two grouper reserves are now a reality and went into effect on June 19, 2000. In addition, a sunset provision has been added after four years so that the effects of the closed areas can be evaluated. Both of the areas are along the 70- to 80-m depth contour. The Madison and Swanson site south of Panama City is a high-relief site. Steamboat Lumps, west of Tarpon Springs, is the lower portion of the original 423-nmi^2 closed-area proposal. It is a low-relief site that has been reported by fishermen to be a good area for gag spawning.

Another NOAA Fisheries' proposal has been made to reduce longliner bycatch, especially of billfish, by issuing a longlining ban in the Gulf of Mexico and along the southeastern Atlantic coast. This proposal has drawn opposition from sport and commercial swordfish fishermen, as well as from seafood dealers, albeit for different reasons in each case. All waters of the EEZ would be subject to the closure for longline fishing from March 1 to September 30 each year in the western Gulf of Mexico. In the Atlantic between Key West, Florida, and Georgetown, South Carolina, the closure would be year-round. Closures would not affect bottom fishermen, who target grouper and sharks. Longliners stated to the GMFMC that 80 percent of their catch comes from the western Gulf and that the proposal would put them out of business. Sport fishermen said the proposal would leave the Eastern Gulf open to longliners. In addition, commercial fishermen questioned the wisdom of the NOAA Fisheries' proposal, given, they said, that Mexico has no restrictions on longlining or catching billfish, which migrate between U.S. and Mexican waters. Shoreside interests said their businesses—shipyards, marine electronics dealers, fuel suppliers, freight handlers, restaurants, and seafood distributors—would also suffer as a result of the ban. The NOAA Fisheries was urged to consider alternatives, such as requiring circle hooks, which are designed not to snag fish that do not hit the bait, and a ban on live bait. On August 4, 2000, the NOAA Fisheries (formerly NMFS) announced some new regulations to reduce bycatch and bycatch mortality in the pelagic longline fishery. On November 1, 2000, NOAA Fisheries (formerly NMFS) put into effect a new regulation to reduce bycatch and bycatch mortality in the pelagic longline fishery. Two rectangular areas in the Gulf of Mexico (one of which lies over a portion of the region known as DeSoto Canyon) are closed year-round to pelagic longline fishing. These closed areas cover 32,800 mi^2 (Figure 3-9). This region has been identified by NOAA Fisheries as a swordfish nursery area, where there has historically been a low ratio of swordfish kept to the number of undersized swordfish discarded, which over the period of 1993-1998 has averaged less than one swordfish kept to one swordfish discarded. The area closure is expected to produce approximately a 4 percent reduction in Gulf and Atlantic undersized swordfish bycatch. The DeSoto Canyon area coordinates are as follows:

Upper Area

North boundary:	30 ^{o}N. latitude
South boundary:	28 ^{o}N. latitude
East boundary:	86 ^{o}W. longitude
West boundary:	88 ^{o}W. longitude

Lower Area

North boundary:	28 ^{o}N. latitude
South boundary:	26 ^{o}N. latitude
East boundary:	84 ^{o}W. longitude
West boundary:	86 ^{o}W. longitude

Only a very small portion of the "upper area" includes lease blocks in the CPA. All of the "lower area" and most of the upper area are located in the EPA.

The increasing and often confusing restrictions, constraints, license costs, certifications, and general limitations has the fishing industry wondering if it has a viable future. Until the late 1980's most commercial fishing endeavors in the Gulf of Mexico had relatively few constraints. Commercial fishermen are becoming more organized and have hired fisheries consultants and attorneys to challenge the system as they see it.

Compared with the development of deep-sea fisheries by other countries, the United States has developed only a few of its deep-sea resources. Upper ocean trolling, mixed-depth longlining, deep bottom trawling, and deep bottom longlining are practiced on a limited basis in deepwater areas of the Eastern Gulf of Mexico. Deep-sea fishing includes commercial efforts and charter boats for hire. The equipment and practice of deepwater fishing are substantial in terms of size, weight, time, and expense.

Despite encouragement from NOAA Fisheries, fewer than 10 commercial fishermen are known to harvest benthic species from the DeSoto Canyon region. Royal red shrimp has been harvested by fishers for at least a decade from areas in DeSoto Canyon. Due to the depth (200-400 m; 656-1,312 ft), which requires specialized gear, time involved, and the localized, spotty nature of this shrimp species, trawling and harvest have been the effort of a very small number of focused fishermen. It is unlikely that fishing for this species will increase in the future.

Commercial fishing for tilefish in the Eastern Gulf is done with bottom longlines. Tilefish species represent a typical deep-sea resource that is long-lived, slow to develop, and reproduce with limited numbers of offspring (Moore, 1999). Tilefish show an affinity for a sandy bottom, where they sit in indentations or burrows in the ocean floor. Because of their life history, tilefish are easily overfished and depleted. A sporadic, commercial harvest of golden tilefish on the eastern shoulder of DeSoto Canyon and along the Florida shelf-slope break is several decades old. Harvest is intermittent and limited within the Gulf due to depleted populations. Tilefish are found in water from 240 to 400 ft (73-122 m) in depth, which requires the use of highly selected gear.

3.3.2. Archaeological Resources

Archaeological resources are any material remains of human life or activities that are at least 50 years of age and that are of archaeological interest (30 CFR 250.2). The Archaeological Resources Regulation (30 CFR 250.26) provides specific authority to each MMS Regional Director to require archaeological resource surveys, analyses, and reports. Surveys are required prior to any exploration or development activities on leases within the high probability areas (NTL 2001-G01).

3.3.2.1. Historic

With the exception of the Ship Shoal Lighthouse structure, historic archaeological resources on the OCS consist of historic shipwrecks. A historic shipwreck is defined as a submerged or buried vessel, at least 50 years old, that has foundered, stranded, or wrecked and is presently lying on or embedded in the seafloor. This includes vessels that exist intact or as scattered components on or in the seafloor. A 1977 MMS archaeological resources baseline study for the northern Gulf of Mexico concluded that two-thirds of the total number of shipwrecks in the northern Gulf lie within 1.5 km of shore and most of the remainder lie between 1.5 and 10 km of the coast (CEI, 1977). A subsequent MMS study published in 1989 found that changes in the late 19th- and early 20th-century sailing routes increased the frequency of shipwrecks in the open sea in the Eastern Gulf to nearly double that of the Central and Western Gulf (Garrison et al., 1989). The highest observed frequency of shipwrecks occurred within areas of intense marine traffic, such as the approaches and entrances to seaports and the mouths of navigable rivers and straits.

Garrison et al. (1989) lists numerous shipwrecks that fall within the CPA and WPA. Many of these reported shipwrecks may be considered historic and could be eligible for nomination to the National Register of Historic Places. Most of these wrecks are known only through the historical record and, to date, have not been located on the ocean floor. The Garrison study lists 561 wrecks in the CPA and 615 wrecks in the WPA. These wrecks are listed by planning area in Table 3-10. This list should not be considered an exhaustive list. Regular reporting of shipwrecks did not occur until late in the 19th century, and losses of several classes of vessels, such as small coastal fishing boats, were largely unreported in official records.

Submerged shipwrecks off the coasts Texas, Louisiana, and Alabama are likely to be moderately well preserved because of the high sediment load in the water column from upland drainage and wind and water erosion. Wrecks occurring in or close to the mouth of bays would have been quickly buried by transported sediment and therefore protected from the destructive effects of wood-eating shipworms (*Teredo navalis*) or storms (Anuskiewicz, 1989, page 90). A good example of this type of historic wreck is the *la Belle* a shallow draft French sailing vessel classified as a *barque longue* lost in 1686 and discovered in Matagorda Bay, Texas, in 1995 (Ball, personal communication, 2001). Wrecks occurring in deeper water also have a moderate to high preservation potential. In the deep water, temperature at the seafloor is extremely cold, which slows the oxidation of ferrous metals. The cold water would also eliminate wood-eating shipworms. There have been two recent deepwater shipwreck discoveries in the CPA both off the mouth of the Mississippi River and lying about 35 mi apart. These wrecks were discovered by the oil and gas industry during required MMS remote-sensing surveys.

These discoveries include an early 19th-century wooden sailing vessel lying in nearly 2,700 ft of water. There are also two victims of a Gulf of Mexico WWII sea battle—the American passenger liner *Robert E. Lee* and the German submarine *U-166*. After sinking the *Robert E. Lee*, the *U-166* was immediately attacked by a Coast Guard patrol boat and sunk. Both vessels lie a mere 4,000 ft apart in 5,000 ft of water. All three wrecks have been investigated using a remotely-operated vehicle from a surface vessel and are in an excellent state of preservation.

Aside from acts of war, hurricanes cause the greatest number of wrecks in the Gulf. Wrecks occurring as a result of an extreme violent storm are more likely to be scattered over a broad area. The wreckage of the 19th-century steamer *New York*, which was destroyed in a hurricane, lies in 16 m of water and has been documented by MMS (Irion and Anuskiewicz, 1999) as scattered over the ocean floor in a swath over 1,500 ft long. Shipwrecks occurring in shallow water nearer to shore are more likely to have been reworked and scattered by subsequent storms than those wrecks occurring at greater depths on the OCS. Historic research indicates that shipwrecks occur less frequently in Federal waters. These wrecks are likely to be better preserved, less disturbed, and, therefore, more likely to be eligible for nomination to the National Register of Historic Places than are wrecks in shallower State waters.

3.3.2.2. Prehistoric

Available evidence suggests that sea level in the northern Gulf of Mexico was at least 90 m, and possibly as much as 130 m, lower than present sea level and that the low sea-stand occurred during the period 20,000-17,000 years Before Present (B.P.) (Nelson and Bray, 1970). Sea level in the northern Gulf reached its present stand around 3,500 years B.P. (Pearson et al., 1986).

During periods that the continental shelf was exposed above sea level, the area was open to habitation by prehistoric peoples. The advent of early man into the Gulf of Mexico region is currently accepted to be around 12,000 years B.P. (Aten, 1983). The sea-level curve for the northern Gulf of Mexico proposed by Coastal Environments, Inc. (CEI) suggests that sea level at 12,000 B.P., would have been approximately 45-60 m below the present day sea level (CEI, 1977 and 1982). On this basis, the continental shelf shoreward of the 45- to 60-m bathymetric contours have potential for prehistoric sites dating after 12,000 B.P. Because of inherent uncertainties in both the depth of sea level and the entry date of prehistoric man into North America, MMS adopted the 12,000 years B.P. and the 60-m water depth as the seaward extent of the prehistoric archaeological high-probability area.

Based on their 1977 baseline study, CEI (1977) proposed that sites analogous to the types of sites frequented by Paleo-Indians can be identified on the now-submerged shelf. Geomorphic features that have a high probability for associated prehistoric sites include barrier islands and back-barrier embayments, river channels and associated floodplains and terraces, and salt-dome features. Remote-sensing surveys have been very successful in identifying these types of geographic features, which have a high probability for associated prehistoric sites. Recent investigations in Louisiana and Florida indicate the mound-building activity by prehistoric inhabitants may have occurred as early as 6,200 B.P. (cf. Haag, 1992; Saunders et al., 1992; Russo, 1992). Therefore, manmade features, such as mounds, may also exist in the shallow inundated portions of the OCS.

Regional geological mapping studies by MMS allow interpretations of specific geomorphic features and assessments of archaeological potential in terms of age, the type of system the geomorphic features belong to, and geologic processes that formed and modified them. The potential for site preservation must also be considered as an integral part of the predictive model. In general, sites protected by sediment overburden have a high probability for preservation from the destructive effects of marine transgression. The same holds true for sites submerged in areas subjected to low wave energy and for sites on relatively steep shelves during periods of rapid rise in sea level. Though many specific areas in the Gulf having a high potential for prehistoric sites have been identified through required archaeological surveys, industry generally has chosen to avoid these areas rather than conduct further investigations.

Holocene sediments form a thin veneer or are absent over the majority of the continental shelf off western Louisiana and eastern Texas (USDOI, MMS, 1984). Many large, late Pleistocene, fluvial systems (e.g., the Sabine-Calcasieu River Valley) are within a few meters of the seafloor in this area. Further to the south and west, a blanket of Holocene sediments overlays the Pleistocene horizon. In the Western Gulf, prehistoric sites representing the Paleo-Indian culture period through European contact have been reported. The McFaddin Beach site, east of Galveston in the McFaddin National Wildlife Refuge, has produced late Pleistocene megafaunal remains and lithics from all archaeological periods, including a large percentage of Paleo-Indian artifacts (Stright et al., 1999). A study funded by MMS to locate prehistoric archaeological sites in association with the buried Sabine-Calcasieu River Valley was completed in 1986 (CEI, 1986). Five types of relict landforms were identified and evaluated for archaeological potential. Coring of selected features was performed, and sedimentary analyses suggested the presence of at least two archaeological sites.

Surveys from other areas of the western part of the CPA have produced evidence of floodplains, terracing, and point-bar deposits in association with relict late Pleistocene fluvial systems. Prehistoric sites associated with these features would have a high probability for preservation. Salt diapirs with bathymetric expression have also been recorded during lease-block surveys in this area. Solution features at the crest of these domes would have a high probability for preservation of associated prehistoric sites. The Salt Mine Valley site on Avery Island is a Paleo-Indian site associated with a salt-dome solution feature (CEI, 1977). The proximity of most of these relict landforms to the seafloor facilitates further investigation and data recovery.

3.3.3. Human Resources and Land Use

The addition of any new human activity, such as oil and gas development resulting from a proposed lease sale, can affect local communities in a variety of ways. Typically, these effects are in the form of people and money, which can translate into changes in local social and economic institutions and land use. In this section, MMS describes the current socioeconomic analysis area baseline in order to differentiate the effects of the proposed actions (Chapters 4.2.1.14 and 4.3.1.12).

3.3.3.1. Socioeconomic Analysis Area

3.3.3.1.1. Description of the Analysis Area

The MMS defines the analysis area for potential impacts on population, labor, and employment as that portion of the Gulf of Mexico coastal zone whose social and economic well-being (population, labor, and employment) is directly or indirectly affected by the OCS oil and gas industry (Figure 4-1). This analysis area is based on the results of the recent MMS socioeconomic study "Modeling the Economic Impacts of Offshore Oil and Gas Activities in the Gulf of Mexico: Methods and Applications; Final Draft" (Dismukes et al., in preparation). Geographically the analysis area is defined as all coastal counties and parishes along the U.S. portion of the Gulf of Mexico and any inland counties and parishes where offshore oil and gas activities are known to exist, offshore-related petroleum industries are established, or one or more counties or parishes within a Metropolitan Statistical Area (MSA) are on the coast. For examination purposes, MMS has divided the analysis area into subareas. The counties and parishes included in each subarea are presented in Figure 4-1. Note that coastal Subareas TX-1 and TX-2 correspond to the offshore WPA; coastal Subareas LA-1, LA-2, LA-3, and MA-1 correspond to the CPA; and coastal Subareas FL-1, FL-2, FL-3, and FL-4 correspond to the EPA.

One of the objectives of the above-mentioned study was to allocate expenditures from the offshore oil and gas industry to the representative onshore subarea where the dollars are spent. Table 3-11 presents these findings in percentage terms. Table 3-11, the IMPLAN number is the code given to the industry (sector) by the input-output software (IMPLAN) used to calculate impacts in Chapters 4.2.1.14 and 4.3.1.12. It is analogous to the standardized industry code (SIC). Table 3-11 makes clear the reasons for including all of the Gulf of Mexico subareas in the economic analysis area. Expenditures to several sectors are either exclusively found in Texas or make up a very large percentage of the total. In addition, a large percentage of total sector expenditures is allocated to each Louisiana subarea. As shown in Table 3-11, very little has been spent in the Florida subareas. This is to be expected given the lack of offshore leasing in this area and the State of Florida's position on oil and gas development off their beaches.

3.3.3.1.2. Land Use

The primary region of geographic influence of the proposed actions is coastal Texas and Louisiana with a lesser influence on coastal Mississippi and Alabama. Few offshore oil and gas activities occur in the Florida area. The coastal zone of the northern Gulf of Mexico is not a physically, culturally, or economically homogenous unit (Gramling, 1984). The counties and parishes along the coasts of Texas, Louisiana, Mississippi, and Alabama represent some of the most valuable coastline in the United States. Not only does it include miles of recreational beaches and the protection of an extended system of barrier islands, but it also has deepwater ports, oil and gas support industries, manufacturing, farming, ranching, and hundreds of thousands of acres of wetlands and protected habitat. These counties and parishes vary in their histories and in the composition and economic activities of their respective local governments.

Figure 3-10 illustrates the analysis area's key infrastructure. Major cities in the analysis area include Houston, Texas; Baton Rouge and New Orleans, Louisiana; and Mobile, Alabama. Other important cities in the analysis area include Corpus Christi, Galveston, Port Aurthur, and Beaumont, Texas; Lake Charles and Lafayette, Louisiana; and Pascagoula, Mississippi. Several international and regional airports are located throughout the analysis area. One major interstate (I-10) traverses the area along the inner margin of the coastal zone while six interstate highways access the area longitudinally. There are numerous highways into and across the analysis area. On November 28, 1995, LA Hwy 1 was designated as part of the National Highway System (NHS). The NHS Act designated 160,955 mi of interstate, highways, and other roads that are critical for the economy, defense, and mobility of the Nation as the NHS. "These highways provide access to major ports, airports, rail stations, public transit facilities, and border crossings. They comprise only 4 percent of total highways in the country; however, they carry nearly 50 percent of total highway traffic including the majority of commercial and tourism traffic. They are estimated to service more than 90 percent of businesses and industries through out the nation." (LA Hwy 1 Project Task Force, 1999). LA Hwy 1 was designated because of "its intermodal link to this Nation's energy supply" (LA Hwy 1 Project Task Force, 1999). The area's railroad configuration is similar to the highway system. An extensive maritime industry exists in the analysis area. Major ports and waterways are discussed in detail in Chapter 3.3.3.6, while Chapter 3.3.3 describes OCS-related coastal infrastructure. A listing of major public, recreational, and conservation areas are presented in Chapter 3.3.4.

The Gulf coastal plain of Texas makes up most of eastern and southern Texas and occupies more than one-third of the State. Near the coast this region is mostly flat and low-lying. It rises gradually to 300 m (1,000 ft) farther inland, where the land becomes more rolling. Belts of low hills cross the Gulf coastal plain in many areas. In the higher areas the stream valleys are deeper and sharper than those along the coast. Texas' coastline along the Gulf of Mexico is 591 km (367 mi). However, long narrow islands called barrier islands extend along the coast; if the shoreline of all the islands and bays is taken into account, the coastline is 5,406 km (3,359 mi) long (Internet website: http://www.encarta.msn.com). The region is made up of farmland (cotton, rice, and citrus fruit), forest, cattle ranches, major cities of commerce (Houston) and education, tourist locales (South Padre Island), Federal installations (e.g., Lyndon B. Johnson Space Center), and major ports. The oil and gas industry has also been part of the local economies since the early 1900's. Today, the majority of oil and gas corporations have headquarters in Houston, while numerous industries associated with oil and gas (petrochemicals and the manufacture of equipment) are located in the area. In addition to oil and gas, the area has aggressively pursued technology companies such as computers and aerospace. The military has had a significant presence in general, particularly in the Corpus Christi Bay area, and more recently in San Patricio County on the eastern shore of the bay.

The Louisiana coastal area includes broad expanses of coastal marshes and swamps interspersed with ridges of higher well-drained land along the courses of modern and extinct river systems. Most of the urban centers in coastal Louisiana are located along major navigable rivers and along the landward edge of the coastal zone (i.e., Lafayette and Lake Charles). Southwestern Louisiana is Acadian country. The area's natural features vary from marshland, waterways, and bayous in the coastal areas to flat agricultural lands in the northern part of the same parishes. While the area's traditionally strong ties to agriculture, fishing, and trapping are still evident, they are no longer the mainstay of the economy. Southeastern Louisiana, from Jefferson Parish east to St. Tammany Parish and the state border with Mississippi, is a thriving metropolitan area with shipping, navigation, U.S. Navy facilities, and oil and chemical refineries, all vying with local residents for land. Historically, Terrebonne and Lafourche Parishes have been the primary staging and support area for offshore oil and gas exploration and development. The Port of Fourchon, at the mouth of Bayou Lafourche on the Gulf of Mexico, is a major onshore staging area for OCS oil and gas activities in the CPA and WPA and the headquarters of LOOP. Chapter 3.3.3.2 above discusses the Port Fourchon area in detail.

Coastal Mississippi is characterized by bays, deltas, marshland, and waterways. Two-thirds of this coast is devoted to State-chartered gambling barges and heavy tourism along the beachfront. The remaining third (Jackson County) is industrial—oil refining and shipbuilding. Upland portions of the three coastal counties—Hancock, Harrison, and Jackson—are timberlands. Jackson County has a strong industrial base and designated industrial parks. Pascagoula, in Jackson County, is home to Ingalls Shipyard and Chevron's Pascagoula Refinery. Bayou Casotte, also in Jackson County, currently has boat and helicopter facilities, and the onshore support base for drilling and production.

Southwestern Alabama's coastline is comprised of Mobile and Baldwin Counties, which oppose each other across Mobile Bay. Coastal resource-dependent industries in this area include navigation, tourism, marine recreation, commercial fishing, and most recently, offshore natural gas development and production. Large quantities of natural gas were discovered in Alabama's offshore waters in 1979. Baldwin County has a strong tourism economy and a large retiree population. The important commercial fishing industry in the area is located in southeastern Mobile County. The Port of Mobile, the largest seaport in Alabama, is also in Mobile County. The military has had a long presence in the area. The buildup and downsizing of military installations has handed the area some special challenges. There are several oil- and gas-related businesses, including Mobil's MaryAnn/823 plant, established in 1990, and Shell's Yellowhammer plant, founded in 1989; both of these plants process natural gas (Harris InfoSource, 1998).

3.3.3.2. How OCS Development Has Affected the Analysis Area

The following section presents a brief, general narrative of how OCS development has affected the analysis area over the last 20 years. This narrative is followed by a specific account of how OCS development has affected certain locales in the analysis area.

1980-1989

In the oil and gas industry, drilling-rig use is employed as a barometer of economic activity. Between the end of 1981 and mid-1983, drilling-rig activity in the Gulf of Mexico took a sharp downturn. By 1986, the demand for mobile drilling rigs had suffered an even greater decline due to a collapse in oil prices. Population and net migration paralleled these fluctuations in mobile drilling rig activity. Population growth rates for all subareas were relatively high prior to 1983; families moved to the Gulf of Mexico coast looking for work in the booming oil and gas industry. Lower rates of population growth accompanied the decline in drilling activity as workers were laid off and left the area in search of work elsewhere. After 1983, all subareas experienced several years of significant net migration out of the region. In 1986 the demand for mobile rigs declined to its lowest level in over a decade. This negative trend on population continued through the late 1980's.

1990-1997

In the early to mid-1990's, the analysis area experienced a major resurgence in oil exploration and drilling in response to advances in technology and the enactment of the Deep Water Royalty Relief Act in 1995. The renewed interest in oil and gas exploration and development in the Gulf of Mexico produced a modest to significant recovery from the high unemployment levels experienced after the 1986 downturn. Ironically, the Gulf of Mexico coast encountered a shortage of skilled labor in the oil and gas industry as the oil industry restructured to centralize management, finance, and business services, and new generation computer technologies were applied during the downturn (Baxter, 1990). Workers who previously lost high-paying jobs in the oil industry (or oil-service industry) during the 1980's downturn were reluctant to return. This "shadow effect," coupled with the shortage of skilled labor where the core problems were lack of education and/or training for requisite skills, created a situation where temporary communities of workers from out of the area (some from out of the country) were established. Furthermore, the higher skill levels required by deepwater development drilling could not be completely met by the existing impact areas' labor force, causing in-migration. Unemployment in the analysis area, though, declined due to increased economic diversification in the region.

1998-Present

In early 1998, crude oil prices were hovering near 12-year lows due in part to economic developments in East Asia and resulting oversupply of oil (USDOE, EIA, 2001a). This restrained the resurgence of exploration and development activity in the Gulf of Mexico. While offshore development strategy varied by company, most major oil companies, diversified firms, and small independents cut back production and curtailed exploration projects. Several large integrated companies resorted to layoffs and mergers as ways to show profitiablity in a low-price environment. Redistribution of industry personnel from the New Orleans area to the Houston area also occurred. Unemployment in the analysis area rose. Offshore drilling strategies focused on mega and large prospects, foregoing small prospects, and only considering medium prospects when prices rose (Rike, 2000). A few companies, though, took advantage of lower drilling rates during this period and increased their drilling. Concurrently, technological innovations (such as the availability of 3-D seismic data, slim-hole drilling, and hydraulic rigs) decreased the cost of exploration and thus stimulated the discovery and development of large or mega prospects that were considered economic at low prices.

In March 1999, OPEC, which produces 40 percent of the world's oil, announced crude oil production cutbacks. Full member compliance increased oil prices to 20-year highs, encouraging moderate exploration and development spending in 1999. Crude oil prices continued to increase during 2000 and hold into 2001. It is generally believed that the increase in price is being driven by two major factors. First is the determination by OPEC to maintain prices within their current output targets of a \$22 minimum and a \$28 maximum per barrel crude oil price. The second factor is the world capacity to supply oil has not kept pace with the growth of oil demand spurred by a resurgent world economy. Furthermore, a short supply of oil tankers, rising shipping rates, and low inventories of refined product and crude oil have added upward pressure to spot crude oil prices (Brown, 2000). The prices throughout much of the 1990's were too low to stimulate additions to capacity. In addition, many tankers were scrapped in the 1990's when weak demand, low shipping rates, and increasing environmental regulation put a lot of pressure on the tanker industry (Brown, 2000).

Federal environmental/clean-air efforts in the 1990's and high oil prices in the late 1990's prompted some industries to switch from crude oil to natural gas. This development was and continues to be especially prevalent in the electricity generating industry. Natural gas, in addition to heating about 53 percent of American homes, is also being used to generate about 16 percent of the country's electricity – a percentage that is still growing (Simmons, 2001). Like crude oil, the supply of natural gas did not keep up with demand, which pushed prices higher. In December 2000, the price of natural gas broke record highs, closing at \$10.10 per 1,000 cubic feet. In recent months, however, natural gas prices have decreased as much as 75 percent. Several factors have kept a downward pressure on natural gas prices in 2002. These factors include moderate weather in most of the Nation, which has kept the demand for gas by electricity generators in check; relatively low oil prices; and a general economic slowdown that began in 2001, which has reduced demand for gas by the industrial sector (FERC, 2001). Even without this pronounced drop in price, demand growth for natural gas is expected to be strong during the next 20 years. The 2001 Update of the Fueling the Future: Natural Gas and New Technologies for a Cleaner 21st Century report projects that natural gas demand would increase by 53 percent by the year 2020 (American Gas Association, 2001).

Recent technological advances and the passage of the Deep Water Royalty Relief Act in 1995 have stimulated deepwater leasing and subsequent exploration and development activities. Needs specific to these deepwater projects have resulted in more focused stresses placed on areas that are capable of supporting large-scale development projects (e.g., ports that can handle deeper draft service vessels such as Port Fourchon, Louisiana), which in turn has resulted in stresses to infrastructure servicing these focal points (particularly highways and ports), as well as placing stresses on the infrastructure associated with the focal point. This is what has occurred at Port Fourchon.

Port Fourchon, Louisiana, located at the mouth of Bayou Lafourche, is one of the main service-supply bases for offshore oil and gas exploration and development in the Gulf of Mexico. While the port has maintained steady growth over the last 25 years, the escalation of deepwater activities has produced rapid growth at the port in the last 5 years, as the port has become one of the OCS Program's focal points. More than 82,500 offshore workers use the port for helicopter transportation each year. Approximately 170 OCS-related vessels travel in and out of the port each day (based on monthly helicopter and daily vessel logs). In addition to more than 130 OCS oil- and gas-related businesses, the Louisiana Offshore Oil Port (LOOP) facilities are located at the port. The LOOP is the only offshore oil terminal in the U.S.; it transports an estimated 13-15 percent of the Nation's imported crude oil. The LOOP is expanding its storage capabilities with three large, above-ground tanks in Galliano, Louisiana. Shell and BP operations are based from the port, while all three major helicopter companies (ERA, PHI, and Air Logistics) have heliports at the port. The ERA is currently building a larger $4 million heliport at the port; it is expected to be completed in 2002. Air Logistics is planning to build a similar facility. Halliburton, another port tenant, recently completed a state-of-the-art drilling liquids facility. ChevronTexaco has tank farms at the port. Seven ship and barge repair facilities are located at the port. In addition, the port has five barge lines and six barge fleeting operations.

In 1996, Edison Chouest Offshore (Chouest) built its highly successful C-Port at Port Fourchon. The C-Port is a multi-services port terminal facility supplying offshore vessels that operate in the Gulf of Mexico. The C-Port can load/offload deck cargoes, fuel, water, cements, barite muds, liquid muds, and completion fuels simultaneously. These services are provided under the protection of a covered building, eliminating weather and darkness, while improving safety and efficiency, making it a highly cost-effective, cost-saving solution (Edison Chouest, 2001). Prior to C-Port, it took 2-3 days to service a vessel; today, service time is down to a few hours. This results in huge dollar savings for offshore companies. In addition, the companies need to lease fewer service boats because of the larger, technologically advanced ships that Chouest is building. In 1999, Chouest completed a second C-Port at Port Fourchon, C-Port 2; three additional slips are planned for C-Port 2 in 2002. Together, C-Port and C-Port 2 are servicing 90 percent of OCS deepwater activity. In addition to the port expansion, Chouest began an aggressive "new build" program in the late 1990's for their offshore service vessels. The company has produced over 50 new generation offshore vessels to serve deepwater oil and gas production. The new vessels are larger (260 ft in length) and faster than their predecessors servicing shallow-water activities. The C-Ports and the new deepwater service vessels have increased activity at Port Fourchon greatly. Chouest has also started constructing a C-Port at Galveston, Texas, to service deepwater activities in the WPA and is looking into locations in Mississippi and Alabama to build a C-Port to service deepwater activities in the EPA.

Based on OCS activity at the port, the Corps of Engineers (COE) justified deepening Port Fourchon's channel from 12 ft to 24 ft. The port had been maintaining the channel at 20 ft for the larger OCS supply vessels. In August 2001, the COE dredged the channel to a depth of 26 ft (24 ft plus 2 ft of advance maintenance) and will maintain this depth in the future.

To date, this focusing of offshore service activities at Port Fourchon has resulted in both positive and negative impacts on the area. Lafourche Parish, where the port is located, has one of the lowest unemployment rates in the nation, but its citizens' quality of life has decreased. The most significant negative impacts include

- increased OCS activity is straining the local infrastructure;
- the area is suffering with a substandard highway that will not be able to handle the truck traffic increase anticipated from OCS activities;
- severe coastal erosion is eating away the State's hurricane protection, endangering the infrastructure and industry; and
- saltwater intrusion from coastal erosion is impacting the drinking water supply.

Louisiana Highway 1 (LA Hwy 1), largely a rural substandard two-lane road, is the only land-based transportation route to the port. Results from an MMS-funded study on the infrastructural impacts of expanding OCS oil and gas activities in south Lafourche Parish*, An Analysis of Louisiana Highway 1 in Relation to Expanding Oil and Gas Activities in the Central Gulf of Mexico*, indicate that the levels of service provided by LA Hwy 1 will decline significantly through time (Guo et al., 2001). The study estimated a 3-6 percent growth in daily vehicle traffic along LA Hwy 1. Actual 2000 growth was 24 percent; more than 1,000 OCS supply and equipment trucks travel LA Hwy 1 to the port each day. The average national growth in daily vehicle traffic is 2-5 percent. In addition to servicing the OCS, LA Hwy 1 serves as an evacuation and oil-spill response route for offshore spills. In the event of an impending storm, more than 3,000 offshore workers, 1,000 port personnel, and 5,000 citizens from Grand Isle and Leeville (south of the bridge) must evacuate the area by LA Hwy 1. Offshore companies also take valuable equipment, such as bagged drilling fluids, off offshore rigs and bring it to safety inland. This increases the truck traffic along LA Hwy 1 during the evacuation process. Furthermore, statistics from the Louisiana Department of Transportation and Development (DOTD) reveal LA Hwy 1 is twice as deadly as any similar class highway in the state. The number of fatalities on LA Hwy 1 has increased directly with the growth of the OCS and, therefore, the port.

The south Lafourche Parish study concluded that deterioration of LA Hwy 1 will be exacerbated with expanding oil and gas activities, particularly those in deep water. The size and complexity of these deepwater projects, along with the limited number of service bases capable of handling their unique needs, and the addition of the C-Ports at Port Fourchon, will likely result in continued stresses on port infrastructure and associated stresses placed on the local infrastructure, especially LA Hwy 1 and the parish's water supply (Guo et al., 2001).

Exacerbating the traffic problems on LA Hwy 1 are delays caused by the six bridge openings necessary to accommodate barge traffic on Bayou Lafourche. Fifty percent of all oil and gas materials brought to Port Fourchon is barged. On average, each bridge is opened 16 times a day resulting in bottlenecks, increased accidents, and a lower quality of life. Part of the increased barge traffic is from shipping an average of 500,0000 gallons of fresh water per day to the port for offshore activities. Deepwater expansion has significantly increased the demand for water, taxing the local freshwater district. Port Fourchon uses 30 percent of the local water supply, but comprises only 1 percent of the serving population.

The demand for OCS-related labor in the area has resulted in the presence of in-migration. This temporary importation of labor, particularly in south Lafourche, is a unique situation exacerbated by the shadow effect. The unusual work schedules in the oil and gas extraction industry also supports employment outside the analysis area because long-distance commuting can be reasonably accomplished on such an infrequent basis. So, while employment opportunities are growing in the oil and gas extraction and supporting industries within the Gulf of Mexico analysis area, some of that employment has been met from outside the area. This has resulted in net positive migration in some focal point locales and has caused a scarcity of housing, a shortage of municipal personnel (i.e., policemen, firemen, engineers, etc.), stresses on the capabilities of available infrastructure, and an increase in the cost of living. Chouest, which owns C-Port and C-Port 2 in Port Fourchon, North American Shipbuilding in Larose, Louisiana, and North American Fabricators in Houma, Louisiana, have experienced these impacts first hand. Unable to find housing for their workers, Chouest built an apartment complex for the workers they had to recruit from outside of Louisiana because of the labor and skills shortage within the State.

The extensive deterioration of LA Hwy 1 is mostly due to coastal landloss from wave forces; LA Hwy 1 divides the Barataria and Terrebonne estuaries, the Nation's two most productive estuaries. Port Fourchon has been active in building up the embankment with channel dredging materials, but it is a short-term fix to a long-term problem that grows worse every day. At present, Golden Meadow, Louisiana, to Larose, Louisiana, is the only section of the highway that is four lanes. While the State and local government have received revenue from the increased OCS activity at Port Fourchon, the cost of impacts from OCS operations have exceeded growth in the revenue stream. At present, the Louisiana Department of Transportation and Development (DOTD), which manages LA Hwy 1, and Port Fourchon are completing a draft EIS on a new four-lane highway. Funding is estimated at $650 million. The port and community leaders realize that efforts such as the Conservation and Reinvestment Act (CARA) will be vital in mitigating OCS impacts, but it will not completely cover the cost of a new highway. Monies from the Act are to be used for all offshore oil and gas impacts; consequently, only a portion can go to infrastructure projects.

In the EA prepared for Lease Sale 182, MMS recognized Port Fourchon and LA Hwy 1's importance to the nation's energy infrastructure and emphasized its desire for impact assistance to ameliorate effects of the OCS Program. As the port has grown, its importance to the nation's energy infrastructure has increased significantly. Twenty percent of the Nation's oil and 25-27 percent of the natural gas are located offshore Louisiana. The port services 90 percent of the Gulf's deepwater activity. In addition, as of September 5, 2001, Port Fourchon is servicing about 39 percent of all offshore mobile rigs working in the Gulf of Mexico OCS. Of this total, nearly 59 percent are located in deepwater (One Offshore, 2001a). Furthermore, LOOP is connected to 30 percent of the U.S.'s refineries. With the increasing importance of deepwater development and the potential for FPSO's working in the Gulf of Mexico in the near future, LOOP will become even more important to the U.S. energy intermodal system and, therefore, so will Port Fourchon.

LA Hwy 1 has also been recognized on the national level. In 1995 LA Hwy 1 was selected as part of the National Highway System (NHS) because of its intermodal link to this nation's energy supply. The NHS Act designates roads that are critical for the economy, defense, and mobility of the nation. In December 2001, Congress designated LA Hwy 1 as one of only 44 high priority corridors in the U.S. based on its significance to the nation's energy infrastructure.

Several other service bases have also seen a large increase in OCS-related activity and concomitant stresses placed on their local infrastructure. These ports include Cameron, Venice, and Morgan City, Louisiana, which are servicing 18 percent, 15 percent, and 10 percent of OCS-related offshore mobile rig activity, respectively (One Offshore, 2001a). The limited number of service bases capable of servicing deepwater activities suggests that stresses placed on local infrastructure at these bases will continue to the extent that deepwater tracts are leased, explored, and developed. Recent leasing history has shown an increase in deepwater interest.

3.3.3.3. Current Economic Baseline Data

Oil and natural gas prices are used to evaluate the oil and gas industry's ability to economically develop resources. Current crude oil and natural gas prices are substantially above the economically viable threshold for drilling in the Gulf of Mexico. As of October 4, 2001, Henry Hub Natural Gas closed at $2.414 per million BTU (a decrease of 3.5% or $0.086 from a month ago) (Oilnergy, 2001). During September 2001, natural gas futures plummeted below $2 per thousand cubic feet for the first time since April 1999 amid concerns that the U.S. economy may enter a recession. Natural gas demand from manufacturers, which accounts for about a quarter of U.S. consumption, is down and a turnaround in the economy is not expected in the short term (Houston Chronicle On-line, 2001a). Although the Secretary-General of OPEC, Ali Rodriguez, said that the Arab-dominated cartel would ensure world oil supplies and price stability immediately following the September 11, 2001, terrorist attacks on the United States, oil and gold prices surged (COMTEX, 2001). Crude oil prices then dropped, taking their biggest hit in 10 years during September 2001. Fear of a recession that would reduce demand is compounded by the belief that OPEC will not act to maintain prices (Houston Chronicle On-line, 2001b). Oil prices have since moved moderately higher. Market reaction has been muted because Allied strikes in response to the terrorist attacks do not threaten Middle East oil supplies (Reuters, 2001). On October 4, 2001, light sweet crude listed for $22.63 per barrel on the New York Mercantile Exchange (a decrease of 19.27% or $5.40 from a month ago).

New rig deliveries and orders are another indicator of the industry. Fifteen new rigs were delivered in 2000, three of which were speculative new builds. All three of these "spec" rigs had contracts waiting for them by the time they were delivered. After a hiatus from placing new rig orders in 1999, drilling contractors looked to increase their level of activities in 2000. Orders for six new drilling rigs were placed in 2000. A recent survey by Lehman Brothers asked over 60 "leading experts" how many rig orders would be placed for 2001. The average of all the predictions was 13 (One Offshore, 2001b). Another indicator of the direction of the industry is the exploration and development (E&D) expenditures of the major oil and gas companies. After substantially cutting their E&D budgets during the 1998 and 1999 fiscal years, majors are once again increasing activity levels. Lehman Brothers' semi-annual Original E&P Spending Survey predicts a 19.1 percent worldwide spending increase, although natural gas prices, not oil prices, were identified as the number one determinant of E&P spending in 2001 (One Offshore, 2001b).

In addition to new rig deliveries and orders, drilling rig use is employed by the industry as a barometer of economic activity. After having hovered around 90 percent or better for most of 2000, the September 2001 utilization rate for all marketed mobile rigs in the Gulf of Mexico was 62.7 percent (One Offshore, 2001a). This breaks down as a 56.7 percent utilization rate for jackups (average day rates of $20,000-66,000); 76.7 percent for semisubmersibles (average day rates of $30,000-175,000); 100 percent for drillships (average day rates of $125,000-150,000); and 57.1 percent for submersibles (average day rates of about $22,500). Platform rigs in the Gulf recorded a 58.8 percent utilization rate, while inland barges had a 71.2 percent utilization rate. The decline in the Gulf of Mexico rig market utilization is the result of a weakening demand brought on the slide in U.S. natural gas prices in 2001-2002. Most of the weakness in the market continues to remain in the jackup fleet. Gulf jackup utilization now stands at 56.7 percent, off 3.3 percentage points from the previous week. The soft conditions the region is experiencing are likely to continue into the first quarter of next year (One Offshore, 2001a).

As rig utilization rates have fallen and the market has become much softer, drilling contractors are no longer in search of skilled crews to run their rigs. While some contractors are recruiting full speed ahead, some are only recruiting for deepwater vessels, while others are not recruiting at all or only at the entry level. While some operators are still impacted from laying off too many crews during the downturn in 1998, it appears that many companies are more careful about laying off crews this time in response to a slowing market. If companies begin laying off personnel and then the market turns up again, drilling contractors may once again struggle to recruit skilled personnel (One Offshore, 2001b).

Offshore service vessel (OSV) day rates, another indicator of the industry's activity, remains strong despite the softening of the drilling rig market, which most vessel operators believe will become active later this year (Greenberg, 2001). The July 2001 average day rates for all three types of vessels used by the offshore oil and gas industry increased from the July 2000 averages. Anchor-handling tug/supply vessel (AHTS) average day rates ranged from $10,500 for under 6,000-hp vessels to $12,500 for over 6,000-hp vessels; utilization rates were 88 percent and 100 percent, respectively. Supply boat average day rates ranged from $7,718 for boats up to 200 ft and $10,950 for boats 200 ft and over; utilization was 89 percent and 100 percent, respectively. Crewboat average day rates ranged from $2,928 for boats under 125 ft to $3,775 for boats 125 ft and over; utilization was 100 percent and 98 percent, respectively.

Commencing with Central Gulf of Mexico Lease Sale 178 Part 1 in March 2001, new royalty relief provisions for both oil and gas production in the Gulf of Mexico's deep and shallow waters were enacted. These rules will govern the next three years of lease sales. Central Lease Sale 178 Part 1 resulted in 534 leases (an increase of 59.88% or 200 blocks from Central Lease Sale 175 in March 2000). Of these 534 leases, 348 were in shallow water (0-400 m). This increase of 67.30 percent from the last Central lease sale largely reflects the intensified interest in natural gas due to higher prices over the last year and the new royalty relief provisions. The 186 blocks receiving bids in deepwater (greater than 400 m) reflect an increase of 47.62 percent or 60 blocks. Again, this dramatic increase in leasing could be a result of the recently issued royalty relief provisions. Western Gulf of Mexico Lease Sale 180 and Central Gulf of Mexico Lease Sale 178 Part 2, offering the newly available United States' blocks beyond the U.S. Exclusive Economic Zone, were held jointly on August 22, 2001. No bids were received for blocks offered in Central Gulf Lease Sale 178 Part 2. Of the 4,114 blocks offered in Western Gulf Lease Sale 180, 320 received bids. About 55 percent of blocks receiving bids (or 177 blocks) in Western Lease Sale 180 are in deepwater.

3.3.3.4. Demographics

Tables 3-12 to 3-3-27 contain the analysis area's baseline projections for population, age, race and ethnic composition, and education over the life of the proposed actions. These tables present the projections by subarea, each Gulf of Mexico state, and the United States. Projections, through 2040, are based on the Woods and Poole Economics Inc.'s *Complete Economic and Demographic Data Source* (2001). These baseline projections assume the continuation of existing social, economic, and technological trends. Therefore the projections include population associated with the continuation of current patterns in OCS leasing activity, which encompasses the proposed actions in the CPA and WPA.

In some analysis area locales, i.e., Port Fourchon and Lockport, Louisiana, there has been an influx of workers from Mexico, India, and other parts of the U.S. because of the shortage of local workers in the local community (Keithly, 2001). While these new residents present stresses on communities' infrastructure and government services, they have only minimally changed local demographics (i.e., population, educational attainment, age, and race distribution have only changed negligibly with respect to OCS activities).

3.3.3.4.1. Population

The analysis area consists of highly populated metropolitan areas (such as the Houston MSA, which predominates Subarea TX-2) and sparsely populated rural areas (as is much of Subarea TX-1). Some communities in the analysis area experienced extensive growth during the late 1970's and early 1980's when OCS activity was booming. Following the drop in oil prices, many of these same areas experienced a loss in population (Gramling, 1984; Laska et al., 1993). All subarea populations are expected to grow at a higher rate than the United States' average annual population growth rate over the life of the proposed actions, reflecting the region to region migration pattern of favoring the south and west over the northeast and midwest (USDOC, Bureau of the Census, 2001). This is a continuation of historic trends. Average annual population growth projected over the life of the proposed actions range from a low of 0.87 percent for Subarea LA-3 (dominated by the Orleans MSA) to a high of 1.59 percent for Subarea FL-1 in the western panhandle of Florida. Over the same time period, the population for the United States is expected to grow at about 0.76 percent per year.

The population in the analysis area throughout the life of the proposed actions is expected to remain a fairly even mix of male/female, with the female population having a slight edge over the male population (particularly over time as the population ages). The population mix of the subareas is only slightly more female than that of the United States.

3.3.3.4.2. Age

The median age for the subareas in Texas, Louisiana, Mississippi, and Alabama compare favorably with the median age of the United States as a whole, with a slight tendency toward an older population moving eastward across the subareas. Nationwide there is an expected aging tendency with the percentage of the population in the 65 years and over category doubling. By 2011, the baby boomers will start to turn 65, and by the year 2025, the percentage of older people projected to live in the United States as a whole will be greater than the current percentage in Florida (AmeriStat, 2001). Over the same 40 years, all of the subareas, with the exception of Subarea FL-3, are expected to show a similar trend.

3.3.3.4.3. Race and Ethnic Composition

The racial and ethnic composition of the analysis area reflects both historical settlement patterns and current economic activities. For example, those counties in Texas where Hispanics are the dominant group – Cameron to Nueces (Brownsville to Corpus Christi) – were also settled by people from Mexico. Their descendants remain, typically working in truck farming, tending cattle, or in low-wage industrial jobs. From Aransas to Harris County (Houston), the size of the African-American populace increases, indicating more urban and diverse economic pursuits. In Jefferson County, Texas, adjacent to Louisiana, African-Americans outnumber Hispanics, reflecting the dominant minority status of African-Americans throughout the rest of the analysis area. Despite the larger number of white, non-Hispanic people in coastal Texas, Louisiana, Mississippi, and Alabama, together African-Americans and Hispanics outnumber whites, a trend which is national, not just regional, and a trend which is increasing. Compared with the United States, there is a higher non-white racial composition to the Texas, Louisiana, Mississippi, and Alabama coastal areas with the exception of Subarea TX-1. This subarea borders Mexico and has the highest concentration of Hispanic population. Southwestern Louisiana is Acadian country. Settlers included Houma Indians, French, Spanish, English, and African. (See Chapter 3.3.3.10 Environmental Justice for further discussion of minority and low-income populations.)

3.3.3.4.4. Education

At present, the 2000 U.S. Census data for education at the county/parish level have not been released. The last available data at this level is the 1990 Census data. Therefore, this analysis uses the 2000 U.S. Census Supplementary Survey Profile educational attainment data for States. For people 25 years and over, 75.2 percent of the population in the U.S. has graduated from high school, while 20.3 percent has received a bachelor's degree. Texas' educational attainment percentages are higher than the national average for both categories: 76.8 and 23.5 percent, respectively. Louisiana, while higher than the national average for high school graduates, 76.7 percent, is lower for college degrees, 19.5 percent. Mississippi's educational attainments are lower than the Nation's for both categories—74.3 and 18.6 percent, respectively. Alabama, like Louisiana, has a higher than national high school graduation rate (76.0%), but a lower rate for bachelor's degree (20.2%).

Responsibility for public education rests with each State. American College Test (ACT) scores are available for all states as well as the nation. The ACT assessment is a curriculum-based exam that measures students on what they have learned in school. Students' scores reflect the skills they possess in four academic areas – English, reading, mathematics, and science reasoning. Table 3-28 depicts average ACT scores for the states that border the Gulf of Mexico.

The School-based Administration Test (SAT) is taken primarily by college bound seniors. The SAT scores nationwide have risen significantly over the past decade. Since 1991, verbal scores have increased 7 points while math scores have increased 14 points. Table 3-29 depicts Mean SAT I Verbal and Math Scores for the Gulf of Mexico Coast States. Students also report higher academic aspirations than did students of the past. More than half of all college-bound students plan to pursue Master and/or doctoral degrees. The College Board discourages comparison of SAT scores by state.

Texas School Regions 1 through 5 roughly correspond to the Texas analysis area. Texas School Region 4 includes Houston, the international headquarters for many energy industries. Student enrollment in the public education system has slightly declined for all Texas School Regions except Region 4. Nearly 80 percent of all Texas students taking the Texas Assessment of Academic Skills (TAAS) passed all tests taken in 2000. Performance has increased by 24.3 percent over the past 6 years, with some minority groups increasing their performance by as much as 35 points. Texas students in the public school system have shown significant improvement in mathematics, increasing by almost 27 percent since 1994. Minority and economically disadvantage students have made the most impressive gains. Texas students also have shown advances in reading, as evidenced by TAAS tests, with performance increasing by 7.4 percent since 1996. These gains have been credited to the implementation of the Texas Reading Initiative in 1996. Participation in college admission testing has increased in Texas at higher rates than the nation. From 1995 to 1999, the number of SAT test takers increased 21.6 percent in Texas, compared to 14.2 percent nationwide; while the number of ACT test takers increased 8.7 percent in Texas, compared to 7.8 percent nationwide (Texas Public Education Portal, 2001). Texas students averaged an ACT composite score of 20.3 in all years from 1998 to 2001 as compared to the national average of 21.6 for all years.

In Louisiana, enrollment in parochial and other non-public school systems is sizable, particularly in the New Orleans metropolitan area. About 83 percent of nonpublic students in Louisiana are white, about 13 percent are black, and the remaining 4 percent are American Indian, Asian, or Hispanic. In the 1999-2000 school year, about $5,814/student was spent in the Louisiana public school system. Average daily attendance as a percent of public school membership in the 1999-2000 school years was 92.7 percent for Louisiana, as compared to the U.S. average of 91.29 percent. Nearly 70 percent of Louisiana's public middle and elementary schools improved their performance significantly in the past two years. A school's Louisiana Educational Assessment Program results, Iowa test results, attendance, and drop-out data measures performance. The State's average performance score has risen from 69.4 in 1999 to 81.3 in 2001. The goal is to earn a performance score of 100 by 2009, about the national average. Louisiana students averaged an ACT composite score of 19.6 in all years from 1999 to 2001, as compared to the national average of 21.6 for those years.

"The local school system in [Greater Lafourche Parish] is now facing the issues and challenges related to bilingual education as Spanish speakers [from increased OCS activities] begin to move to the area. This is often a difficult task for large metropolitan school system and the community in this case is rather small and strongly French in its background and history" (Keithly, 2001). Furthermore, this has resulted in additional costs to the school system.

Harrison, Hancock, and Jackson County School Districts are located in the Mississippi analysis area. The curriculum reflects national standards and addresses the competencies measured by high stakes testing in Mississippi. Technology is used as a tool of instruction through computer-assisted instruction and to enhance skills of search and product development. The Hancock County School District, serving about 4,200 students in grades kindergarten through twelve, has a district-wide student/teacher ratio of 23 to 1, and an average per pupil expenditure in 1997-1998 of about $5,900. The Hancock County School District is ranked in the top quarter of all Mississippi school districts. The Jackson Public School District is the largest and only urban school district in Mississippi, with a 31,235 student enrollment (94.5% minority). The District's rating from the Mississippi Commission on School Accreditation is Level 3 (successful) and every school in the district is accredited by the Southern Association of Colleges and Schools. Mississippi students averaged ACT composite scores of 18.7 in all years from 1998 to 2000 and 18.5 for the year 2001 as compared to the national average of 21.6 for all years.

Alabama has recently adopted the Equity and Adequacy Plan. The Plan increases class time and adds teachers to the classroom. It also addresses practically every area of public education, such as buildings and maintenance, teacher testing, the addition of textbooks and computers, special education, educational initiatives, and school libraries. Major changes in the current Alabama Education Foundation Program will be required to support educationally adequate initiatives, which are estimated to cost about $1.7 billion. Alabama students averaged ACT composite scores of 20.1 for years 1998 and 2001 and 20.2 for the years 1999 and 2000, as compared to the national average of 21.6 for all years.

3.3.3.5. Economic Factors

Tables 3-12 to 3-27 contain the analysis area's baseline projections for employment, business patterns, and income and wealth over the life of the proposed actions. These tables present the projections by subarea, each Gulf of Mexico state, and the Unites States. Projections through 2040 are based on the Woods and Poole's "Complete Economic and Demographic Data Source" (Woods and Poole Economics, Inc., 2001). These baseline projections assume the continuation of existing social, economic, and technological trends. Therefore, the projections include employment associated with the continuation of current patterns in OCS leasing activity, which encompasses the proposed actions in the CPA and WPA, as well as the continuation of trends in other industries important to the region. Chapter 3.3.3.1.2 discusses the analysis area's major employment sectors.

While the OCS industry may not be the dominant industry in a subarea, it can be in a specific locale within a subarea, causing that focal point to experience impacts. For example, in Port Fourchon and Lockport, Louisiana, there has been an influx of workers from Mexico, India, and other parts of the U.S. because of the shortage of local workers in the local community. While these new residents are expected to only negligibly impact the subarea's demographics, they have presented the communities with added stress to infrastructure and government services. Many of these increased costs to local governments are hard to quantify. Some locally provided services are tied to the unique needs of the oil and gas offshore industry. For example, schools, city water, law enforcement, and roads have been particularly affected by the growth of offshore development (Keithly, 2001). Furthermore, the cyclical nature of the oil and gas industry (boom/bust) makes allocating budgetary monies and personnel to these services difficult.

3.3.3.5.1. Employment

Average annual employment growth projected over the life of the proposed actions range from a low of 0.99 percent for Subarea LA-3 (predominated by the Orleans MSA) to a high of 1.92 percent for Subarea FL-1 in the western panhandle of Florida. Over the same time period, employment for the United States is expected to grow at about 1.29 percent per year, while the Gulf of Mexico analysis area is expected to grow at about 1.54 percent per year. As stated above, this represents growth in general employment for the subareas. Continuation of existing trends, both in OCS activity and other industries in the area, are included in the projections. (See Chapter 3.3.3.5 for more a more complete examination of employment and labor issues with respect to each OCS industry.)

3.3.3.5.2. Income and Wealth

Median household income in the United States was $42,148 in the year 2000. This value equaled the value for 1999 in real terms, the highest level ever recorded in the Current Population Survey. Median incomes for Hispanic (who may be of any race) and Black (African American) households hit new all-time highs of $33,447 and $30,439, respectively. The median household incomes of white non-Hispanic ($45,904) and Asian and Pacific Islander ($55,521) households equaled their highest level ever (USDOC, Bureau of the Census, 2001).

Income associated with the industrial sectors for the WPA coastal subareas and that of the CPA are similar. Because the service industry is a major employer in the analysis area, this industry contributes significantly (percentage-wise) to income. The manufacturing and construction industries also contribute greatly, in percentage terms, towards income earned for the subareas.

Using the Woods and Poole Wealth Index, all subareas within the Gulf of Mexico analysis area, with the exception of Subareas FL-3 and FL-4, rank considerably below the United States in terms of wealth. Subareas FL-3 and FL-4 rank slightly higher than the U.S. Ironically, Subarea FL-2 ranks lowest on the wealth scale of all subareas in the region. The Florida counties are the least influenced by OCS development in the analysis area. All other subareas range from the low 70's to upper 80's for their respective wealth indices throughout time, with the United States being 100. The Wealth Index is the weighted average of regional income per capita divided by U.S. income per capita (80% of the index); plus the regional proportion of income from dividends/interest/rent divided by the U.S. proportion (10% of the index); plus the U.S. proportion of income from transfers divided by the regional proportion (10% of the index). (See Chapter 3.3.3.10 Environmental Justice for further discussion of minority and low-income populations.)

3.3.3.5.3. Business Patterns by Industrial Sector

The industrial composition for the subareas in the WPA and that in the CPA are similar. With the exception of Subareas LA-2 and MA-1, the top four ranking sectors in terms of employment in the analysis area are the service, manufacturing, retail trade, and State and local government sectors. In Subareas LA-2 and MA-1, construction and State and local government, respectively, replace manufacturing as one of the top four industries on the basis of employment. The service industry employs more people in all subareas with the exception of Subarea FL-2, in which State and local government is first in terms of employment. The service industry is also the fastest growing industry.

As part of its economic impact analysis in Chapter 4, MMS uses IMPLAN's input-output model. A set of multipliers is created for each subarea in the analysis area based on each subarea's unique industry make-up described above. An assessment of the change in overall economic activity for each subarea is then modeled as a result of the expected changes in economic activity associated with holding a CPA or WPA lease sale.

3.3.3.6. Non-OCS-Related Marine Transport

An extensive maritime industry exists in the northern Gulf of Mexico. Figure 3-11 shows the major ports and domestic waterways in the analysis area, while Tables 3-30 and 3-31 present the 1999 channel depth, number of trips, and freight traffic of OCS-related waterways. Maritime traffic is either domestic or foreign. There is a substantial amount of domestic waterborne commerce in the analysis area through the Gulf Intracoastal Waterway (GIWW), which follows the coastline inshore and through bays and estuaries, and in some cases offshore. In addition to coastwise transport between Gulf of Mexico ports, foreign maritime traffic is extensive. Major trade shipping routes between Gulf ports and ports outside the northern Gulf of Mexico occur via the Bay of Campeche, the Yucatan Channel, and the Straits of Florida.

Fourteen of the 50 leading U.S. ports (based on millions of short tons in 1999) are located on the Gulf of Mexico. All five Gulf States, when ranked by state tons in 1999, are in the top 20 (1-Louisiana, 2-Texas, 5-Florida, 16-Alabama, and 20-Mississippi), reflecting the importance of the analysis area's ports to U.S. waterborne traffic. Major ports in the analysis area by port tons for 1999 include 1-South Louisiana, Louisiana; 2-Houston, Texas; 4-New Orleans, Louisiana; 5-Corpus Christi, Texas; 6-Beaumont, Texas; 7-Baton Rouge, Louisiana; and 8-Port of Plaquemines, Louisiana. The ports of Tampa, Florida; Lake Charles, Louisiana; Texas City, Texas; Mobile, Alabama; Pascagoula, Mississippi; Freeport, Texas; and Port Arthur, Texas, are also in the top 50 ports. Major inland waterways include the Gulf Intracoastal Waterway; the Houston-Galveston Ship Channel; the Sabine River; the Calcasieu River; the Atchafalaya River; the Morgan City-Port Allen Route; the Chene, Bouef, and Black Waterway; the Houma Navigation Canal; the Bayou Lafourche/West Belle Pass; the Mississippi River; the Tombigbee River; the Alabama River; and the Mobile Ship Channel (U.S. Dept. of the Army, COE, 2001a).

In terms of tonnage for all commodities, including domestic or foreign, inbound or outbound, the top six ports in 1999, in decreasing order, were the Port of South Louisiana, Sabine-Neches, Port of New

Orleans, Beaumont, Port of Baton Rouge, and Port of Plaquemines. As seen in Table 3-31, crude and petroleum products make up a large portion of total commodities transported through the analysis area's ports. Extensive refinery capacity, easy port access, and a well-developed transportation system have contributed to the development of the Gulf of Mexico coast region as an important center for handling oil to meet the world's energy needs. Both crude oil and petroleum products travel through the Gulf and these ports. Crude oil is tankard into area refineries from domestic production occurring in the Atlantic and Pacific Oceans. Crude oil produced within the Gulf of Mexico region is barged among Gulf terminals to reach refineries and onshore transportation routes. Petroleum products are barged, tankered, piped, or trucked from the large refinery complexes. Between 60 and 65 percent of the crude oil being imported into the United States comes through Gulf of Mexico waters. The area also includes the Nation's Strategic Petroleum Reserve and LOOP, the only deepwater crude-oil terminals in the country.

In 1999, there was a considerable amount of waterborne commerce along the Gulf Coast from Pensacola Bay, Florida, to the Mexican border (U.S. Dept. of the Army, COE, 2001a). Review of non-OCS-related vessel and freight traffic during 1999 (Tables 3-30 and 3-31) shows that vessel trips and waterborne commerce occurred primarily west of the mouth of the Mississippi River. More than 42 percent of the vessel trips recorded in 1999 within the Pensacola Bay to Mexican border segment of the GIWW took place between the Mississippi and Sabine Rivers. Vessel trips from Mobile Bay, Alabama, to New Orleans, Louisiana, accounted for 16 percent of total GIWW trips, while the Sabine to Galveston route and the Galveston to Corpus Christi route accounted for 21 and 15 percent, respectively. Tanker traffic was most intense between the Mississippi and Sabine Rivers.

The 1999 statistics for vessel trips in harbors, channels, and waterways located between Pensacola Bay and Sabine Pass show that there were eight major locations of vessel activity. These locations in decreasing order of activity were as follows: Port of South Louisiana, Port of New Orleans, Sabine-Neches Waterway, Port of Baton Rouge, Port of Plaquemines, Mobile Harbor, Calcasieu River and Pass, and Bayou Lafourche. The top seven waterways in terms of tanker trips during 1999 were (in decreasing order by number of tanker trips inbound and outbound trips combined), as follows: Sabine-Neches, Port of South Louisiana, Port of Baton Rouge, Port of New Orleans, Morgan City to Port Allen, Calcasieu River, and Beaumont.

The transport of crude petroleum was concentrated in four locations: Sabine-Neches, Beaumont, Port of South Louisiana, and Calcasieu River. The transport of crude petroleum was mostly imported. The four major petroleum products locations were (in descending order) Port of South Louisiana, Sabine-Neches, Port of New Orleans, and Port of Baton Rouge.

Tanker imports and exports of crude and petroleum products into the Gulf of Mexico are projected to increase (USDOE, EIA, 2001a). In 2000, approximately 2.08 BBO of crude oil (38% of U.S. total) and 1.09 BBO of petroleum products (13% of U.S. total) moved through analysis area ports. By the year 2020, these volumes are projected to grow to 2.79 BBO of crude oil and 1.77 BBO of petroleum products. Crude oil will continue to be tankered into the Gulf of Mexico for refining from Alaska, California, and the Atlantic.

3.3.3.7. OCS-Related Offshore Infrastructure

3.3.3.7.1. Offshore Platforms

Unless otherwise indicated, the following information is from the MMS study, "Deepwater Program: OCS-Related Infrastructure in the Gulf of Mexico Fact Book" (Louis Berger Group, Inc., in preparation).

Offshore platforms play a pivotal role in the development of offshore oil and gas resources. The purpose of a platform is to house production and drilling equipment and living quarters for personnel (for manned platforms). A platform consists of two major components: an underwater part (jacket or tower) and an above water part (deck). Other platform components are living quarters, control building, and production modules. Several types of production systems are used for offshore oil and gas development in the analysis area.

A fixed platform is the most commonly used type of production system in the U.S. Gulf of Mexico. A fixed platform is a large skeletal structure extending from the bottom of the ocean to above the water level. It consists of a metal jacket, which is attached to the ocean bottom with the piles, and a deck, which accommodates drilling and production equipment and living quarters. Fixed platforms are typically installed in water depths up to 1,500 ft.

A compliant tower is similar to a fixed platform; however, the underwater section is not a jacket but a narrow, flexible tower which, due to the flexibility of its structure, can move around in the horizontal dimension, thereby withstanding significant wave and wind impact. Compliant towers are typically installed in water depth from 1,000 to 2,000 ft.

Tension and mini-tension leg platforms do not have skeletal structures extending all the way to the ocean floor. Instead, they consist of floating structures, which are kept in place by steel tendons attached to the ocean floor. Tension leg platforms can be used in different depth ranges, up to 4,000 ft.

A spar platform consists of a large vertical hull, which is moored to the ocean floor with up to 20 lines. On top of the hull sits the deck with production equipment and living quarters. At present, SPAR platforms are used in water depth up to 3,000 ft; however, SPAR technology allows installations in waters as deep as 7,500 ft.

A floating production system consists of a semi-submersible unit that is kept stationary either by anchoring with wire ropes and chains or by the use of rotating thrusters, which self propel the semi-submersible unit. Floating production systems are suited for deepwater production in depths up to 7,500 ft.

A subsea system consists of a single subsea well or several wells producing either to a nearby platform or to a distant production facility through a pipeline and manifold systems. At present, subsea systems are used in water depths exceeding 5,000 ft.

A floating production, storage, and offloading (FPSO) system consists of a large vessel that houses production equipment. It collects oil from several sub-sea wells, stores it, and periodically offloads it to a shuttle tanker. The FPSO systems are particularly useful in development of remote oil fields where pipeline infrastructure is not available. To date, MMS has received no proposals for use of FPSO systems in the Gulf of Mexico.

Platforms are fabricated onshore and then towed to an offshore location for installation. Facilities where platforms are fabricated are called platform fabrication yards. Production operations at fabrication yards include the cutting and welding of steel components and the construction of living quarters and other structures, as well as the assembly of platform components. Fixed platform fabrication can be subdivided into two major tasks: jacket fabrication and deck fabrication.

The jacket is constructed by welding together steel plates and tubes to form a tower-like skeletal structure. Because the height of a jacket is several hundred feet, jackets are made lying horizontally on skid runners. Once the jacket is completed, it is pulled over, maintaining the same horizontal position, to a barge that transports it to an offshore location where the jacket is installed. Along with the jacket is the construction of smaller ancillary structures such as pile guides, boat landings, walkways, buoyancy tanks, handrails, etc. These structures are attached to the jacket while it is still in a horizontal position.

The deck is fabricated separately from the jacket. A typical deck is a flat platform supported by several vertical columns (deck legs). The deck provides the necessary surface to place production equipment, living quarters, and various storage facilities. Once the deck fabrication is completed, it is loaded onto a barge and transported to the site of the platform, where it is lifted by derrick barges and attached to the already installed jacket.

Tables in Chapter 9.1.5 present information on platforms operating in the OCS.

3.3.3.7.2. Offshore Transport

Service Vessels

Unless otherwise indicated, the following information is from "The Gulf of Mexico Supply Vessel Industry, A Return to the Crossroads" (Simmons & Company International, 2000).

Service vessels are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. In addition to offshore personnel, service vessels carry cargo (i.e., freshwater, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, and food) offshore. There are currently 376 supply vessels (platform supply vessels (PSV's) and anchor handling tugs/supply vessels (AHTS)) in the Gulf of Mexico analysis area (up from a 1993 low of 247 units). One hundred and sixteen (or 35%) of the 376 supply vessels were built since 1996. This breaks down as 83 PSV's, 15 AHTS, and 18 units for specialty services. The first newbuilds commenced construction in late 1996 when dayrates were in the $6,000-7,000 range and utilization was steady at 95 percent; a primary driver of supply vessel demand is rig activity. The first deliveries were in early 1997. As dayrates continued to accelerate during 1997, reaching the $8,000-9,000 range, more orders were placed. With an average delivery time of 12-16 months (and an average cost of $8-10 million), most newbuilds entered the market during the second half of 1998 and 1999, just as the Asian crisis and falling oil prices began to take hold, leading to demand, utilization, and dayrates ($2,400) falling dramatically.

Although the traditional workhorse of the Gulf of Mexico has been the standard 180-ft supply vessel, none of the boats built were less than 190 ft in length. Eighty-seven percent of the newbuilds were 200 ft in length or greater while over half were 220 ft in length or greater. The increasing size of the newbuild fleet is directly related to the emergence of deepwater drilling in the Gulf of Mexico over the past four years. At present, nearly three-quarters of the supply fleet in the analysis area is less than 200 ft long and work primarily in the shallow waters; 28 percent of the fleet is 200 ft or larger and works primarily in deepwater. Although length is typically used to describe supply vessels, it is actually the liquid mud capacity and dynamic positioning capability that are the most important criteria for deepwater operators. Most operators view 220-ft boats as the minimum for work in supporting drilling operations. Typical Gulf of Mexico vessel specifications are shown in Table 3-32. The Gulf of Mexico supply boat industry does not have a young fleet. Nearly 40 percent of the entire fleet is at least 20 years old. Only 26 percent of the fleet is 10 years old or younger. The average age of the fleet in 1997 was 17.9 years. At present, the average age is 15.7 years, reflecting the newbuild expansion of the last cycle. The estimated life of a service vessel is 25 years.

Since the last industry downturn that began in 1998, the supply boat market has experienced a great deal of consolidation. During the last two years, numerous smaller players exited the industry via bankruptcy, asset sales to larger competitors, or asset sales to outside the industry. More than half of the smaller boat operators that operated three or fewer boats in the last cycle are no longer in the business. The resulting Gulf of Mexico supply boat industry is very fragmented. There are 24 boat operators in the analysis area. Sixteen of these operators own fleets of less than 10 boats. Nine own three boats are less. Of the 24 operators, 6 are public and 18 are privately held. The six public companies (Trico Marine, 13%; Ensco Marine, 7%; Seacor Smith, 7%; Sea Mar, 7%; and Seabulk Offshore, 6%) control 70 percent of the total fleet. Edison Chouest is the largest private boat operator with 11 percent of the total supply-vessel fleet. Chouest was the first company to undertake major newbuilding projects and was the most significant builder in the last cycle with respect to the number of units (49) and total capital invested ($677 million). Over 8 percent of the 220-ft newbuilds were Edison Chouest vessels. The modern, high-capacity fleet has given Chouest a strong presence in deepwater. The second most active newbuild participant was Seacor, which spent over $222.5 million on 14 vessels. The market share for several major companies has experienced significant changes. The most noticeable change is the decline in Tidewater's market share from 42 percent in 1997 to 30 percent in 2000. This decline is a result of Tidewater's restraint from building in the last cycle, although Tidewater has recently announced that it has committed up to $300 million to a program that will bring 21 crew and fast crew/supply vessels into its fleet by the year 2003. Chouest almost doubled their market share over the last three years through their aggressive newbuild program.

The emergence of deepwater drilling has become the most important factor going forward in the Gulf of Mexico supply boat industry. As a result of newbuilds and conversions, the number of drilling rigs capable of drilling in over 3,000 ft of water has quadrupled sine 1996. Compared to the shallow waters of the Gulf of Mexico, deepwater drilling support requires a significantly enhanced supply boat. In deepwater more drilling mud is required to fill wellbore and risers. Thus, deepwater supply vessels need large liquid mud capacities. Deepwater drilling rigs generally operated farther from shore than conventional shallow-water units. Weather patterns can be violent, and the sea conditions are typically rougher. Therefore, in order for a supply vessel to safely maintain its position near a deepwater rig, dynamic positioning (DP) is required. With DP capability, a supply vessel uses global positioning satellites to determine an exact location and small engines or thrusters to maintain the boat's position.

Given the relative youth of the Gulf of Mexico deepwater industry, exploration and production (E&P) operating practices have not been standardized. Some E&P companies have chosen to employ two boats of the 200- to 205-ft class for support of a deepwater drilling rig. This allows the operator to shuttle boats between the rig and port, while still having a boat on location at all times. If additional items are required that are not at the rig location, the boat in port can bring the items to the rig on its next trip, effectively reducing the time needed to get supplies had only one large boat been contracted. It generally takes supply vessels 10-15 hours (one way) to get to deepwater locations compared to only a few hours for wells drilling on the shelf. While some E&P operators are using two vessels, it appears that most are moving toward the use of one larger boat (220+ ft) to support activities. Industry is increasingly using the 200-205 ft class in shallower waters. This obviously has implications for the 180-ft supply boat category.

Several E&P companies in the analysis area are currently undertaking the concept of boat pooling. Rather than assigning specific boats to specific rigs, E&P companies are experimenting with the use of several boats for a pool of rigs. Some operators will share their contracted boats with other E&P companies, while others are utilizing boat pooling specifically for their own rigs. Initial indications are that E&P companies have been successful in reducing their boat usage. Along the same vein, there is a growing interest among E&P customers toward the issue of logistics as a way to improve efficiency and reduce costs. The larger boats that have been added by the industry have the capacity and capability to serve multiple rigs on one trip from port. This is a critical factor in the logistics business. Edison Chouest recently introduced a logistics company, C-Logistics. Their first customer, Shell, was able to generate higher boat utilization and lower costs. ASCo Group and Baker Energy are also establishing logistics products.

Helicopters

Helicopters are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. Helicopters are routinely used for normal crew changes and at other times to transport management and special service personnel to offshore exploration and production sites. In addition, equipment and supplies are sometimes transported. For small parts needed for an emergency repair or for a costly piece of equipment, it is more economical to get it to and from offshore fast rather than by supply boat. Normal offshore work schedules involve two-week (or longer) periods with some crew changes on a weekly basis; therefore, helicopters will travel to some facilities at least once a week. According to the Helicopter Safety Advisory Conference (Osborne, 2000), the number of helicopter trips in support of Gulfwide OCS operations have been increasing steadily since 1994 to over 1.7 million trips annually, carrying 3.7 million passengers during 417,000 flight hours.

The Federal Aviation Administration (FAA) regulates helicopter flight patterns. Because of noise concerns, FAA Circular 91-36C encourages pilots to maintain higher than minimum altitudes near noise-sensitive areas. Corporate policy (for all helicopter companies) states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms and drilling rigs. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas and coastlines, and 2,000 ft over populated areas and sensitive areas including national parks, recreational seashores, and wildlife refuges. In addition, the guidelines and regulations promulgated by NOAA Fisheries require helicopter pilots to maintain 1,000 ft of airspace over marine mammals.

Deepwater drilling farther offshore is the growth area for helicopters. The offshore helicopter industry is purchasing new helicopters to meet the demands of deepwater: travel farther and faster, carry more personnel, all-weather capability, and lower operating costs. The helicopters in service today have travel ranges up to 450 nmi, can attain speeds over 200 mph, can carry up to 20 passengers, and may cost $10 million or more. Bell Helicopter Textron is the leading manufacturer of helicopters in the world. Other major manufacturers include Eurocopter, MD Helicopters, Sikorsky, and Agusta Westland.

Many of the platforms offshore Texas, Louisiana, Mississippi, and Alabama serve as helicopter refueling stations. At present, aircraft fuel is barged to these offshore refueling stations. While there are offshore fueling sites, it saves the industry time and money not to stop. Transportation is one of the exploration and production industry's top three costs. The newer helicopters operating in the Gulf of Mexico, though, have the range and capacity to fly without stopping to refuel, but they are more costly to operate.

Since the tasks the offshore helicopter industry provides are the same tasks supply vessels provide, they are competition for one another. While exploration and production companies like helicopters, the industry is outsourcing more and more operations to oilfield support companies, such as Baker Hughes, who are much more cost conscious and skeptical about the high cost of helicopters. Fast boats are beginning to erode the helicopter industry's share of the offshore transportation business, particularly in shallow water. Another consideration for the helicopter industry is new technology such as subsea systems. As discussed in Chapter 4.1.1.3, a subsea system consists of a single subsea well or several wells producing either to a nearby platform or to a distant production facility through pipeline and manifold systems. These systems decrease the number of platforms and personnel needed offshore, therefore reducing the amount of transportation needed.

3.3.3.8. OCS-Related Coastal Infrastructure

Unless otherwise indicated, the following information is from the MMS study, "Deepwater Program: OCS-Related Infrastructure in the Gulf of Mexico Fact Book" (Louis Berger Group, Inc., in preparation).

The OCS development is supported by a large onshore infrastructure industry consisting of thousands of small and large contractors responsible for virtually every facet of the activity, including supply, maintenance, and crew bases. These contractors are hired by major and independent companies alike to service production areas, provide material and manpower support, and to repair and maintain facilities along the coasts. The offshore support industry employs thousands of workers and is responsible for billions of dollars in economic activity in the analysis area. Virtually all of these support industries are found adjacent to ports.

Throughout the last 50 years the fabrication industry in the analysis area has been the cornerstone for the offshore oil and gas industry. There are hundreds of onshore facilities in the analysis area that support the offshore industry. The fabrication corridor stretches approximately 1,000 mi from the Texas/Mexico border to Alabama. Other offshore support industries are responsible for such products and services as engine and turbine construction and repair, electric generators, chains, gears, tools, pumps, compressors, and a variety of other tools. Additionally, drilling muds, chemicals, and fluids are produced and transported from onshore support facilities. Many types of transportation vessels and helicopters are used to transport workers and materials to and from OCS platforms. As technology matures, additional support industries will evolve.

With the expanding interest in deepwater activities, many onshore facilities have migrated somewhat to areas that have capabilities of handling deepwater vessels, which require more draft. Since fewer ports have such access, dredging operations at existing facilities or contractor expansion to areas that can handle such vessels has occurred. This has also led to heated competition between port facilities. Many support industries have multiple locations among the key port facilities. For instance, Bollinger Shipyards has locations in Texas City, Galveston, Calcasieu, Morgan City, Houma, Lockport, and Fourchon, as well as many other locations.

Shipbuilding and repair facilities are located in key ports along the Gulf of Mexico coast. A typical shipbuilding facility consists of a variety of structures, including maintenance and repair facilities. These yards are typically found adjacent to a deep ship channel that allows them to serve deepwater vessels. Additionally, these facilities also serve other commercial and military needs in order to diversify and protect themselves against leaner oil industry times.

Pipelaying and burial contractors are also found near port facilities. Though there has been a consolidation of sorts, at least five companies account for almost 90 percent of the total footage laid as recently as 1999, resulting in sufficient competition. As offshore production enters deeper water, it requires contractors to retool because thicker-walled pipe is required to withstand the pressures exerted at such depths. This has also led to an evolution of sorts for pipelaying vessels.

Other support facilities are located near ports, including warehouses for chemicals, muds, tools, and other equipment. Crew quarters and bases are also near ports, but some helicopter facilities are located farther inland. Transportation to and from offshore rigs is a major expense for producers, and many transportation companies exist to provide this service. Often one or two supply ships and at least one helicopter is used to support each platform.

In the exploration and development stage, the majority of costs are associated with exploration (19.2%), drilling (16.1%), steel pipe (10.3%), specialized machinery (7.1%), chemicals (6.9%), and water transport (6.7%). The majority of expenses in the pipelaying segment are associated with construction (52.8%) and steel pipe (26%), while the largest expenses associated with the platform operations include instrumentation (44.3%), pipeline construction (15.9%), specialized machinery (13.7%), and pumps and compressors (10.2%). In the ongoing operation and maintenance stage, the largest expenses are associated with operations (36.3%), followed by other services (18.4%) and environmental engineering services (14.7%). The percentage of expenses associated with each of these areas is indicative of the size of the supporting industries.

Like onshore development, OCS exploration and production is driven by oil and gas prices. The 1986 collapse of oil prices forced many offshore companies to close their doors, while the remaining companies often consolidated and expanded operations to include commercial and military business. This was true throughout the entire supporting industry infrastructure.

During slow times all areas feel the effects. Fewer rigs are built and maintained, fewer boats are needed, fewer chemicals are manufactured and purchased, and much less research and development (R&D) is conducted. Perhaps the most detrimental result of a downturn is the flight of many experienced personnel. This has led to severe problems for an industry closely tied to the price volatility of oil and natural gas. When experienced workers leave it is very difficult to entice them back to an industry that is so volatile.

One of the results of fewer R&D dollars is that producers, who are saddled with billion dollar projects, are forced to push much of the R&D expenditures for new technologies onto their suppliers. For example, it is common to see many suppliers shoulder the burden of seismic surveys today. Unfortunately, no single company can adequately fund and support such activities. It is important to realize that new technologies have led to the development of unrecognized, unreachable or uneconomic reserves, which often lead to significant work for the onshore support industry.

Following the massive shift in the industry in the mid-1980's, subsequent price downturns have not been as decimating to the industry, though the 1998-1999 price drop did force companies to lay off employees and to close a few facilities. Drilling declined significantly but did not cause the massive contractor flight evidenced in the mid-1980's. During this downturn, activity shifted somewhat to platform removal, maintenance, renovations, and rig surveys. Some fabrication yards diversified in order to keep their doors open, often taking in non-oil-related work such as barge repair and even military work.

The move into deepwater has increased activity and has led to a significant transformation for some contractors. Since ports with sufficient draft to accommodate deepwater-servicing equipment are limited; onshore effects appear to be concentrated in a few communities. This contrasts with earlier, nearer-shore developments that are supported by many ports and coastal communities.

3.3.3.8.1. Service Bases

Unless otherwise indicated, the following information is from the 2001 MMS study, "Deepwater Program: OCS-Related Infrastructure in the Gulf of Mexico Fact Book" (Louis Berger Group, Inc., in preparation).

A service base is a community of businesses that load, store, and supply equipment, supplies, and personnel that are needed at offshore work sites. Although a service base may primarily serve the OCS planning area and subarea in which it is located, it may also provide significant services for the other OCS planning areas and subareas.

The oil and gas industry has thrived in the Gulf of Mexico. With the industry has come a logistical support system that links all phases of the operation and extends beyond the local community. Land-based supply and fabrication centers provide the equipment, personnel, and supplies necessary for the industry to function through intermodal connections at the Gulf of Mexico coast ports. The necessary onshore support segment includes inland transportation to supply bases, equipment manufacturing, and fabrication. The offshore support involves both waterborne and airborne transportation modes.

States along the Gulf of Mexico provide substantial amounts of support to service the oil and gas industry that is so active on the OCS. Many ports offer a variety of services and support activities to assist the industry in its ventures. Personnel, supplies, and equipment must come from the land-based support industry. All of those services must pass through a port to reach the drilling site. Table 3-33 shows the 50 service bases currently used for the OCS. These facilities were assessed from the MMS Platform Plans' primary service base designation. As can be seen from the Table 3-33, 33 of the service bases (or 66%) are located in the CPA. Of these, 29 reside in Louisiana. In addition to servicing the offshore, several of the services bases are commercially oriented ports: Mobile, Alabama; Pascagoula, Mississippi; Lake Charles, Morgan City, and Port of Plaquemines/Venice, Louisiana; and Corpus Christi, Freeport, Galveston, and Port Arthur, Texas. These activities were discussed in Chapter 3.3.3.6. The other service bases are a combination of local recreation and offshore service activity.

Based on numbers provided by Offshore Data Services, the ports of Cameron, Fourchon, Morgan City, and Venice, Louisiana, service over 81 percent of all Gulf of Mexico mobile rigs and over 91 percent of all deepwater rigs (One Offshore, 2001a). With respect to shallow-water platforms, Pascagoula, Mississippi, and Theodore, Alabama, service the EPA platforms; Cameron, Fourchon, Intracoastal City, and Morgan City, Louisiana, service 55 percent of the CPA platform; and Cameron, Louisiana, and Freeport, Galveston, and Port O'Connor, Texas, service 68 percent of the WPA shallow-water platforms. Fourchon, Morgan City, and Venice, Louisiana, service 84 percent of the CPA deepwater platforms. Freeport, Texas, and Fourchon and Morgan City, Louisiana, service 69 percent of the deepwater platforms in the WPA. While some service bases focus primarily on supplies, others focus on transportation.

This extensive network of supply ports includes a wide variety of shore-side operations from intermodal transfer to manufacturing. Their distinguishing features show great variation in size, ownership, and functional characteristics. Basically, two types of ports provide this supply base. Private ports operate as dedicated terminals to support the operation of an individual company. They often integrate both fabrication and offshore transport into their activities. Public ports lease space to individual business ventures and derive benefit through leases, fees charged, and jobs created. These benefits spread throughout the entire area and are viewed as economic development impacts. Thus, the public ports play a dual role by functioning as offshore supply points and as industrial or economic development districts. An efficient network of ports lowers costs associated with oil and gas production and significantly boosts the well-being of citizens of the adjacent communities.

The significant prosperity that has followed the industry has resulted in issues and concerns that must be addressed at the local community level. For example, additional commercial traffic associated with offshore supplies has caused worsening road conditions at Port Fourchon. While local governments near the service bases have gained revenue from the increased activity within their jurisdictions, the demands for additional services and facilities resulting from oil and gas operations have exceeded growth in the revenue stream. Local tax dollars cannot meet the demand for so many improvements in such a short time. State and Federal matching funds are sought where possible, but the acquisition of those funds often has built-in delaying factors. Nevertheless, communities are attempting to meet the demands of the offshore industry. Thus, the oil and gas industry is determining the direction and scope of improvements being made at local levels. Communities, just like the ports, must be able to anticipate future demands for their services. In order to plan for this growth, communities need timely information about trends in the industry.

Rapidly developing offshore technology has placed an additional burden on service-base ports. As OCS operations have progressively moved into deeper waters, larger vessels with deeper drafts have been phased into service, mainly for their greater range of travel, greater speed of travel, and larger carrying capacity. Services bases with the greatest appeal for deepwater activity have several common characteristics: a strong and reliable transportation system; adequate depth and width of navigation channels; adequate port facilities; existing petroleum industry support infrastructure; a location central to OCS deepwater activities; adequate worker population within commuting distance; and an insightful strong leadership. Typically, deeper draft service vessels require channels with depths of 6-8 m.

Edison Chouest, in 1996, built their C-Port facility in Fourchon, Louisiana, as a one-stop shopping service base for the offshore. This facility was described in Chapter 3.3.3.2. The success of the C-Port caused Port Fourchon to emerge as the deepwater service-base port for the OCS. In September 2001 the Corps of Engineers deepened Bayou Lafourche at Port Fourchon to accommodate the larger supply vessels. To service the WPA and northern Mexico, Chouest has started constructing a C-Port in Galveston, Texas. Services at the new Texas C-Port should commence at the end of 2002 or the beginning of 2003. In order to service the EPA, Chouest has started scouting sites for a C-Port in either Pascagoula, Mississippi, or Mobile/Theodore, Alabama. Construction on this facility will depend on successful exploration in the EPA. Based on Edison Chouest's C-Port locations and the trend for the industry to consolidate, Port Fourchon, Galveston, and either Pascagoula or Mobile/Theodore will serve as the primary deepwater service-base ports for the OCS.

The following are profiles of three ports that are significantly involved in offshore support. These profiles are representative of OCS supply/crew bases. An effort has been made to describe their operational structure as well as to describe their facilities and equipment. However, to continue to offer a viable service and to stay current with technological trends and industry standards, ports must be able to incorporate offshore oil and gas trends into their planning for future infrastructure development, staffing needs, and other impacts associated with rapid industrial growth.

Morgan City, Louisiana

The Port of Morgan City is located within the community of Morgan City in St. Mary Parish, Louisiana. With immediate access to I-49, it is one hour away from New Orleans, Lafayette, and Baton Rouge. Two thousand linear feet of rail spur and 1,500 linear feet of sidings connect the port warehouses with Burlington Northern mainline. Daily rail service is provided by Burlington Northern. The port was created in 1952. Since 1957, it has been active in both domestic and international trade. It is governed by a nine-member Board of Commissioners, who are appointed by the Governor and serve for a nine-year term. Morgan City is the only medium draft harbor between New Orleans and Houston on the Gulf. Its 400-ft wide channel is maintained by the U.S. Army Corps of Engineers to a constant depth of 20 ft. Its docking and cargo handling facilities serve a wide variety of medium draft vessels.

Centrally located along the Gulf Coast, the port is only 18 mi from the open waters of the Gulf of Mexico at the intersection of the Gulf Intracoastal Waterway (GIWW) and the Atchafalaya River. It is on the east bank of the Atchafalaya River in a natural wide and deep harbor known as Berwick Bay. The Atchafalaya River, the GIWW, and Bayous Boeuf, Black, and Chene are the connections to traffic throughout the continental United States and abroad. The Atchafalaya River has its beginnings at the junction of Old River and the Red River in east-central Louisiana. Old River is a short connection between the head of the Atchafalaya and the Mississippi Rivers. The Atchafalaya River flows southward a distance of 135 mi and empties into the Atchafalaya Bay. Traffic between points in the southwest United States and the Upper Mississippi River Valley saves approximately 342 mi per round trip by using the Atchafalaya River rather than the alternate link of the GIWW via the Harvey Locks at New Orleans.

The port is suitable to handle container, general, and bulk cargo. There are over 200 private dock facilities located in the Morgan City vicinity, most of which are oil and gas related. These facilities have heavy-lift, barge-mounted cranes with capacities to 5,000 tons, track cranes to 300 tons, and mobile cranes to 150 tons. Facilities include a 500-ft dock with a 300-ft extension, a 20,000ft^2 warehouse with rail access, a large marshalling yard, a 50 ton capacity mobile track crane, 3 forklifts, a 35-ton cherry picker, and a rail spur. In addition to 3.75 ac of on-dock storage, about 12 ac of auxiliary yard storage is available. Bulk cargo loading/unloading from/to barge and from/to yard from trucks and rail is also offered.

The port plans to expand facilities with a 30,000-lb forklift, 3 yard jockeys, 6 flat-bed trailers, and 6 chassis trailers. The Board of Commissioners is also working with the U.S. Army Corps of Engineers to determine if there is justification for dredging the channel to 35 ft. McDermott, who uses the channel, can not compete with foreign companies to manufacture the larger platforms required by deepwater because of the lack of channel depth necessary to transport the platforms to open waters.

Port Fourchon, Louisiana

Port Fourchon, Louisiana, is located at the mouth of Bayou Lafourche where it empties into the Gulf of Mexico. It is approximately 60 mi south of New Orleans. Its easy accessibility from any area in the Gulf of Mexico has made it one of the most active oil and gas ports on the coast. Port Fourchon's location at the end of Louisiana Highway 1 is in the center of one of the richest and most rapidly developing industrial areas of the Gulf region. While the growth of other ports has slowed, Port Fourchon has been expanding to meet the changing needs of the offshore oil-field industry. Port Fourchon has been designated as one of Louisiana's Enterprise Zones and therefore offers many tax advantages. Its close proximity to the Gulf of Mexico, along with its planned development and multidimensional services, make Port Fourchon one of the most significant oil and gas ports on the Gulf Coast.

The development and supervision of Port Fourchon is under the authority of the Board of Commissioners of the Greater Lafourche Port Commission (GLPC) with headquarters in Galliano, Louisiana. The Commission is composed of nine members who are elected to serve six year terms. Established in 1960, the GLPC Board is the only elected port authority in Louisiana and its members must be at least 21 years of age and residents of the 10th Ward of Lafourche Parish, Louisiana. The Commission regulates commerce and vessel traffic within the Port Fourchon area, owns land and lease facilities, establishes 24-hr law enforcement through its Harbor Police Division, maintains paved roads and provides facilities for governmental coordination such as the U.S. Customs Service and U.S. Coast Guard. Over its 40-year history, the GLPC has cultivated opportunities for businesses and steady economic growth for Port Fourchon and the surrounding area.

Port Fourchon is a multiuse port primarily servicing the needs of oil and gas development. Other uses include commercial fishing, recreation, and shipping as well as serving as the land base for the Louisiana Offshore Port Authority (LOOP). Today, the port is comprised of approximately 600 ac and has nearly 25,000 ft of waterfront facilities. The port has grown at a phenomenal rate due to the growth in the oil and gas industry and its development in the deepwater areas of the Gulf of Mexico. In 1999 there were 124 businesses located at the port and they were increasing by one per month.

The port is connected to the GIWW via Bayou Lafourche, the Houma Navigation Canal, and the Barataria Waterway. The port's channel is 26 ft deep, enabling it to accommodate the larger supply vessels. The port also houses a large number of docks with crane service, loading/unloading equipment, warehouses, refrigerated warehouse, and numerous storage yards. Improved and unimproved property is available.

Planned expansions at the port include the Northern Expansion Project. This is a 700 acre development consisting of 600-ft wide slips and over 1 mi of waterfront. Phase I of the expansion is to be complete in 2001. While location on the Gulf of Mexico is an advantage to Port Fourchon, it has limited water access to major metropolitan centers. In addition, the two-lane LA Highway 1, the ports only access, and the lack of rail access are major impediments for the port. Chapter 3.3.3.2 also discussed the port and its conditions.

Port of Mobile, Alabama

With its deepwater seaport facilities at the Port of Mobile, the Alabama State Docks is conveniently located on the Central Gulf of Mexico. It is closer to open water than any other major port on the Gulf. There has been commerce in and out of the Port of Mobile since the early part of the 17th century. It was not until 1826 that the U.S. Congress authorized money for the development of a navigable channel in Mobile Bay. The current navigation channel, maintained by the U.S. Army Corps of Engineers, provides a navigational depth of 45 ft from the Gulf of Mexico to the mouth of the Mobile River. Four trunkline railroads (Burlington Northern/Santa Fe, CSX, Illinois Central, and Norfolk Southern) serve the port, which is situated at the intersection of two major interstate highways. The State offers 1,500 mi of navigable inland barge routes and is served by the Tennessee-Tombigbee Waterway, which connects 16,000 mi of interstate barge lanes with the Port of Mobile.

For the first 200 years of its existence, the Port of Mobile did not have a central organization to guide the development and operation of the port. In 1922 the State Docks Commission was established with the power to build, operate, and maintain wharves, piers, docks, quays, grain elevators, cotton compresses, warehouses, and other water and rail terminals, structures, and facilities. Since that time, the Alabama State Docks have been a part of Alabama State government and functions as an independent department with a board of directors. Today, the Department operates as a self-supporting enterprise agency of the Executive branch of State government.

About 375 employees operate, maintain, and market the facilities at the port. In 1999, the Port of Mobile was the 14th largest port in the nation in total tonnage. The economic impact to the State of Alabama was over \$3 billion statewide. Tax payments of \$467 million were made from activities in the international trade sector. And most importantly, the Alabama State Docks supports the jobs of more than 118,000 Alabamians.

The port offers 29 general cargo and 6 bulk berths with about 4 million ft^2 of covered storage space and an additional 4 million ft^2 of open storage area adjacent to piers and tracks. The general cargo capabilities have been enhanced in recent years, with about \$80 million invested in capital improvement projects. New state-of-the-art wharves and warehouses include the 360,000-ft^2 Forest Products Terminal at Pier C, the 152,000-ft^2 Blakeley Terminal on the east bank of the Mobile River, the Steel & Heavy Lift Operations Berth at Pier North C, two warehouses with a combined space of 253,000 ft^2, a new pier for Roll On-Roll Off operations, and a concreted marshaling area. The port also provides a container port operation and other Roll O/Roll Off berths, accommodating some of the largest ocean-going vessels afloat. At present, the port is awaiting legislative approval for a \$100 million appropriation that would fund a container intermodal facility.

As the industry continues to evolve so do the requirements of the onshore support network. With advancements in technology, the shore-side supply network continues to be challenged to meet the needs and requirements of the industry and will be challenged in the future. All supplies must be transported from land-based facilities to marine vessels or helicopters to reach offshore destinations. This uses both water and air transportation modes. The intermodal nature of the entire operation gives ports (who traditionally have water, rail, and highway access) a natural advantage as an ideal location for onshore activities and intermodal transfer points. Therefore, ports will continue to be a vital factor in the total process and must incorporate the needs of the offshore oil and gas industry into their planning and development efforts, particularly with regard to determining their future investment needs. In this manner both technical and economic determinants influence the dynamics of port development.

3.3.3.8.2. Navigation Channels

The analysis performed to identify current OCS service bases (Chapter 3.3.3.8.1) was also used to identify relevant navigation waterways that support OCS activities. Table 3-30 identifies the waterways and their project depth, while Figure 3-12 shows their locations throughout the analysis area. In addition to OCS activities, navigation waterways also attract recreational and commercial developments along their banks. These developments are generally dependent upon the water resources or transportation that those waterways make accessible.

3.3.3.8.3. Helicopter Hubs

Helicopter hubs or "heliports" are facilities where helicopters can land, load and offload passengers and supplies, refuel, and be serviced. These hubs are used primarily as flight support bases to service the offshore oil and gas industry. Most of the OCS-related helicopter trips originate at helicopter hubs in coastal Texas and Louisiana. There are 128 heliports in the analysis area that support OCS activities. Of the 128, most are in Louisiana: 7 are in TX-1, 32 in TX-2, 29 in LA-1, 28 in LA-2, 27 in LA-3, and 5 in MA-1. Three helicopter companies dominate the Gulf of Mexico offshore helicopter industry: Air Logistics, Era Aviation (Era), and Petroleum Helicopters, Inc. (PHI). A few major oil companies operate and maintain their own fleets, although this is a decreasing trend.

Offshore helicopter business volume is linked to drilling activity, which is in turn tied to the price of oil. When there is more cash flowing in the oil and gas industry, there is more drilling and therefore more helicopter trips (Craig, personal communication, 2001). As discussed in Chapter 3.3.3.2, due to the low price of oil ($10) during 1998-1999, the offshore oil and gas industry experienced a slowdown that resulted in a slowdown for the helicopter industry. During this time the oil and gas industry merged, consolidated, and formed alliances. Also, instead of running their own fleets, oil and gas companies are increasingly subcontracting all helicopter support to independent contractors. This trend is occurring largely because of oil-industry consolidation (Persinos, 1999). Also during this downturn, PHI's core business changed profoundly. In 1990, about 84 percent of PHI's core business came from the Gulf of Mexico oil and gas industry; now it is 76 percent. The company has increased its aeromedical market services.

The offshore helicopter business improved during 2000; this increase is attributed to increasing deepwater activity. Deepwater drilling, which is farther offshore, is the growth area for helicopters. At present, about 35 percent of PHI's business is in support of deepwater oil and gas activities. Era, the first of the three major helicopter companies to provide helicopter support of deepwater operations, has 50-60 percent of the deepwater market. Most of Era's work is in support of deepwater activities; they only have twin-engine helicopters rather than the single-engine helicopters that generally operate in shallower waters. To meet the demands of deepwater (travel further and faster, carry more personnel, all-weather capabilities, and the need for lower operating costs), the offshore helicopter industry is purchasing new helicopters. For example, Air Logistics recently purchased 38 helicopters: 10 new ones, 16 from Horizon, and Mobil's 12 helicopters. In the last few months, Air Logistics enlarged their fleets at Venice, Louisiana, and Harbor Island, near Corpus Christi, Texas. The helicopters operating in the Gulf of Mexico have travel ranges up to 450 nmi, can attain speeds over 200 mph, carry up to 20 passengers, and may cost $10 million or more.

While some heliports located farther inland have closed or consolidated, some heliports are expanding or opening due to more of the industry's work being farther offshore. Air Logistics has leased 90 additional acres at their heliport in Fourchon, Louisiana. Further, Air Logistics just completed a new heliport in Cameron (Creole), Louisiana, because of offshore activity. This is Air Logistics first new heliport in the last 20 years. Era Aviation is also expanding their facilities at Fourchon and Venice. The heliport in Fourchon will hold 1,500 cars and 15 helicopters, while the facility in Venice will increase three-fold.

Transportation is one of the offshore oil and gas industry's top three costs. Adding to this cost is the 30 percent rate increases levied by the three majors in the past year. While exploration and production companies like helicopters, the industry is outsourcing more and more operations to oilfield support companies, such as Baker Hughes, who are much more cost conscious and skeptical about the high cost of helicopters. Surface transportation, though, is not as feasible in deepwater. Another consideration for the helicopter industry is new technology such as subsea systems. As discussed in Chapter 4.1.1.3, a subsea system consists of a single subsea well or several wells producing either to a nearby platform or to a distant production facility through a pipeline and manifold system. These systems decrease the number of platforms and personnel needed offshore, therefore reducing the amount of transportation needed.

Seventy-five percent of the helicopter pilots in the Gulf of Mexico are members of the Office Professional Employees International Union (OPEIU). While pilots at PHI and Air Logistics have voted for the union, Era's pilots have not. Since unionization, pilots' salaries have increased. At the same time, however, the industry has experienced a pilot shortage that has also contributed to the larger salaries. Most helicopters need at least two pilots per helicopter. A majority of the pilots in the 50-60 age group, mostly Vietnam War pilots, are retiring. In addition, because of the decreasing size of the military, fewer pilots are available from the military pool. Furthermore, the offshore helicopter industry has trouble getting pilots and keeping them because of the shadow effect. People are leery of the oil and gas industry because of past layoffs. In response to this last problem, Air Logistics started a 'grow your own program' in which they are training pilots themselves.

3.3.3.8.4. Construction Facilities

Unless otherwise indicated, the following information is from the 2001 MMS study, "Deepwater Program: OCS-Related Infrastructure in the Gulf of Mexico Fact Book"(Louis Berger Group, Inc., in preparation).

Platform Fabrication Yards

Platforms are fabricated onshore then towed to an offshore location for installation. Facilities where platforms are fabricated are called platform-fabrication yards. Production operations at fabrication yards include cutting and welding of steel components, construction of living quarters and other structures, as well as assembling platform components. There are 43 platform fabrication yards located in the analysis area. Table 4-11 shows the distribution of platform fabrication yards by coastal subarea. Most of the yards are located in Louisiana (31). Major fabrication yards in the analysis area include Atlantic Marine, Friede Goldman, Gulf Island Fabricators, J. Ray McDermott, and Unifab International. The structure of the platform fabrication industry is currently undergoing a period of restructuring characterized by the transformation from privately to publicly held companies on the one hand to the consolidation of the industry through mergers and acquisitions.

The location of platform fabrication yards is tied to the availability of a navigable channel sufficiently large to allow for towing of bulky and long structures such as offshore drilling and production platforms. Thus, platform fabrication yards are located either directly on the coast of the Gulf of Mexico or inland, along large navigable channels, such as the Intracoastal Waterway. Average bulkhead depth for water access for fabrication yards in the Gulf is 15-20 ft. Most fabrication yards in the analysis area are located along the Intracoastal Waterway and within easy access to the Gulf of Mexico. At least 12 of these plants have deep channel access to their facilities, which allows them to easily handle deeper draft vessels required in deepwater. Several fabricators in the analysis area, though, have lost contracts to foreign competition for large, deepwater platforms due to lack of water depth.

For the most part, each yard has a specialty, whether it is the fabrication of separator or heater/treater skids, the construction of living quarters, the provision for hookup services, or the fabrication of jackets, decks and topside modules. Few facilities have complete capabilities for all facets of offshore projects. Despite the longer-term outlook most producers take toward offshore exploration and production, activity is still closely tied to the price of oil and gas. As prices drop, supporting industries such as fabrication become less busy, often resulting in layoffs that tend to drive experienced workers to other industries.

Due to the size of the fabricated product and the need to store a large quantity of materials such as metal pipes and beams, fabrication yards typically occupy large areas, ranging from a just few acres to several hundred acres. Typical fabrication yard equipment includes lifts and cranes, various types of welding equipment, rolling mills, and sandblasting machinery. Besides large open spaces required for jacket assembly, fabrication yards also have covered warehouses and shops. Because the construction of platforms is not likely to be standardized, an assembly-line approach is unlikely and most fabrication yards work on projects one at a time. Once a platform is completed, it is towed to its offshore location; work then begins on a new platform. The number of employees between fabrication yards varies from less than a hundred to several thousands, and due to the project-oriented type of work, temporary workers account for a significant portion of the workforce.

As mentioned, platform fabrication is not a mass production industry; every platform is custom built to meet the requirements of a specific project. This feature has given rise to a great degree of specialization in platform fabrication. No two fabrication yards are identical; most yards specialize in the fabrication of a particular type of platform or platform component. Examples of specialization include construction of living quarters, provision of hook-up services, and fabrication of jackets and decks. According to a published survey of fabrication yards in the Gulf of Mexico, 23 yards fabricate jackets, 15 fabricate decks, 29 fabricate modules, 22 fabricate living quarters, and 20 fabricate control buildings. Despite the specialization of these yards, most facilities do include

- steel stockyards and cutting shops that supply and shape steel;
- assembly shops that put together a variety of components such as deck sections, modules, and tanks;
- paint and sandblasting shops;
- drydocks that work on small vessels;
- piers that work on transportation equipment and the platform components that are mobile and can be transported onto barges; and
- pipe and welding shops.

Despite the large number of platform fabrication facilities in the analysis area, only a few facilities can handle large-scale fabrication. Nine yards have single-piece fabrication capacity over 100,000 tons and 12 have capacity to fabricate structures for water depths over 1,000 ft. Only a few yards fabricate structures other than fixed platforms: one fabricates compliant towers (J. Ray McDermott, Inc. in Amelia, Louisiana) and two fabricate tension-leg platforms (Gulf Island Fabrication Inc. in Houma, Louisiana, and Friede Goldman Offshore in Pascagoula, Mississippi). Another important characteristic of the industry is the high degree of interdependency and cooperation among the fabrication yards; offshore platforms, particularly the ones destined for deepwater, are such complex engineering projects, most facilities do not have the technical capabilities to complete the entire projects "in-house."

Over the history of its existence, the platform fabrication industry has been closely tied to the fortunes of the oil and gas industry. Drilling and production activities are sensitive to the changing prices for oil and gas. This sensitivity, in turn, is translated into "boom and bust" cycles for the fabrication industry, where a period of no work follows a period of more fabrication orders than a yard can complete. In order to shield themselves from the volatility inherent in the oil and gas industry, platform fabrication yards in the analysis area have started to implement various diversification strategies. These diversification strategies, coupled with the new challenges brought about by deepwater oil and gas exploration and development, are significantly changing the industry.

In order to use the existing equipment and to retain their highly-skilled workforce during periods of low or no fabrication orders, many fabrication yards are expanding their operations into areas such as maintenance and renovations of drilling rigs, fabrication of barges and other marine vessels, dry-docking, and surveying of equipment. These projects, although much smaller in scale and scope than platform fabrication, allow the yards to survive during low periods. Another avenue of diversification is pursuit of international platform fabrication. For example, McDermott does fabrication for offshore waters in the Far East and Middle East. Fabrication yards in the analysis area have the advantages of vast experience in fabrication work and good climatic conditions that allow for year-round operations. Fabrication companies have also developed new offshore management software and company specific systems for managing and monitoring offshore sites onshore. New and improved platforms or platform upgrades and revamps complement many of these systems and software.

The platform fabrication industry has experienced a lack of skilled workers at the beginning of an upswing in the business cycle; during the downswing the skilled labor migrates to other jobs. Having learned from past mistakes, some fabrication companies have organized technical training programs in the local communities. A locally trained workforce provides a readily available pool of skilled labor for the fabrication yards. Other companies have found a solution to the workforce problem through the acquisition of several individual fabrication yards located within the commuting area. This allows companies to dispatch their personnel to several yards to accommodate the existing need at any given time.

Pipecoating Plants and Yards

Pipecoating plants generally do not manufacture or supply pipe. They receive the manufactured pipe by rail or water at either their plant or pipe yard depending on their inventory capabilities. At the plant, pipe surfaces are coated with metallic, inorganic, and organic materials to protect from corrosion and abrasion. This process also adds weight to counteract buoyancy. Sometimes the inside of the pipe is also coated for corrosion control. Two to four sections of pipe are then welded at the plant into 40-ft segments. The coated pipe is stored (stacked) at the pipe yard until it is needed offshore. It is then placed on barges or layships where the pipeline contractor welds the 40-ft sections together, and cleans and coats the newly welded joints. Finally, the pipe is laid.

There are currently 19 pipecoating plants in the analysis area (Table 4-11). Twelve of the 19 plants are located in coastal Subareas TX-2 and LA-2. There are two pipecoating plants in the Mississippi-Alabama area, two in the Florida Panhandle area, and one near Tampa, Florida. To meet deepwater demand, pipecoating companies have been expanding capacity or building new plants. Major pipecoating companies in the analysis area are Bayou, Bredaro Price, eb, and Womble. Many pipecoating plants also handle pipe for non-OCS companies, other countries, and non-petroleum-related industries.

The pipecoating industry is labor intensive. The coatings are mostly applied by hand. The companies try to maintain a core base of laborers, then either scale up or down with temporary labor according to workload. Due to the cyclical nature of the business, maintaining labor is a problem for the industry. In addition, pipecoating companies compete with other infrastructure industries for welders. In order to reduce this problem, several companies have started welding training programs. Bredaro Price has brought international labor to their Mobile plant in an effort to bring in experience and knowledge. They were also able to hire labor from a local paper mill that closed. Safety is a big part of the pipecoating business. Bredaro Price recently added money to their Mobile plant to automate rolling pipe. This has decreased the amount of labor needed, increased the amount of skilled labor needed, and decreased the number of accidents at the plant.

Some pipecoating plants are affiliated with a mill. These are American mills that manufacture high-grade pipe with light walls that can be used in shallow water. Foreign mills, mostly in Europe and Japan, manufacture heavy-walled pipe needed for deepwater pressure. U.S. Steel in Youngstown, Ohio, currently has the capability to manufacture the thick pipe necessary for deepwater, but it lacks the processing needed to heat-treat the pipe. Pipecoating customers are both exploration and production operators (direct) and pipelaying contractors (subcontracting). A new trend in the industry is single-source contracts where the pipe manufacturing, coating, welding, and laying are all under one contract. This results in a more efficient, less costly operation. At present, only foreign companies have this capability.

Shipyards

The 1980's were dismal times for the shipbuilding industry. This was brought about by a combination of factors that included lack of a comprehensive and enforced U.S. maritime policy, failure to continue funding subsidies established by the Merchant Marine Act of 1936, and the collapse of the U.S. offshore oil industry, which not only hurt the shipbuilding industry but all support industries such as small shipyards and repair yards. Approximately 120,000 jobs for shipyard workers and shipyard suppliers were lost.

At present, there are about 106 shipyards in the United States with the capability of repairing oceangoing ships greater that 400 ft in length. Only 19 are capable of building large oceangoing vessels, while the rest deal mainly in repairs. This is a decrease of approximately 40 percent from what was available at the start of the 1980's. Several mergers, acquisitions, and closings occurred during the downturn. In addition to the major shipyards, there are about 2,600 other companies that build or repair other craft such as tugboats, supply boats, ferries, fishing vessels, barges, and pleasure boats. Within the analysis area, there are 94 shipyards (Table 4-11). Major shipyards in the analysis area include Bollinger Shipyards; Harrison Brothers Dry Dock & Repair Yard, Inc.; First Wave/Newpark Shipyards; Edison Chouest Offshore: North American Shipbuilding in Larose, Louisiana (an ECO affiliate); North American Fabricators in Houma, Louisiana (an ECO affiliate); and Litton Ship Systems: Avondale\The Shipyards Division and Ingalls Shipyard.

The American Shipbuilding Association is the professional organization for those in the industry who are capable of constructing mega vessels that are in excess of 400 ft in length and weigh in excess of 20,000 dead weight tonnage (DWT). For this reason, their membership consists of only six companies. Of those six, two have a presence in the Gulf of Mexico. Both Avondale Shipyard of New Orleans, Louisiana, and Ingalls Shipyard of Pascagoula, Mississippi, have enormous capabilities and expertise in the design, construction, and repair of vessels. This highly developed level of specialized knowledge has made these two companies ideal contractors for the nation's defense efforts. Therefore, most of the work that has been accomplished in these two yards has been for the U.S. military.

The existence of enormous commercial needs has led to the development of a very large number of boat and barge builders. These companies have directed their efforts toward the requirements of specific industries such as the offshore oil and gas industry, which is undergoing a recovery from the marked decline of the 1980's. The vessels they produce are not as large as those being built by Avondale and Ingalls. However, as the oil and gas industry has evolved and become more sophisticated, particularly with deepwater drilling, so too has the capability of this segment of the boat-building industry. The need for supply and other types of industry support vessels has increased. With changing technology has come the need for more sophisticated and higher capacity vessels. Many of these companies are now producing ships in the 300-ft range. As discussed in Chapter 3.3.3.8.2, service-vessel operators ordered over 100 vessels during the last newbuild cycle. Over a dozen shipyards participated, with Halter Marine (now part of Friede Glodman) being the most active. Other shipyards participating included (in decreasing order): Ingalls, North American, Leevac, Bender, Atlantic Marine, Service Marine, Eastern, Conrad, Houma Fabrication, Bollinger, Seafab, Steiner, and McDermott. Five of the six most active shipyards are still in the commercial business and all are actively pursuing further supply-vessel opportunities. Ingalls has narrowed its focus to government work and is no longer building commercial vessels.

Several pertinent issues have affected and will continue to affect shipbuilding in the U.S. and particularly in the analysis area—maritime policy, declining military budget, foreign subsidies, USCG regulations, OPA 90, financing, and an aging fleet. These issues are discussed below.

Since the 1980's, military spending for new ship construction has declined. During that administration a 600-vessel fleet was envisioned. During the Bush tenure that figure dropped to 420 vessels. The current vessel fleet is less than 350 ships. Despite the downsizing, there will continue to be military associated work. Downsizing itself will provide deactivation work for many shipyards. There should be an increase in overhauls, repairs, and service life extensions. In addition, the Navy has affirmed a need for Sealift capabilities. Some vessels will be converted for this usage.

Most foreign nations subsidize their shipbuilding industries. Methods to accomplish this include construction subsidies, investment subsidies, research and development subsidies, preferential tax policies, officially financed export credits, reduced financing rates, loans, and loan guarantees. The type and amount of government support varies from country to country. At present, the U.S. does not have a subsidy or incentive program available for a foreign or domestic owner to build a large vessel in this country.

All U.S.-built vessels must comply with USCG rules and regulations. This automatically increases the cost of the vessel by 10-12 percent over the cost of a vessel built outside of the U.S. for international trade. In addition, OPA 90 requires that all new tank vessels trading in U.S. waters be equipped with double hulls and that existing tankers without double hulls be retrofitted or removed from oil production transportation. A phase-out schedule was established to implement the requirements of this legislation.

Passage of OPA 90 resulted in some new construction of double-hulled tank vessels. This helped to bring about a slight upturn in the industry.

Lastly, it is difficult to obtain financing to build large ships in the U.S. Rules and regulations of the Export-Import Bank are complex and difficult to interpret. The aging fleet, together with increasing environmental concerns, will provide an opportunity for additional construction and repair activities. The Jones Act requires that vessels that transport cargo between ports or points in the U.S. be constructed in the United States.

3.3.3.8.5. Processing Facilities

Unless otherwise indicated, the following information is from the 2001 MMS study, "Deepwater Program: OCS-Related Infrastructure in the Gulf of Mexico Fact Book" (Louis Berger Group, Inc., in preparation).

Refineries

Petroleum is a mixture of liquid hydrocarbons formed beneath the earth's surface. Found in both gaseous and liquid form, the exact composition of these hydrocarbons varies according to locality. Crude oil is a mixture of hydrocarbon compounds and relatively small quantities of other materials such as oxygen, nitrogen, sulfur, salt, and water. Crude oil varies in color and composition from a pale yellow, low-viscosity liquid to a heavy black tar consistency. Because it is of little use in its raw state, further processing of crude oil is necessary to unlock the full potential of this resource.

A refinery is an organized arrangement of manufacturing units designed to produce physical and chemical changes to turn crude oil into petroleum products. Refineries vary in size, sophistication, and cost depending on their location, the types of crude they refine, and the products they manufacture. Because crude oil is not homogeneous (varying in color, viscosity, sulfur content, and mineral content), oil produced from different fields or geographic areas have different quality characteristics that give rise to different economic values.

In the refinery, most of the nonhydrocarbon substances are removed from crude oil, and the oil is broken down into its various components and blended into useful products. Every refinery begins with the separation of crude oil into different fractions by distillation. The fractions are further treated to convert them into mixtures of more useful saleable products by various methods such as cracking, reforming, alkylation, polymerisation, and isomerisation. These mixtures of new compounds are then separated using methods such as fractionation and solvent extraction.

Because there are various blends of different crude oils available, different configurations of refining units are used to produce a given set of products. A change in the availability of a certain type of crude oil can affect a refinery's ability to produce a particular product. For example, one important crude quality is gravity. Stated in API degrees (API^{o}), gravity is a measure of the density of the crude oil and can affect the complexity of a refinery. The higher the gravity, the lighter the crude and, conversely, the lower the gravity, the heavier the crude. A second quality measure is sulfur content. Sulfur content is usually measured in terms of the percentage of the crude's weight that is comprised by sulfur. Low-sulfur or "sweet" crudes typically have less than 0.5 percent sulfur content. Crude oil considered high sulfur or "sour" typically has over 0.5 percent sulfur content.

These two qualities are important in refining. Heavy crudes require more sophisticated processes to produce lighter, more valuable products; therefore, they are expensive to manufacture. Because of its corrosive qualities, higher sulfur content makes a crude more expensive to handle and process. In general, light crudes are more valuable, i.e., they yield more of the lighter, higher-priced products than heavy crudes. The product slate at a given refinery is determined by a combination of demand, inputs and process units available, and the fact that some products are the result (co-products) of producing other products.

In the early 1970's, the Federal Government set price controls that gave an economic advantage to refineries that had access to low-cost domestic oil. In 1975, the "Crude Oil Entitlements Program" was implemented to distribute oil supplies among refiners. This program basically provided a subsidy to small refining companies, many of which had simple "topping" facilities and little or no downstream processing capability. (A simple "topping" refinery will have a distillation tower and possibly a reformer and some sulfur treating capability, while complex refineries will have more extensive downstream facilities.) A refiner who had access to light crude oils needed only a distillation tower to produce motor gasoline. Therefore, many simple refineries sprang up across the country, most notably in the analysis area.

In the early 1980's, the Crude Oil Entitlements Program ended and crude oil prices were no longer controlled. This caused the number of petroleum refineries to drop sharply, leading to 13 years of decline in U.S. refining capacity. Between 1981 and 1989, the reduction in the number of refineries from 324 to 204 represented a loss of 3 million barrels per day (Mbbl/day) in operable capacity. Another 41 refineries (mainly small) shut down between 1990 and 1997. Since the 1980's, the refining industry's focus has turned from increasing crude oil distillation capacity to investment in downstream charge capacity, thereby increasing overall refinery complexity. This transition began several years before the passage of the Clean Air Act Amendments in 1990 as a result of increased demand for lighter, cleaner products that have to be produced from increasingly heavier and more-sour crude oils.

The decade of the 1990's was characterized by low product margins and low profitability. Stiff environmental mandates stemming from 1990 amendments to the Clean Air Act heaped capital costs on the industry at a time of relatively flat product demand. By implementing massive capital spending programs, refiners met and surpassed plant emission goals while retooling to produce a new generation of cleaner burning fuels. Low profitability was also partially due to the narrowing of the spread between petroleum product prices and raw material input costs. Additionally, persistently low profits prompted domestic refiners and marketers to make concerted efforts to realize greater value from their fixed assets and to reduce their operating costs. Refining operations were consolidated, the capacity of existing facilities was expanded, and several refineries were closed.

The analysis area hosts over one-third of the petroleum refineries in the U.S. Most of the region's refineries are located in Texas and Louisiana (Table 4-11). Texas has 19 refineries, with a combined crude oil operating capacity of 3.9 Mbbl/day, while Louisiana has 14 refineries with 2.7 Mbbl/day of operating capacity, representing 55.04 and 38.49 percent, respectively, of total U.S. refining capacity. Most refineries are part of major, vertically integrated oil companies that are engaged in both upstream and downstream aspects of the petroleum industry. These companies dominated the refining industry, although most majors are spinning off their refinery facilities to independents or entering joint ventures to decrease the risk associated with low refining returns. The top 10 U.S. refiners, all of them major, integrated oil companies, account for about 60 percent of the total domestic refinery operating capacity.

By consolidating operations and sharing assets and operations, downstream petroleum companies hope to be able to increase the value of their fixed assets and reduce their costs. The largest of the recent joint ventures affecting U.S. refining and marketing was announced in late 1996 but was not completed until early 1998. That venture merged Texaco, Star Enterprise (a joint venture between Texaco and Aramco, the Saudi Arabian state oil company), and Shell Oil (the U.S. subsidiary of Royal Dutch/Shell). The joint venture resulted in the creation of two companies, Equilon Enterprises L.L.C. and Motiva Enterprises L.L.C (in January and May, 1998, respectively). Equilon consisted of the companies' western and midwestern U.S. operations as well as their nationwide trading, transportation, and lubricants businesses. Motiva consisted of the companies' eastern and U.S. Gulf Coast operations (with the exception of Shell's Deer Park, Texas, refinery, which is operated as a joint venture between Shell Oil and the state oil company of Mexico, Petroleos Mexicanos (PEMEX)).

Significant mergers have also occurred between independent refiners and marketers. However, unlike the major U.S. petroleum companies, which are consolidating their refining and marketing operations through joint ventures, the independent refiners and marketers are expanding their operations through mergers and, at least in one case, joint ventures. For example, in 1997 Ultramar Diamond Shamrock (itself created by a late 1996 merger) acquired Total Petroleum North America, gaining three refineries, more than 2,100 marketing outlets, and hundreds of miles of pipelines, in addition to other associated assets.

Petrochemical Plants

The chemical industry converts raw materials such as oil, natural gas, air, water, metals, and minerals into more than 70,000 different products. The non-fuel components derived from crude oil and natural gas are known as petrochemicals. Petroleum is composed mostly of hydrogen and carbon compounds (called hydrocarbons). It also contains nitrogen and sulfur, and all four of these components are valuable in the manufacture of chemicals.

The industrial organic chemical sector includes thousands of chemicals and hundreds of processes. In general, a set of building blocks (feedstocks) is combined in a series of reaction steps to produce both intermediate and end products. The processes of importance in petrochemical manufacturing are distillation, solvent extraction, crystallization, absorption, adsorption, cracking, reforming, alkylation, isomerization, and polymerization.

The boundaries of the petrochemical industry are rather unclear. On the upstream end, they blend into the petroleum refining sector, which furnishes a major share of petrochemical feedstocks; downstream it is often impossible to draw a clear line between petrochemical manufacturing and other organic chemistry-based industries such as plastics, synthetic fibers, agricultural chemicals, paints and resins, and pharmaceuticals. Operating in this field are petroleum companies who have broadened their interests into chemicals, chemical companies who buy raw petroleum materials, and joint ventures between chemical and petroleum companies.

Texas, New Jersey, Louisiana, North Carolina, and Illinois are the top U.S. chemical producers. However, most of the basic chemical production is concentrated in the analysis area, where petroleum and natural gas feedstocks are available from refineries. About 70 percent of all primary petrochemicals are produced in Texas and Louisiana. At present, there are 29 petrochemical plants in the analysis area, all of which are in Texas or Louisiana. The distribution of these plants by subarea is shown in Table 4-11.

Chemical manufacturing facility sites are typically chosen for their access to raw materials and to transportation routes. And, because the chemical industry is its own best customer, facilities tend to cluster near such end-users. A small number of very large facilities account for the majority of the industry's value of shipments. The 16 largest plants (greater than 1,000 employees) manufacture about 25 percent of the total value of shipments.

Laid out like industrial parks, most petrochemical complexes include plants that manufacture any combination of primary, intermediate, and end-use products. Changes in market conditions and technologies are reflected over time in the changing product slates of petrochemical complexes. In general, petrochemical plants are designed to attain the cheapest manufacturing costs and thus are highly synergistic. Product slates and system designs are carefully coordinated to optimize the use of chemical by-products and to use heat and power efficiently.

The transformation of raw materials into chemical products requires chemical, physical, and biological separation and synthesis processes. These processes use large amounts of energy for heating, cooling, or electrical power. The industry is the single largest consumer of natural gas (over 10% of the domestic total) and uses virtually all the liquefied petroleum gas (LPG) consumed in U.S. manufacturing. Other energy sources include by-products produced onsite, hot water, and purchased steam. Physical and biological separation plays a critical role in processing and accounts for 40-70 percent of both capital and operating costs. The most widely used separation process is distillation, which accounts for as much as 40 percent of the industry's energy use. Chemical synthesis is the backbone of the industry; process heat is integral and supports nearly all chemical operations.

Gas Processing Plants

After raw gas is brought to the earth's surface, it is processed at a gas processing plant to remove impurities such as water, carbon dioxide, sulfur, and inert gases, and it is transformed into a sellable, useful energy source. It is then moved into a pipeline system for transportation to an area where it is sold. Because natural gas reserves are not evenly spaced across the continent, an efficient, reliable gas transportation system is essential. At present, there are 35 gas processing plants in the analysis area that process OCS-produced gas; 28 of these are in Louisiana. The distribution of these plants by coastal subarea is shown in Table 4-11. Major operators include BP, Exxon, Dynergy, Duke Energy, and El Paso.

Natural gas is found below the earth's surface in three principal forms. Associated gas is found in crude oil reservoirs, either dissolved in the crude oil, or combined with crude oil deposits. This gas is produced from oil wells along with the crude and is separated from the oil at the head of the well. Non-associated gas is found in reservoirs separate from crude oil; its production is not a result of the production of crude oil. It is commonly called "gas-well gas" or "dry gas." Today about 75 percent of all U.S. natural gas produced is nonassociated gas. Gas condensate is a hydrocarbon that is neither true gas nor true liquid. It is not a gas because of its high density, and it is not a liquid because no surface boundary exists between gas and liquid. Gas condensate reservoirs are usually deeper and have higher pressures, which pose special problems in the production, processing, and recycling of the gas for maintenance of reservoir pressure.

The quality and quantity of components in natural gas vary widely by the field, reservoir or location from which the natural gas is produced. Although there is not a "typical" makeup of natural gas, it is primarily composed of methane (the lightest hydrocarbon component) and ethane. In general, there are four types of natural gas: wet, dry, sweet, and sour. Wet gas contains some of the heavier hydrocarbon molecules and water vapor. When the gas reaches the earth's surface, a certain amount of liquid is formed. A wet gas may contain five or more gallons of recoverable hydrocarbons per thousand cubic feet; the water has no value. If the gas does not contain enough of the heavier hydrocarbon molecules to form a liquid at the surface, it is a dry gas. Sweet gas has very low concentrations of sulfur compounds, while sour gas contains excessive amounts of sulfur and an offensive odor. Sour gas can be harmful to breathe or even fatal.

Centrally located to serve different fields, natural-gas processing plants have two main purposes: (1) remove essentially all impurities from the gas; and (2) separate the gas into its useful components for eventual distribution to consumers. The modern gas-processing industry uses a variety of sophisticated processes to treat natural gas and extract natural-gas liquids from the gas stream. The two most important extraction processes are the absorption and cryogenic expander process. Together, these processes account for an estimated 90 percent of total natural-gas liquids (NGL) production.

The total number of natural-gas processing plants operating throughout the U.S. has been declining over the past several years as companies have merged, exchanged assets, and closed older, less efficient plants. This trend was reversed in 1999; Louisiana's capacity is undergoing significant increases as a wave of new plants and expansions try to anticipate the increased volumes of natural gas coming ashore from new gas developments in the Gulf of Mexico. New plants were also built in Mobile, Alabama, and Pascagoula, Mississippi. There are approximately 581 operating gas-processing plants in the U.S., most of which are located in eight states: California, Colorado, Louisiana, Michigan, New Mexico, Oklahoma, Texas, and Wyoming. Louisiana continues to lead other U.S. states in the number of gas-processing plants, followed closely by Texas. Between them, the two states hold more than 52 percent of the nation's gas-processing capacity. In 1999, the two states produced more than half of the NGL produced in the U.S. Texas produced nearly 43.5 percent (up from 41% in 1998) while Louisiana produced over 17.8 percent (up from 15% in 1998).

3.3.3.8.6. Terminals

Pipeline Shore Facilities

The term "pipeline shore facility" is a broad term describing the onshore location where the first stage of processing occurs for OCS pipelines carrying different combinations of oil, condensate, gas, and produced water. These facilities may also be referred to as a separation or field facilities. Pipelines carrying only dry gas do not require pipeline shore facilities; the dry gas is piped directly to a gas processing plant (Chapter 3.3.3.8.5). Although in some cases some processing occurs offshore at the platform, only onshore facilities are addressed in this section.

Pipeline shore facilities may separate, process, pump, meter, and store oil, water, and gas depending on the quality of the resource carried by the pipeline. After processing and metering, the liquids are either piped or barged to refineries or storage facilities. The gas is piped to a gas processing plant for further refinement, if necessary; otherwise it is transported via transmission lines for distribution to commercial consumers. Water that has been separated out is usually disposed into on-site injection wells.

A pipeline shore facility may support one or several pipelines. Typical facilities occupy 2-25 ha. The distribution of existing pipeline shore facilities associated with the OCS Program are given in the table below. These facilities are also shown on Figure 3-13.

Existing Pipeline Shore Facilities for the OCS Program (2003-2042) by Coastal Subarea

TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	FL-1	Total
6	7	18	10	9	0	0	50

Barge Terminals

Barge terminals are the receiving stations where oil is first offloaded from barges transporting oil from OCS platforms. These facilities usually have some storage capabilities and processing facilities. Some barge terminals may also serve as pipeline shore facilities.

Most of the land required at a barge terminal is for storage tanks. Space requirements range from 6 to 25 ha (NERBC, 1976).

Eight barge terminals along the Gulf Coast are currently being used by the OCS oil industry (Table 3-3-34 and Figure 3-14). Of the four barge terminals in Louisiana, three receive oil from only CPA leases and one receives oil from both WPA and CPA leases. Of the four barge terminals in Texas, three receive oil from only WPA leases and one receives oil from only CPA leases. These barge terminals may also receive oil from State production or imports. Texas terminals receive approximately 30 percent of OCS barged oil and Louisiana terminals receive approximately 70 percent.

Chapter 3.3.3.8.9 discusses OCS barging operations in general.

Tanker Port Areas

The transport of OCS-produced oil from FPSO operations to shore facilities would be accomplished with shuttle tankers rather than oil pipelines. The FPSO's temporarily store produced oil on location within the hull of the FPSO; the oil is periodically transferred to shuttle tankers. Shuttle-tanker transport could also be used in support of extended well-test operations or for transporting produced oil from other OCS deepwater facilities. Shuttle-tanker destination ports are determined by channel depthproximity to refineries. Channel-depth requirements are based on tanker size and draft. In the Gulf of Mexico, the 34- to 47-ft water depths of refinery ports limit the maximum size of shuttle tankers to about 500,000 bbl of crude oil cargo. The following refinery ports are currently the likely destinations for shuttle tankers transporting crude oil from FPSO operations in the Gulf of Mexico: Corpus Christi, Freeport, Port Arthur/Beaumont, and Houston/Galveston, Texas; and Lake Charles, the lower Mississippi River ports (Baton Rouge, Port of South Louisiana, New Orleans, and Plaquemines), and the Louisiana Offshore Oil Port, Louisiana.

3.3.3.8.7. Disposal and Storage Facilities for Offshore Operations

Unless otherwise stated, the following information is from the 2001 MMS study "Deepwater Program: OCS-Related Infrastructure in the Gulf of Mexico Fact Book" (Louis Berger Group, Inc., in preparation).

The infrastructure network needed to manage the spectrum of waste generated by OCS exploration and production activities and returned to land for management can be divided into three categories:

(1) transfer facilities at ports, where the waste is transferred from supply boats to another transportation mode, either barge or truck, toward a final point of disposition;

(2) special-purpose, oil-field waste management facilities, which are dedicated to handling particular types of oil-field waste; and

(3) generic waste management facilities, which receive waste from a broad spectrum of American industry, of which waste generated in the oil field is only a small part.

The first two categories lend themselves to a capacity analysis while the third does not. Table 4-11shows the waste disposal facilities in the analysis area by subarea.

The capacity of a waste facility has two dimensions. The first is the throughput capacity over a given period of time. In the short term, a waste facility can face limits to the volume of waste it accepts either from permit conditions or from physical limitations to the site, such as unloading bays, traffic conditions, or equipment capacity. Life-of-site capacity is also a limiting factor for disposal facilities. Limitations of storage space or, in the case of an injection well, service life of the well make it necessary to consider what must happen after existing facilities have exhausted their capacity.

A number of different types of waste are generated as a result of offshore exploration and production activity. The different physical and chemical character of these wastes make certain management methods preferable over others. The types of waste include

- solids, such as drill cuttings, pipe scale, produced sand, and other solid sediments encountered during drilling, completion, and production phases;
- aqueous fluids having relatively little solids content, such as produced waters, waters separated from a drilling mud system, clear brine completion fluids, acids used in stimulation activities, and wash waters from drilling and production operations. (Although most of these are potentially dischargeable under the NPDES general permit, the possibility always exists that some amount of material will become contaminated beyond the limits of treatment capabilities and will require disposal in a land-based facility. A minute percentage of the total volume consists of chemicals (such as zinc bromide), which do not meet discharge criteria.);
- drilling muds (oil-based, synthetic, or water-based);
- naturally occurring radioactive materials (NORM), such as tank bottoms, pipe scale, and other sediments that contain naturally high levels of radioactive materials. (NORM occurs in sludge and also as scale on used steel vessels and piping when equipment has been exposed to other NORM materials after very long periods of use.);
- industrial hazardous wastes, such as solvents and certain compounds, with chemical characteristics that render them hazardous under Subtitle C of the Resource Conservation and Recovery Act (RCRA) and thus not subject to the exemption applicable to wastes generated in the drilling, production, and exploration phases of oil and gas activities;
- nonhazardous industrial oily waste streams generated by machinery operations and maintenance, such as used compressor oils, diesel fuel, and lubricating oils, as well as pipeline testing and pigging fluids. (Wastes from marine transportation as well as pipeline construction and operations are always classified as industrial wastes, while some operators and State regulators may choose to handle or classify waste from drilling and production machinery this way. Used oil generated by exploration and production operations may legally be mixed with produced oil, but refineries discourage the practice. These streams often become commingled with wash water. They may be handled in drums or in bulk as part of a larger waste stream.); and
- municipal solid waste generated by the industry's personnel on offshore rigs, platforms, tankers, and workboats.

Federal regulations govern what may be discharged in Gulf of Mexico waters and set different standards in different parts of the Gulf Coast. Table 3-35 summarizes current Federal rules. Wastes that cannot be discharged or injected offshore must be brought to shore. Transportation, packaging, and unloading of the waste at ports are governed by U.S. Department of Transportation (DOT) regulations while the USCG regulates vessel fitness. Once on the dock, transportation and packaging is subject to an overlay of DOT and State laws. State regulations governing reporting and manifesting requirements may vary somewhat, but Federal law has, for the most part, preempted the field of transportation waste regulation. Dockside facilities that serve as transfer points from water to land modes of transportation are regulated by both USCG and State regulations covering the management of oil-field wastes.

Once at a waste management facility, regulations regarding storage, processing, and disposal vary depending on the type of waste. Most would fall under the oil and gas waste exemption of RCRA Subtitle C and would be subject only to State regulations regarding the disposal of oil-field wastes. A minute volume of the waste would be subject to Federal regulation as hazardous waste under RCRA Subtitle C. State laws governing hazardous wastes are allowed to be more restrictive than Federal law, but no material differences exist between State and Federal law in Texas, Louisiana, Mississippi, or

Alabama. For the most part, the wastes generated by oil-field activities, called nonhazardous oilfield waste (NOW) are exempt from hazardous waste regulation by Federal law because they are produced from the exploration, development, or production of hydrocarbons and thus fall under what is generally referred to as the oil and gas waste exemption found in 40 CFR 261.

Waste fluids and solids containing NORM are subject to State regulations that require special handling and disposal techniques. There are currently no Federal regulations governing NORM. The special handling and disposal requirements for NORM generally result in the segregation of these materials from NOW and in substantially higher disposal costs when managed by commercial disposal firms.

Commercial disposal of NORM is available in Texas at two different sites. Alabama has not fully developed its NORM regulatory program, but waste within 5 piC/g of background is considered acceptable for on-site disposal. The NORM waste generated in Mississippi, Alabama, and Florida is typically shipped to Louisiana or Texas.

Differences in laws among the states lead to differences in waste management methods as well as industry preferences in the siting of waste facilities in certain states. The substantive differences that distinguish the states are comparatively few. Texas allows and regulates salt dome disposal of waste, while no other state does. Louisiana, Alabama, and Mississippi allow the landfilling of used oil filters and oil-based drilling muds, while Texas requires them to be recycled. Texas generally has stricter limits on the hydrocarbon content of waste going into municipal landfills. Texas also has regulations allowing oil-based drilling mud to be recycled through bioremediation into road-building material. None of the other Gulf States have enabled oil-field waste land application recycling operations in their regulatory framework.

The USEPA has established a hierarchy of waste management methods that it deems preferentially protective of the environment. For those technologies applicable to oil and gas production waste, the following general waste management techniques are described in order of USEPA's preference:

- Recycle/Reuse—When usable components such as oil or drilling mud can be recovered from a waste, these components are not discarded and do not burden the environment with impacts from either manufacturing or disposal.
- Treatment/Detoxification—When a waste cannot be recycled or reused, it can sometimes be treated to remove or detoxify a particular constituent prior to disposal. Neutralization of pH or removal of sulfides are examples of technologies that are used with oil and gas wastes.
- Thermal Treatment/Incineration—Wastes with organic content can be burned, resulting in a relatively small amount of residual ash that is incorporated into a product or sent to disposal. This technology results in air emissions, but the residuals are generally free of organic constituents.
- Subsurface Land Disposal—This technology places waste below usable drinking water resources and is viewed as superior to land filling because of the low potential for waste migration. Injection wells and salt cavern disposal are examples of this type of technology.
- Surface Land Disposal/Treatment—This type of technology involves the placement of wastes into a landfill or onto a land farm. Although well-designed and constructed landfills minimize the potential for waste migration, generators remain concerned about migration of contaminants into water resources and avoid it whenever practical. The USEPA classifies surface land disposal as the least desirable disposal method.

Several waste management methods are used to handle the spectrum of wastes generated by OCS activity, and most types of wastes lend themselves to more than one method of management. Each option has a different set of environmental impacts, regulatory constraints, costs, and capacity limitations.

Subsurface injection is the management method used for more than 90 percent of the 16 billion barrels of saltwater produced by onshore oil and gas production each year in the U.S.

Nonhazardous Oil-field Waste Sites

Most of the OCS solids-laden waste streams arepresently injected at one facility, Newpark Environmental Services near Fannett, Texas. It is the most important NOW facility for the offshore industry, having received some 5 million barrels of offshore waste in 1998, constituting about 75 percent of the total offshore NOW streams shipped ashore. This facility has a number of injection wells, not all of which are needed at any given time. Any number of other injection wells are available on the Gulf of Mexico coast, but few have Newpark's capability to handle solids-laden streams, and few have focused on the logistical requirements of the offshore market to the extent Newpark has. These factors account for the Newpark facility's very large share of the offshore market. Newpark appears to have some economies of scale that serve to offset the cost of a long barge trip back from transfer points such as Port Fourchon.

The Newpark facility near Winnie, Texas, has five wells completed into the caprock of a salt dome that is permitted to inject up to 17.5 million barrels per year of slurried solids. A separate Newpark facility near Big Hill, Texas, also in Jefferson County, has three injection wells dedicated to injecting NORM. It received 13,900 bbl of NORM solids in 1999 and 16,500 bbl in 1988. The NORM waste receipts are trending down because operators are careful to segregate NORM to minimize the volumes that must be disposed of at a comparatively high commercial price.

One commercial salt cavern, operated by Trinity Field Services, has recently opened near Hamshire, Texas, on the Trinity River. It presently receives waste only by truck, although management expects a barge mooring to be permitted within a year. If the company is successful in obtaining additional permits that would allow receipt by barge and securing dock space in ports to serve as transfer points, then the company may present a significant source of new capacity—perhaps on the scale of Newpark's. Four other commercial salt domes are operational in northeastern and western Texas. One commercial salt dome, Lotus, L.L.C. in Andrews County near the New Mexico border, accepts NORM, some of which comes from offshore operations. Due to their distance from the Gulf Coast, no others receive any OCS waste. With the addition of Trinity Field Services bringing 6.2 million barrels of available space to the market, enough to take 8-10 years' worth of OCS liquids and sludges at current rates, the OCS has its first salt dome disposal operation in a competitive location.

Landfills

Workers on a rig or production platform generate the same types of waste as any other consumer in industrial society and are therefore responsible for their fair share of municipal solid waste (MSW). Landfarm facilities are available to accept offshore waste but actually accept very little because offshore operators prefer other methods. The MSW disposal from OCS activities currently imposes only a small incremental load on landfills in the analysis area, probably no more than 5 percent of total receipts by all the landfills serving south Louisiana.

3.3.3.8.8. Coastal Pipelines

This section discusses OCS pipelines in coastal waters (State offshore and inland waters) and coastal onshore areas. The OCS pipelines near shore and onshore may join pipelines carrying production from State waters or territories for transport to processing facilities or to distribution pipelines located farther inland. See Chapter 3.3.3.9.2 for a discussion of pipelines supporting State oil and gas production.

Nearly 400 OCS pipelines cross the Federal/State boundary into State waters. There are nearly 1,700 km of OCS pipelines in State waters, with an average of 5 km per pipeline. Over half of the pipelines in State waters are directly the results of the OCS Program.

Where a pipeline crosses the shoreline is referred to as a pipeline landfall. Gulfwide, two-thirds of OCS pipelines entering State waters tie into existing pipeline systems and do not result in new pipeline landfalls. Because of the extensive trunklines that parallel the Texas coastline, this ratio is lower in Texas. About 85 percent of OCS pipeline landfalls are in Louisiana. The oldest pipeline systems are also in Louisiana; some datie back to the 1950's. The OCS pipelines making landfall have resulted in 700 km of pipelines onshore, with an average of 10 km per pipeline. A small percentage of onshore pipelines in the coastal subareas are directly the results of the OCS Program.

3.3.3.8.9. Coastal Barging

A general discussion of barging operations from offshore platforms to onshore terminals is found in Chapter 3.3.3.8.9. A discussion of the onshore barge terminals is found in Chapter 3.3.3.8.6.

The percentage of OCS oil barged (<1%) from offshore platforms to shore bases is only a small portion of the total amount of oil barged in coastal waters. There is a tremendous amount of barging that occurs in the coastal waters of the Gulf of Mexico, and no estimates exist of the volume that is attributable to the OCS industry. Secondary barging of OCS oil often occurs between terminals or from terminals to refineries. Oil that is piped to shore facilities and terminals is often subsequently transported by barge up rivers, through the Gulf Intracoastal Waterway, or along the coast.

3.3.3.9. State Oil and Gas Activities

3.3.3.9.1. Leasing and Production

Texas

The Lands and Minerals Division of the Texas General Land Office holds quarterly lease sales on the first Tuesday in January, April, July, and October of each year. Prior to July 1999, biannual sales were held.

The Texas coast is the largest along the Gulf of Mexico, spanning 400 mi and encompassing 12 counties. Texas also has the largest legal area of land extending Gulfward. Initially, all coastal states owned 3 mi of land into the Gulf of Mexico; however, with the enactment of the Submerged Lands Act and its interpretation by the Supreme Court in 1960, Texas land extends 3 marine leagues (10.4 mi). The State of Texas has authority over and owns the water, beds, and shores of the Gulf of Mexico equaling approximately 2.5 million acres.

The growth of the oil industry in the 20th century helped reform the State's land policy from an emphasis on income through the sale of land to an emphasis on income through resource management and development. The Texas General Land Office is directly responsible for the management of more than 22 million acres of land that remains in the public domain. According to the Relinquishment Act of 1919, a surface owner acts as leasing agent for the state on privately owned land where the State retains the mineral rights, and the State and surface owner share rentals, royalties, and bonuses.

The Texas Land Commissioner is authorized to lease designated public land for oil and gas production, and it now accounts for most of the income derived from public land. The State receives revenues from royalties, rentals, and bonuses. In addition to being leased for mineral production, land is leased for hunting, grazing, fishing, and commercial development. Land trades, experimental projects, and in-kind gas sales also provide revenue for the State. The Railroad Commission of Texas is the agency charged by the Texas Legislature with the regulation of the oil and gas industry in the State of Texas. The Commission's primary regulatory responsibilities are protecting the correlative rights of the mineral interest owners, preventing the waste of otherwise recoverable natural resources, and protecting the environment from pollution by oil and gas exploration and production activities.

In recent years, oil and gas production in the State of Texas has been declining. From 1978 to 1998 annual crude oil production fell from 1,040,966 million bbl to 457,499 million bbl. However, in that same time frame, the number of producing oil wells rose from 166,65 to 170,288. Natural gas production has shown a similar trend over the same time period. From 1978 to 1998, Texas natural gas production fell from 7,077.1 tcf to 5,772.1 tcf, and the number of producing gas wells rose from 33,157 to 58,436. Texas offshore oil and gas production for the year 2000 was 41,106 tcf of natural gas and 520,352 bbl of oil. Texas offshore oil and gas production for the year 2001 (as of May 2001) is 18,057 tcf of natural gas and 210,783 bbl of oil (Texas Railroad Commission, 2001).

Louisiana

The Louisiana Office of Mineral Resources holds regularly scheduled lease sales on the second Wednesday of every month.

The first oil production in commercial quantities occurred in 1901 and it marked the beginning of the industry in the State. The first over-water drilling in America occurred in 1910 in Caddo Lake near

Shreveport. The State began its offshore history in 1947. The territorial waters of Louisiana extend Gulfward for 3 mi and its shoreline extends nearly 350 mi.

Louisiana, through its aggressive mineral management programs, became the Nation's third leading producer of natural gas and the number four producer of crude oil in the country. When including the oil and gas production in the Gulf of Mexico, Louisiana becomes the second leading natural gas producer in the country and the third leading crude oil producer. There are 19 active refineries in the State of Louisiana, which accounts for 15 percent of the total refining capacity in the United States. There are thousands of miles of pipelines in the State carrying crude oil from the Gulf of Mexico to refineries in Louisiana and other states as well as carrying natural gas throughout the United States (Louisiana Mid-Continent Oil and Gas Association, 2001).

In 1999, Louisiana offshore production totaled 12.8 million bbl of crude oil from about 554 offshore oil wells and 147.5 tcf of natural gas from about 177 natural gas wells. In the same year, 44,645 persons were employed in the oil and gas production industry; 28,898 persons in the chemical industry; 11,046 persons in the oil refining industry; and 693 persons in the Oil Pipeline industry (Louisiana Dept. of Natural Resources, 2001). In fiscal year 1999-2000, \$237,967,797 of royalties and \$354,765,574 in severance tax were collected by the State on all oil and natural gas production taking place on State-owned lands and water bottoms (Louisiana Dept. of Natural Resources, 2001).

Mississippi

Mississippi's petroleum infrastructure includes four refineries including the Chevron refinery at Pascagoula and a moderately extensive network of crude oil, product, and liquefied petroleum gas pipelines. Mississippi ranks eleventh in the nation, including Federal offshore areas, in crude oil production, with 54,000 bbl per day. A major propane supply hub is located at Hattiesburg, Mississippi, where the Dixie Pipeline has a network of terminals and storage facilities. Natural gas as a primary heating fuel is used by 41 percent of homeowners, followed by electricity, which is used by about 31 percent of homeowners (USDOE, EIA, 2001c).

For onshore oil and gas development, the State of Mississippi passed legislation in 1994 allowing companies to enjoy substantial tax breaks based on the types of discovery involved and the methods they use. Those tax breaks range from a five-year exemption from the State's 6 percent severance tax for new discoveries to a 50 percent reduction in the tax for using 3-D technology to locate new oil and gas fields or for using enhanced recovery methods. As a result of the incentive program, 84 new oil pools have received the exemption, 108 inactive wells have been brought back into production, 13 development wells have been drilled in existing fields, 34 enhanced wells have received exemption, and 14 wells have received exemptions for using 3-D technology (Sheffield, 2000).

The State of Mississippi does not have an offshore oil and gas leasing program.

Alabama

Alabama has no established schedule of lease sales. The limited number of tracts in State waters is an inhibiting factor in scheduling regular lease sales. The last lease sale was held in 1997.

The territorial waters of Alabama extend Gulfward for 3 nmi and its shoreline extends nearly 52 mi. The first oil wells drilled for oil in the southeastern United States were drilled in Lawrence County in 1865, just six years after the first oil well in the United States. The first commercially marketed natural gas production in the southeastern United States occurred in the early 1900's near Huntsville. In 1979, gas was first discovered by MOEPSI in the mouth of Mobile Bay.

Alabama owns oil, gas, and mineral interests on small upland tracts, submerged river bottoms, estuaries, bays, and in the 3-mi area offshore. Most significant economically are the natural gas reserves lying within the 3-mi offshore area of Mobile and Baldwin Counties. The Alabama State Oil and Gas Board was created after the oil discovery in 1944 in Choctaw County and is responsible for regulating the exploration and development of these natural resources. The discovery of Alabama's giant Citronelle Field in Mobile County in 1955 focused national attention on the State's oil and gas potential. Major discoveries of natural gas in the 1980's led to the development of an array of natural gas reservoirs, and Alabama became a world leader in the development of coal-bed methane gas as an energy resource. The Norphlet Formation development, which started in November 1978, results in high production rates of gas from the Norphlet Formation. This gas is a hot, sour, high-pressure, corrosive mixture of methane, hydrogen sulfide, carbon dioxide, and free water.

Alabama has reaped tremendous financial benefits from the development of offshore mineral resources. Revenues include severance taxes, bonuses, royalties, and rentals. At present, Alabama is considered a major oil- and gas-producing state.

As of August 2001, a total of 69 test wells have been drilled in Alabama coastal waters. Forty of these wells were permitted to test the Norphlet formation below a depth of 20,000 ft. The two earliest wells were drilled to test undifferentiated rocks of Cretaceous age, and 27 wells have targeted shallow Miocene gas reservoirs generally at depths of less than 3,500 ft. Operators have experienced a high success rate in drilling wells in Alabama coastal waters. A total of 28 of the 40 wells drilled into the Norphlet Formation to date have tested gas, and 23 of the 27 Miocene wells drilled have tested gas. Sixteen gas fields have been established in the offshore region of the State with seven being productive from the Norphlet formation and nine being productive from sands of Miocene age (Alabama State Oil and Gas Board, 2001). Indigenous crude oil production totals 29,000 bbl per day, ranking Alabama 16th out of the 32 producing states and Federal offshore areas. The State's three refineries have a combined crude oil distillation capacity of 130,000 bbl per calendar day, while several crude oil, product, and liquefied petroleum gas pipelines pass through the State (USDOE, EIA, 2001c).

Production of gas from the State's coastal waters flows through 44 fixed structures and platforms and now exceeds 220 billion cubic feet annually. This accounts for approximately 50 percent of the total gas production in Alabama, which now ranks as one of the top 10 gas-producing states in the nation. Production capabilities for individual wells range from a few million to more than 110 million cubic feet per day (Alabama State Oil and Gas Board, 2001).

3.3.3.9.2. Pipeline Infrastructure for Transporting State Production

The pipeline network in the Gulf of Mexico states is extensive. Pipelines transport crude oil and natural gas from the wellhead to the processing plants and refineries. Pipelines transport natural gas from producing states such as Texas and Louisiana and to a lesser extent Mississippi and Alabama to utility companies, chemical companies, and other users throughout the nation. Pipelines are used to transport refined petroleum products such as gasoline and diesel from refineries in the Gulf of Mexico region to markets all over the country. Pipelines are also used to transport chemical products (Louisiana Mid-Continent Oil and Gas Association, 2001).

The natural gas pipeline network has grown substantially since 1990 nationwide. The increasing growth in natural gas demand over the past several years has led to an increase in the utilization of pipelines and has resulted in some pressure for expansion in several areas. In the Gulf of Mexico, after several consecutive years of extensive pipeline development, installation of additional offshore Gulf of Mexico pipeline capacity has slowed. In 1997 and 1998, 14 natural gas pipeline projects were completed and added a total of 6.4 billion cubic feet per day of new pipeline capacity, most of which represented large-capacity pipelines connecting onshore facilities with developing offshore sites, particularly in the deepwater areas of the Gulf. During 1999-2000, 8 significant projects were completed, adding 1.8 billion cubic feet per day to the area's pipeline capacity. The majority of these projects were built primarily to improve gathering operations and to link new and expanding producing platforms in the Gulf with recently completed offshore mainlines directed to onshore facilities (USDOE, EIA, 2001d).

Texas

The pipeline industry is a vital part of the oil and gas industry in Texas. At present, there are 218,000 mi under permit that transport natural gas, crude oil, and refined products. Of this figure, 142,000 mi are permitted to transport natural gas, 40,000 mi are permitted to transport crude oil, and about 36,000 mi are permitted refined products. The Railroad Commission of Texas' Pipeline Safety Section has safety jurisdiction for those pipelines that transport natural gas, crude oil, and refined products across Texas.

Louisiana

As in Texas, the pipeline industry is a vital part of the oil and gas industry in Louisiana. There are about 25,000 mi of pipe moving natural gas through interstate pipeline and about 7,600 mi of pipelines that carry natural gas through intrastate pipelines to users within the State's boundaries. Another 3,450 mi of pipe in Louisiana transport crude oil and crude oil products. There are thousands of miles of flow lines and gathering lines moving oil and gas from the wellhead to separating facilities, while other pipelines transport chemical products with no petroleum base. Louisiana is home to the world's only offshore superport, LOOP, which enables supertankers to unload crude oil away from shore so that it can be transported via pipeline to onshore terminals. The Henry Hub in Louisiana is a hub of pipelines and is the point where financial markets determine the value of natural gas (Louisiana Mid-Continent Oil and Gas Association, 2001).

Mississippi

The petroleum infrastructure in Mississippi includes a moderately extensive network of crude oil, product, and liquefied petroleum gas pipelines. A major propane supply hub is the Dixie Pipeline; it has a network of terminals and storage facilities. Major pipelines for crude oil are operated by EOTT Energy, Genesis, Hunt, Shell, Mid-Valley, Scurlock-Permian, and BP. Major pipelines for liquefied petroleum gas are operated by Dixie, Plantation, Enterprise BP Dixie, and Enterprise (USDOE, EIA, 2001c).

Alabama

Alabama's petroleum infrastructure includes a somewhat extensive network of crude oil, product, and liquefied petroleum gas pipelines. Major pipelines for crude oil are operated by Hess, Hunt, Genesis, Citronelle-Mobile, and Miller. Major pipelines for liquefied petroleum gas are operated by Dixie, and Enterprise (USDOE, EIA, 2001c).

3.3.3.10. Environmental Justice

On February 11, 1994, President Clinton issued Executive Order 12898, entitled *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, which directs Federal agencies to assess whether their actions have disproportionate environmental effects on people of ethnic or racial minorities or with low incomes. Those environmental effects encompass human health, social, and economic consequences. The Federal agency in charge of the proposed action must provide opportunities for community input during the NEPA process (See Chapter 5 for a discussion of scoping, and community consultation and coordination.).

There are no environmental justice issues in the actual offshore Gulf of Mexico OCS planning areas; however, environmental justice concerns may be related to nearshore and onshore activities that result from a proposed action. These concerns are addressed in two categories—those related to routine operations and those related to non-routine events (accidents). Concerns related to routine operations center on increases in onshore activity (such as employment, migration, commuter traffic, and truck traffic) and on additions to or expansions of the infrastructure supporting this activity (such as fabrication yards, supply ports, and onshore disposal sites for offshore waste). Concerns related to nonroutine events focus on oil spills.

The OCS Program in the Gulf of Mexico is large and has been ongoing for more than 50 years. During this period, substantial leasing has occurred off Texas, Louisiana, Mississippi, and Alabama. An extensive support infrastructure system exists consisting of platform fabrication yards, shipyards, repair and maintenance yards, onshore service bases, heliports, marinas for crew and supply boats, pipeline coating companies, waste management facilities, gas processing plants, petrochemical plants, and gas and petroleum pipelines. This infrastructure system is both widespread and concentrated. Much infrastructure is located in coastal Louisiana, less in coastal Texas, and less still in Mississippi's Jackson County and Alabama's Mobile County. While many fabrication and supply facilities are concentrated around coastal ports, downstream processing is concentrated more in industrial corridors farther inland. Support system infrastructure is described in Chapters 3.3.3.4 and 3.3.3.10. The potential impacts to and from infrastructure is an ongoing concern for Gulf Coast States and communities. The MMS is currently conducting several studies to obtain and refine pertinent information. An ongoing study of infrastructure (Louis Berger Group, Inc., in preparation) is coding each facility and developing a database describing its functions and capacity. Ongoing cooperative agreements with Louisiana State University and the University of New Orleans are developing better descriptions and measures of the concentrated functions at specific coastal locations. Chapter 3.3.3.5 describes the even more widespread multitude of companies that provide goods and services to this system. One study (Applied Technology Research Corporation, 1994) counted 6,600 businesses that served oil and gas production companies. These vendors were distributed over 38 states, but they were concentrated in Texas, Mississippi, Alabama, and particularly Louisiana.

U.S. Census data aggregated at the county/parish level is too broad to reveal relationships between OCS leasing effects and geographic distributions of minority and low-income populations. Therefore, this environmental justice analysis considers the population distributions at the smaller, more detailed census tract level, which raises a data problem because tract-level household income data from the 2000 Census is not yet available. Because of the importance of geographic detail to the environmental justice analysis, MMS has opted to use 1997 projections of 1990 Census data for comparable and valid distributions for minority and low-income populations. While the 1997 projections are not expected to differ significantly from 2000 Census results, use of these projections raise additional issues. First, MMS purchased these data in 1997 and they do not include county/parishes recently added to the study area. Seven inland Texas counties were added to reflect the expanded Corpus Christi and Houston metropolitan areas; 12 inland Louisiana parishes were added to reflect the expanded Lafayette, Baton Rouge, and New Orleans metropolitan areas. Second, the U.S. Census 1997 nationwide definition of poverty was a household income of less than $16,276, while MMS data includes figures for income of greater than $15,000 and greater than $25,000. The MMS has chosen to use the lower figure since it is closer to the nationwide definition and since the cost of living is generally lower in the South than for the Nation as a whole.

Figure 3-15 maps census tracts that are 50 percent or more minority for the coastal areas of Texas, Louisiana, Mississippi, and Alabama. The MMS chose this percentage based on CEQ (1997) guidelines that defined a minority population of an affected that area exceeds 50 percent as an appropriate definition for environmental justice analysis. Most of these concentrations occur in large urban areas (such as Houston and Beaumont in Texas; Lafayette, Baton Rouge, and New Orleans in Louisiana; and Mobile in Alabama) or in smaller coastal urban areas (such as Corpus Christi and Galveston in Texas; Morgan City in Louisiana; and Gulfport, Biloxi, and Pascagoula in Mississippi). Large, rural, agricultural, predominantly minority census tracts are found in Texas, Louisiana, and Alabama. The Louisiana census tracts around Morgan City and along the Mississippi River below New Orleans are areas of mixed industry and agriculture. Both coastal areas are sparsely inhabited. These pockets of minority populations do not match the distribution of the offshore oil industry and its supporting infrastructure. Instead, they are the product of urbanization and of the historical role African Americans had in southern agriculture.

Figure 3-16 maps census tracts that have 50 percent or more of low-income households. The CEQ (1997) guidance for defining low-income areas is less explicit than it is for minority areas. The MMS selected the 50-percent level as comparable to the minority definition. In almost every case, these census tracts are neighborhoods in large or coastal urban areas (e.g., Galveston, Houston, Beaumont, Lafayette, Baton Rouge, New Orleans, Biloxi, and Mobile). Except in south Texas, all low-income census tracts are also minority census tracts. Again, like the concentrations of minority population, these pockets of poverty are a product of urbanization and southern agriculture.

As noted above, certain offshore fabrication and support functions are concentrated in coastal areas, particularly in Louisiana. Lafourche Parish, Louisiana, is described here because the analysis in Chapter 4.2.1.14 identifies it as a coastal area with a concentration of OCS-related infrastructure and with possible environmental justice concerns. Like its neighbors, Lafourche Parish is heavily involved in the offshore oil industry, particularly fabrication and support sectors. The founding and continued expansion of Port Fourchon, a port designed for deepwater OCS support, has added to the industry's presence (Keithly, 2001; Hughes, in preparation). Agriculture (primarily sugar cane and cattle) and commercial fishing make up smaller parts of the Lafourche Parish economy. In 2000, the parish's population was 89,974. Thibodaux, the parish seat and largest city, had a population of was 15,730; Larose, Raceland, and Cut Off had over 5,000 inhabitants; Galliano over 4,000; and Lockport and Golden Meadow over 2,000. The parish's population was 83 percent white (many of Cajun descent), 13 percent African American, 2 percent American Indian, and 1 percent Hispanic.

Much of Lafourche Parish is coastal wetlands. Habitable land—high ground—comprises narrow natural levees formed by existing and ancient bayous. Roads are built on top of these levees and communities are built along the roads and in the long, narrow bands described as "string settlements" (Davis and Place, 1983). This settlement pattern has tended to mix residential and business activities and to limit residential segregation by ethnicity and income. For example, the Houma, a State-recognized Indian tribe in the parish, resides interspersed among the dominant population group and are physically indistinguishable (Gibson, 1982; Fischer, 1970). Both the rich and the poor of Port Fourchon in Lafourche Parish have experienced the effects of port-related truck traffic; MMS scoping for this EIS and past EIS's has identified this as an issue of community-wide concern.

3.3.4. Recreational Resources

The northern Gulf of Mexico coastal zone has become increasingly developed over the past 20 years. In addition to homes, condominiums, and some industry, this coastline supports one of the major recreational regions of the United States, particularly for marine fishing and beach activities, both of which are viewed as public assets. There is a diversity of natural and developed landscapes and seascapes, including coastal beaches, barrier islands, estuarine bays and sounds, river deltas, and tidal marshes. Other recreational resources are publicly owned and administered, such as national and State seashores, parks, beaches, and wildlife lands, as well as designated preservation areas, such as historic and natural sites and landmarks, wilderness areas, wildlife sanctuaries, research reserves, and scenic rivers. Gulf Coast residents and tourists from throughout the nation, as well as from foreign countries, use these resources extensively and intensively for recreational activity. Commercial and private recreational facilities and establishments, such as resorts, marinas, amusement parks, and ornamental gardens, also serve as primary-interest areas. Locating, identifying, and observing coastal and marine birds, is a recreational activity of growing interest and importance all along the Gulf Coast.

The U.S. coastline along the Gulf of Mexico runs from Brownsville, Texas, and the southern tip of Padre Island, north, east, and south to the Dry Tortugas off Key West, Florida. It encompasses the confluence with the sea of the Mobile and Mississippi Rivers, which have two of the largest delta systems in the United States (Alabama State Docks Dept., 2001). More than 25 years ago, Congress set aside outstanding examples of Gulf coastal beach and barrier island ecosystems to be managed by the National Park Service for the preservation, enjoyment, and understanding of their inherent natural, cultural, and recreational values. State and county legislation added to this preservation program so that today there is a lengthy list of reserves, refuges, and public parks.

The shorefront of the northern Gulf of Mexico is diverse. It consists of national seashores such as Padre Island, traditional beachfront cities such as Galveston, State parks, marshland, casino-dotted beaches, the migratory bird habitats of Fort Morgan, and the sugar white sands of Gulf Shores, Alabama. Eco-tourism in national estuarine research reserves and beach recreation are interspersed with condominiums, hotels, planned communities, and private residences. Tourists and travelers are also attracted to the sites, sounds, shopping, and dining associated with developed marine areas.

The value of recreation and tourism in the Gulf of Mexico coastal zone from Texas through Florida has been estimated in the tens of billions of dollars annually (USDOI, MMS, 2001g; pages III-101 and III-102). A significant portion of these expenditures is made in coastal counties, where major shoreline beaches are primary recreational attractions. For example, well over 1 million people visited the beaches of Galveston Island and the Padre Island National Seashore in 1996, demonstrating the popularity of destination beach parks throughout the WPA as recreational resources.

Over 1 million people visit the mainland unit and barrier island beaches of the Gulf Island National Seashore in Mississippi and Florida annually, demonstrating the popularity of destination beach parks throughout the Gulf Coast region east of the Mississippi River. Trash and debris from OCS operations can wash ashore on Gulf of Mexico recreational beaches. Recreational beaches west of the Mississippi River are most likely to be impacted by waterborne trash from the OCS. Litter on recreational beaches from OCS operations could adversely affect the ambience of the beach environment, detract from the enjoyment of beach activities, and increase administrative costs on maintained beaches. Some trash items, such as glass, pieces of steel, and drums with chemical residues, can also be a health threat to users of recreational beaches. Current industry waste management practices; training and awareness programs focused on the beach litter problem; and the OCS industry's continuing efforts to minimize, track, and control offshore wastes are expected to minimize the potential for accidental loss of solid wastes from OCS oil and gas operations.

In this section, the coastline has been divided into segments according to topography, discrete human and other biological populations, barrier island formations, and special preservation areas. This gives the reader the chance to put in geographical context the textual descriptions.

Texas — Coastal Bend

From west to east, the counties of the Texas Coastal Bend area are Cameron, Wallacy, Kenedy, Kleberg, Nueces, and Aransas Counties. The coastal features include Padre Island, the Padre Island National Seashore, and Laguna Madre. The region boasts Corpus Christi Bay of the National Estuary Program and the western end of the Gulf Islands National Seashore, according to the Center for Marine Conservation web site as of May 10, 2001. There also are a State-designated coastal preserve at South Bay, a State park at Boca Chica, and the Port Isabel Lighthouse State Historical Park, all in Cameron County. Further up the coast in Nueces County, Mustang Island State Park is just south of Port Aransas, and Goose Island State Park is in Aransas County.

Texas — Matagorda

This segment includes Calhoun and Matagorda Counties. Matagorda Island is a barrier island protected under the Texas General Land Office's delineation of the Matagorda Island State Park and Wildlife Management Area.

Texas — Galveston

There are three counties in this portion of the shoreline: Brazoria; Galveston; and Chambers. Galveston Bay is part of the National Estuary Program. On the western perimeter of the Bay are the San Jacinto Battleground State Historical Park and the Battleship *Texas*. Galveston Island State Park is on the western end of Galveston Island.

Texas — Sea Rim

This stretch of the Texas coast includes Jefferson County and Sea Rim State Park. Nearby is the Sabine Pass Battleground State Historical Park.

Louisiana — Beaches

The three parishes of Cameron, Lafourche, and Jefferson comprise this segment. Spanning part of this coastline is the Barataria-Terrebonne National Estuary, the Atchafalaya National Wildlife Refuge, and the Jean Lafitte National Historic Park and Reserve.

Mississippi and Alabama — Gulf Islands

Gulf Islands National Seashore in this part of the Gulf stretches some 40 mi from Hancock, Harrison, and Jackson Counties in Mississippi to neighboring Mobile County and Dauphin Island in Alabama and over into the Florida Panhandle. This part of the National Seashore accommodates more than 1 million recreational visits a year. In addition to beaches, the Seashore harbors historic forts, shipwrecks, wetlands, lagoons and estuaries, seagrass, fish and wildlife, and archeological sites. In 1978, Congress designated approximately 1,800 ac on Horn and Petit Bois Islands, part of Gulf Islands National Seashore in Mississippi, as components of the National Wilderness System. And there is a national estuarine research reserve at Grand Bay (Weeks Bay Reserve Foundation, 1999).

Alabama — Gulf Shores

The southernmost part of Baldwin County is also known as Pleasure Island. It was a peninsula until the U.S. Army Corps of Engineers built the intracoastal waterway and cut the land ties to the mainland. Mobile Bay is part of the national estuary program, and Weeks Bay, at the southeastern end of the bay, is also part of the national estuarine research reserve system.

Florida Panhandle — West

This segment encompasses the three counties of Escambia, Santa Rosa, and Okaloosa. The area includes the eastern portion of Gulf Islands National Seashore, which is known as the Emerald Coast. Grayson State Park in Escambia County is near the Alabama/Florida state line.

Florida Panhandle — East

The four counties of Walton, Bay, Gulf, and Franklin are adjacent to Florida's Big Bend. St. George's Island is the easternmost of the system of barrier islands in the Gulf of Mexico. The Apalachicola National Estuarine Research Reserve has been established in this area to preserve the delta, river, and bay.

Florida — Dixie Stretch

Also known as the Big Bend stretch of Wakulla, Jefferson, Taylor, Dixie, Levy, Citrus, and Hernando Counties, this area is characterized by few recreational or tourist sites. This stretch of the coast includes the St. Vincent, St. Marks, Lower Suwannee, Cedar Keys, Crystal River, and Chassahowitzka National Wildlife Refuges, and the Homosassa Springs State Wildlife Park.

Florida — Southwest

This is the largest segment, running from Pasco, Hillsborough, Manatee, Sarasota and Charlotte Counties south to Lee County. There are three bays that have become part of the national estuarine program: Tampa Bay; Sarasota Bay; and Charlotte Harbor.

CHAPTER 4

ENVIRONMENTAL CONSEQUENCES

4. ENVIRONMENTAL CONSEQUENCES

4.1. IMPACT-PRODUCING FACTORY AND SCENARIO — ROUTINE OPERATIONS

4.1.1. Offshore Impact-Producing Factors and Scenario

This section describes the offshore infrastructure, activities, and disturbances associated with the proposed actions in the Central Planning Area (CPA) and Western Planning Area (WPA) and with the Gulfwide OCS Program that could potentially affect the biological, physical, and socioeconomic resources of the Gulf of Mexico. Offshore is defined here as the OCS portion of the Gulf of Mexico that begins 10 mi offshore Florida; 3 mi offshore Louisiana, Mississippi, and Alabama; and 3 leagues offshore Texas; and it extends seaward to the limits of the Exclusive Economic Zone (EEZ) (Figure 4-1). Coastal infrastructure, activities, and disturbances associated with the proposed actions and the OCS Program are described in Chapter 4.1.2.

Offshore activities and disturbances are described in the context of proposed action scenarios and an OCS Program scenario. The MMS, Gulf of Mexico OCS Region, developed these scenarios to provide a framework for detailed analyses of potential impacts of the proposed lease sales. Each scenario is a hypothetical framework of assumptions based on estimated amounts, timing, and general locations of OCS exploration, development, and production activities and facilities, both offshore and onshore. The proposed actions analyzed in this EIS are presented as a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors. The scenarios do not predict future oil and gas activities with absolute certainty, even though they were formulated using historical information and current trends in the oil and gas industry. Indeed, these scenarios are only approximate since future factors such as the contemporary economic marketplace, the availability of support facilities, and pipeline capacities are all unknown. Notwithstanding these unpredictable factors, the scenarios used in this EIS represent the best assumptions and estimates of a set of future conditions that are considered reasonably foreseeable and suitable for presale impact analyses. The development scenarios do not represent an MMS recommendation, preference, or endorsement of any level of leasing or offshore operations, or of the types, numbers, and/or locations of any onshore operations or facilities.

The assumed life of the leases resulting from a proposed sale does not exceed 40 years. This is based on averages for time required for exploration, development, production life, and abandonment for leases in the Gulf of Mexico. For the cumulative analysis, the OCS Program is discussed in terms of current activities, current trends, and projections of these trends into the reasonably foreseeable future. For modeling purposes and quantified OCS Program activities, a 40-year analysis period (year of the first WPA lease sale through 34 years after the last CPA sale as proposed in the 5-Year Program for 2002-2007) is used. Activity projections become increasingly uncertain as the length of time for projections are made increases and the number of influencing factors increases. The projections used to develop the proposed actions and OCS Program scenarios are based on resource and reserves estimates as presented in the *2000 Assessment of Conventionally Recoverable Hydrocarbon Resources of the Gulf of Mexico and Atlantic Outer Continental Shelf as of January 1, 1999* (Lore et al., 2001), current industry information, and historical trends.

The statistics used for these historic trends exhibit a lag time of about two years; therefore, the models using the trends also reflect two-year-old statistics. In addition, the overall trends average out the "boom and bust" nature of Gulf of Mexico OCS operations. The models cannot fully adjust for short-term changes in the rates of activities. In fact, these short-term changes should not be projected into the long term. An example of a short-term change was the surge in deepwater activities in the mid-1990's as a result of technological advancements in seismic surveying and development options, as well as a reflection of deepwater royalty relief. This short-term effect was greater than the activity level predicted by the resources and socioeconomic models. The MMS believes that the models, with continuing adjustments and refinements, adequately project Gulf OCS activities in the long term for the EIS analyses.

The proposed actions and the OCS Program scenarios are based on the following factors:

- recent trends in the amount and location of leasing, exploration, and development activity;
- estimates of undiscovered, unleased, conventionally recoverable oil and gas resources in the planning area;
- existing offshore and onshore oil and/or gas infrastructure;
- industry information; and
- oil and gas technologies, and the economic considerations and environmental constraints of these technologies.

The proposed actions in the CPA are Central Gulf Lease Sales 185, 190, 194, 198, and 201, as scheduled in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007*. In general, a proposed CPA lease sale represents 1.8-2.9 percent of the OCS Program in the CPA based on barrels of oil equivalent (BOE) resource estimates. Activities associated with a proposed lease sale in the CPA are assumed to represent 1.8-2.9 percent of OCS Program activities in the CPA unless otherwise indicated. In general, a proposed CPA lease sale represents 2 percent of the Gulfwide OCS Program based on BOE resource estimates. Activities associated with a proposed action are assumed to represent 2 percent of Gulfwide OCS Program activities and impacts unless otherwise indicated.

The proposed actions in the WPA are Western Gulf Lease Sales 187, 192, 196, and 200, as scheduled in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007*. In general, a proposed WPA lease sale represents 2.6-3.3 percent of the OCS Program in the WPA based on BOE resource estimates. Activities associated with a proposed action are assumed to represent 2.6-3.3 percent of OCS Program activities in the WPA unless otherwise indicated. In general, a proposed WPA lease sale represents 1 percent of the Gulfwide OCS Program based on BOE resource estimates. Activities associated with a proposed lease sale in the WPA are assumed to represent 1 percent of Gulfwide OCS Program activities and impacts unless otherwise indicated.

Specific projections for activities associated with the proposed actions are discussed in the following scenario sections. The potential impacts of the activities and disturbances associated with the proposed actions are considered in the environmental analysis sections (Chapters 4.2, 4.3, and 4.4).

The Gulfwide OCS Program resource and reserve estimates and projected activity levels for this multisale EIS are substantially different than those for the last multisale EIS's (the multisale EIS for the 1998-2002 CPA lease sales and the multisale EIS for the 1997-2002 WPA lease sales). There are several reasons for these changes. The MMS recently completed an assessment of Gulf OCS resources — the *2000 Assessment of Conventionally Recoverable Hydrocarbon Resources of the Gulf of Mexico and Atlantic Outer Continental Shelf as of January 1, 1999* (Lore et al., 2001). This assessment is based on geophysical data collected with new technologies allowing increased penetration and resolution, as well as on the latest available engineering and well bore information. This 2000 assessment resulted in a more than 200 percent increase in total Gulf of Mexico undiscovered conventionally recoverable hydrocarbon resources prompting similar changes in exploration and development activity levels used in this multisale EIS.

Projections for OCS Program installations and removals of structures have changed dramatically. Structures include all sea-surface-piercing facilities, ranging from single well caissons to large deepwater hubs and subsea development systems. The projections for this multisale EIS scenario are based on the application of historical platform installation and removal trends to annual production rate projections. The annual production rates more closely reflect the "profile" of a developing and then maturing hydrocarbon province, while the historic trends are more reactive to the cyclic changes in the economic environment. The previous projections were for a 9-23 percent net increase from the nearly 4,000 platform structures currently operating in the Gulf of Mexico, with 985-1,865 installations and 620-925 removals during the 40-year analysis period. Projections for the current EIS are for a net decrease of more than 80 percent in operational structures by the end of the 40-year analysis period, with 2,987-3,999 installations and 6,316-7,322 removals projected.

For the previous multisale EIS's, the range of annual production rates were projected to decrease from 1,530-1,597 million barrels of oil equivalent per year (MMBOE/yr) in 2002 to 319-537 MMBOE/yr in 2036. For the current multisale EIS, range of annual production is projected to decrease from 1,469-1,477 MMBOE/yr in 2002 to 427-812 MMBOE/yr by the end of the 40-year analysis period.

Many factors influencing the rate of platform installation and removals have changed in recent years. Platform removals are projected to outpace installations as the aging population of a large number of small production platforms and single well caissons on the shelf are decommissioned while fewer, deep-water structures are installed. These deepwater production host facilities may handle production throughput equivalent to 50 typical platforms on the continental shelf. These host facilities are much larger to accommodate the production and processing equipment for the greater throughput as well as accommodations for the large crews required. As the cost of multiplexed umbilicals increase, there is a trend toward "minimal structures" in deepwater. These minimal structures are essentially large buoys designed to provide remote control capabilities for the subsea systems and to provide chemical injection operations. Some of the minimal structures may also have helipads.

Additional structures are projected for installation on the continental shelf to develop deep gas. New discoveries for deep gas offer the best short-term opportunity for achieving the large reserve additions and flow rates to offset declining gas production (USDOI, MMS, 2001b). Sediments at greater than 15,000 ft below sea level and in less than 200 m water depth are relatively unexplored. Only 5 percent of all wells on the OCS have drilled to sediments below 15,000 ft subsea. The MMS estimates that there could be 5-20 tcf with the most likely value at 10.5 tcf of deep gas recoverable resources below 15,000 ft. In order to achieve economic success, deep wells require larger structures and must therefore have higher flow rates to compensate for the higher drilling costs. Wells into deep gas reservoirs on the Gulf of Mexico continental shelf encounter high temperatures, high pressures, and high corrosive content, all of which add to higher costs for drilling and production. The MMS offered incentives to operators in the form of royalty relief on deep gas production from any new leases issued in Lease Sale 178 (March 2001). Such royalty relief may well be extended to deep gas production on other existing and future leases.

The OCS Program scenario includes all activities that are projected to occur from past, proposed, and future lease sales during the analysis period. Activities that take place beyond the analysis timeframe as a result of future sales are not included in this analysis. The impacts of activities and disturbances associated with the OCS Program on biological, physical, and socioeconomic resources are analyzed in the major cumulative action analyses (Chapter 4.5).

4.1.1.1. Resource Estimates and Timetables

4.1.1.1.1. Proposed Actions

The proposed action scenarios are used to assess the potential impacts of the proposed lease sales. The resource estimates for the proposed actions are based on two factors: (1) the conditional estimates of undiscovered, unleased, conventionally recoverable oil and gas resources in the proposed lease sale areas; and (2) estimates of the portion or percentage of these resources assumed to be leased, discovered, developed, and produced as a result of the proposed actions. The estimates of undiscovered, unleased, conventionally recoverable oil and gas resources are based upon a comprehensive appraisal of the conventionally recoverable petroleum resources of the Nation as of January 1, 1999. Due to the inherent uncertainties associated with an assessment of undiscovered resources, probabilistic techniques were employed and the results were reported as a range of values corresponding to different probabilities of occurrence. A thorough discussion of the methodologies employed and the results obtained in the assessment are presented in the MMS report *2000 Assessment of Conventionally Recoverable Hydrocarbon Resources of the Gulf of Mexico and Atlantic Outer Continental Shelf as of January 1, 1999* (Lore et al., 2001). The estimates of the portion of the resources assumed to be leased, discovered, developed, and produced as a result of the proposed actions are based upon logical sequences of events that incorporate past experience, current conditions, and foreseeable development strategies. A profusion of historical databases and information derived from oil and gas exploration and development activities are available to MMS and were used extensively. The undiscovered, unleased, conventionally recoverable resource estimates for the proposed actions are expressed as ranges, from low to high. The range reflects a range of projected economic valuations of the produced oil and gas. The "low" end of the range is based on an economic case of $18 per barrel of oil and $2.11 per thousand cubic feet (Mcf) for gas. The "high" estimate is based on an economic case of $30 per barrel of oil and $3.52 per Mcf for gas.

Table 4-1 presents the projected oil and gas production for the proposed actions and for the OCS Program. Tables 4-2 and 4-3 provide a summary of major elements of a proposed action scenarios and some of the related impact-producing factors. To analyze impact-producing factors for the proposed actions and the OCS Program, the proposed lease sale areas were divided into offshore subareas based upon ranges in water depth. Figure 4-1 depicts the location of the offshore subareas. The water depth ranges reflect the technological requirements and related physical and economic impacts as a consequence of the oil and gas potential, exploration and development activities, and lease terms unique to each water-depth range. Estimates of resources and facilities are distributed into each of the subareas.

The estimated amounts of resources projected to be leased, discovered, developed, and produced as a result of a proposed lease sale are 0.276-0.654 BBO and 1.590-3.300 tcf of gas for a CPA lease sale, and 0.136-0.262 BBO and 0.810-1.440 tcf of gas for a WPA lease sale. The number of exploration and delineation wells, production platforms, and development wells projected to develop and produce the estimated resources for the proposed actions are given in Tables 4-2 and 4-3. The tables show the distribution of these factors by offshore subareas in the proposed lease sale areas. Tables 4-2 and 4-3 also include estimates of the major impact-producing factors related to the projected levels of exploration, development, and production activity.

For purposes of analysis, the life of the leases resulting from the proposed actions is assumed to not exceed 40 years. Exploratory activity takes place over a 25- to 34-year period, beginning in the year of the lease sale. Development activity takes place over a 35-year period, beginning with the installation of the first production platform and ending with the drilling of the last development wells. Production of oil and gas begins by the fourth year after the lease sale and continues through the 38th year. Final abandonment and removal activities occur in the last two years.

4.1.1.1.2. OCS Program

Gulfwide OCS Program: Estimates of total reserve/resource production related to a proposed action plus prior and future sales in the entire Gulf of Mexico OCS (CPA,WPA, and EPA) over the 40-year analysis period -are 15.49-22.42 BBO and 153.42-207.98 tcf of gas. Table 4-4 presents projections of the major activities and impact-producing factors related to future OCS Program activities.

Western Planning Area: Estimates of total reserve/resource production related to the proposed actions in the WPA plus prior and future sales (OCS Program) in the WPA over the 40-year analysis period are 3.35-5.53 BBO and 42.66-58.17 tcf of gas. This represents approximately 22-25 percent of the oil and 28 percent of the gas of the total OCS Program. Table 4-5 presents projections of the major activities and impact-producing factors related to future operations in the WPA.

Central Planning Area: Estimates of total reserve/resource production related to the proposed actions in the CPA plus prior and future sales (OCS Program) in the CPA over the 40-year analysis period are 12.00-16.52 BBO and 108.27-146.27 tcf of gas. This represents approximately 74-78 percent of the oil and 70 percent of the gas of the total OCS Program. Table 4-6 presents projections of the major activities and impact-producing factors related to future operations in the CPA.

Eastern Planning Area: Projected production for the OCS Program in the EPA represents anticipated production from lands currently under lease in the EPA, plus anticipated production from future EPA sales over the 40-year analysis period. The projected production for the OCS Program in the EPA assumes future leasing only in the Revised Proposal Lease Sale 181 area. The reader should be aware that the moratoria on leasing in the EPA may be lifted or reconfigured at some future time and leasing could occur in a larger area, which would change the projections for the cumulative OCS Program in the EPA.

Estimates of total reserve/resource production related to prior and future sales (OCS Program) in the EPA over the 40-year analysis period are 0.14-0.37 BBO and 2.49-3.54 tcf of gas. This represents 1-2 percent of the oil and approximately 2 percent of the gas of the total OCS Program. Table 4-7 presents projections of the major activities and impact-producing factors related to future operations in the EPA.

4.1.1.2. Exploration

4.1.1.2.1. Seismic Surveying Operations

Geophysical seismic surveys are performed to obtain information on surface and near-surface geology and on subsurface geologic formations. The MMS has almost completed a programmatic environmental assessment (EA) on geological and geophysical (G&G) permit activities in the Gulf of Mexico (USDOI, MMS, in preparation). The EA includes a detailed description of the seismic surveying technologies and operations; this information was used in the preparation of this EIS and is incorporated here by reference and is summarized below. High-resolution surveys done in support of lease operations are authorized under the lease. Most other seismic surveys are authorized under G&G permits.

High-resolution seismic surveys collect data on surficial geology used to identify potential shallow geologic hazards for engineering and site planning for bottom-founded structures. They are also used to identify environmental resources such as chemosynthetic community habitat. Deep-penetration, common-depth-point (CDP) seismic surveys obtain data about geologic formations greater than 10,000 m below the seafloor. High-energy, marine seismic surveys include both two-dimensional (2D) and three-dimensional (3D) surveys. Data from 2D/3D surveys are used to map structure features of stratigraphically important horizons in order to identify potential hydrocarbon traps. They can also be used to identify and map habitats for chemosynthetic communities.

Typical seismic surveying operations tow an array of airguns (the seismic sound source) and a streamer (signal receiver cable) behind the vessel 5-10 m below the sea surface. The airgun array produces a burst of underwater sound by releasing compressed air into the water column, which creates an acoustical energy pulse. The release of compressed air every several seconds creates a regular series of strong acoustic impulses separated by silent periods lasting 7-16 seconds, depending on survey type and depth to the target formations. Airgun arrays are designed to focus the sound energy downward. Acoustic (sound) signals are reflected off the subsurface sedimentary layers and recorded near the water surface by hydrophones spaced within streamer cables. These streamer cables are often 3 mi or greater in length. Vessel speed is typically 4.5-6 knots (about 4-8 mph) with gear deployed.

The 3D seismic surveying enables a more accurate assessment of potential hydrocarbon reservoirs to optimally locate exploration and development wells and minimize the number of wells required to develop a field. State-of-the-art interactive computer mapping systems can handle much denser data coverage than the older 2D seismic surveys. Multiple-source and multiple-streamer technologies are used for 3D seismic surveys. A typical 3D survey might employ a dual array of 18 guns per array. Each array might emit a 3,000-in^3 burst of compressed air at 2,000 pounds per square inch (psi), generating approximately 4,500 kilojoule (kJ) of acoustic energy for each burst. At 10 m from the source, the pressure experienced is approximately ambient pressure plus 1 atmosphere (atm). The streamer array might consist of 6-8 parallel cables, each 6,000-8,000 m long, spaced 75 m apart. A series of 3D surveys collected over time (four-dimensional or 4D seismic surveying) is used for reservoir monitoring and management (the movement of oil, gas, and water in reservoirs can be observed over time).

Prior to 1989, explosives (dynamite) were used in certain limited areas to generate seismic pulses. Explosives have been replaced by piston-type acoustic sources that generate superior acoustic signals and that do not cause the damaging environmental impacts associated with explosives. Rapid rise time (high velocity), high peak pressure, and rapid energy decrease characterize acoustical energy from explosives. Seismic airguns are considered nonexplosive and have long rise times to peak pressure (low velocity). It is assumed that no explosives will be used in future seismic surveys.

Multicomponent data, sometimes referred to as 4C data, is a product of an emerging technology that incorporates recording the traditional seismic compressional (P) waves with a full complement of other wave types, but predominantly shear (S) waves. The 4C technology provides a second independent image of a geologic section as well as improves the lithology picture in structurally complex areas. It can also aid in reservoir fluid prediction. The 4C data may be 2D or 3D in nature and procedurally involves draped or towed ocean-bottom receiver cable(s) for acquisition. The 4C data can be used as a defining prelease tool or a postlease aid for reservoir prediction.

The number of prelease geophysical permits in the Gulf has been consistently high over the last five years. The MMS anticipates an increase in the number of permit applications Gulfwide, due in part to an increase of high-resolution data applications, as well as additional 2D-4C and 3D-4C multicomponent applications for operations mostly located in mature areas on the shelf. In addition, extensive 2D surveys with deep-penetration capabilities are being run in areas where limited or dated seismic coverage presently exist. State-of-the-art 3D seismic data have enabled industry to identify, with greater precision, where the most promising deepwater prospects are located.

Postlease seismic surveying may include high-resolution, 2D, 3D, or 4D (4D is a series of 3D surveys collected over time) surveying. In addition, multicomponent data (2D-4C and 3D-4C data) may be collected to improve lithology and reservoir prediction. High-resolution surveying is done on a site-specific or lease-specific basis or along a proposed pipeline route. These surveys are used to identify potential shallow, geologic hazards for engineering and site planning for bottom-founded structures. They are also used to identify environmental resources such as hard-bottom areas, topographic features, potential chemosynthetic community habitat, or historical archaeological resources. New technology has allowed for 3D acquisition and for deeper focusing of high-resolution data. Postlease, high-resolution seismic surveying is assumed to be done once for each lease.

Deeper penetration seismic surveying (2D, 3D, or 4D) may also be done postlease for more accurate identification of potential reservoirs, increasing success rates for exploratory drilling and aiding in the identification of additional reservoirs in "known" fields. This 3D technology can be used in developed areas to identify bypassed hydrocarbon-bearing zones in currently producing formations and new productive horizons near or below currently producing formations. It can also be used in developed areas for reservoir monitoring and field management. The 4D seismic surveying is used for reservoir monitoring and management, as well as in identifying bypassed "pay zones." Through time-lapsed surveys, the movement of oil, gas, and water in reservoirs can be observed over time. Postlease, deep seismic surveys may occur periodically throughout the productive life of a lease.

Developing technologies that may provide additional detail on the geology and fluids beneath the seafloor might be appropriate for use in the deepwater areas of the Gulf. These technologies include vertical cables, marine vibrators, and combinations of multiple vessels, source arrays, and streamers.

4.1.1.2.2. Exploration and Delineation Drilling Plans

Operators use drilling terms that represent stages in the discovery and exploitation of hydrocarbon resources. An exploration well generally refers to the first well drilled on a prospective structure to determine if a resource exists. If a resource is discovered, a delineation well is a follow-up well used to define the amount of resource or the extent of the reservoir.

In the Gulf of Mexico, exploration and delineation wells are typically drilled with mobile offshore drilling units (MODU's), e.g., jack-up, semisubmersible, or drillship. The type of rig chosen to drill a prospect depends primarily on water depth. Since the water depth ranges for each type of drilling rig overlap, other factors such as availability and daily rates are also considered when deciding upon the type of rig to use. The table below indicates the depth ranges used in this analysis for Gulf of Mexico MODU's.

MODU or Drilling Rig Type	Water-Depth Range
Jack-up	up to 100 m
Semisubmersible	100 to 600 m
Drillship	greater than 600 m

This scenario assumes that an average exploration/delineation well will require 30-45 days to drill. The actual time required for each well depends on a variety of factors including the depth of the prospect's potential target zone, complexity of the well design, and the directional offset of the well bore needed to reach a particular zone. This scenario assumes that the average exploration or delineation well depth will be 3,674 m (12,055 ft) below mudline.

Dual gradient drilling (DGD) is perhaps the greatest single technological advancement for drilling in deep water and ultra-deepwater environments (Figure 4-33). As drilling operations move into deeper waters, the hydrostatic pressure represented by the mud column in the riser introduces a major challenge for well control. In drilling young, rapidly subsiding depositional basins typical of the Gulf of Mexico, the margin between high-formation pore pressures and low-fracture resistance pressures require additional casing strings in both the upper part of the hole and in pressure transition zones. At issue is that slightly overweighted mud can be quickly lost to the formation because the difference in pressure between keeping the well and formation pressure in balance with the mud and fracking the formation is very small. With extra casing strings in the shallow part of the well, the bottom-hole casing size can be as small as 6-6.75 in - too small to permit horizontal or multilateral completions. The cost of an ultra-deepwater (>6,000 ft water depth) well can be $30-50 million or more, without certainty that objectives can be reached. The solution to the problem of narrow margins between formation pore pressure and fracture resistance is DGD.

Unlike conventional single gradient drilling technology, in which control of bottom-hole pressure is achieved with a mud column from the bottom of the well back to the rig, DGD achieves the same effect by using drilling mud from the hole bottom to the mudline, and seawater in the riser from the mudline to the surface rig floor; the result is a DGD system. Subsea pumps separate formation water or hydrocarbon from drilling fluid and cuttings and circulate it back to the surface in separate lines. Seawater replaces mud in the marine riser that connects the wellhead to the surface rig. The basic goal of DGD is to create a situation where the well perceives that only the weight of seawater exists above the mudline so that the formation below the mudline reacts as though the rig is sitting on the seafloor and the problem of hydrostatic pressure is eliminated. Not only does this method eliminate as many as four strings of casing, but it is possible to drill in almost any water depth and reach the well's objectives with a bottom-hole diameter of about 12 in. This diameter is large enough to permit 7-in production casing to be installed up to the mudline and provide for both horizontal and multilateral completions. Operators estimate that DGD systems can save $5-15 million on a deepwater well.

The MMS mandates that operators conduct their offshore operations in a safe manner. Subpart D of the MMS's operating regulations (30 CFR 250) provides guidance to operators on drilling activities. For example, operators are required by 30 CFR 250.400 to take necessary precautions to keep their wells under control at all times using the best available and safest drilling technology (NTL 99-G01). Deepwater areas pose some unique concerns regarding well control activities. In 1998, the International Association of Drilling Contractor (IADC) published deepwater well control guidelines (IADC, 1998) to assist operators in this requirement. These guidelines address well planning, well control procedures, equipment, emergency response, and training.

As drilling activities occur in progressively deeper waters, operators may consider using MODU’s that have onboard hydrocarbon storage capabilities. This option may be exercised if a well requires extended flow testing, 1-2 weeks or longer, in order to fully evaluate potential producible zones and to justify the higher costs of deepwater development activities. The liquid hydrocarbons resulting from an extended well test could be stored and later transported to shore for processing. Operators may also consider barging hydrocarbons from test wells to shore. There are some dangers inherit with barging operations if adverse weather conditions develop during testing. If operators do not choose to store produced liquid hydrocarbons during the well testing, they must request and receive approval from the MMS to burn test hydrocarbons.

Drilling Rig Availability: The average number of rigs drilling in the deep waters (waters depths of 305 m or greater) in the Gulf of Mexico jumped dramatically between 1992 and 1999, from 3 to 27 rigs (Baud et al., 2000). Competition for deepwater drilling rigs in the GOM may limit the availability of these MODU’s to drill deepwater prospectsDrilling activities may also be constrained by the availability of both rig crews, risers, and other equipment.

CPA Proposed Action Scenario: It is estimated that 111-247 exploration and delineation wells will be drilled as a result of a proposed action in the CPA. Table 4-2 shows the estimated range of exploration and delineation wells by water depth subarea. Approximately 64 percent of the projected wells are expected to be on the continental shelf (0-200 m water depth) and about 25 percent are expected in the intermediate water-depth range (200-1,600 m). Exploratory drilling activities in support of a proposed action in the CPA are projected to increase for the first nine years following a proposed sale, reach its peak in year nine, and begin a steady decline through the 40-year analysis period.

WPA Proposed Action Scenario: It is estimated that 37-115 exploration and delineation wells will be drilled as a result of a proposed action in the WPA. Table 4-3 shows the estimated range of exploration and delineation wells by water depth subarea. Approximately 46 percent of the projected wells are expected to be on the continental shelf (0-200 m water depth) and slightly over 39 percent are expected in the intermediate water-depth range (200-1,600 m). Exploratory drilling activities in support of a proposed action in the WPA are projected to increase for the first six years following a proposed sale, then drilling intensity is projected to dramatically drop off.

OCS Program Scenario: It is estimated that 8,996-11,333 exploration and delineation wells will be drilled Gulfwide as a result of the OCS Program. Table 4-4 shows the estimated range of exploration and delineation wells by water depth subarea. Of these wells 76-79 percent will be in the CPA and 20-24 percent will be in the WPA. Activity is projected to be relatively stable for the first 10 years of the analysis period, and then a steady reduction in the annual rate of exploration and delineation wells to 50 percent.

4.1.1.3. Development and Production

4.1.1.3.1. Development and Production Drilling

A production well is drilled to exploit the unique configuration of a discovered or known hydrocarbon field. Delineation or production wells can collectively be termed development wells. Development or production wells may be drilled from movable structures, such as jack-up rigs fixed bottom-supported structures, floating vertically moored structures, floating production facilities (often called semisubmersibles), and drillships (dynamically positioned drilling vessels). The spectrum of these production systems are shown in Figure 4-2.

The type of production structure installed at a site depends mainly on water depth. The number of wells per structure varies according to the type of production structure used, the prospect size, and the drilling/production strategy deployed for the drilling program and for resource conservation. Systems used to produce hydrocarbons can be fixed, floating, or increasingly in deep water subsea. Advances in the composition of drilling fluids and dual-density drilling technology are likely to provide operators with the means to reduce rig costs in the deepwater OCS program.

Types of Production Structures: The MMS has described and characterized production structures in its deepwater reference document (Regg et al., 2000). These descriptions were used in preparing the scenario for this EIS. In water depths of up to 400 m, the scenario assumes that conventional, fixed platforms that are rigidly attached to the seafloor will be the type of structure preferred by operators. In water depths of less than 200 m, 20 percent of the platforms are expected to be manned (defined as having sleeping quarters on the structure). In depths between 200 and 400 m, all structures are assumed to be manned. It is also assumed that helipads will be located on 66 percent of the structures in water depths less than 60 m, on 94 percent of structures in water depths between 60 and 200 m, and on 100 percent of the structures in water depths greater than 200 m. At water depths exceeding 400 m, platform designs based on rigid attachment to the seafloor are not expected to be used. The 400-m isobath appears to be the current economic limit for this type of structure.

Fixed: A fixed platform (Figure 4-2) consists of a jacket (a vertical section made of tubular steel members supported by piles driven into the seafloor) with a deck section to provide space for crew quarters, a drilling rig, other equipment, storage, and production and support facilities.

A compliant tower consists of a piled foundation that usually supports a narrow, tubular steel trellis-type tower. The structure is kept on station by guyed wires anchored to the seabed or stressed members within the tower. A conventional deck sits on top of the tower for drilling, workover, and production operations. Compliant towers may be used in water depths between 300 and 900 m.

Floating: A tension-leg platform (TLP) consists of a floating structure or hull held in place by tensioned tendons connected to a foundation on the seafloor that is secured by piles that are driven into the seabed. The tensioned tendons provide a broad depth range of utilization and also limit the TLP's vertical motion and, to a degree, its horizontal motion. At present, TLP's can be used in water depths up to approximately 2,100 m. Mini-TLP's may be used to develop smaller deepwater reservoirs when economics dictate. Mini-TLP's may also be used as utility, satellite, or early production structures for larger deepwater discoveries. Operators may consider using mini-TLP's for prospects in water depths from l80 to 1,100 m.

A spar structure is a deep-draft, floating caisson that may consist of a large-diameter (27.4 to 36.6 m) cylinder or a cylinder with a lower tubular steel trellis-type component (truss spar) that supports a conventional production deck. The cylinder or hull may be moored via a chain catenary or semi-taut line system connected to 6-20 anchors on the seafloor. Spars are now used in water depths up to 900 m and may be used in water depths as great as 3,000 m.

Semisubmersible production structures resemble their drilling rig counterparts. Their hull contains pontoons below the waterline and vertical columns to the hull box/deck. The structures keep on station with conventional catenary or semi-taut line mooring systems connected to anchors in the seabed. Semisubmersibles may be used in similar water depths as spars (3,000 m or deeper).

The MMS has prepared an EIS on the potential use of floating production, storage, and offloading (FPSO) systems on the Gulf of Mexico OCS (USDOI, MMS, 2001a). In accordance with the scenario provided by industry, the FPSO EIS addresses the proposed use of FPSO's in the deepwater areas of the WPA and CPA only. At this time, industry has not submitted a development plan indicating that an FPSO will be used for development. However, the cumulative scenarios project possible FPSO usage in either the WPA or CPA. A new and evolving technology for deepwater development involves the use of minimal floating structures. These buoy-like structures allow the placement of minimal equipment at the surface. They have the advantages of relatively low cost and surface access to the well(s). These structures are dependent on "host" facilities for control and for final processing of the produced hydrocarbons.

Subsea: For some development programs, especially those in deep water, an operator may chose to use a subsea production system instead of a floating production structure. A subsea production system comprises various components including templates, production tree (well head), "jumper" pipe connections, manifolds, pipelines, control equipment, and umbilicals. A subsea production system can range from a single-well template with production going to a nearby structure to multiple-well templates producing through a manifold to a pipeline and then to a riser system at a distant production facility, possibly in shallower waters.

Subsea systems rely on a "host" facility for support and well control. Centralized or "host" production facilities in deep water or on the shelf may support several satellite subsea developments. Unlike wells from conventional fixed structures, subsea wells do not have surface facilities directly supporting them during their production phases. A drilling rig must be brought on location to provide surface support to reenter a well for workovers and other types of well maintenance activities. In addition, should the production safety system fail and a blowout result, surface support must be brought on location to regain well control.

Although the use of subsea systems has recently increased as development has moved into deeper water, subsea systems are not new to the Gulf and subsea systems are not used exclusively for deepwater development. The first subsea wells in the Gulf were installed in 1964. Subsea systems in the Gulf are currently used in water depths up to 1,615 m. Operators are contemplating their use out to 3,000 m and beyond.

Emerging Technologies: Technological advancements in the oil and gas industry have not only improved the discovery and recovery of hydrocarbons on the OCS, but they have lessened impacts on the environment. For example, extended-reach well drilling, horizontal well bores and completions, electronic safety systems, dual gradient drilling, and synthetic drilling fluids are technologies that accomplished both goals. Extended-reach technology (specialized directional drilling) allows wells to be drilled as far as 6-8 km (4-5 mi) from a centralized surface location. The advantage to the environment from this technology comes from reducing the number of structures needed to develop a field. Horizontal drilling allows a well bore to intersect more of the producing formation than is possible with conventionally drilled holes. Increased production can be realized from these horizontally drilled wells. This technology allows more reserves to be produced from a single wellbore. Ultimately, fewer wells may be drilled to recover equal quantities of hydrocarbons from a particular zone. Electronic safety systems are used to monitor safety functions including shutdowns, alarms, and other critical devices. These systems are more reliable and accurate than previously used safety systems, allowing operators to respond more quickly to potential problems.

Dual gradient drilling (DGD) is an emerging technology that may revolutionize drilling operations in the deeper areas of the Gulf of Mexico. The industry is currently drilling its first well using this technology in Green Canyon, Block 136. A series of papers presented at the 2001 Society of Petroleum Engineers conference in New Orleans describe this joint industry project (Smith et al., 2001; Schumacher et al., 2001; and Eggemeyer et al., 2001). The DGD technology is similar to single gradient drilling procedures in that it provides the appropriate amount of hydrostatic bottom-hole pressure to maintain well control. The DGD system differs from conventional drilling procedures by using two fluids instead of one fluid in the well to accomplish this requirement. Under conventional drilling technology, a single mud weight is used from the surface facilities on the drilling rig to the well's total depth. The DGD system has drilling fluid from the seafloor mudline to the well's total depth but uses another fluid such as treated seawater from the mudline back up to the rig's floor. Specialized equipment, including subsea mud pumps, is used to circulate drilling fluid and cuttings to the surface under DGD operations. Using the DGD system, the margins between fracture gradient and pore pressure are significantly greater than under conventional single gradient drilling procedures. Operators believe that DGD wells may be drilled at lower costs with more safety and more completion flexibility than under single gradient drilling procedures.

The MMS prepared Site-specific Environmental Assessments (S-5409 and S-5499) for the test well. The MMS determined that the potential environmental effects from the use of the DGD technology were comparable to, or better than, those expected from more conventional technology (30 CFR 250.141) (USDOI, MMS, 2000b; SEA S-5409).

Synthetic drilling fluids (SDF) have also had a significant effect on exploration and development operations. A recent Department of Energy publication (USDOE, 1999) cites results from a Gulf of Mexico operator study that concluded that SDF significantly outperformed water-based fluids (WBF). Of eight wells drilled under comparable conditions to the same depth, the study found that the three wells drilled using SDF were completed in an average of 53 days at a cost of approximately $5.5 million. In comparison, the five wells drilled using WBF were completed in an average of 195 days at a cost of approximately $12.4 million. The environmental benefits from the use of SDF include reduced air emissions because of shorter drilling times and less waste because SDF are reconditioned and recycled.

CPA Proposed Action Scenario: It is estimated that 178-352 development will be drilled as a result of a proposed action in the CPA. Table 4-2 shows the estimated range of development wells by water-depth subarea. Approximately 50 percent of the projected wells are expected to be on the continental shelf (0-200 m water depth) and about 33 percent are expected in the intermediate water-depth range (200-1,600 m). For gas development wells, approximately 68 percent of those projected are on the continental shelf (0-200 m water depth) and about 23 percent are in the intermediate water-depth range (200-1,600 m). For oil development wells, approximately 31 percent are on the continental shelf (0-200 m water depth) and about 44 percent are in the intermediate water-depth range (200-1,600 m). Drilling is projected to steadily increase for the first 10 years, then hit a plateau for the next 12 years, and start an almost linear decline.

WPA Proposed Action Scenario: It is estimated that 97-166 development will be drilled as a result of a proposed action in the CPA. Table 4-3 shows the estimated range of development wells by water-depth subarea. Approximately 37 percent of the projected wells are expected to be on the continental shelf (0-200 m water depth) and about 47 percent are expected in the intermediate water-depth range (200-1,600 m). Trends between the oil and gas development wells are markedly different. For oil wells, the intermediate water-depth range (200-1,600 m) constitutes the largest portion of oil wells, over 59 percent. For gas wells, the continental shelf (0-200 m water depth) had the greatest concentration of projected gas wells, about 58 percent. Drilling is projected to steadily increases to a plateau peak about year 9 through year 19. Then, a steady decrease in activity is projected.

OCS Program Scenario: It is estimated that 17,148-21,079 development wells will be drilled Gulfwide as a result of the OCS Program. Table 4-4 shows the estimated range of development wells by water depth. In the CPA, development activities start at a relatively high rate (about 450 wells per year) and remain around that level for approximately 13 years. Activities then begin to decline fairly steadily until the end of the scenario. In the WPA, development activities are projected to steadily increase for the scenario's first 14 years, level off for approximately 9 or 10 years, and then begin to decline.

4.1.1.3.2. Infrastructure Emplacement/Structure Installation and Commissioning Activities

Bottom-founded or floating structures may be placed over development wells to facilitate production from a prospect. They provide protection for and control of the wells. They also serve as a platform to conduct additional drilling and workover activities, to process and treat produced fluids from the wells, and to initiate export of the produced hydrocarbons.

Structure installation and commissioning activities may take place over a period of a week to a month at the beginning of a platform's 20- to 40-year production life. Derrick barges may be used to upright and position structures. Usually moorings and anchors are attached to keep the structure on station. Commissioning activities involve all of the interconnecting and testing of the structure's modular components.

CPA Proposed Action Scenario: Table 4-2 shows the projected number of structure installations for a proposed action in the CPA by water-depth range. About 81 percent of all the production structure installation projected for a proposed action in the CPA are on the continental shelf (0-200 m). Approximately 12 percent of the structures are projected for the 200-1,600 m water-depth range.

WPA Proposed Action Scenario: Table 4-3 shows the projected number of structure installations for a proposed action in the WPA by water-depth range. About 65 percent of all the production structure installation projected for a proposed action in the WPA are slated for the traditional shelf (0-200 m). Approximately 19 percent of the structures are projected for the 200-1,600 m water-depth range.

OCS Program Scenario: Table 4-4 shows the projected number of structure installations by water-depth range for the Gulfwide OCS Program. In the WPA, about 84 percent of all the production structure installations projected for the WPA are estimated for the continental shelf (0-200 m) and 13 percent in 200-1,600 m water depths. In the CPA, more than 90 percent of all the production structure installations projected for the CPA are estimated for the continental shelf (0-200 m).

4.1.1.3.2.1. Bottom Area Disturbance

Structures emplaced or anchored on the OCS to facilitate oil and gas exploration, development, and production include drilling rigs (jack-ups, semisubmersibles, and drillships), production platforms, subsea systems, and pipelines. The emplacement of these structures disturbs some area of the sea bottom beneath the structure. If anchors are employed, there are some areas around the structure that are also disturbed. This disturbance includes both physical compaction beneath the structure and the resuspension and settlement of sediments. Jack-up rigs and semisubmersibles are assumed to be used in water depths less than 750 m and to disturb about 1.5 ha (3.7 ac) each. In water depths greater than 750 m, dynamically positioned drillships will be used, disturbing no bottom area (except a very small area where the well is drilled). Conventional, fixed platforms installed in water depths less than about 400 m disturb about 2 ha. At water depths exceeding 400 m, compliant towers, tension-leg platforms (TLP's), spars, and floating production systems (FPS's) will be used (Figure 4-2). A compliant tower consists of a narrow flexible tower and a piled formation that supports a conventional deck. A compliant tower would disturb the same bottom area—about 2 ha—as a conventional, fixed platform. A TLP consists of a floating structure held in place by tensioned tendons connected to the seafloor by templates secured with piles. A TLP would disturb about 5 ha of bottom area. A spar platform consists of a large-diameter cylinder supporting a conventional deck, three types of risers (production, drilling, and export), and a hull that is moored via a taut catenary system of 6-20 lines anchored to the seafloor. The bottom area disturbed by a spar is dependent on the anchor configuration and would be about 5 ha. A FPS consists of a semisubmersible vessel anchored in place with wire rope and chain. A FPS would disturb about 1.5 ha of sea bottom. Subsea systems, located on the ocean floor, are connected to the surface deck via production risers and would disturb less than 1 ha each. Emplacement of pipelines disturbs about 0.32 ha of seafloor per kilometer of pipeline.

Impacts from bottom disturbance are of concern near sensitive areas such as topographic features, pinnacles, low-relief live-bottom features, chemosynthetic communities, high-density biological communities in water 400 m or greater, and archaeological sites. Regulations and mitigating measures protect these sensitive areas from potential impacts resulting from bottom disturbance.

4.1.1.3.2.2. Sediment Displacement

Trenching for pipeline burial causes displacement or resuspension of seafloor sediments. The MMS's regulations (30 CFR 250.1003(a)(1)) require that pipelines installed in water depths <61 m (<200 ft) are buried to a depth of at least 3 ft below the mudline. Burying is required to reduce the movement of pipelines by high currents and storms, to protect the pipeline from the external damage that could result from anchors and fishing gear, to reduce the risk of fishing gear becoming snagged, and to minimize interference with the operations of other users of the OCS. It is assumed that 5,000 m^3 of sediment will be resuspended for each kilometer of pipeline trenched.

Sediment displacement also occurs as a result of the removal of pipelines. It is projected that the number of pipeline removals (or relocations) will increase Gulfwide as the existing pipeline infrastructure ages. For each kilometer of pipeline removed in water depths less than 61 m, approximately 5,000 m^3 of sediment would be resuspended.

Displaced sediments are those that have been physically moved "in bulk." Displaced sediments will cover or bury an area of the seafloor, while resuspended sediments will cause an increase in turbidity of the adjacent water-column. Resuspended sediments eventually settle, covering the surrounding seafloor. Resuspended sediments may include entrained heavy metals or hydrocarbons.

4.1.1.3.3. Infrastructure Presence

4.1.1.3.3.1. Anchoring

Most exploration drilling, production platform, and pipeline emplacement operations on the OCS require anchors to hold the rig, structure, or support vessels in place. These anchors disturb the seafloor and sediments of the area. Anchoring can cause physical compaction beneath the anchor and associated chains or lines, and the resuspension and settlement of sediments.

Conventional pipelaying barges use an array of eight 9,000-kg anchors to position the barge and to move it forward along the pipeline route. These anchors are continually moved as the pipelaying operation proceeds. The area actually affected by these anchors depends on water depth, wind, currents, chain length, and the size of the anchor and chain. Dynamically positioned pipelaying barges do not anchor.

Mooring buoys may be placed near drilling rigs or platforms so that service vessels need not anchor, especially in deeper water. These temporarily installed anchors will most likely be smaller and lighter than those used for vessel anchoring and, thus, will have less impact on the sea bottom. Moreover, installing one buoy will preclude the need for numerous individual vessel-anchoring incidents. Service-vessel anchoring is assumed to not occur in water depths greater than 150 m and only occasionally in shallower waters (vessels would always tie up to a platform or buoy in water depths > 150 m).

Barges are assumed to always tie up to a production system rather than anchor. Barges and other vessels are also used for both installing and removing structures. These vessels use anchors placed away from their location of work. Drillships use dynamic positioning systems to remain in place and do not anchor.

4.1.1.3.3.2. Space-Use Conflicts

During OCS operations, the areas occupied by seismic vessels, structures, anchor cables, and safety zones are unavailable to commercial fishermen. Seismic surveys will occur in both shallow and deepwater areas of the proposed actions. Usually, fishermen are precluded from a very small area for several days during active seismic surveying. Exploratory drilling rigs spend approximately 40-150 days on-site and are a short-term interference to commercial fishing. A major bottom-founded production platform in water depths less than 450 m, with a surrounding 100-m navigational safety zone, requires approximately 6 ha of space. A bunkhouse structure requires about 4 ha and a satellite structure requires about 1.5 ha of space. Virtually all commercial trawl fishing in the Gulf of Mexico is performed in water depths less than 200 m (Louisiana Dept. of Wildlife and Fisheries, 1992). A total of 31.2 million ha in the Central and Western Gulf is located in water depths of 200 m or less.

Longline fishing is performed in water depths greater than 100 m and usually beyond 300 m. All surface longlining is prohibited in the northern DeSoto Canyon area (designated as a swordfish nursery area by the National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries), formerly known as the National Marine Fisheries Service (NMFS)). The longline closure area encompasses at least some part of 173 blocks in the CPA. In the EPA, the closure area encompasses 160 blocks within the Revised Proposal Lease Sale 181 area. Longline fishing will also probably be precluded from blocks for miles around the closure area because of the great length of typical longline sets and time required for their retrieval.

In water depths greater than 450 m, production platforms will be compliant or floating structures (such as TLP's and spar's) (Figure 4-2); this is beyond the range of typical commercial trawling. Even though production structures in deeper water are larger and individually will take up more space, there will be fewer of them compared to the great numbers of bottom-founded platforms in shallower water depths. The use of tanker-based FPSO's is also being considered by operators in the Gulf. The U.S. Coast Guard (USCG) has not yet determined what size navigational safety zone will be required during offloading operations. Factoring in various configurations of navigational safety zones, other deepwater facilities may require up to a 500-m-radius safety zone or 79 ha of space (USCG regulations, 33 CFR Chapter 1, Part 147.15). Production structures in all water depths have a life expectancy of 20-30 years. The MMS data indicate that the total area lost to commercial fishing due to the presence of production platforms has historically been and will continue to be less than 1 percent of the total area available.

Proposed Action Scenario: A maximum of 102 ha (17 structures @ 6 ha) will be lost to commercial fishing as a result of a proposed action in the WPA and 300 ha (50 structures @ 6 ha) for a proposed action in the CPA. This is approximately 0.001 percent of the total area available in the sale areas. Considering that virtually all trawling occurs in water depths of less than 200 m, the maximum area lost to trawling is about 22 percent less than the total unavailable area (15 of the 67 total structures projected for the proposed actions are in water depths greater than 200 m).

OCS Program Scenario: Total OCS production structure installation Gulfwide has been estimated through the year 2042. The estimated number of platforms installed varies widely between water-depth subareas. In the WPA, production structure installation ranges from a low of 3-8 platforms in depths greater than 2,400 m to a high range of 428-628 in the shallowest water depth subarea (to a depth of 60 m). Projected CPA installations range from 9 to 23 in the deepwater (greater than 2,400 m) to a high of 1,810-2,441 structures in the shallowest water depth subarea (to a depth of 60 m). The total number of installations for the CPA ranges from 2,360 to 3,218 for all depth ranges. Total activity in the EPA is estimated to range from 4 to 7 installed production structures between 2003 and 2042.

As identified oil and gas fields are developed and fewer new reservoirs are located, the overall annual rate of platform and structure installation will decrease. Platform removal rates are expected to increase as mature fields are depleted. The rate of platform removal is projected to average between 130 and 180 structures per year. The trend of increased area lost to commercial fishing will be reversed over time as the rate of platform removals exceeds the rate of platform installation. It is assumed that the total area lost to commercial fishing due to the presence of OCS production platforms will continue to be less than 0.1 percent of the total area available to commercial fishing.

4.1.1.3.3.3. Aesthetic Interference

The factors that could adversely affect the aesthetics of the coastline are oil spills and residue, tarballs, trash and debris, noise, pollution, increased vessel and air traffic, and the presence of drilling and production platforms visible from land. Oil spills, oil residue from tankers cleaning their holding tanks, and tarballs could affect the beauty of beaches, wetlands, and coastal residences. Increased vessel and air traffic may result in additional noise, or in oil and chemical pollution of water in port and out to sea. The potential visibility of fixed structures in local Gulf waters is worrisome for local chambers of commerce and tourist organizations. In a study conducted by the Geological Survey of Alabama (GSA) in 1998, several facets of the visibility of offshore structures were analyzed. The GSA earth scientists found that visibility is dictated not only by size and location of the structures and curvature of the Earth, but also by atmospheric conditions. Social scientists added factors, such as the viewer's elevation—ground level, in a two-story house, or in a 30-story condominium—and the viewer's expectations and perceptions. The size of an offshore structure depends on the reservoir being tapped, characteristics of the well-stream fluid, and the type of processing needed to treat the hydrocarbons. Location reflects the geology of the reservoir being exploited. Optimal location of structures means at or near the surface of the reservoir (GSA, 1998). Atmosphere refers to conditions of weather, air quality, and the presence or absence of fog, rain, smog, and/or winds. The height of the viewer affects their ability to see and distinguish objects several yards or miles away. Perceptions often dictate what people expect to see and, hence, what they do see.

To test visibility in as scientific a way as possible, GSA staff worked with members of the Offshore Operators Committee. They took a series of photographs on one day in October 1997, from a helicopter hovering at 300 ft. They used the same camera, lens, shutter speed, and f-stop setting. The subjects of the photos were four different types of structures usually found in both State and Federal waters offshore Alabama. The structures ranged in height from 60 to 70 ft; they varied in size from 120 ft by 205 ft to 40 ft by 90 ft with the smallest being 50 ft by 80 ft. The tallest and widest structures, i.e., those showing the most surface in the viewscape, were visible at up to 5 mi from shore. The shorter and the smaller the structure, the less visible at 5 mi; the smallest could barely be seen at 3 mi from shore. According to this study, no structure located more than 10 mi offshore would be visible (GSA, 1999).

Additional impact-producing factors associated with offshore oil and gas exploitation are oil spills, and trash and debris. These are the most widely recognized as major threats to the aesthetics of coastal lands, especially recreational beaches. These factors, individually or collectively, may adversely affect the fishing industry, resort use, and the number and value of recreational beach visits. The effects of an oil spill on the aesthetics of the coastline depends on factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, and cleanup methods (if any).

4.1.1.3.4. Operational Waste Discharged Offshore

The primary operational waste discharges generated during offshore oil and gas exploration and development are drilling fluids, drill cuttings, produced water, deck drainage, sanitary wastes, and domestic wastes. During production activities, additional waste streams include produced sand and well treatment, workover, and completion (TWC) fluids. Minor additional discharges occur from numerous sources; these discharges may include desalination unit discharges, blowout preventer fluids, boiler blowdown discharges, excess cement slurry, and uncontaminated freshwater and saltwater.

The USEPA, through general permits issued by the USEPA Region that has jurisdictional oversight, regulates all waste streams generated from offshore oil and gas activities. The USEPA published the most recent effluent guidelines for the oil and gas extraction point-source category in 1993 (58 FR 12454). The USEPA Region 4 has jurisdiction over the eastern portion of the Gulf of Mexico OCS including all of the EPA and the CPA off the coasts of Alabama and Mississippi. The USEPA Region 6 has jurisdiction over the rest of the CPA and all of the WPA. Each Region has promulgated general permits for discharges that incorporate the 1993 effluent guidelines as a minimum. The current Region 4 general permit was issued on October 16, 1998 (63 FR 55718), was modified on March 14, 2001 (66 FR 14988), and expires on October 31, 2003. The Region 6 general permit was issued on November 2, 1998 (63 FR 58722), was modified on April 19, 1999 (64 FR 19156), and expires on November 3, 2003. The USEPA also published new guidelines for the discharge of SBF on January 22, 2001 (66 FR 6850). On December 18, 2001, Region 6 published a notice of revision to the general permit, which became effective on February 16, 2002. The revision authorizes the discharge of drill cuttings produced using SBF and other nonaqueous-based drilling fluids and wastewater used to pressure test existing piping and pipelines. Region 4 has not revised the general permit to incorporate the new guidelines for SBF and other nonaqueous-based drilling fluids.

4.1.1.3.4.1. Drilling Muds and Cuttings

The largest discharges from drilling operations are drilling fluids (also known as drilling muds) and cuttings. Drilling fluids are used in rotary drilling to remove cuttings from beneath the bit, to control well pressure, to cool and lubricate the drill string, and to seal the well. Drill cuttings are the fragments of rock generated during drilling and carried to the surface with the drilling fluid.

The composition of drilling fluids is complex. The bulk of the mud consists of clays, barite, and a base fluid, which can be fresh or salt water; mineral or diesel oil; or any of a number of synthetic oils. Three categories of drilling fluids or muds are used on the OCS: water based, oil based, and synthetic based. Water-based drilling fluids (WBF) have been used for decades to aid drilling on the continental shelf. The WBF may have diesel oil or mineral oil added to them for lubricity. Occasionally, oil-based drilling fluids (OBF) are used for directional drilling and in sections where problems arise from using WBF. Since 1992, synthetic-based drilling fluids (SBF), have been increasingly used, especially in deepwater, because they perform better, are less toxic than OBF, and reduce drilling times, thus reducing the costs incurred from expensive drilling rigs. Most recently, internal olefins are the most prevalent base fluid for the SBF used in deepwater drilling in the Gulf of Mexico. However, some operators have used polyalpha olefins, esters, or their own proprietary blend as the base fluid. Numerous chemicals are added to improve the performance of the drilling fluid (Boehm et al., 2001).

The discharge of WBF and cuttings associated with WBF is allowed everywhere on the OCS under the general National Pollution Discharge Elimination System (NPDES) permits issued by Regions 4 and 6, as long as the discharge meets the toxicity guidelines. The USEPA (1993a and b) estimated that 12 percent of all drilling fluids and two percent of all drill cuttings were brought to shore for treatment and disposal under the previous NPDES general permit criteria. All OBF and associated cuttings must be transported to shore for recycling or disposal unless reinjected. For SBF, the discharge of the drilling muds is prohibited. Region 6 has allowed the discharge of cuttings wetted with SBF, while Region 4 does not. The current NPDES General Permits for OCS discharges in USEPA Region 4 (eastern CPA and EPA) and Region 6 (WPA and western CPA) will expire in October 2003 and April 2004, respectively.

In deeper water, the upper portion of the well, 1,000-1,500 m, is drilled with WBF and the remainder is drilled with SBF. The upper sections are drilled with a large diameter bit; progressively smaller drill bits are used with increasing depth. Therefore, the volume of cuttings per interval (length of wellbore) in the upper section of the well is greater than the volume generated in the deeper sections. Average values of muds and cuttings discharged during drilling are given in the Table 4-9. The estimated volume of SBF mud discharged is the amount of the base fluid adhering to cuttings and not a direct discharge of SBF, which is prohibited. The SBF is rented by the operator and at the end of drilling, the SBF is returned to the mud company for recycling. Since OBF's are used under special circumstances and may be replaced with SBF estimates of the amount of OBF muds and cuttings is not possible.

Drilling discharges of muds and cuttings are regulated by USEPA through an NPDES permit. Barite, barium sulfate, is a major component of all drilling fluid types (WBF, OBF, and SBF). Mercury and other trace metals are naturally occurring impurities in barite. Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 part per million (ppm) and 3 ppm, respectively, in the stock barite used to make drilling muds. Through mercury and cadmium regulation, USEPA can also control levels of other trace metals in barite. This reduces the addition of mercury to values similar to the concentration of mercury found in marine sediments throughout the GOM (Avanti Corporation, 1993a and b; USEPA, 1993a and b). Trace metals including mercury are of concern because of the potential for a toxic effect or bioaccumulation in some marine organisms. Mercury is of particular concern because it can be bioaccumulated in aquatic organisms. Concentrations of total mercury in uncontaminated estuarine and marine sediments generally are 0.2 μg/g dry weight or lower. Surface sediments collected 20-2,000 m away from four oil production platforms in the northwestern GOM contained 0.044-0.12 μg/g total mercury. These amounts are essentially background concentrations for mercury in surficial sediments on the GOM OCS (Neff, 2002).

Atmospheric mercury deposition is believed to be the main source of anthropogenic mercury inputs into the marine environment. Mercury in barite has been suggested as a secondary source in the GOM. Trace mercury in barite deposits is present predominantly as mercuric sulfate and mercuric sulfide (Trefry, 1998). Barite is nearly insoluble in seawater, thus trapping mercury and other trace metals in the barite grains. Therefore, unless the mercuric sulfide in the barite can be microbially methylated, this source of mercury is relatively unavailable for uptake into the marine food web. Research conducted by Neff et al. (1989) showed no uptake of mercury in winter flounder exposed to barite-amended sediments.

Inorganic mercury is converted to methylmercury in the environment. Methylmercury bioaccumulates through the food chain. It is bioaccumulated in the muscle of marine animals. Elevated levels of methylmercury have been found in top predatory fish and marine mammals (USEPA, 1997).

4.1.1.3.4.2. Produced Waters

Produced water is brought up from the hydrocarbon-bearing strata along with produced oil and gas. This waste stream can include formation water, injection water, and any chemicals (including well treatment, completion, and workover chemicals) added downhole or during the oil/water separation. Since the oil/water separation process does not completely separate the oil, some hydrocarbons remain with the produced water and often the water is treated to prevent the formation of sheen. The composition of the discharge can vary greatly in the amounts of organic and inorganic compounds.

The USEPA general permits allow the discharge of produced water on the OCS provided they meet discharge criteria. Oil and grease cannot exceed 42 milligrams per liter (mg/l) daily maximum or 29 mg/l monthly average. The Region 4 requires no discharge within 1,000 m of an area of biological concern. The discharge must also be tested for toxicity on a monthly basis.

Estimates of the volume of produced water generated per well are difficult because the percent water is a site-specific phenomenon. Usually, produced-water volumes are small during the initial production phase and increase as the formation approaches hydrocarbon depletion. Produced-water volumes range from 2 to 150,000 bbl/day (USEPA, 1993a and b). In some cases, a centralized platform is used to process water from several surrounding platforms. Some of the produced water may be reinjected into the well. Reinjection occurs when the produced water does not meet discharge criteria or when the water is used as part of operations.

The MMS maintains records of the volume of water produced from each block on the OCS. This information for the years 1996-2000 is summarized in the Table 4-10 and illustrated in Figure 4-3. The majority of blocks where water is produced are on the continental shelf off the coast of Louisiana. Very little water is produced off the coast of Texas because they are primarily gas fields.

Deepwater (>400 m water depth) production is fairly recent and very little water is produced at this time. For deepwater operations, new technologies are being developed that may discharge produced water at the seafloor or at "minimal surface structures" before the production stream is transported by pipeline to the host production facility.

4.1.1.3.4.3. Well Treatment, Workover, and Completion Fluids

Well treatment fluids are fluids that resurface from acidizing and/or hydraulic fracturing operations to improve hydrocarbon recovery. Production (well) treatment fluids consist of a wide variety of chemicals including corrosion and scale inhibitors, bactericides, paraffin solvents, demulsifiers, foamers, defoamers, and water treatment chemicals (Boehm et al., 2001). Some of the chemicals mix with the production stream and are transported to shore with the product. Other chemicals are discharged with the produced water. From 10 to 500 bbl per well treatment may be discharged as neutralized spent acid (USEPA, 1993a and b). In addition, most produced water cannot be discharged without some chemical treatment. Even water that is reinjected downhole must be cleaned to protect equipment.

Workover fluids and completion fluids are low solids fluids used to prepare a well for production, provide hydrostatic control, and/or prevent formation damage. Workover fluids include hydrochloric and other acids. Because of the corrosive nature of acids, particularly when hot, corrosion inhibitors are added. Since the fluids are altered, they cannot be recovered and recycled; however, these products may be mixed with the produced water and discharged overboard. The volume discharged can range from 100 to 1,000 bbl per job (USEPA, 1993a and b). Fluids used for completion consist of brines made from seawater mixed with calcium chloride, calcium bromide, and/or zinc bromide (Boehm et al., 2001). These salts can be adjusted to increase or decrease the density of the brine. Additives such as defoamers and corrosion inhibitors are used to reduce problems associated with the completion fluid. The recovered completion fluids are recycled for reuse.

The USEPA Region 4 and Region 6 general permits allow the discharge of well-treatment, workover, and completion (WTC) fluids, but the discharges must meet specified guidelines.

The discharge of free oil with the fluids is prohibited and must be monitored using the static sheen test. Oil and grease measurements must meet both a daily maximum of 42 mg/l and a monthly average of 29 mg/l. The discharge of priority pollutants is prohibited except in trace amounts. The fluids may be commingled and monitored with the produced water according to the Region 6 permit.

4.1.1.3.4.4. Production Solids and Equipment

As defined by USEPA in the discharge guidelines (58 FR 12454), produced sands are slurried particles, which surface from hydraulic fracturing, and the accumulated formation sands and other particles including scale generated during production. This waste stream also includes sludges generated in the produced-water treatment system, such as tank bottoms from oil/water separators and solids removed in filtration. The guidelines do not permit the discharge of produced sand, which must be transported to shore and disposed of as nonhazardous oil-field waste according to State regulations. Estimates of total produced sand expected from a platform are from 0 to 35 bbl/day according to USEPA (1993a and b).

A variety of solid wastes are generated including construction/demolition debris, garbage, and industrial solid waste. No equipment or solid waste may be disposed of in marine waters.

4.1.1.3.4.5. Deck Drainage

Deck drainage includes all wastewater resulting from platform washings, deck washings, rainwater, and runoff from curbs, gutters, and drains including drip pans and work areas. The USEPA general guidelines for deck drainage require that no free oil be discharged, as determined by visual sheen.

The quantities of deck drainage vary greatly depending on the size and location of the facility. An analysis of 950 Gulf of Mexico platforms during 1982-1983 determined that deck drainage averaged 50 bbl/day/platform (USEPA, 1993a and b). The deck drainage is collected, the oil is separated, and the water is discharged to the sea. Impacts from the discharge of deck drainage are assumed to be negligible for a proposed action.

4.1.1.3.4.6. Treated Domestic and Sanitary Wastes

Domestic wastes originate from sinks, showers, laundries, and galleys. Sanitary wastes originate from toilets. For domestic waste, no solids or foam may be discharged. In addition, the discharge of all food waste within 12 nmi from nearest land is prohibited. In sanitary waste, floating solids are prohibited. Facilities with 10 or more people must meet the requirement of total residual chlorine greater than 1 mg/l and maintained as close to this concentration as possible. There is an exception in both general permits for the use of marine sanitation devices.

In general, a typical manned platform will discharge 35 gallons per person per day of treated sanitary wastes and 50-100 gallons per person per day of domestic wastes (USEPA, 1993a and b). It is assumed that these discharges are rapidly diluted and dispersed; therefore, no analysis of the impacts will be performed for a proposed action.

4.1.1.3.4.7. Minor Discharges

Minor discharges include all other discharges not already discussed that may result during oil and gas operations. Minor or miscellaneous wastes include desalination unit discharge, blowout preventer fluid, boiler blowdown, excess cement slurry, and uncontaminated freshwater and saltwater. In all cases, no free oil shall be discharged with the waste. Unmanned facilities may discharge uncontaminated water through an automatic purge system without monitoring for free oil. The discharge of freshwater or seawater that has been treated with chemicals is permitted providing that the prescribed discharge criteria are met. No projections of volumes or contaminant levels of minor discharges are made for a proposed action because the impacts are considered negligible.

4.1.1.3.4.8. Vessel Operational Wastes

The USCG defines offshore supply vessels as a vessel propelled by machinery other than steam that is of 15 gross tons and less than 500 gross tons (46 CFR 90.10-40). Operational waste generated from supply vessels that support oil and gas operations include bilge and ballast waters, trash and debris, and sanitary and domestic wastes.

Bilge water is water that collects in the lower part of a ship. The bilge water is often contaminated by oil that leaks from the machinery within the vessel. The discharge of any oil or oily mixtures is prohibited under 33 CFR 151.10; however, discharges may occur in waters greater than 12 nmi if the oil concentration is less than 100 ppm. Discharges may occur within 12 nmi, if the concentration is less than 15 ppm.

Ballast water is used to maintain stability of the vessel and may be pumped from coastal or marine waters. Generally, the ballast water is pumped into and out of separate compartments and is not usually contaminated with oil; however, the same discharge criteria apply as for bilge water (33 CFR 151.10).

The discharge of trash and debris is prohibited (33 CFR 151.51-77) unless it is passed through a comminutor and can pass through a 25-mm mesh screen. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste.

All vessels with toilet facilities must have a marine sanitation device (MSD) that complies with 40 CFR 140 and 33 CFR 149. Vessels complying with 33 CFR 159 are not subject to State and local MSD requirements. However, a State may prohibit the discharge of all sewage within any or all of its waters. Domestic waste consists of all types of wastes generated in the living spaces on board a ship including gray water that is generated from dishwasher, shower, laundry, bath and washbasin drains.

Gray water from vessels is not regulated in the Gulf of Mexico. Gray water should not be processed through the MSD, which is specifically designed to handle sewage.

4.1.1.3.4.9. Assumptions About Future Impacts from OCS Wastes

- The use of SBF will increase, replacing the use of OBF in most situations.
- The discharge of cuttings wetted with SBF (i.e., cuttings with drilling fluid adhered to the surface of the rock fragments) to the seafloor will reduce the volume of cuttings transported to shore for disposal.
- New technologies in deepwater may result in discharges at the seafloor, reducing the potential for water column impacts but increasing impacts at the seafloor.
- The movement into deepwater will result in fewer total platforms but greater volumes of discharges at each platform.

4.1.1.3.5. Trash and Debris

Oil and gas operations on the OCS generate waste materials made of paper, plastic, wood, glass, and metal. Most of this waste is associated with galley and offshore food service operations and with operational supplies such as shipping pallets, containers used for drilling muds and chemical additives (sacks, drums, and buckets), and protective coverings used on mud sacks and drilling pipes (shrink wrap and pipe-thread protectors). Some personal items, such as hardhats and personal flotation devices, are accidentally lost overboard from time to time. Generally, galley, operational, and household wastes are collected and stored on the lower deck near the loading dock in large receptacles resembling dumpsters. These large containers are generally covered with netting to avoid loss and are returned to shore by service vessels for disposal in approved landfills.

The MMS regulations, the USEPA's NPDES general permit, and the USCG regulations implementing MARPOL 73/78 Annex V prohibit the disposal of any trash and debris into the marine environment. Victual matter or organic food waste are allowed to be ground up into small pieces and disposed of overboard from structures located more than 20 km from shore.

Information provided by industry gives some indication on the amount of trash historically generated during the drilling of an average offshore well. Historically, a typical well drilled to about 4,300 m might require 9,300 mud sacks, 100 pails, 250 pallets, 225 shrink wrap applications, and two 55-gallon drums. Most drilling muds are now shipped pre-mixed in reusable bulk tanks. This change has resulted in a significant reduction in the amount of solid waste associated with drilling operations. Still, drilling operations require the most supplies, equipment, and personnel, and therefore, generate more solid waste than production operations.

Over the last several years, companies have employed waste reduction and improved waste-handling practices to reduce the amount of trash offshore that could potentially be lost into the marine environment. Improved waste management practices, such as substituting paper cups and reusable ceramic cups and dishes for those made of styrofoam, recycling offshore waste, and transporting and storing supplies and materials in bulk containers when feasible, are commonplace. Experimental technology, such as reinjection of waste materials reduced to slurry into downhole formations, is also under development. These practices have resulted in a marked decline in accidental loss of trash and debris.

4.1.1.3.6. Air Emissions

The OCS activities that use any equipment that burns a fuel, that transports and/or transfers hydrocarbons, or that results in accidental releases of petroleum hydrocarbons or chemicals, will cause emission of air pollutants. Some of these pollutants are precursors to ozone, which is formed by complex photochemical reactions in the atmosphere.

The criteria pollutants considered here are nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur oxides (SO_x), volatile organic chemicals (VOC), and particulate matter less than 10 microns in size (PM_{10}). Criteria pollutant emissions from OCS platforms and drilling operations are estimated using the emission rates presented in Table 4-11. These emission rates are derived from a 1991-1992 MMS inventory of offshore OCS structures (Steiner et al., 1994).

See Table 4-11 for average annual emission rates from OCS infrastructures in the Gulf of Mexico. Emissions of air pollutants during loading, storage, and transportation of crude oil and gas are calculated using the methodology and emission factors presented in USEPA publication AP-42 of 1985 with supplements A, B, and C. Helicopter emissions are also calculated using the methodology presented in the previous reference.

Flaring is the venting and/or burning of natural gas from a specially designed boom. Flaring systems are also used to vent gas during well testing or during repair/installation of production equipment. The MMS operating regulations provide for some limited volume, short duration flaring, or venting of some natural gas volumes upon approval by MMS. These operations may occur for short periods (typically 2-14 days) as part of unloading/testing operations that are necessary to remove potentially damaging completion fluids from the well bore, to provide sufficient reservoir data for the operator to evaluate a reservoir and development options, and in emergency situations. Emissions from flaring were included in the emissions tables and in the modeling analysis (since platform emissions included flaring along with all other sources). Flaring is not expected to be a significant source of heat, light, or additional air emissions.

4.1.1.3.7. Noise

Noise associated with OCS oil and gas development results from seismic surveys, the operation of fixed structures such as offshore platforms and drilling rigs, and helicopter and service-vessel traffic. Noise generated from these activities can be transmitted through both air and water, and may be extended or transient. Offshore drilling and production involves various activities that produce a composite underwater noise field. The intensity level and frequency of the noise emissions are highly variable, both between and among the various industry sources. Noise from proposed OCS activities may affect resources near the activities. Whether a sound is or is not detected by marine organisms will depend both on the acoustic properties of the source (spectral characteristics, intensity, and transmission patterns) and sensitivity of the hearing system in the marine organism. Extreme levels of noise can cause physical damage or death to an exposed animal; intense levels can damage hearing; loud or novel sounds may induce disruptive behavior or other responses of lesser importance. Loud, manmade underwater sounds are a recent and rapidly increasing perturbation of the marine acoustic environment (Jasny, 1999). It is generally recognized that commercial shipping is a dominant component of the ambient, low-frequency background noise in modern world oceans (Gordon and Moscrop, 1996) and that OCS-related, service-vessel traffic will contribute to this. For the Gulf of Mexico, that contribution to existing shipping noise is likely insignificant (USDOI, MMS, in preparation). Another sound source more specific to OCS operations originates from seismic operations. Airguns produce an intense, but highly localized, sound energy and represent a noise source of possible concern. The MMS has almost completed a programmatic EA on G&G permit activities in the Gulf of Mexico (USDOI, MMS, in preparation). The EA includes a detailed description of the seismic surveying technologies, energy output, and operations; these descriptions are incorporated here by reference.

Marine seismic surveys direct a low-frequency energy wave (generated by an airgun array) into the ocean floor and record the reflected energy waves' strength and return arrival time. The pattern of reflected waves, recorded by a series of hydrophones embedded in cables towed by the seismic vessel (streamers), can be used to "map" subsurface layers and features. Seismic surveys can be used to check for foundation stability, detect groundwater, locate mineral deposits (coal), and search for oil and gas. Most commercial seismic surveying is carried out for the energy sector (Gulland and Walker, 1998). Two general types of seismic surveys are conducted in the Gulf of Mexico relative to oil and gas operations. High-resolution site surveys collect data up to 1 km deep through bottom sediments and are used for initial site evaluation for potential structures as well as for exploration. This involves a small vessel and perhaps a single airgun source and is also usually restricted to small areas, most often a single lease site.

Seismic exploration and development surveys are often conducted over large survey areas (multiple leases and blocks) and obtain information on geological formations to several thousands meters below the ocean floor. For "2D" surveys, a single streamer (hydrophones) is towed behind the survey vessel, together with a single source (airguns) (Gulland and Walker, 1998). Seismic vessels generally operate at low hull speeds (<10 kn) and follow a systematic pattern during a survey, typically a simple grid pattern for 2D work with lines no closer than half a kilometer.

In simplistic terms, "3D" surveys collect a very large number of 2D slices, perhaps with line separations of only 25-30 m. A 3D survey may take months to complete and involves a precise definition of the survey area and transects, usually a series of passes to cover a given survey area (Caldwell, 2001). In 1984, industry operated the first twin streamers. By 1990, industry achieved a single vessel towing two airgun sources and six streamers. Industry continues to increase the capability of a single vessel, now using eight streamer/dual source configurations and multi-vessel operations (Gulland and Walker, 1998). For exploration surveys, 3D methods represent a substantial improvement in resolution and useful information relative to 2D methods. Many areas in the Gulf of Mexico previously surveyed using 2D have been or will be surveyed using 3D. It can be assumed that for new deepwater areas, 3D surveys will be the preferred method for seismic exploration, until and if better technology evolves.

A typical 3D airgun array will involve 15-30 individual guns. The firing times of the guns are staggered by milliseconds (tuned) in an effort to make the farfield noise pulse as coherent as possible. In short, the intent of a tuned airgun array is to have it emit a very symmetric packet of energy in a very short amount of time, and with a frequency content that penetrates well into the earth at a particular location (Caldwell, 2001). The noise generated by airguns is intermittent, with pulses generally less than one second in duration, for relatively short survey periods of several days to weeks for 2D work and site surveys (Gales, 1982) and weeks to months for 3D surveys (Gulland and Walker, 1998). Airgun arrays produce noise pulses with very high peak levels. The pulses are a fraction of a second and repeat every 5-15 seconds. In other words, while airgun arrays are by far the strongest sources of underwater noise associated with offshore oil and gas activities, because of the short duration of the pulses, the total energy is limited (Gordon and Moscroup, 1996). This is an important factor when evaluating potential effects on marine animals.

At distances of about 500 m and more (farfield), the array of individual guns will effectively appear to be a single point source (Caldwell, 2001). In the past, sound-energy levels were expected to be less than 200 dB re-1µPa-m at distances beyond 90 m from the source (Gales, 1982). Gulland and Walker (1998) state a typical source will output approximately 220 dB re-1µPa-m, although the peak-to-peak source level directly below a seismic array can be as high as 262 dB re-1µPa-m (Davis et al., 1998b). More recently, it has been estimated a typical 240-dB seismic array will have a 180 dB re-1µPa-m level at approximately 225 m from the array (USDOI, MMS, in preparation). The 180 dB re-1µPa-m level is an estimate of the threshold of sound energy that may cause hearing damage in cetaceans (U.S. Dept. of the Navy, 2001). It is unclear which measurements of a seismic pulse provide the most helpful indications of its potential impact on marine mammals (Gordon et al., 1998). Gordon et al. speculate that peak broadband pressure and pulse time and duration would be most relevant at short ranges (hearing damage range) while sound intensity in 1/3 octave bands is a more useful measurement at distance (behavioral effects).

Information on drilling noise in the Gulf of Mexico is unavailable to date. From studies mostly in Alaskan waters, drilling operations often produce noise that includes strong tonal components at low frequencies, including infrasonic frequencies in at least some cases. Drillships are apparently noisier than semisubmersibles (Richardson et al., 1995). Sound and vibration paths to the water are through either the air or the risers, in contrast to the direct paths through the hull of a drillship.

Machinery noise generated during the operation of fixed structures can be continuous or transient, and variable in intensity. Underwater noise from fixed structures ranges from about 20 to 40 dB above background levels within a frequency spectrum of 30-300 Hz at a distance of 30 m from the source (Gales, 1982). These levels vary with type of platform and water depth. Underwater noise from platforms standing on metal legs would be expected to be relatively weak because of the small surface area in contact with the water and the placement of machinery on decks well above the water.

Aircraft and vessel support may further ensonify broad areas. Noise generated from helicopter and service-vessel traffic is transient in nature and extremely variable in intensity. Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al., 1995). Helicopters often radiate more sound forward than backward; thus, underwater noise is generally brief in duration, compared with the duration of audibility in the air. In addition to the altitude of the helicopter, water depth and bottom conditions strongly influence propagation and levels of underwater noise from passing aircraft. Lateral propagation of sound is greater in shallow than in deep water. Helicopters, while flying offshore, generally maintain altitudes above 700 ft during transit to and from the working area and an altitude of about 500 ft while between platforms.

Service vessels transmit noise through both air and water. 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). Propeller cavitation is usually the dominant noise source. The intensity of noise from service vessels is roughly related to ship size, laden or not, and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. For a given vessel, relative noise also tends to increase with increased speed. Commercial vessel noise is a dominant component of manmade ambient noise in the ocean (Jasny, 1999). Given the amount of vessel traffic from all sources in the Gulf of Mexico, CSA concludes that the contribution of noise from offshore service vessels is a minor component of the total ambient noise level (USDOI, MMS, in preparation). In the immediate vicinity of a service vessel, noise could disturb marine mammals; however, this effect would be limited in area and duration.

4.1.1.3.8. Offshore Transport

4.1.1.3.8.1. Pipelines

Pipelines are the primary method used to transport a variety of liquid and gaseous products between OCS production sites and onshore facilities around the Gulf of Mexico. These products include unprocessed (bulk) oil and gas; mixtures of gas and condensate; mixtures of gas and oil; processed condensate, oil, or gas; produced water; methanol; and a variety of chemicals used by the OCS industry offshore. Pipelines in the Gulf are designated as either trunklines or gathering lines. Gathering lines are typically shorter segments of small-diameter pipelines that transport the well stream from one or more wells to a production facility or from a production facility to a central facility serving one or several leases, e.g., a trunkline or central storage or processing terminal. Trunklines are typically large-diameter pipelines that receive and mix similar production products and transport them from the production fields to shore. A trunkline may contain production from many discovery wells drilled on several hydrocarbon fields. The OCS-related pipelines near shore and onshore may merge with pipelines carrying materials produced in State territories for transport to processing facilities or to connections with pipelines located further inland. Most of the active length of OCS pipelines transport mostly gas (64%); the reminder transport predominately oil (25%).

Over the last 10 years, the average annual installation rate for OCS pipelines was 1,600 km and more than 200 pipelines and pipeline segments. Pipelines in the CPA accounted for 83 percent of the length installed; pipelines in the WPA accounted for 17 percent. The installation rate for pipelines is expected to remain steady; this includes consideration of expansion and replacement of the existing and aging pipeline infrastructure in the Gulf.

Projected Lengths of OCS Pipelines to be Installed during 2003-2042

OCS Program	WPA Proposed Action	CPA Proposed Action
27,600-52,400 km	320-640 km	560-1,040 km

It is expected that pipelines from most of the new offshore production facilities will connect to the existing pipeline infrastructure, which will result in few new pipeline landfalls. Production from a proposed action in the CPA and WPA will contribute 2 percent and 1 percent, respectively, to existing and future pipelines and pipeline landfalls. For the period 2003-2042, a range of 23-38 new landfalls is projected for the OCS Program. For each proposed action, 0-1 new landfalls are projected. See Chapter 4.1.2.1.7 for a discussion of coastal pipelines.

The typical operational life of a pipeline has been estimated to be 20-40 years, but with current corrosion management, that lifetime has been significantly increased. One technique for extending the operational life of a gas pipeline is to periodically treat the inside of the pipe with a corrosion inhibiting substance (CIS). The treatment may be applied as either an aerosol that is pumped in with the production stream or as a liquid "slug" that is pushed through the pipe with a series of mechanized plungers, referred to as a "pigs."

As of August 2001, more than 35,000 km (78%) of the total pipeline length installed were still active. About 22 percent of the total length of pipelines that have been installed in the Gulf was not active (i.e., out of service, abandoned, proposed to be abandoned, or proposed to be removed). From 1991 to 2000, an average of 228 km of pipelines (81 pipeline segments) were abandoned annually.

Removal of pipelines will be rare and will generally involve short lengths. As of August 2001, less than 1 percent of the total length of pipelines installed, or about 300 km, were removed. All pipelines removed were in the CPA, except for 1 km in the WPA. Most pipelines were in water depths of less than 66 ft (20 m); 6 pipelines were in water depths greater than 656 ft (200 m).

Pipelines constructed in water depths <200 ft (60 m) are potential snags for anchors and trawls. Of the pipeline constructed in Federal waters, 58 percent (49% of the WPA and 59% of the CPA) were constructed in water depths ≤200 ft. According to MMS regulations (30 CFR 250.1003(a)(1)), pipelines with diameters $\geq 8^5/_8$ inches that are installed in water depths <200 ft are to be buried to a depth of at least 3 ft below the mudline. The regulations also provide for the burial of any pipeline, regardless of size, if MMS determines that the pipeline may constitute a hazard to other uses of the OCS; in the Gulf of Mexico, MMS has determined that all pipelines installed in water depths <200 ft must be buried. The purpose of these requirements is to reduce the movement of pipelines by high currents and storms, to protect the pipeline from the external damage that could result from anchors and fishing gear, to reduce the risk of fishing gear becoming snagged, and to minimize interference with the operations of other users of the OCS. For lines $8^5/_8$ inches and smaller, a waiver of the burial requirement may be requested and may be approved if the line is to be laid in an area where the character of the seafloor will allow the weight of the line to cause it to sink into the sediments (self-burial). For water depths ≤200 ft, any length of pipeline that crosses a fairway or anchorage in Federal waters must be buried to a minimum depth of 10 ft below mudline across a fairway and a minimum depth of 16 ft below mudline across an anchorage area. Some operators voluntarily bury these pipelines deeper than the minimum.

Where pipeline burial is necessary, a jetting sled will be used. Such sleds are mounted with high-pressure water jets and pulled along the seafloor behind the pipelaying barge. The water jets are directed downward to dig a trench; the sled guides the pipeline into the trench. Such an apparatus can jet pipe at an average of 1.6 km/day. The cross section of a typical jetted trench for the flowline bundles would be about 4 m^2; for deeper burial when crossing a fairway, the cross section would be about 13 m^2. The cross section of a typical jetted trench for the export and interconnecting export pipelines would be about 5 m^2; for a pipeline trench crossing a fairway, the cross section would be about 15 m^2.

Jetting disperses sediments over the otherwise undisturbed water bottom that flanks the jetted trench. The area covered by settled sediment and the thickness of the settled sediment depends upon variations in bottom topography, sediment density, and currents (see also Chapter 4.1.1.3.8.1).

New installation methods have allowed the pipeline infrastructure to extend to deeper water. At present, the deepest pipeline in the Gulf is in 2,300 m water depth. More than 200 pipelines reach water depths of 300 m or more, and almost half of those reach water depths of 800 m or more.

Pipeline installation activities in deepwater areas can be difficult both in terms of route selection and construction. Depending on the location, the sea bottom surface can be extremely irregular and present engineering challenges (for example, high hydrostatic pressure, cold temperatures, and darkness, as well as varying subsurface and bottom current velocities and directions). Rugged seafloor may cause terrain-induced pressures within the pipe that can be operationally problematic, as the oil must be pumped up and down steep slopes. An uneven seafloor could result in unacceptably long lengths of unsupported pipeline, referred to as "spanning," which in turn could lead to pipe failure from bending stress early in the life of the line. It is important to identify areas where significant lengths of pipeline may go unsupported. Accurate, high-resolution geophysical surveying becomes increasingly important in areas with irregular seafloor. Recent advances in surveying techniques have significantly improved the capabilities for accurately defining seafloor conditions, providing the resolution needed to determine areas where pipeline spans may occur. After analyzing survey data, the operator chooses a route that minimizes pipeline length and avoids areas of seafloor geologic structures and obstructions that might cause excessive pipe spanning, unstable seafloor, and potential benthic communities.

The greater pressures and colder temperatures in deepwater present difficulties with respect to maintaining the flow of crude oil and gas through pipelines. Under these conditions, the physical and chemical characteristics of the produced hydrocarbons can lead to the accumulation of gas hydrate, paraffin, and other substances within the pipeline. These accumulations can restrict and eventually block flow if not successfully prevented and/or abated. There are physical and chemical techniques that can be applied to manage these potential accumulations. The leading strategy to mitigate these deleterious effects is to minimize heat loss from the system by using insulation. Other measures include forcing plunger-like "pigging" devices through the pipeline to scrape the pipe walls clean, and the continuous injection of flow-assurance chemicals (e.g., methanol or ethylene glycol) into the pipeline system to minimize the formation of flow-inhibiting substances. However, the great water depths of the OCS and the extreme distance to shoreside facilities make these flow-assurance measures difficult to implement and can significantly increase the cost to produce and transport the product. Companies are continuously looking for and developing new technologies such as electrically and water-heated pipelines and burial of pipelines in deepwater for insulation purposes.

Long-distance transport of multiphase well-stream fluids can be achieved with an effectively insulated pipeline. There are several methods to achieve pipeline insulation: pipe-in-pipe systems, which included electrically and water-heated pipelines; pipe with insulating wrap material; and as previously mentioned, buried pipelines where the soils act as an insulator. The design of all of these systems seeks a balance between the high cost of the insulation, the intended operability of the system, and the acceptable risk level. Such systems minimize the costs, revenue loss, and risks from the following:

- hydrate formation during steady state or transient flowing conditions;
- paraffin accumulation on the inner pipe wall that can result in pipeline plugging or flow rate reductions;
- adverse fluid viscosity effects at low temperatures that lead to reduced hydraulic performance or to difficulties restarting a cooled system after a short shut-in; and
- additional surface processing facilities required to heat produced fluids to aid in the separation processes.

Formation of gas hydrates in deepwater operations is a well-recognized and potentially hazardous operational problem in water depths greater than 1,000 ft (300 m). Seabed conditions of high pressure and low temperature become conducive to gas hydrate formation in deepwater. Gas hydrates are ice-like crystalline solids formed by low-molecular-weight hydrocarbon gas molecules (mostly methane) combining with produced water. The formation of gas hydrates is potentially hazardous because hydrates can restrict or even completely block fluid flow in a pipeline, resulting in a possible overpressure condition. The interaction between the water and gas is physical in nature and is not a chemical bond. Gas hydrates are formed and remain stable over a limited range of temperatures and pressures.

Hydrate prevention is normally accomplished through the use of methanol, ethylene glycol, or triethylene glycol as inhibitors, and the use of insulated pipelines and risers. Chemical injection is sometimes provided both at the wellhead and at a location within the well just above the subsurface safety valve. Wells that have the potential for hydrate formation can be treated with either continuous chemical injection or intermittent or "batch" injection. In many cases, batch treatment is sufficient to maintain well flow. In such cases, it is necessary only to inject the inhibitor at well start-up, and the well will continue flowing without the need for further treatment. In the event that a hydrate plug should form in a well that is not being injected with a chemical, the remediation process would be to depressurize the pipelines and inject the chemical. Hydrate formation within a gas sales line can be eliminated by dehydrating the gas with a glycol dehydrating system prior to input of gas into the sales line. In the future, molecular sieve and membrane processes may also be options for dehydrating gas. Monitoring of the dewpoint downstream of the dehydration tower should take place on a continuous basis. In the event that the dehydration equipment is bypassed because it may be temporarily out of service, a chemical could be injected to help prevent the formation of hydrates if the gas purchaser agrees to this arrangement beforehand.

Hydrocarbon flows that contain paraffin or asphaltenes may occlude pipelines as these substances, which have relatively low melting points, form deposits on the interior walls of the pipe. To help ensure product flow under these conditions, an analysis should be made to determine the cloud point and hydrate formation point during normal production temperatures and pressures. To minimize the formation of paraffin or hydrate depositions, wells can be equipped with a chemical injection system. If, despite treatment within the well, it still becomes necessary to inhibit the formation of paraffin in a pipeline, this can be accomplished through the injection of a solvent such as diesel fuel into the pipeline.

Pigging is a term used to describe a mechanical method of displacing a liquid in a pipeline or to clean accumulated paraffin from the interior of the pipeline by using a mechanized plunger or "pig." Paraffin is a waxy substance associated with some types of liquid hydrocarbon production. The physical properties of paraffin are dependent on the composition of the associated crude oil, and temperature and pressure. At atmospheric pressure, paraffin is typically a semisolid at temperatures above about 100 °F and will solidify at about 50 °F. Paraffin deposits will form inside pipelines that transport liquid hydrocarbons and, if some remedial action such as pigging is not taken, the deposited paraffin will eventually completely block all fluid flow through the line. The pigging method involves moving a pipeline pig through the pipeline to be cleaned. Pipeline pigs are available in various shapes and are made of various materials, depending on the pigging task to be accomplished. A pipeline pig can be a disc or a spherical or cylindrical device made of a pliable material such as neoprene rubber and having an outside diameter nearly equal to the inside diameter of the pipeline to be cleaned. The movement of the pig through the pipeline is accomplished by applying pressure from gas or a liquid such as oil or water to the back or upstream end of the pig. The pig fits inside the pipe closely enough to form a seal against the applied pressure. The applied pressure then causes the pig to move forward through the pipe. As the pig travels through the pipe, it scrapes the inside of the pipe and sweeps any accumulated contaminants or liquids ahead of it. In deepwater operations, pigging will be used to remove any paraffin deposition in the pipelines as a normal part of production operations. Routine pigging will be required of oil sale lines at frequencies determined by production rates and operating temperatures. The frequency of pigging could range from several times a week to monthly or longer, depending on the nature of the produced fluid. In cases where paraffin accumulation cannot be mitigated, extreme measures can be taken in some cases such as coil tubing entry into a pipeline to allow washing (dissolving) of paraffin plugs. If that fails, then it could result in having to replace a pipeline

4.1.1.3.8.2. Barges

Barges may be used offshore to transport oil and gas, supplies such as chemicals or drilling mud, or wastes between shore bases and offshore platforms. Barges are non-self-propelled vessels that must be accompanied by one or more tugs. Because of this, barge transport is usually constrained to shallow waters of the Gulf, close to the shoreline.

Barging of OCS oil from platforms to shore terminals is an option used by the oil industry in lieu of transporting their product to shore via pipeline. A platform operator generally decides at the beginning of a development project whether the production will be barged or piped. Barging is used very infrequently as an interim transport system prior to the installation of a pipeline system.

As of August 2001, eight barge systems were operating in the Gulf, servicing 25 OCS platforms (Figure 3-14). These platforms were located in water depths less than 60 m with the exception of two platforms located in slightly deeper water. Five barge systems operate in the CPA, with one system handling a small amount of oil from the WPA, and three barge systems operate only in the WPA.

About 1 percent of the oil produced in less than 60 m is barged to shore. Eighty percent of barged oil is from leases east of the Mississippi River. An examination of the last 10 years reveals a significant decline in barging activity from an average of 4.5 MMbbl to 1.5 MMbbl per year (Figure 4-4). From 1997 to 2000, the average volume barged remained steady at approximately 1.5 MMbbl per year. The volume of oil barged is projected to remain fairly constant at this level.

Other types of barging operations may occur in connection with OCS operations. Besides barging from platform to shore terminal, a few platform operators choose to barge their oil to other platforms where it is then offloaded to storage tanks and later piped to shore. Recently there has been some barging of oil from deepwater sites during extended well testing; this activity is likely to increase in the future. Storage and barging of the well stream from extended well tests is an alternative to flaring the gas and burning the liquids produced during well testing. No information is currently available on the number of barge trips associated with these other types of offshore oil barging operations. Secondary intracoastal barging of OCS-produced oil from terminal to terminal or from terminal to refinery also occurs along the Gulf Coast and is discussed under the coastal scenario (Chapter 4.1.2.1.8).

Chapter 4.1.2.1.5.2 describes the shore terminals receiving OCS-produced barged oil.

The capacity of oil barges used offshore can range from 5,000 to 80,000 bbl. Barges transporting oil typically remain offshore for as long as one week while collecting oil; each trip is assumed to be five days.

It is assumed that barging will account for less than 1 percent of the oil transported for the entire OCS Program and each proposed action. Tables 4-2, 4-3 and 4-4 provide the percentages of oil barged to shore by subarea for the proposed actions and the Gulfwide OCS Program. Tables 4-6, 4-5 and 4-7 provide the percentages of oil barged to shore for the Gulfwide OCS Program by planning area.

Assuming that about eight barge systems will continue operating in the Gulf and that the barge will go out once a month to pick up oil from the platforms in each system nearly 100 trips are projected to occur annually Gulfwide. It is assumed that the WPA activities will account for 1 percent of these trips—30 trips spread over a 31-year production period. The CPA activities will account for 2 percent of these trips—60 trips spread over a 31-year production period. Only primary barging activity from offshore production platforms to onshore terminals is considered in these projections.

4.1.1.3.8.3. Oil Tankers

Shuttle tanker transport of Gulf of Mexico OCS-produced oil has not occurred to date. Tankering is projected for some future OCS operations located in deepwater beyond the existing pipeline network. In early 1997, discussions between industry and MMS began concerning the feasibility of floating production, storage, and offloading (FPSO) systems and associated tanker transport of OCS-produced oil in the Gulf of Mexico. The FPSO's are floating production systems that store crude oil in tanks located in the hull of the vessel and periodically offload the crude to shuttle tankers or ocean-going barges for transport to shore. The FPSO's may be used to develop marginal oil fields or used in areas remote from the existing OCS pipeline infrastructure. A workshop was held in April 1997 to identify significant issues related to four areas: environmental effects, conservation of oil and gas resources, technology, and regulatory framework. Subsequent to the workshop, MMS prepared an EIS to evaluate potential environmental effects of the proposed use of FPSO systems and tankering in the deepwater CPA and WPA. The MMS funded a comparative risk analysis that looked at risks associated with FPSO's and tankering in relation to risks associated with three currently accepted deepwater production systems and oil pipelines. A joint MMS/USCG/industry team has reviewed the existing MMS and USCG regulatory framework applicable to FPSO's and shuttle tankering.

Shuttle tankers would be used to transport crude oil from FPSO production systems to Gulf Coast refinery ports or to offshore deepwater ports such as the Louisiana Offshore Oil Port (LOOP). The shuttle tanker design and systems would be in compliance with USCG regulations. Under the Jones Act and OPA 90 requirements, shuttle tankers would be required to be double hulled. Shuttles can have internal propulsion systems, or they may use other propulsion system configurations, such as an articulated tug barge (ATB). The ATB's involve the connectable/disconnectable integration of a tug-type vessel to a recess in the stern of a large-capacity barge. Shuttle tankers also vary in size. In the Gulf, the maximum size of shuttle tankers is limited primarily by the 34- to 47-ft water depths of U.S. Gulf Coast refinery ports. Due to these depth limitations, shuttle tankers are likely to be 500,000-550,000 bbl in cargo capacity.

Offloading operations involve the arrival, positioning, and hook-up of a shuttle tanker to the FPSO. Shuttle tankers could maintain their station during FPSO offloading operations using several techniques. These include side-by-side mooring to the FPSO, use of a hawser mooring system with or without thruster assist, or by use of a dynamic positioning system that maintains the vessel's station by use of thrusters rather than mooring lines. Hawser mooring systems used in a tandem offloading configuration is the most likely configuration for FPSO offloading operations in the Gulf of Mexico. Offloading would occur at an average rate 50,000 barrels per hour (BPH). During the FPSO offloading procedure, the shuttle tanker would continue to operate its engines in an idle mode so that any necessary maneuvers of the vessel could be promptly executed.

Tandem offloading would occur under maximum wave height limitations of 3.5 m (11.5 ft) for hook up/connection and 4.5 m (14.8 ft) for disconnect. These wave height limitations are currently being used in the North Sea. Hook-up is accomplished by the use of a retractable hose and a messenger line that is fired from the FPSO to the shuttle tanker via compressed air. The hawser and hose(s) are then pulled over to the shuttle tanker and connected. Cargo oil would be offloaded to the shuttle tanker using the FPSO's main cargo pumps, with oil being routed through a deck line to a stern offloading station, and then through a floating hose to the midship loading manifold of the tanker. Safety features, such as marine break-away offloading hoses and emergency shut-off valves, will be incorporated in order to minimize the potential for, and size of, an oil spill. In addition, weather and sea-state limitations will be established to further ensure that hook-up and disconnect operations will not lead to accidental oil release. A vapor recovery system between the FPSO and shuttle tanker would be employed to minimize release of fugitive emissions from cargo tanks during offloading operations.

The number of shuttle tanker trips to port in a given year is primarily a function of the FPSO production rate and the capacity of supporting shuttle tankers. Considering an FPSO operating at a peak production rate of 150,000 bbl/day, supported by shuttle tankers of 500,000 bbl capacity, offloading would occur once every 3.3 days. This would equate to 54.75 million bbl production with 110 offloading events and shuttle tanker transits to Gulf coastal or offshore ports annually.

Proposed Action Scenario: It is estimated that no tankering will occur as a result of a single proposed action in the CPA or WPA. An FPSO and associated tankering is assumed to support production from leases resulting from multiple sales; any one proposed action is expected to contribute incrementally to tankering under the OCS Program.

OCS Program Scenario: To develop a scenario for analytical purposes, the following assumptions are made regarding future OCS oil transportation by shuttle tanker:

- advances in pipelaying technology will keep pace with the expansion of the oil industry into the deeper waters of the Gulf beyond the continental slope;
- all produced gas will be piped;
- tankering will not occur from operations on the continental shelf;
- tankering will only take place from marginal fields or fields in areas remote from the existing OCS pipeline infrastructure; and
- offloading frequency for an FPSO would be once every three days during peak production.

These assumptions result in an estimate that 5-10 percent of the oil will be tankered from the OCS Program in water depths greater than 200 m in the CPA and WPA. It is projected that 500-1,000 offloading operations and shuttle tanker transits will occur annually from OCS Program activities during the peak years of FPSO use in the CPA and WPA.

4.1.1.3.8.4. Service Vessels

Service vessels are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. In addition to offshore personnel, service vessels carry cargo (i.e., freshwater, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, and food) offshore. A trip is considered the transportation from a service base to an offshore site and back, in other words a round trip. Based on MMS calculations, each vessel makes an average of three round trips per week for 40 weeks in support of drilling an exploration well and for 35 weeks in support of drilling an a development well. A platform is estimated to require two vessel trips per week over its 20-year production life. All trips are assumed to originate from the service base.

There are currently approximately 376 supply vessels operating in the Gulf of Mexico. Over the 40-year life of the proposed actions, supply vessels will retire and replacement vessels will be built. In general, the new type of vessels built will continue to be larger, deeper drafted, and more technologically advanced for deepwater activities. In the short term, if any oversupply of deepwater vessels develops, some of the smaller deepwater vessels (200-220 ft) will be forced to work in shallow waters where they will compete with the older 180-ft vessels for jobs. Oversupply could result from lower OCS activity (decreased demand) or from construction of too many vessels (increased supply).

Support of deepwater operations will continue to be the future of the service-vessel industry. Compared to shelf-bound service vessels, deepwater service vessels have improved hull designs (increased efficiency and speed), a passive computerized anti-roll system, drier and safer working decks, increased cargo capacity (water, cement, barite, drilling muds, etc.), increased deck cargo capability, increased cargo transfer rates to reduce the time and risk alongside structures (e.g., TLP), dual and independent propulsion systems, true dynamic positioning system, fuel and NO_x efficient engines, and Safety of Life at Sea (SOLAS) capability (*WorkBoat*, 1998). Service vessels primarily used in deepwater are offshore supply vessels (OSV), fast supply vessels, and anchor-handling towing supply/mooring vessels (AHTS) (*WorkBoat*, 2000). Other deepwater specialty service vessels include well stimulation vessels. The OSV's and AHTS's carry the same type of cargo (freshwater, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, food, and miscellaneous supplies) but have different functions. The AHTS's also differ from the supply vessels by their deepwater mooring deployment and towing capabilities.

Consolidation may continue within the industry as smaller operations are unable to compete with the larger, more advanced companies. Also, issues such as logistics and boat pooling will continue to emerge as bottom line accounting persists to direct the offshore oil and gas industry.

Proposed Action Scenario: Service-vessel trips projected for a proposed action in the CPA are 63,000-111,000 trips, with most trips going to the western subarea for the 0-60 m water depth range (Table 4-2). This equates to an average annual rate of 2,000 - 3,000 trips. A proposed action in the WPA is estimated to generate 25,000-36,000 service-vessel trips or about 1,000 trips annually (Table 4-3).

OCS Program Scenario: The projected number of service-vessel trips estimated for the OCS Program is 11,889,000-12,479,000 over the 2003-2042 period (Table 4-4). This equates to an average rate of 296,000-312,000 trips annually.

4.1.1.3.8.5. Helicopters

Helicopters are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. Helicopters are routinely used for normal crew changes and at other times to transport management and special service personnel to offshore exploration and production sites. In addition, equipment and supplies are sometimes transported. A trip is considered the transportation from a helicopter hub to an offshore site and back, in other words a round trip.

Deepwater operations require helicopters that travel farther and faster, carry more personnel, are all-weather capable, and have lower operating costs. There are several issues of concern for the helicopter industry's future. Since the tasks the offshore helicopter industry provides are the same tasks supply vessels provide, they are competition for one another. Fast boats are beginning to erode the helicopter industry's share of the offshore transportation business, particularly in shallow water. The exploration and production industry is outsourcing more and more operations to oil-field support companies who are much more cost conscious and skeptical about the high cost of helicopters. Another consideration for the helicopter industry is new technology such as subsea systems. These systems decrease the number of platforms and personnel needed offshore, therefore reducing the amount of transportation needed.

Proposed Action Scenario: Helicopter trips projected for a proposed action in the CPA are 220,000-870,000 trips (Table 4-2). This equates to an average annual rate of 5,500-21,750 trips. A proposed action in the WPA is projected to generate 110,000-410,000 helicopter trips or 3,000-10,000 trips annually (Table 4-3).

OCS Program Scenario: The projected number of helicopter trips for the OCS Program is 27,997,000-50,692,000 trips over the 2003-2042 period (Table 4-4). This equates to an average rate of 700,000-1,267,000 trips annually.

To meet the demands of deepwater activities, the offshore helicopter industry is purchasing new helicopters that travel farther and faster, carry more personnel, are all-weather capable, and have lower operating cost. Also, instead of running their own fleets, oil and gas companies are increasingly subcontracting all helicopter support to independent contractors who are very cost conscience. The number of helicopters operating in the Gulf of Mexico is expected to decrease in the future, and helicopters that do operate are expected to be larger and faster.

4.1.1.3.8.6. Alternative Transportation Methods of Natural Gas

As the country's gas consumption is expected to increase by 65 percent over the next 20 years (USDOE, EIA, 2001b), industry is looking at alternative methods of transporting OCS gas in the Gulf of Mexico. These methods involve transporting natural gas as liquefied natural gas (LNG) or compressed natural gas (CNG) in specially designed vessels. The focus has been on deepwater where it is costly and technically challenging to install pipelines to transport gas. The LNG and CNG options may make it economically viable to produce marginal gas fields. The CNG option may also be an economical way of transporting "stranded" associated gas instead of the gas being flared or reinjected. Although both technologies could bring gas to shore, most discussions suggest the use of offshore terminals and the existing nearshore pipeline infrastructure. The offloading platforms would require USCG-designated safety zones with "no surface occupancy" restrictions for oil and gas exploration, development, and production operations.

In the LNG process, gas is super-cooled, reducing its volume to a fraction of its gaseous state. Then, tankers with specially designed cargo holds transport the LNG to terminals for regasification. At present, LNG is being imported into four existing U.S. terminals, and more terminals are proposed. The LNG imports already travel through the Gulf of Mexico to one of the existing terminals at Lake Charles, Louisiana.

The CNG process uses less of the energy because liquefaction and regasification are not required as it is with LNG. The CNG technology is not currently being used to transport gas. The first application of CNG will be a pilot project shipping gas from Venezuela or Trinidad to Curacao (Cran and Stenning Technology Inc., 2001).

4.1.1.3.9. Hydrogen Sulfide and Sulfurous Petroleum

Sulfur may be present in oil as elemental sulfur, within hydrogen sulfide (H_2S) gas, or within organic molecules, all three of which vary in concentration independently. Although sulfur-rich petroleum is often called "sour" regardless of the type of sulfur present, the term "sour" should properly be applied to petroleum containing appreciable amounts of H_2S, and "sulfurous" should be applied to other sulfur-rich petroleum types. Using this terminology, the following matrix of concerns is recognized:

Potentially Affected Endpoint	Sour Natural Gas	Sour Oil	Sulfurous Oil
Engineering	Equipment and pipeline corrosion	Equipment and pipeline corrosion	N/A
On-Platform Industrial Hygiene	Irritation, injury, and lethality from leaks	Irritation, injury, and lethality from outgassing from spilled oil	Irritation, injury, and lethality from exposure to sulfur oxides produced by flaring
Off-Platform General Human Health and Safety	Irritation, injury, and lethality from leaks	Irritation, injury, and lethality from outgassing from spilled oil	Irritation, injury, and lethality from exposure to sulfur oxides produced by flaring
Marine and Coastal Species and Habitats	Irritation, injury, and lethality from leaks	Synergistic amplification of oil-spill impacts from outgassing	No effects other than impacts hydrocarbon contact and acid rain

Sour Oil, Sour Gas, and Sulfurous Oil in the Gulf of Mexico

Occurrence

Sour oil and gas occur sparsely throughout the Gulf of Mexico OCS (e.g., about 65 operations had encountered H_2S-bearing zones in the Gulf of Mexico as of mid-1998), but principally offshore the Mississippi Delta (Louisiana), Mississippi, and Alabama. Occurrences of H_2S offshore Texas are in Miocene rocks and occur principally within a geographically narrow band. The occurrences of H_2S offshore Louisiana are mostly on or near piercement domes with caprock and are associated with salt and gypsum deposits. Examination of industry exploration and production data show that H_2S concentrations vary from as low as fractional parts per million (ppm) in either oil or gas to 650,000 ppm in the gas phase of a single oil well near the Mississippi Delta. The next highest concentrations of H_2S encountered to date are in the range of 20,000-55,000 ppm in some natural gas wells offshore Mississippi/Alabama.

There is some evidence that petroleum from deepwater plays may be sulfurous, but there is no evidence that it is sour.

Only 5 percent of all wells drilled on the OCS to date have penetrated sediments below 15,000 ft subsea. The MMS estimates that there could be 5-20 tcf of recoverable gas resources below 15,000 ft. Deep gas reservoirs on the Gulf of Mexico continental shelf are likely to have high corrosive content, including H_2S. To encourage exploration and development of deep gas prospects on the continental shelf, MMS offered incentives in the form of royalty relief on deep gas production from any new leases issued in Lease Sale 178 (March 2001). Such royalty relief may well be extended to deep gas production on other existing and future leases.

Treatment (Sweetening)

Removal of H_2S from sour petroleum may proceed in one of two ways. The product can either be "sweetened" (removal of H_2S from the hydrocarbons) offshore or it can be transported onshore to a processing facility equipped to handle H_2S hydrocarbons, where the product is sweetened. Several processes based on a variety of chemical and physical principles have been developed for gas sweetening. The processes include solid bed absorption, chemical solvents (e.g., amine units), physical solvents, direct conversion of H_2S to sulfur (e.g., Claus units), distillation, and gas permeation (Arnold and Stewart, 1988). Gas streams with H_2S or SO_2 are frequently treated offshore by amine units to reduce the corrosive properties of the product. A by-product of this process is a concentrated acid gas stream, which is frequently treated as a waste and flared if SO_2 emissions are not of concern. In cases where SO_2 emissions must be minimized, other options for handling acid gas must be sought. Sulfur recovery units to further process the H_2S to elemental sulfur or reduced sulfur compounds is a common method of treating acid gas streams. Reinjection of acid gas is an option that has also been considered. The feasibility of reinjecting acid gas in the offshore environment has not been demonstrated. In addition, MMS conservation requirements may not allow reinjection of this gas. Another option would be to send the untreated gas to shore for treatment; this requires the use of "sour gas" pipelines built to handle the highly corrosive materials.

Requirements for Safety Planning and Engineering Standards

The MMS reviews all proposed actions in the Gulf of Mexico OCS for the possible presence of H_2S. Activities found to be associated with a presence of H_2S are subjected to further review and requirements. Federal regulations at 30 CFR 250.417 require all lessees, prior to beginning exploration or development operations, to request a classification of the potential for encountering H_2S. The classification is based on previous drilling and production experience in the areas surrounding the proposed operations, as well as other factors. All operators on the OCS involved in production of sour gas or oil (i.e., greater than 20 ppm H_2S) are also required to file an H_2S contingency plan. This plan delimits procedures to ensure the safety of the workers on the production facility. In addition, all operators are required to adhere to the National Association of Corrosion Engineers' (NACE) *Standard Material Requirement MR.01-75-96 for Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment* (NACE, 1990). These engineering standards serve to enhance the integrity of the infrastructure used to produce the sour oil and gas, and further serve to ensure safe operations. The MMS has issued a final rule governing requirements for preventing hydrogen sulfide releases, detecting and monitoring hydrogen sulfide and sulfur dioxide, protecting personnel, providing warning systems, and establishing requirements for hydrogen sulfide flaring. The rule went into effect on March 28, 1997. An associated NTL (98-16) titled "Hydrogen Sulfide (H_2S) Requirements" was issued on August 10, 1998, to provide clarification, guidance, and information on the revised requirements. The NTL provides guidance on sensor location, sensor calibration, respirator breathing time, measures for protection against sulfur dioxide, requirements for classifying an area for the presence of H_2S, requirements for flaring and venting of gas containing H_2S, and other issues pertaining to H_2S-related operations.

Environmental Fate of H_2S

Atmospheric Release

Normal dispersion mechanisms in the surface mixed layer of the atmosphere (wind, etc.) cause natural gas leaks and associated H_2S to disperse away from release sites. The MMS reviews of proposed sour gas operations are based on the conservative assumptions of horizontal, noncombusted releases to achieve environmentally conservative results, although vertical release or combustion of the gas plume (greatly reducing potential exposure) would be possible. Both simple Gaussian estimation techniques (conforming to air quality rules) and more rigorous analytical modeling are used in the MMS review of activities associated with a presence of H_2S. For a very large facility (throughput on the order of 100 MMcfd of produced natural gas) with high concentration levels (on the order of 20,000 ppm) and using very calm winds (speed of <1 m/sec), H_2S levels reduce to 20 ppm at several kilometers from the source; H_2S levels are reduced to 500 ppm at 1 km. Most "sour gas" facilities have H_2S concentrations below 500 ppm, which reduces to 20 ppm within the dimensions of a typical platform (or considerably less).

Aquatic Release

Hydrogen sulfide is soluble in water with 4,000 ppm dissolving in water at 20°C and one atmosphere pressure. This implies that a small sour gas leak would result in almost complete dissolution of the contained H_2S into the water column. Larger leaks would result in proportionally less dissolution, depending on turbulence, depth of release, and temperature; and H_2S could be released into the atmosphere if the surrounding waters reach saturation or the gas plume reaches the surface before complete dissolution. Because the oxidation of H_2S in the water column takes place slowly (on the order of hours), the chemical oxygen demand of H_2S is spread out over a long time interval (related to the ambient current speed) and should not create appreciable zones of hypoxia; except, in the case of a very large, long-lived submarine release.

H_2S Toxicology

Humans

The Occupational Safety and Health Administration's permissible exposure limit for H_2S is 20 ppm. A permissible exposure limit is an allowable exposure level in workplace air averaged over an 8-hour workshift. The American Conference of Governmental Hygienists recommends a time weighted average concentration of 10 ppm. The time-weighted average is a concentration for a normal 8-hour workday to which nearly all workers may be repeatedly exposed, day after day, without adverse affect. This is 30 times lower than the "immediately dangerous to life and health" level of 300 ppm set by the National Institute for Occupational Safety and Health. Despite a normal human ability to smell H_2S at levels below 1 ppm, H_2S is considered to be an insidious poison because the sense of smell rapidly fatigues, failing to detect H_2S after continued exposure. Although there are many different systems of classifying exposure levels and their associated health risks, MMS has synthesized these into a single, simple set of concentration levels to be used in identifying and assessing exposure risks:

Atmospheric Exposure Levels (volume fractions)	Characteristic Human Health Impact	Protective Measures Taken by MMS at this Level
20 ppm	Irritation within minutes	Operator required to develop and file "H_2S Contingency Plan"
100 ppm	Injury within minutes	
500 ppm	Death within minutes	Operator required to model atmospheric dispersion of total, horizontal, noncombusted rupture

Wildlife

While impacts on humans are well documented, the literature on the impact of H_2S on wildlife is sparse, with no information available for marine mammals and turtles.

In general, birds seem more tolerant of H_2S than mammals, indicating that birds may have a higher blood capacity to oxidize H_2S to nontoxic forms. In tests with white leghorn chickens, all birds died when inhaling H_2S at 4,000 ppm. At 500 ppm, no impact was observed on ventilation, while between 2,000 and 3,000 ppm respiratory frequency and tidal volume become irregular and variable in these birds (Klentz and Fedde, 1978). In the western United States, oil production and geothermal operations often flare or vent pipes to release the natural gases accumulated during drilling, storage, and pipeline operations, with significant impacts on wildlife (Maniero, 1996). Numerous instances of dead birds at the release site have been reported in the literature; extremely high concentrations of H_2S would occur at these sites.

Fish

Fish will strongly avoid any water column that is contaminated with H_2S, provided an escape route is available. In terms of acute toxicity testing, fish can survive at levels reaching 0.4 ppm (Van Horn, 1958; Theede et al., 1969). Walleye eggs (*Stizostedion vitreum*) did not hatch at levels from 0.02 to 0.1 ppm (USEPA, 1986). The hatchability of northern pike (*Esox lucius*) was substantially reduced at 25 ppb with complete mortality at 45 ppb. Northern pike fry had 96-hour LC_{50} values that varied from 17 to 32 ppb at O_2 levels of 6 ppm. Sensitive eggs and fry of northern pike exhibited no observable effects at 14 and 4 ppb, respectively (Adelman and Smith, 1970; USEPA, 1986). In a series of tests on the eggs, fry, and juveniles of walleyes, white suckers (*Catostomus commersoni*), and fathead minnows (*Pimephales promelas*), with various levels of H_2S from 2.9 to 12 ppb, eggs were the least sensitive while juveniles were the most sensitive. In 96-hour bioassays, fathead minnows and goldfish (*Carassius auratus)* varied greatly in tolerance to H_2S with changes in temperature (Smith et al., 1976; USEPA, 1986). Pacific salmon (*Oncorhynchus sp.*) experienced 100 percent mortality within 72 hours at 1 ppm.

On the basis of chronic toxicity testing, juveniles and adults of bluegill (*Lepomis macrochirus*) exposed to 2 ppb survived and grew normally. Egg deposition in bluegills was reduced after 46 days of exposure to 1.4 ppb (Smith et al., 1976; USEPA, 1986). White sucker eggs were hatched at 15 ppb, but juveniles showed growth reductions at 1 ppb. Safe levels for fathead minnows were between 2 and 3 ppb. For *Gammarus pseudolimnaeus* and *Hexagenia limbata*, 2 and 15 ppb, respectively, were considered safe levels (USEPA, 1986).

4.1.1.3.10. Workover Operations and Other Well Activities

Workover operations are conducted on a well, after the initial well completion, in order to service, maintain, or restore the productivity of the well; to evaluate a geologic formation or reservoir; or to abandon the well. Examples of workover operations are acidizing the perforated interval in the casing, plugging back, squeezing cement, milling out cement, jetting the well in with coiled tubing and nitrogen, and setting positive plugs to isolate hydrocarbon zones. It is estimated that about 20 percent of all workover operations will require a jack-up rig or other major rig. Workovers on subsea completions require that a rig be moved on location to provide surface support. Workovers can take from a few days to several months to complete, with an average of about 5-15 days. Historical data suggest that each producing well averages one workover or other well operation/treatment about every 4 years (USEPA, 1993a and b). Current oil-field practices include preemptive procedures or treatments that reduce the number of workovers required for each well. The MMS's projections suggest that a development well may expect to have 6-9 workovers or other well activities during its lifetime. Note that these data include well abandonment procedures as a workover operation.

Examples of other well operations include well completions, well treatments, and well abandonments. Well completion is the process of installing the downhole equipment to allow production of oil or gas from the hydrocarbon-bearing formation. Examples of completion activities include setting and cementing the casing, perforating the casing and surrounding cement, installing production tubing and packers, and gravel-packing the well. Completions are expected to occur on approximately 80 percent of the development wells drilled. Well treatments are done to improve well productivity. In the Gulf of

Mexico, acidizing is the most common well treatment. There are two types of well abandonment operations–temporary and permanent. An operator may temporarily abandon a well to drill additional delineation wells to determine if a prospect is feasible; to save the well bore for a future sidetrack to a new geologic bottom hole location; or while waiting on design, construction, and installation of production equipment and facilities. The operator must meet specific requirement to temporarily abandon a well (30 CFR 250.703). Permanent abandonment operations are undertaken when a well bore is of no further use to the operator (i.e., the well's producible hydrocarbon resources have been economically depleted). During permanent abandonment operations, equipment is removed from the well, and specific intervals in the well are plugged with cement. There will be one permanent abandonment operation per well.

CPA Proposed Action Scenario: Table 4-2 shows there are 726-1,441 workovers projected as a result of a proposed action in the CPA. The projected number of workovers is a function of development wells and will follow the same trends as development wells.

WPA Proposed Action Scenario: Table 4-3 shows there are 398-681 workovers projected as a result of a proposed action in the CPA. The projected number of workovers is a function of development wells and will follow the same trends as development wells.

OCS Program Scenario: Table 4-4 shows there are 148,300-167,000 workovers projected as a result of the gulf-wide OCS Program. The projected number of workovers is a function of development wells and will follow the same trends as development wells.

4.1.1.4. Structure Decommissionings/Removals

Lessees are required to remove all structures and related underwater obstructions from their Federal OCS leases within one year after the lease is terminated or relinquished, unless there are mitigating circumstances to be considered by the Regional Supervisor. For example, structures located on the seafloor in waters exceeding 800 m in depth may be left in place; however, such requests are coordinated with the U.S. Navy. Under normal circumstances, MMS regulations require lessees to sever all components at least 5 m below the seafloor to ensure that no part of the structure or its appurtenances will be exposed to and interfere with commercial fishing. Structure removal operations take a day to several weeks to complete once decommissioning commences. For fixed production platforms, this occurs at the end of a platform's 15- to 30-year lifespan.

Fixed platforms and compliant towers anchored to the seafloor by steel pilings are the dominant structures in water depths less than 400 m. Because these platforms must withstand probable hurricane conditions over their designed life span, the structures are designed and constructed to avoid collapsing under such adverse conditions. Consequently, these fortified structures often necessitate the use of explosives for the decommissioning process (severing the structure's pilings and well conductors and removal of equipment).

Structures placed in waters deeper than 400 m include compliant towers and floating structures such as tension-leg platforms, spar's, or FPSO's. Compliant towers, which may be placed in as much as 800 m of water, may require explosives for their removal. Floating production structures will typically host a series of subsea systems that may include an array of subsea wells, manifolds, central umbilicals, and flowlines that can be located many miles away from the host facility. It is presently not known whether explosives will be used to remove some of these structures, particularly since pending regulations would allow for some subsea structures to remain on the seafloor in waters exceeding 800 m in depth. Demolition experts indicate, however, that anchoring systems used to secure floating production structures to the seafloor may be severed using small explosive charges when such structures are decommissioned.

From 1996 to 2001, approximately 43-70 percent of fixed structures were removed using explosives. Approximately 92 percent of the structures removed using explosives during this period were located in less than 60 m of water. However, the number of structure removals using explosives in waters deeper than 60 m is expected to increase. Not included in these numbers are the numerous exploratory wells that are abandoned, sometimes using explosive charges to sever the well stub. The number of well stubs removed using explosives is unknown at this time.

Structures and well stubs that are not removed using explosives typically involve other removal techniques (e.g., cutting the legs and casing strings with an underwater cutting tool). Examples of current nonexplosive techniques to sever pilings of offshore structures include mechanical-cutting (also used for well casings) and torch-cutting (by divers) operations. Nonexplosive removals pose a danger to divers working in the vicinity of structures being severed. Additional information concerning explosive removal of offshore structures can be found in Chapter 4.1.1.4.2.

The MMS and NOAA Fisheries have conferred extensively in the development of structure removal precautions. The NOAA Fisheries has instituted a comprehensive program to protect sea turtles and cetaceans. If sea turtles are observed in the vicinity of structures slated for removal, detonation of the explosives is postponed until the animals are removed or they leave the area of potential impact. Likewise, if cetaceans are observed in the vicinity of a removal site, the detonations are postponed until the animals have vacated the area.

Since NOAA Fisheries' protective observer program began in 1986, explosive removals have impacted only two sea turtles. The first event involved a sea turtle that was observed drifting below the water surface 1.5 hours after the explosive removal of a structure in 1986 (Gitschlag and Renaud, 1989). Only one other injured turtle has been observed since 1987, when monitoring became mandatory (NRC, 1996). In 1991, within one minute after the detonation of explosives during a decommissioning operation, a loggerhead turtle surfaced 5-30 m from the structure with a fracture down a portion of its carapace. No cetacean has been reported as injured since the observer program was implemented.

In October 1995, NOAA Fisheries issued regulations authorizing and governing the "taking" of bottlenose and spotted dolphins incidental to the removal of oil and gas drilling and production structures in State waters and on the Gulf of Mexico OCS (*Federal Register*, 1995a). Letters of Authorization for Incidental Take must be requested from, and issued to, individual applicants (operators) to conduct the activities (structure removals) pursuant to the regulations.

Not only are operators required to remove structures or objects emplaced on the OCS once a lease is terminated, they must also verify that the site is clear of any obstructions that may conflict with other uses of the OCS. The MMS NTL 98-26, "Minimum Interim Requirements for Site Clearance (and Verification) of Abandoned Oil and Gas Structures in the Gulf of Mexico," provides the requirements for site clearance. The lessee must develop, and submit to the MMS for approval, a procedural plan for the site clearance verification procedures. For platform and caisson locations in water depths of less than 91 m (300 ft), the sites must be trawled over 100 percent of the designated area in two directions (i.e., N-S and E-W). Individual well-site clearances may use high-frequency (500 kHz) sonar searches for verification. Site-clearance verification must take place within 60 days after structure removal operations have been conducted.

Proposed Action Scenario: Tables 4-2 and 4-3 show platform removals by water-depth subarea. All structures installed as a result of a proposed action in the CPA (28-49 structures total) or WPA (11-15 structures total) are assumed to be removed by the end of the 40-year life of a proposed action. It is estimated that 16-29 production structures installed landward of the 800-m isobath will be removed using explosives as a result of a proposed action in the CPA. Likewise, 5-7 production structures installed landward of the 800-m isobath as a result of a proposed action in the WPA are likely to be removed using explosives. It is anticipated that multiple appurtenances will not be removed from the seafloor if placed in waters exceeding 800 m. Federal regulations allowing for the abandonment of structures in waters deeper than 800 m are being formalized. An estimate of the well stubs and other various subsea structures that may be removed using explosives is not possible at this time.

OCS Program Scenario: Tables 4-4 to 4-7 show the number of structures removed by water-depth subarea for the total OCS Program and by planning area. The number of structures to be removed in the next several decades is expected to exceed the number of production structures installed (Pulsipher et al., 2001). It is estimated that a total of 943-1,174 production structures will be removed from the WPA during 2003-2042. It is estimated that 629-783 production structures installed landward of the 800-m isobath in the WPA will be removed using explosives during 2003-2042. It is estimated that a total of 5,350-6,110 production structures will be removed from the CPA during 2003-2042. The number of production structures installed landward of the 800-m isobath in the CPA to be removed using explosives during the interval of 2003-2042 is estimated at 3,676-4,183. It is estimated that a total of 10-12 production structures will be removed from the EPA during 2003-2042. Explosive removal will not be used in the EPA. An unknown number of well stubs and subsea structures may be removed using explosives; an estimate is not possible at this time.

4.1.1.4.1. Explosive Removal Disturbance

Possible injury or death to sealife (e.g., sea turtles) from detonating explosives below the seafloor extends at least 915 m from a decommissioning site and upward to the sea surface (Klima et al., 1988). For structure removals requiring the use of explosives, explosive packages are sometimes built to "shape" or "focus" the energy in a narrow zone thus decreasing the amount of explosive required to sever a piling or casing string. The operator must consider the specific conditions (design, water depth, etc.) at each structure when planning its removal. One must also consider that some nonexplosive decommissioning operations are hazardous to divers.

Explosives used to sever and remove structures release energy into the environment in the form of a pressure wave and noise emanating from the explosive charge. Because the resulting pressure wave and noise may harass, harm, or kill protected species of fishes, sea turtles, or marine mammals, MMS and NMFS have conferred over the use of explosives for removing structures and have instituted a comprehensive program of mitigation measures. For example, if sea turtles, dolphins, or whales are observed in the vicinity of structures to be removed, detonation of the explosives must be postponed until the animals are removed or leave the impact area. No cetaceans have been documented as injured or killed since the mitigation measures became mandatory. Since 1986, NMFS observers have documented five loggerhead sea turtles as impacted during explosive removals. Two sea turtles were documented as impacted during 1986-1994 (Gitschlag and Herczeg, 1994; NRC, 1996), one in 1997 (Gitschlag, personal communication, 1999), one in 1998 (Shah, personal communication, 1998), and one in 2001 (Gitschlag, personal communication, 2001).

In October 1995, NMFS issued regulations authorizing and governing the "taking" of bottlenose and spotted dolphins by harassment and incidental to the removal of oil and gas structures in State waters and on the Gulf of Mexico OCS. Letters of Authorization for Incidental Take must be requested from, and issued to, individual applicants (operators) to conduct the activities (structure removal using explosives) pursuant to the regulations.

With the advancement of petroleum exploration and production into deeper waters seaward of the continental shelf, MMS anticipates that some structures fixed or anchored on the continental slope and seaward (beyond the continental shelf) may require the use of explosives when removed in the future. Waters over the continental slope and seaward are inhabited by a variety of cetacean species, including the endangered sperm whale. The current mitigation measures for structure removals using explosives were designed for water depths of less than 50-60 m. Consequently, the MMS is actively working with industry and NOAA Fisheries to develop mitigation measures to detect and protect marine mammals (e.g., sperm whale) and sea turtles (e.g., leatherback sea turtle), regardless of water depth, during decommissioning activities that require explosives to remove the structures.

Proposed Action Scenario: Explosives used to remove structures will disturb the environment because of the unnatural pressure wave and noise that this activity generates. It is estimated that 16-29 production structures installed landward of the 800-m isobath will be removed using explosives as a result of a proposed action in the CPA. Likewise, 5-7 production structures installed landward of the 800-m isobath as a result of a proposed action in the WPA are likely to be removed using explosives.

OCS Program Scenario: The number of structures to be removed in the next several decades is expected to exceed the number of production structures installed (Pulsipher et al., 2001). Explosive removals will disturb the environment as explosives generate an unnatural pressure wave and noise. It is estimated that 629-783 production structures installed landward of the 800-m isobath in the WPA will be removed using explosives during 2003-2042. The number of production structures installed landward of the 800-m isobath in the CPA to be removed using explosives during the interval of 2003-2042 is estimated at 3,676-4,183. Explosive removal will not be used in the EPA. An unknown number of well stubs and subsea structures may be removed using explosives; an estimate is not possible at this time.

4.1.1.4.2. Bottom Debris

Bottom debris is defined as material resting on the seabed (such as cable, tools, pipe, drums, anchors, and structural parts of platforms, as well as objects made of plastic, aluminum, wood, etc.) that are accidentally lost (e.g., during hurricanes) or tossed overboard from fixed or floating facilities. The maximum quantity of bottom debris per operation is estimated to be several tons. The MMS requires site clearance over a radius of 400 m, which is assumed to be the areal extent over which debris will fall.

Chapter 4.1.1.4.4 describes the requirements and guidelines for removing bottom debris and gear after structure decommissioning and removal operations. There are also requirements for verification that operational debris has been removed from the areas around the platform removal site (e.g., by trawling the area to verify that the site has, in fact, been cleared of debris).

The Fishermen's Contingency Fund (FCF) was established to provide recourse for recovery of commercial fishing equipment losses due to entanglement on OCS oil and gas structures and debris. In FY 99, a total of 28 claims were approved and a total of $173,433 was paid. In FY 2000, a total of 25 claims were approved and $187,436 was paid. In FY 2001, a total of 15 claims were approved and $120,293 was paid.

Proposed Action Scenario: Up to a few hundred tons of bottom debris are expected to result from activities associated with each proposed action. It is assumed that most of this debris will be removed from the seafloor during the structure decommissioning and removal process as a result of the MMS site clearance and verification requirements.

OCS Program Scenario: It is estimated that several hundred tons of bottom debris (both ferromagnetic and nonferromagnetic) have been deposited on the seafloor as a result of prior OCS oil and gas activity. Oil and gas activities on the Gulf of Mexico OCS over the next 40 years will likely add several thousand tons of bottom debris on the seafloor. It is assumed that most of the future lost or tossed debris will be removed from the seafloor during the structure decommissioning, site clearance, and verification process.

4.1.2. Coastal Impact-Producing Factors and Scenario

4.1.2.1. Coastal Infrastructure

4.1.2.1.1. Service Bases

The proposed actions are expected to impact only those ports that currently have facilities needed for use by the oil and gas industry as offshore service bases. A service base is a community of businesses that load, store and supply equipment, supplies and personnel that are needed at offshore work sites. Although a service base may primarily serve the OCS planning area and coastal Subarea in which it is located, it may also provide significant services for the other OCS planning areas and coastal Subareas. Table 3-33 shows the 50 services bases the OCS currently uses. These facilities were identified as the primary service base by platform plans received by MMS. Based on numbers provided by Offshore Data Services, the ports of Fourchon, Cameron, Venice, and Morgan City, Louisiana, are the primary service bases for Gulf of Mexico mobile rigs. Major platform service bases are Galveston, Freeport, and Port O'Connor, Texas; Cameron, Fourchon, Intracoastal City, Morgan City, and Venice, Louisiana; Pascagoula, Mississippi; and Theodore, Alabama.

As the industry continues to evolve so do the requirements of the onshore support network. With advancements in technology, the shore-side supply network will continue to be challenged to meet the needs and requirements of the industry. All supplies must be transported from land-based facilities to marine vessels or helicopters to reach offshore destinations. This utilizes both water and air transportation modes. The intermodal nature of the entire operation gives ports (which traditionally have water, rail, and highway access) a natural advantage as an ideal location for onshore activities and intermodal transfer points. Therefore, ports will continue to be a vital factor in the total process and must incorporate the needs of the offshore oil and gas industry into their planning and development efforts particularly with regard to determining their future investment needs. In this manner both technical and economic determinants must influence the dynamics of port development.

Issues and concerns that must be addressed at the local level have resulted from the significant prosperity that has followed the industry. These extend beyond specific port needs into the community itself. Most of these problems can be nullified with additional infrastructure. However, additional infrastructure is difficult to develop. It is expensive to construct and requires substantial planning and construction time prior to completion. Rapidly developing technology has resulted in changing needs for the offshore oil and gas industry. This has placed a burden on the ports to provide the necessary infrastructure and support facilities required to meet the needs of the industry in a timely manner.

To continue to offer a viable service and to stay current with technological trends and industry standards, ports must be able to incorporate offshore oil and gas industry information into their planning for future infrastructure development, staffing needs, and other impacts associated with rapid industrial growth. Expansion of some existing service bases is expected to occur to capture and accommodate the current and future oil and gas business that is generated by development on the OCS and State waters. Some channels in and around the service bases will be deepened and expanded in support of deeper draft vessels and other port activities, some of which will be OCS related.

As OCS operations have progressively moved into deeper waters, larger vessels with deeper drafts have been phased into service, mainly for their greater range, faster speed, and larger carrying capacity. Services bases with the greatest appeal for deepwater activity have several common characteristics: strong and reliable transportation systems; adequate depth and width of navigation channels; adequate port facilities; existing petroleum industry support infrastructure; location central to OCS deepwater activities; adequate worker population within commuting distance; and insightful strong leadership. Typically, deeper draft service vessels require channels with depths of 6-8 m.

Proposed Action Scenario: A proposed action in the CPA or WPA will not change identified service bases or require any additional service bases.

OCS Program Scenario: The OCS Program activities will continue to lead to a consolidation of port activities at specific ports especially with respect to deepwater activities (i.e., Port Fourchon and Galveston). The OCS Program will require no additional service bases.

4.1.2.1.2. Helicopter Hubs

Helicopter hubs or "heliports" are facilities where helicopters can land, load, and offload passengers and supplies, refuel, and be serviced. These hubs are used primarily as flight support bases to service the offshore oil and gas industry. Most of the helicopter trips originate at helicopter hubs in coastal Texas and Louisiana. There are 128 heliports in the analysis area that support OCS activities. Three helicopter companies dominate the Gulf of Mexico offshore helicopter industry: Air Logistics, Era Aviation, and Petroleum Helicopters, Inc. A few major oil companies operate and maintain their own fleets, although this is a decreasing trend. Instead of running their own fleets, oil and gas companies are increasingly sub-contracting the whole operation on a turnkey basis to independent contractors. More and more operations are outsourcing to oil-field support companies, such as Baker Hughes, who are much more cost conscious and skeptical about the high cost of helicopters. Another consideration for the helicopter industry is new technology such as subsea systems. These systems decrease the number of platforms and personnel needed offshore, therefore reducing the amount of transportation needed.

To meet the demands of deep water (travel farther and faster, carry more personnel, be all-weather capable, and have lower operating cost), the offshore helicopter industry is purchasing new helicopters. While some heliports located farther inland have closed or consolidated, some heliports are expanding or opening due to more of the industry's work being farther offshore.

Proposed Action Scenario: A range of 220,000-870,000 helicopter trips is projected to result from activities associated with a proposed action in the CPA. A range of 6,000-22,000 helicopter trips is projected to occur annually. A range of 110,000-410,000 helicopter trips is projected to result from activities associated with a proposed action in the WPA. A range of 3,000-10,000 helicopter trips is projected to occur annually.

OCS Progam Scenario: Minimal helicopter hub construction or closures are anticipated. While some heliports located farther inland have closed or consolidated, some heliports are expanding or opening due to more of the industry's work being farther offshore. No new heliports are projected as a result of the OCS Program, however they may expand at current locations. A range of 27,997,00-50,692,000 helicopter trips is projected to result from activities associated with the OCS Program. A range of 700,000-1,267,000 helicopter trips is projected to occur annually.

4.1.2.1.3. Construction Facilities

4.1.2.1.3.1. Platform Fabrication Yards

Given the platform fabrication industry characteristics and trends therein, it is not likely that new yards will emerge. The existing fabrication yards do not operate as "stand alone" businesses, rather they rely heavily on a dense network of suppliers of products and services. Also, since such a network has been historically evolving in Louisiana and Texas for over 50 years, the existing fabrication yards possess a compelling force of economic concentration to prevent the emergence of new fabrication yards. There are 43 platform fabrication yards in the analysis area.

With respect to the deepwater development, the challenges for the fabrication industry stem from the greater technical sophistication and the increased project complexity of the deepwater structures, such as compliant towers and floating structures. The needs of the deepwater projects are likely to result in two important trends for the fabrication industry. The first is the increasing concentration in the industry, at least with respect to the deepwater projects. As technical and organizational challenges continue to mount up, it is expected that not every fabrication yard will find adequate resources to keep pace with the demands of the oil and gas industry. The second trend is the closer integration—through alliances, amalgamations, or mergers—among the fabrication yards and engineering firms.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: No new facilities are expected to be constructed in support of OCS Program activities. Some current yards may close, be bought out, or merge over the 2003-2042 period resulting in fewer active yards in the analysis area.

4.1.2.1.3.2. Shipyards

The 1980's were dismal for the shipbuilding industry. Several mergers, acquisitions, and closings occurred during the downturn. Of those that have remained, 94 are located with in the analysis area (Table 4-8). Several large companies dominate the oil and gas shipbuilding industry. Most yards in the analysis area are small. To a great extent, growth will be based on a successful resolution of several pertinent issues that have affected and will continue to affect shipbuilding in the U.S. and particularly in the analysis area: maritime policy, declining military budget, foreign subsidies, USCG regulations, OPA 90, financing, and an aging fleet.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: No new facilities are expected to be constructed in support of OCS Program activities. Some current yards may close, be bought out, or merge over the 2003-2042 period, which would result in fewer active yards in the analysis area.

4.1.2.1.3.3. Pipecoating Facilities and Yards

There are currently 19 pipecoating plants in the analysis area (Table 4-8). Pipe-coating facilities receive manufactured pipe, which they then coat the surfaces of with metallic, inorganic, and organic materials to protect from corrosion and abrasion and to add weight to counteract the water's buoyancy. Two to four sections of pipe are then welded at the plant into 40-ft segments. The coated pipe is stored (stacked) at the pipeyard until it is needed offshore.

To meet deepwater demand, pipecoating companies have been expanding capacity or building new plants. A new trend in the industry is single-source contracts where the pipe manufacturing, coating, welding and laying are all under one contract. This results in a more efficient, less costly operation. At present, though, only foreign companies have this capability.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: Current capacity, supplemented by recently built plants and expansions, are anticipated to meet OCS Program demand. No new facilities are expected to be constructed in support of OCS Program activities.

4.1.2.1.4. Processing Facilities

4.1.2.1.4.1. Refineries

A refinery is an organized arrangement of manufacturing units designed to produce physical and chemical changes to turn crude oil into petroleum products. In the refinery, most of the nonhydrocarbon substances are removed from crude oil and it is broken down into its various components, and blended into useful products.

In the early 1980's, the Crude Oil Entitlements Program ended and crude oil prices were no longer controlled. This caused the number of petroleum refineries to drop sharply leading to 13 years of decline in U.S. refining capacity. The decade of the 1990's was characterized by low product margins and low profitability. Refining operations consolidated, the capacity of existing facilities expanded, and several refineries closed. Most refineries are part of major, vertically integrated oil companies that are engaged in both upstream and downstream aspects of the petroleum industry. These companies dominate the refining industry, although most majors are spinning off their refinery facilities to independents or entering joint ventures to decrease the risk associated with low refining returns. The analysis area hosts over one-third of the petroleum refineries in the U.S. Most of the region's refineries are located in Texas and Louisiana (Table 4-8) representing 55.04 and 38.49 percent, respectively, of total U.S. refining capacity.

Two significant environmental considerations facing U.S. refiners are Phase 2 Clean Air Act Amendments (CAAA) of 1990 reformulated motor gasoline (RFG) requirements and the growing public opposition to the use of methyl tertiary butyl ether (MTBE). In order to meet Phase 2 RFG requirements, U.S. refiners will incur numerous expenses and make substantial investments. The MTBE is an additive that increases the oxygen content of motor gasoline causing more complete combustion of the fuel and less pollution. It was a relative inexpensive way for refiners to meet Phase 1 CAAA RFG requirements. Since March 1999, eight states have adopted bans on the use of MTBE because of concerns about groundwater contamination. This will cause additional outlays of money and some restructuring of current facilities in order to move to ethanol.

Distillation capacity is projected to grow from the 1998 year-end level of 16.3 million barrels per day to between 17.6 million and 18.3 million in 2020. Almost all the capacity additions are projected to occur on the Gulf Coast. Financial, environmental, and legal considerations make it unlikely that new refineries will be built in the United States; therefore, expansion at existing refineries likely will increase total U.S. refining capacity in the long-run. Refineries will continue to be utilized intensively, in a range from 93 to 96 percent of design capacity.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: No new facilities are expected to be constructed in support of OCS Program activities. While financial, environmental, and legal considerations make it unlikely that new refineries will be built in the U.S., expansion at existing refineries likely will increase total U.S. refining capacity over the 2003-2042 period.

4.1.2.1.4.2. Gas Processing Plants

After raw gas is brought to the earth's surface, it is processed at a gas processing plant to remove impurities such as water, carbon dioxide, sulfur, and inert gases and transformed into a saleable, useable energy source. The total number of natural gas processing plants operating throughout the U.S. has been declining over the past several years as companies have merged, exchanged assets, and closed older, less efficient plants. However, this trend was reversed in 1999. Louisiana, Mississippi, and Alabama's capacity is undergoing significant increases as a wave of new plants and expansions try to anticipate the increased coming ashore from new gas developments in the Gulf of Mexico. At present, there are 35 gas processing plants in the analysis area that process OCS gas (Table 4-8).

According to a study published by the Gas Research Institute, offshore Gulf of Mexico is the only area of the U.S. that offers potential new gas supplies for gatherers/processors. This is also the only region where any significant exploration is occurring. The MMS anticipates the construction of as many 4-16 new gas-processing plants in the analysis area to process OCS gas (Table 4-8). Of these new plants, 1-5 are expected to be located in Texas, 3-9 in Louisiana, and 0-2 in the Mississippi-Alabama area.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: Due to the potential for gas in the Gulf of Mexico OCS, MMS anticipates 4-16 new gas processing plants will be constructed in the analysis area in support of OCS Program activities.

4.1.2.1.5. Terminals

4.1.2.1.5.1. Pipeline Shore Facilities

The term "pipeline shore facility" is a broad term describing the onshore location where the first stage of processing occurs for OCS pipelines carrying different combinations of oil, condensate, gas, and produced water. Pipelines carrying only dry gas do not require pipeline shore facilities; the dry gas is piped directly to the gas processing plant (Chapter 4.1.2.1.4.2). Some processing may occur offshore at the platform; only onshore facilities are addressed in this section.

Pipeline shore facilities may separate, process, pump, meter, and store oil, water, and gas depending on the quality of the resource carried by the pipeline. After processing and metering, the liquids are either piped or barged to refineries or storage facilities. The gas is piped to a gas processing plant for further refinement, if necessary; otherwise, it is transported via transmission lines for distribution to commercial consumers. Water that has been separated out is usually disposed into on-site injection wells.

A pipeline shore facility may support one or several pipelines. Typical facilities occupy 2-25 ha. Although older facilities may be located in wetlands, current permitting programs prohibit or discourage companies from constructing any new facilities in wetlands. As a result of the OCS Program, new shore facilities may be needed to support new pipeline landfalls (see the table below). It is projected that CPA and WPA proposed actions would represent 2 and 1 percent, respectively, of the resources handled by these shore facilities.

Projected Pipeline Shore Facilities for the OCS Program (2003-2042) by Coastal Subareas

TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	FL-1	Total
0-1	2-4	2-3	3-5	3-4	2-3	0	12-20

4.1.2.1.5.2. Barge Terminals

Eight barge terminals along the Gulf Coast are currently being used by the OCS oil industry (Chapter 3.3.3.8.6). These facilities usually have some storage capabilities and processing facilities. Some barge terminals may also serve as pipeline shore facilities.

Of the four barge terminals in Louisiana, three receive oil from only CPA leases and one receives oil from both WPA and CPA leases. Of the four barge terminals in Texas, three receive oil from only WPA leases and one receives oil from only CPA leases. These barge terminals may also receive oil from State production or imports. Texas terminals receive approximately 30 percent of OCS barged oil and Louisiana terminals receive approximately 70 percent.

Barging of OCS production is expected to remain stable. No major modifications or new barge terminals are expected to be constructed in the foreseeable future to support proposed-action or OCS-Program operations. Chapter 4.1.1.3.8.2 discusses OCS barging operations in general.

4.1.2.1.5.3. Tanker Port Areas

The transport of OCS-produced oil from FPSO operations to inside or shore-side facilities would be accomplished with shuttle tankers rather than oil pipelines. The following tanker ports were identified in Chapter 3.3.3.8.6 as destinations for shuttle tankers transporting crude oil from FPSO operations in the Gulf of Mexico: Corpus Christi, Freeport, Port Arthur/Beaumont, and Houston/Galveston, Texas; and Lake Charles, the lower Mississippi River ports (Baton Rouge, Port of South Louisiana, New Orleans, and Plaquemines), and the Louisiana Offshore Oil Port, Louisiana. These ports were selected based on their location to refineries and channel depth.

The number of shuttle-tanker trips to port in a given year is primarily a function of the FPSO production rate and the capacity of supporting shuttle tankers. Considering an FPSO operating at a peak production rate of 150,000 bbl/day, supported by shuttle tankers of 500,000 bbl capacity, offloading would occur once every 3.3 days. This would equate to 54.75 million bbl of production with 110 offloading events and shuttle-tanker transits to Gulf coastal or offshore ports annually.

Proposed Action Scenario: Chapter 4.1.1.3.8.3 estimated that no tanker transport of OCS-produced oil will occur as a result of a single proposed action in the CPA or WPA. An FPSO and associated tankering is assumed to support production from leases resulting from multiple sales; any one proposed action is expected to contribute incrementally to tankering under the OCS Program. Therefore, there will be no additional traffic through tanker ports with respect to the proposed actions.

OCS Program Scenario: Chapter 4.1.1.3.8.3 developed a scenario for future OCS oil transportation by shuttle tanker. These assumptions resulted in an estimate that 0-6 percent of oil from the OCS Program will be tankered in water depths greater than 200 m in the CPA and WPA. It is projected that 500-1,000 offloading operations and shuttle-tanker transits will occur annually from OCS Program activities during the peak years of FPSO use in the CPA and WPA. There will be no tankering in the EPA. Texas tankering ports will probably receive less than 1 percent of oil production, while each Louisiana tanker port may receive 1-2 percent. Table 4-12 shows the minimum and maximum number of new tanker port trips per year under seven different port options with the most likely option mirroring current tanker traffic activities. As can be seen in Table 3-30, tanker trips associated with OCS Programs activities would represent a small percentage of annual tanker trips into identified tanker ports.

4.1.2.1.6. Disposal and Storage Facilities for Offshore Operational Wastes

Both the Gulf of Mexico offshore oil and gas industry and the oil and gas waste management industry are undergoing significant changes. New drilling technologies and policy decisions as well as higher energy prices should increase the level of OCS activity and, with it, the volumes of waste generated. The oil-field waste industry, having been mired in somewhat stagnant conditions for almost two decades, has developed new increments of capacity, and some new entrants into the market have added to industry capacity and the diversity of technologies available for the industry to use.

Facilities that accept OCS-generated waste that is not unique to oil and gas operations, such as municipal waste landfills and hazardous waste treatment, storage and disposal facilities, are diverse and specialized and manage waste for the broad base of U.S. industry. The OCS activity does not generate a large part of the waste stream into these facilities and is not expected to be material to the overall capacity of the industry. Capacity of industrial waste management facilities is for the most part abundant, as U.S. industries have learned to minimize wastes they ship to offsite facilities for management.

Proposed Action Scenario: No new disposal and storage facilities will be built as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: No new disposal and storage facilities are expected to be constructed in support of OCS Program activities.

4.1.2.1.6.1. Nonhazardous Oil-field Waste Sites

Long-term capacity to install subsurface injection facilities onshore is itself not scarce and oilfield waste injection well permits do not generally attract much public opposition. With the volume of produced water frequently exceeding the volume of oil a well produces by tenfold or more, the main limitation to widespread use of land-based subsurface injection facilities is the space at docks and the traffic in and out of ports.

With the addition of Trinity Field Services to the market this year, the OCS market has its first salt dome disposal operation in a competitive location, with 6.2 million barrels of space available initially. This is enough capacity to take 8-10 year's worth of OCS liquids and sludges at current generation rates and a potential of several times that amount with additional solution mining. Salt domes are well-known and well-documented geological structures, and others could be placed into service as demand dictates. Salt caverns are a finite resource, but nevertheless have the potential to take decades' worth of OCS offsite NOW generation.

Proposed Action Scenario: No new NOW waste sites will be built as a result of a proposed action in the CPA or WPA. Capacity to manage waste generated by a proposed action's drilling and production activities is adequate for the present.

OCS Program Scenario: No new NOW waste sites will be built as a result of the OCS Program. Oil and gas waste management facilities along the Gulf of Mexico coast have adequate capacity and for a hypothetical future that includes a doubling of current waste volumes.

4.1.2.1.6.2. Landfills

The use of landfarming of OCS waste is likely to decline further, particularly with greater availability of injection methods for wastes containing solids. Future regulatory efforts are likely to discourage the practice by adding requirements that damage the economics if not by an outright ban on future permits.

Even though growth in OCS waste volumes can be expected to follow a linear relationship with increased OCS drilling and production activity, landfills will continue to be a small factor in the reduction of trash generated by OCS activity. Assuming a landfill (1) presently had OCS waste constituting 5 percent of its waste stream, (2) the remaining life of a landfill was 20 years at current fill rates, and (3) OCS waste doubled but the rest of the incoming waste stream remained flat, then the OCS activities would cause the landfill to be close at the end of 19 years as a result of the OCS contribution increase. With no waste received from OCS activities at all, the landfill would close in 21 years.

Proposed Action Scenario: No new landfills will be built as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: No new landfill waste sites will be built as a result of the OCS Program. Landfills are a small factor in the reduction of trash generated by OCS activity.

4.1.2.1.7. Coastal Pipelines

This section discusses OCS pipelines in coastal waters (State offshore and inland waters) and coastal onshore areas. See Chapter 4.1.1.3.8.1 for a discussion of pipelines in Federal offshore waters. The OCS pipelines near shore and onshore may join pipelines carrying production from State waters or territories for transport to processing facilities or to distribution pipelines located farther inland. See Chapter 4.1.3.1.2 for a discussion of pipelines supporting State oil and gas production.

Nearly 400 OCS pipelines cross the Federal/State boundary into State waters. There are nearly 1,700 km of OCS pipelines in State waters, with an average of 5 km per pipeline. Over half of the pipelines in State waters are directly the results of the OCS Program.

Pipelines in coastal waters may present a hazard to commercial fishing where bottom-trawling nets are used; this is one reason that pipelines must be buried in waters less than 200 ft. Pipeline burial is also intended to reduce the movement of pipelines by high currents and storms, to protect the pipeline from the external damage that could result from anchors and fishing gear, and to minimize interference with the operations of other users of the OCS. For the nearshore sections of OCS pipelines, COE and State permits for constructing pipelines require that turbidity impacts to submerged vegetation be mitigated through the use of turbidity screens and other turbidity reduction or confinement equipment.

Where a pipeline crosses the shoreline is referred to as a pipeline landfall. Gulfwide, two-thirds of OCS pipelines entering State waters tie into existing pipeline systems and do not result in new pipeline landfalls. Because of the extensive trunklines that parallel the Texas coastline, this ratio is lower in Texas. About 85 percent of OCS pipeline landfalls are in Louisiana. The oldest pipeline systems are also in Louisiana, with some dating back to the 1950's. The OCS pipelines making landfall have resulted in 700 km of pipelines onshore, with an average of 10 km per pipeline. A small percentage of onshore pipelines in the coastal subareas are directly the results of the OCS Program.

Recently, the trend is for new OCS pipelines to tie into existing systems rather than creating new landfalls. Over the last 10 years, there has been an average of two new OCS pipeline landfalls per year. As a mitigation measure to avoid adverse effects of barrier beaches and wetlands, most pipeline landfalls crossing barrier beaches and wetlands will be directionally bored under them.

About 16 percent of OCS pipelines making landfall are inactive or abandoned; some of these may have been or will be reactivated for OCS-related use. Pipelines may be abandoned in place if they do not constitute a hazard to navigation and commercial fishing or unduly interfere with other uses of the OCS.

Preliminary results from the MMS/USGS National Wetland Research Center's (NWRC) current study of coastal wetland impacts from pipeline construction and associated widening of canals utilizing USGS habitat data are summarized below (Johnston and Barras, personal communication, 2002):

> Approximately 15,400 km (9,570 mi) of OCS pipelines have been constructed in Louisiana from the 3-mi State/Federal boundary to the CZM boundary. Of those pipelines, approximately 8,000 km (4,971 mi) crossed wetland (marsh) or upland habitat. The remaining 7,400 km (4,598 mi) crossed waterbodies. Sources of OCS pipeline data

were Penn Well Mapsearch, MMS, National Pipeline Mapping System, and the Geological Survey of Louisiana pipeline datasets. Additionally, based on USGS 1978 habitat data, approximately 56 percent of the length of pipelines crossed marsh habitat and 44 percent crossed upland habitat. Using USGS landloss data from 1956 to 2002 within a 300-m (984-ft) buffer zone (150 m (492 ft) on each side of the pipeline), the total amount of landloss attributed to OCS pipelines was 34,400 ha (85,968 ac). This number represents 0.04 km^2 (4.00 ha, 9.88 ac) per linear km of pipeline installed. When one divides 34,400 ha by the 46-year period (1956-2002), the loss per year is 746 ha (1,843 ac) for the 8,000 km (4,971 mi) of OCS pipeline. This represents 11.9 percent of the total landloss in the Louisiana pipeline study area. Note that from the period 1990-2002 (based on the preliminary data by USGS), the total landloss due to pipelines for the study area was approximately 25 km^2 (~10 mi^2) or 525 ac/yr, which represents a dramatic decline from the 1956-1978 and 1978-1990 analysis periods (Table 4-64). Many of these pipelines were installed prior to the implementation of the NEPA of 1969 and the State of Louisiana's Coastal Permit Program in 1981. Additionally, given the width of the buffer, 300 m (984 ft) versus actual pipeline-canal width, which may be 31-61 m (100-200 ft) wide, an unknown portion of the increase in open water is attributed to other factors unrelated to OCS pipelines. To address this, selected OCS pipelines are being studied in greater detail to ascertain direct and secondary impacts to the extent possible and the information from that analysis will be included in future NEPA documents.

Technologies have been and continue to be developed that decrease the impacts of OCS pipelines on wetlands and associated sensitive habitat. For example, the proposed 30-in Endymion pipeline would deliver crude oil from South Pass Block 89 to the LOOP storage facility near the Clovelly Oil and Gas Field. Based on a review of the data in the COE permit application (No. 20-020-1632), the pipeline construction would have zero (0) impacts to marshes (emergent wetlands) and beaches because the operator is using horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive habitats. Additionally, the proposed route traverses open water to the extent possible.

See Table 4-13 for projected coastal pipelines due to the proposed actions; for existing and projected coastal pipelines as a result of the OCS Program, see Table 4-14.

4.1.2.1.8. Coastal Barging

It is projected that of the percentage of OCS oil barged (<1%) from offshore platforms to shore bases will continue to be only a small portion of the total amount of oil barged in coastal waters. There is a tremendous amount of barging that occurs in the coastal waters of the Gulf of Mexico, and no estimates exist of the volume of this barging that is attributable to the OCS industry. Secondary barging of OCS oil often occurs between terminals or from terminals to refineries. Oil that is piped to shore facilities and terminals is often subsequently transported by barge up rivers, through the Gulf Intracoastal Waterway, or along the coast.

The current rate (<1%) of OCS barging is expected to continue and is not likely to make up a significantly larger percentage of the total oil barged than what is currently occurring.

4.1.2.1.9. Navigation Channels

The current system of navigation channels around the northern Gulf is believed to be generally adequate to accommodate traffic generated by a proposed action and the future OCS Program. Gulf-to-port channels and the Gulf of Mexico Intracoastal Waterway that support the prospective ports are sufficiently deep and wide enough to handle the additional traffic. As exploration and development activities increase on deepwater leases in the Gulf, vessels with generally deeper drafts and longer ranges will be used as needed to support deepwater activities. Therefore, several OCS-related port channels may be deepened or widened during the life of a proposed action to accommodate deeper draft vessels. Typically, no channel deeper than 8 m will be needed to accommodate these deeper draft vessels.

Proposed Action Scenario: Current navigation channels will not change as a result of a proposed action in the CPA or WPA. In addition, no new navigation channels will be required by a proposed action in the CPA or WPA.

OCS Program Scenario: A few OCS-related port channels may be deepened or widened during the 2003-2042 period to accommodate deeper draft vessels necessary for deepwater development. The OCS Program will require no new navigation channels.

4.1.2.1.10. Discharges and Wastes

4.1.2.1.10.1. Onshore Facility Discharges

The primary onshore facilities that support offshore oil and gas activities include service bases, helicopter hubs at local ports/service bases, construction facilities (platform fabrication yards, pipeyards, shipyards), processing facilities (refineries, gas processing plants, petrochemical plants), and terminals (pipeline shore facilities, barge terminals, tanker port areas). A detailed description of these facilities is given in Chapter 3.3.3.8. Discharges from these facilities can be divided into point sources and nonpoint sources. The USEPA regulates point-source discharges as part of the National Pollution Discharge Elimination System (NPDES). Facilities are issued individual permits that limit discharges specific to the facility type and the waterbody receiving the discharge. The USEPA is currently assessing methods of regulating nonpoint-source discharges, which are primarily run-off from facilities. Other wastes generated at these facilities are handled by local municipal and solid waste facilities, which are also regulated by USEPA.

4.1.2.1.10.2. Coastal Service-Vessel Discharges

Operational discharges from vessels include sanitary and domestic water, bilge waters, and ballast waters. Support-vessel operators servicing the OCS industry offshore may still legally discharge oily bilge waters in coastal waters, but they must treat the bilge water to limit its oil content to 15 parts per million prior to discharge. Sanitary wastes are treated on-board ship prior to discharge. State and local governments regulate domestic or gray water discharges.

4.1.2.1.10.3. Offshore Wastes Disposed Onshore

All wastes that are not permitted to be discharged offshore by the USEPA must be transported to shore via service vessels or reinjected downhole. Drilling muds and cuttings from operations that use oil-based drilling fluids (OBF) or synthetic-based drilling fluids (SBF) cannot be discharged offshore. The USEPA Region 4 also does not permit the discharge of cuttings wetted with SBF. Drill cuttings contaminated with hydrocarbons from the reservoir fluid must also be disposed of onshore. Prior to 1993, an estimated 12 percent of drilling fluids and 2 percent of cuttings failed NPDES compliance criteria and were required to be reinjected or brought to shore for disposal (USEPA, 1993a and b); these pre-1993 percentages are based on data related to the use of OBF. More recent data is not available; however, the increased use of SBF and the discharge of the derived cuttings may result in a decrease in drilling waste brought to shore. Regular supply boats can carry 10 cutting boxes on deck and store 2,500 bbl of fluids in tanks below deck; dedicated supply boats carry 16 cutting boxes and can store 2,500 bbl of fluids below deck (USEPA, 1993a and b).

The USEPA allows treatment, workover, and completions (TWC) fluids to be commingled with the produced-water stream if the combined produced-water/TWC discharges pass the toxicity test requirements of the NPDES permit. Facilities with less than 10 producing wells may not have enough produced water to be able to effectively commingle the TWC fluids with the produced-water stream (USEPA, 1993a and b). Analysis of the MMS database shows that about 73 percent of all platform complexes have less than 10 well slots and therefore must bring their waste to shore. Spent TWC fluid is stored in tanks on tending workboats or is stored on platforms and later transported to shore on supply boats or workboats. Once onshore, the TWC wastes are transferred to commercial waste-treatment facility barges and disposed of down commercial disposal wells. Offshore wells are projected to generate an average volume of 200 bbl from either a well treatment or workover job every 4 years. Each new well completion will generate about 150 bbl of completion fluid.

Current USEPA NPDES general permits prohibit operators in the Gulf of Mexico from discharging any produced sands offshore. Cutting boxes (15- to 25-bbl capacities), 55-gallon steel drums, and cone-bottom portable tanks are used to transport the solids to shore via offshore service vessels. Total produced sand from a typical platform is estimated to be 0-35 bbl/day (USEPA, 1993a and b).

4.1.2.1.10.4. Beached Trash and Debris

Trash lost overboard from OCS platforms and support activities can wash ashore on Gulf coastal lands, reducing their attractiveness. However, according to The Ocean Conservancy (formerly The Center for Marine Conservation), beach-goers are a prime source of beach pollution, leaving behind nearly 75 tons of trash per week. Millions of annual visitors attracted to the coast are responsible in large part for the trash and debris that litter coastal lands. Other sources of coastal trash are runoff from storm drains and antiquated storm and sewage systems in older cities. Such systems allow co-mingling and overflows of raw sewage and industrial waste into nearby rivers and coastal areas. Also involved in production of trash and debris are commercial and recreational fishers who discard plastics (for example, ropes, buoys, fishing line and nets, strapping bands, and sheeting), wood, and metal traps.

The Ocean Conservancy sponsors a national marine-debris monitoring program. Data from these efforts in the Gulf of Mexico coastal area are shown in Table 4-15. The cleanup activities take place on all beaches—river, lake, and sea—and adjacent waters. The table indicates the quantities of trash and the location, but it does not indicate the assumed or suspected source of the debris.

Some trash items, such as glass, pieces of steel, and drums with chemical or chemical residues, can also be a health threat to local water supplies, to beachfront residents, and to users of recreational beaches. Cleanup of OCS trash and debris from coastal beaches adds to operation and maintenance costs for coastal beach and park administrators.

4.1.2.1.11. Noise

Coastal noise associated with OCS oil and gas development results from helicopter and service-vessel traffic. Sound generated from these activities can be transmitted through both air and water, and may be continuous or transient. The intensity and frequency of the noise emissions are highly variable, both between and among these sources. The level of underwater sound detected depends on receiver depth and aspect, and the strength/frequencies of the noise source. The duration that a passing airborne or surface sound source can be received underwater may be increased in shallow water by multiple reflections (echoes).

Service vessels and helicopters (discussed also in Chapters 4.1.1.3.8.4 and 4.1.1.3.8.5) may add noise to broad areas. Sound generated from helicopter and service-vessel traffic is transient in nature and extremely variable in intensity.

Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al., 1995). Helicopters often radiate more sound forward than backward, and the underwater noise is generally brief in duration, compared with the duration of audibility in the air. Water depth and bottom conditions strongly influence propagation and levels of underwater noise from passing aircraft. Lateral propagation of sound is greater in shallow than in deep water. Helicopters, while flying offshore, generally maintain altitudes above 700 ft during transit to and from the working area. A range of 6,000-22,000 helicopter trips is projected to occur annually as a result of a proposed action in the CPA. A range of 3,000-10,000 helicopter trips is projected to occur annually as a result of a proposed action in the WPA.

Service vessels transmit noise through both air and water. 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). Propeller cavitation is usually the dominant noise source. The intensity of noise from service vessels is roughly related to ship size and speed. Sounds from support boats range from 400 to 7,000 Hz at 120-160 dB (USDOC, NMFS, 1984). Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. Noise increases with ship speed; ship speeds are often reduced in restricted coastal waters and navigation channels. A range 2,000 - 3,000 service-vessel trips is projected to occur annually as a result of a proposed action in the CPA.

About 1,000 service-vessel trips are projected to occur annually as a result of a proposed action in the WPA.

4.1.3. Other Cumulative Activities Scenario

4.1.3.1. State Oil and Gas Activities

4.1.3.1.1. Leasing and Production

Texas

The Lands and Minerals Division of the Texas General Land Office holds quarterly lease sales on the first Tuesday in January, April, July, and October of each year. Prior to July 1999, biannual sales were held.

The Texas coast is the largest along the Gulf of Mexico, spanning 400 mi and encompassing 12 counties. Texas also has the largest legal area of land extending Gulfward. Initially all coastal states owned 3 mi of land into the Gulf of Mexico; however, with the enactment of the Submerged Lands Act and its interpretation by the Supreme Court in 1960, Texas land extends 3 marine leagues (10.4 mi). The State of Texas has authority over and owns the water, beds, and shores of the Gulf of Mexico equaling nearly 2.5 million ac.

The growth of the oil industry in the 20th century helped reform the State's land policy from an emphasis on income through the sale of land to an emphasis on income through resource management and development. The Texas General Land Office is directly responsible for the management of more than 22 million acres of land that remains in the public domain. According to the Relinquishment Act of 1919, a surface owner acts as leasing agent for the State on privately owned land where the State retains the mineral rights, and the State and surface owner share rentals, royalties, and bonuses.

The Texas Land Commissioner is authorized to lease designated public land for oil and gas production and it now accounts for most of the income derived from public land. The State receives revenues from royalties, rentals, and bonuses. In addition to being leased for mineral production, land is leased for hunting, grazing, fishing, and commercial development. Land trades, experimental projects and in-kind gas sales also provide revenue for the State. The Railroad Commission of Texas is the agency charged by the Texas Legislature with the regulation of the oil and gas industry in the State of Texas. The Commission's primary regulatory responsibilities are protecting the correlative rights of the mineral interest owners, preventing the waste of otherwise recoverable natural resources, and protecting the environment from pollution by oil and gas exploration and production activities.

In recent years, oil and gas production in the State of Texas has been declining. From 1978 to 1998 annual crude oil production fell from 1,040,966 Mbbl to 457,499 Mbbl. However, in that same timeframe, the number of producing oil wells rose from 166,65 to 170,288. Natural gas production has shown a similar trend over the same period. From 1978 to 1998, Texas natural gas production fell from 7,077.1 tcf to 5,772.1 tcf and the number of producing gas wells rose from 33,157 to 58,436. Texas offshore oil and gas production for the year 2000 was 41,106 tcf of natural gas and 520,352 bbl of oil. Texas offshore oil and gas production for the year 2001 (as of May 2001) is 18,057 tcf of natural gas and 210,783 bbl of oil (Texas Railroad Commission, 2001).

Louisiana

The Office of Mineral Resources holds regularly scheduled lease sales on the second Wednesday of every month. The first oil production in commercial quantities occurred in 1901 and it marked the beginning of the industry in the State. The first over-water drilling in America occurred in 1910 in Caddo Lake near Shreveport. The State began its offshore history in 1947. The territorial waters of Louisiana extend Gulfward for 3 mi and its shoreline extends nearly 350 mi.

Louisiana, through its aggressive minerals management programs, became the nation's third leading producer of natural gas and the number four producer of crude oil in the country. When including the oil and gas production in the Gulf of Mexico, Louisiana becomes the second leading natural gas producer in the country and the third leading crude oil producer. There are 19 active refineries in the State of Louisiana, which accounts for 15 percent of the total refining capacity in the United States. There are thousands of miles of pipelines in the State carrying crude oil from the Gulf of Mexico to refineries in

Louisiana and other states, as well as carrying natural gas throughout the United States (Louisiana Mid-Continent Oil and Gas Association, 2001).

In 1999, Louisiana offshore production totaled 12.8 MMbbl of crude oil from about 554 offshore oil wells and 147.5 tcf of natural gas from about 177 natural gas wells. In the same year, 44,645 persons were employed in the oil and gas production industry; 28,898 persons in the chemical industry; 11,046 persons in the oil refining industry; and 693 persons in the oil pipeline industry (Louisiana Dept. of Natural Resources, 2001).

In fiscal year 1999-2000, $237,967,797 of royalties and $354,765,574 in severance tax were collected by the State on all oil and natural gas production taking place on State-owned lands and water bottoms (Louisiana Dept. of Natural Resources, 2001).

Mississippi

Mississippi's petroleum infrastructure includes four refineries and a moderately extensive network of crude oil, product, and liquefied petroleum gas pipelines. Mississippi ranks eleventh in the nation, including Federal offshore areas, in crude oil production with 54,000 bbl per day. A major propane supply hub is located at Hattiesburg, Mississippi, where the Dixie Pipeline has a network of terminals and storage facilities. Natural gas as a primary heating fuel is used by 41 percent of homeowners, followed by electricity that is used by about 31 percent (USDOE, EIA, 2001c).

The State of Mississippi only has an onshore oil and gas leasing program. In 1994 the State of Mississippi passed legislation allowing companies to enjoy substantial tax breaks based on the types of discovery involved and the methods they use. Those tax breaks range from a five-year exemption from the State's 6 percent severance tax for new discoveries to a 50 percent reduction in the tax for using 3D technology to locate new oil and gas fields, or using enhanced recovery methods.

As a result of the incentive program, 84 new oil pools have received the exemption, 108 inactive wells have been brought back into production, 13 development wells have been drilled in existing fields, 34 enhanced wells have received exemption, and 14 have receive exemptions for using 3D technology (Sheffield, 2000).

Alabama

Alabama has no established schedule of lease sales. The limited number of tracts in State waters has resulted in the State not holding regularly scheduled lease sales. The last lease sale was held in 1997.

The territorial waters of Alabama extend Gulfward for 3 nmi and its shoreline extends nearly 52 mi. The first wells drilled for oil in the southeastern United States were drilled in Lawrence County in 1865, just six years after the first oil well was drilled in the United States. The first commercially marketed natural gas production in the southeastern United States occurred in the early 1900's near Huntsville. In 1979, gas was first discovered by MOEPSI in the mouth of Mobile Bay.

Alabama owns oil, gas, and mineral interests on small upland tracts, submerged river bottoms, estuaries, bays, and in the 3-mi area offshore. Most significant economically are the natural gas reserves lying within the 3-mi offshore area of Mobile and Baldwin Counties. The Alabama State Oil and Gas Board was created after the oil discovery in 1944 in Choctaw County and is responsible for regulating the exploration and development of these natural resources. The discovery of Alabama's giant Citronelle Field in Mobile County in 1955 focused national attention on the State's oil and gas potential. Major discoveries of natural gas in the 1980's led to the development of an array of natural gas reservoirs, and Alabama became a world leader in the development of coalbed methane gas as an energy resource. The Norphlet development, which started in November 1978, results in high production rates of Norphlet Formation gas. This gas is a hot, sour, high-pressure, corrosive mixture of methane, hydrogen sulfide, carbon dioxide, and free water.

Alabama has reaped tremendous financial benefits from the development of offshore mineral resources. Revenues include severance taxes, bonuses, royalties, and rentals. At present, Alabama is considered a major oil- and gas-producing state.

As of August 2001, a total of 69 test wells have been drilled in Alabama coastal waters. Forty of these wells were permitted to test the Norphlet Formation below a depth of 20,000 ft. The 2 earliest wells were drilled to test undifferentiated rocks of Cretaceous age and 27 wells have targeted shallow Miocene gas reservoirs generally at depths of less than 3,500 ft. Operators have experienced a high success rate in drilling wells in Alabama coastal waters. A total of 28 of the 40 Norphlet Formation wells drilled to date have tested gas, and 23 of the 27 Miocene wells drilled have tested gas. Sixteen gas fields have been established in the offshore region of the State, with 7 fields being productive from the Norphlet Formation and 9 fields being productive from sands of Miocene age (Alabama State Oil and Gas Board, 2001). Indigenous crude oil production totals 29,000 bbl per day, ranking Alabama 16th out of the 32 producing states and Federal offshore areas. The State's three refineries have a combined crude oil distillation capacity of 130,000 bbl per calendar day, while several crude oil, product, and liquefied petroleum gas pipelines pass through the State (USDOE, EIA, 2001c).

Production of gas from the State's coastal waters flows through 44 fixed structures and platforms and now exceeds 220 Bcf annually. This accounts for approximately 50 percent of the total gas production in Alabama, which now ranks as one of the top 10 gas-producing states in the nation. Production capabilities for individual wells range from a few million to more than 110 million cubic feet per day (Alabama State Oil and Gas Board, 2001).

Florida

The State of Florida has experienced very limited drilling in coastal waters. At present, a moratorium has stopped drilling activity in Florida State waters, and the State has no plans for lease sales in the future. At present, no drilling rigs are operating within the State.

4.1.3.1.2. Pipeline Infrastructure for Transporting State-Produced Oil and Gas

The pipeline network in the Gulf of Mexico states is extensive. Pipelines transport crude oil and natural gas from the wellhead to the processing plants and refineries. Pipelines transport natural gas from producing states such as Texas and Louisiana and to a lesser extent Mississippi and Alabama to utility companies, chemical companies, and other users throughout the nation. Pipelines are used to transport refined petroleum products such as gasoline and diesel from refineries in the Gulf of Mexico region to markets all over the country. Pipelines are also used to transport chemical products (Louisiana Mid-Continent Oil and Gas Association, 2001).

The natural gas pipeline network has grown substantially since 1990 nationwide. The increasing growth in natural gas demand over the past several years has led to an increase in the utilization of pipelines and has resulted in some pressure for expansion in several areas. In the Gulf of Mexico, after several consecutive years of extensive pipeline development, installation of additional offshore Gulf of Mexico pipeline capacity has slowed. In 1997 and 1998, 14 natural gas pipeline projects were completed and added a total of 6.4 Bcf per day of new pipeline capacity, most of which represented large-capacity pipelines connecting onshore facilities with developing offshore sites, particularly in the deepwater areas of the Gulf. During 1999-2000, eight significant projects were completed, adding 1.8 Bcf per day to the area's pipeline capacity. The majority of these projects were built primarily to improve gathering operations and to link new and expanding producing platforms in the Gulf with recently completed offshore mainlines directed to onshore facilities (USDOE, EIA, 2001d).

Texas

The pipeline industry is a vital part of the oil and gas industry in Texas. At present, there are 218,000 mi under permit that transport natural gas, crude oil, and refined products. Of this figure, 142,000 mi are permitted to transport natural gas, 40,000 mi are permitted to transport crude oil and about 36,000 mi are permitted to transport refined products. The Railroad Commission of Texas' Pipeline Safety Section has jurisdiction for most pipelines that transport natural gas, crude oil, and refined products across Texas.

Louisiana

As in Texas, the pipeline industry is a vital part of the oil and gas industry in Louisiana. There are about 25,000 mi of pipe moving natural gas through interstate pipeline and about 7,600 mi of pipelines carrying natural gas through intrastate pipelines to users within the State's boundaries. Another 3,450 mi of pipeline in Louisiana transport crude oil and crude oil products. There are thousands of miles of flow lines and gathering lines moving oil and gas from the wellhead to separating facilities while other pipelines transport chemical products with no petroleum base. Louisiana is home to the world's only offshore superport, Louisiana Offshore Oil Port (LOOP), which allows supertankers to unload crude oil away from shore so that it can be transported via pipeline to onshore terminals. The Henry Hub in Louisiana is a hub of pipelines and is the point where financial markets determine the value of natural gas (Louisiana Mid-Continent Oil and Gas Association, 2001).

Mississippi

Petroleum infrastructure in Mississippi includes a moderately extensive network of crude oil, product, and liquefied petroleum gas pipelines. A major propane supply hub is the Dixie Pipeline has a network of terminals and storage facilities. Major pipelines for crude oil are operated by EOTT Energy, Genesis, Hunt, Shell, Mid-Valley, Scurlock-Permian, and BP. Major pipelines for liquefied petroleum gas are operated by Dixie, Plantation, Enterprise BP Dixie, and Enterprise (USDOE, EIA, 2001c).

Alabama

Petroleum infrastructure in Alabama includes a somewhat extensive network of crude oil, product, and liquefied petroleum gas pipelines. Major pipelines for crude oil are operated by Hess, Hunt, Genesis, Citronelle-Mobile, and Miller. Major pipelines for liquefied petroleum gas are operated by Dixie and Enterprise (USDOE, EIA, 2001c).

Florida

Petroleum infrastructure in Florida includes a limited network of crude oil, product, and liquefied petroleum gas pipelines. Genesis and Sunniland operate major pipelines for crude oil. Enterprise operates major pipelines for liquefied petroleum gas (USDOE, EIA, 2001c).

4.1.3.2. Other Major Offshore Activities

4.1.3.2.1. Dredged Material Disposal

Dredged material is described at 33 CFR 324 as any material excavated or dredged from navigable waters of the United States. According to the USEPA, "virtually all ocean dumping occurring today is dredged material, sediments removed from the bottom of waterbodies in order to maintain navigation channels and berthing areas" (USEPA, 1996).

In response to the Marine Protection, Research, and Sanctuaries Act of 1972, as of February 1996, the USEPA finalized the designation of 27 dredged material disposal sites in the Gulf of Mexico. Another 12 sites in the Gulf were considered interim sites pending completion of baseline or trend assessment surveys and then the final designation or termination of use of these sites (40 CFR 228.14). Since then, one interim site was approved on a final basis (40 CFR 228.15). Of the 39 designated and interim sites , 11, 21, and 7 sites are located in the WPA, CPA, and EPA, respectively. These sites range in area from 0.5 mi^2 to 9 mi^2 and are all within 20 mi of shore.

The COE issues permits for ocean dumping using USEPA's environmental criteria. These permits are subject to USEPA's concurrence. Under the Clean Water Act, the USEPA requires testing of dredge material prior to its disposal to ensure there are no unacceptable adverse impacts to the marine environment.

According to the COE's Ocean Disposal Database (ODD) more than 635 million m^3 of dredged material were disposed in the Gulf of Mexico from 1976 to 1999, which is an average of 26 million m^3 per year (U.S. Dept. of the Army, COE, 2001b). The USEPA, COE, and other interested parties are working to identify appropriate uses for dredged material rather than disposing of the material offshore. These uses may include beach nourishment or wetland habitat development.

A discussion of dredging operations in inland coastal regions around the Gulf is presented in Chapter 4.1.3.3.2.

4.1.3.2.2. Nonenergy Minerals Program in the Gulf of Mexico

This section discusses the impacts of the acquisition of nonenergy minerals (sand, shale, and gravel) from Federal waters in the CPA and WPA. There are many submerged shoals located on the OCS that are expected to be long-term sources of sand (sand borrow sites) for coastal erosion management. This sand is needed because of the general diminishing supply of onshore and nearshore sand. The renourishment cycles for beaches or coastal areas require quantities of sand that are not currently available from State sources. The offshore sites are an environmentally preferable resource because OCS sands generally lie beyond the local wave base and the influence of the nearshore physical regime where long-term dredging can result in adverse changes to the local wave climate and the beach. In addition, the offshore sites could provide compatible sand for immediate/emergency repair of beach and coastal damage from severe coastal storms. The economics of dredging in deeper waters is improving as dredging technology improves.

Sand Resources Programs

The MMS's Office of International Activities and Marine Minerals (INTERMAR) has been developing and procuring contracts to provide needed environmental information regarding environmental management of OCS sand resources. The potential for exploitation of sand resources has grown rapidly in the last several years as similar resources in State waters are being depleted or polluted. Several OCS areas are being examined as possible sources of aggregate for construction purposes. At present, there are no sand leases in the Gulf of Mexico CPA and WPA.

In 1999, the Marine Minerals component of INTERMAR published a study entitled *Environmental Survey of Identified Sand Resource Areas Offshore Alabama* (Byrnes and Hammer, 1999). This survey provided (1) an assessment of the baseline benthic ecological conditions in and around the five previously-identified proposed borrow sites (Figure 4-5); (2) evaluated the benthic infauna resident in the five potential borrow sites and assessed the potential effects of offshore dredging activity on these organisms, including an analysis of the potential rate and success of recolonization; (3) developed a schedule of the best and worst times for offshore dredging with regard to transitory pelagic species; (4) evaluated the potential for modification to waves because of offshore dredging within the five proposed sand borrow areas; and (5) evaluated the impacts of offshore dredging and subsequent beach nourishment in terms of potential alteration of sediment transport patterns, sedimentary environments, and impacts to local shoreline processes. The information gathered during this study will likely be used should a decision be made to proceed with the preparation of an EA or an EIS in support of a negotiated agreement with the State of Alabama for access to Federal sand resources. The information gathered during the course of this study will also enable MMS to monitor and assess the potential impacts of offshore dredging activities and to identify ways that dredging operations can be conducted so as to minimize or preclude long-term adverse impacts to the environment.

Another study, *Synthesis of Hard Mineral Resources on the Florida Panhandle Shelf: Spatial Distribution and Subsurface Evaluation* (McBride, 1999), produced regional baseline information on the hard mineral resources, geologic framework, and long-term sediment dynamics of the Florida Panhandle Shelf (Mobile Bay, Alabama, to Choctawhatchee, Florida (Figure 4-6)). The study's objectives were to (1) quantify hard mineral resource deposits; (2) establish the regional three-dimensional architecture of hard mineral deposits; (3) produce seafloor elevation models; (4) determine patterns and processes of shelf sediment transport; (5) integrate seafloor elevation models with geologic data to establish form-process relationships; (6) disseminate research results; and (7) incorporate appropriate data on hard minerals into the LSU Coastal Studies Institute's Gulfwide Information System.

The *Wave Climate and Bottom Boundary Layer Dynamics with Implications for Offshore Sand Mining and Barrier Island Replenishment in South-Central Louisiana* (Stone, in preparation) study produced measurements of wave characteristics at two locations on Ship Shoal to validate a spectral wave propagation model (STWAVE). The objectives of the study were to (1) obtain direct field measurements of bottom boundary layer hydrodynamic processes and suspended sediment transport; and (2) obtain direct field measurements of temporally and spatially varying directional wave parameters at several locations on Ship Shoal.

Sand sources that are to be used on a continual, multiyear, multiuse basis may require biological/physical monitoring to ensure that long-term adverse impacts to the marine and coastal environment do not occur. However, there exists no standard approach or methodology for properly monitoring the effects of ongoing dredging operations. The ongoing INTERMAR study, *Design of a Monitoring Protocol/Plan for Environmentally Sound Management and Development of Federal Offshore Sand Borrow Areas Along the United States East and Gulf of Mexico Coasts*, will address those concerns and issues. In addition, extensive damage to a beach area as the result of a severe storm may necessitate that a sand borrow area be used prior to the completion of the environmental work needed to support decisions on conditions of lease agreements. Therefore, some form of "conditions of approval" or "stipulation(s)" might be necessary if leases are to be issued.

The objectives of the above study are as follows:

- to provide MMS with an appropriate and sound design for a physical/biological monitoring system to evaluate the near-term, long-term, and cumulative effects of using Federal sand borrow areas on the U.S. East and Gulf Coasts;
- to examine the feasibility and appropriateness of including Federal, State, and local authorities with an interest in the use of offshore Federal sand in a regional management concept for developing ways to assure and monitor the responsible, environmentally sound, long-term management of Federal offshore sand areas; and
- if, in Year 1 of the study, the study team determines that it is feasible and appropriate to manage Federal offshore sand resources on a regional basis, to develop detailed plans and fully identify the relevant parties by geographic area to meet the needs of Federal, State, and local interests to facilitate the environmentally acceptable and cost-effective near and long-term use of Federal sand borrow areas offshore the U.S. East and Gulf of Mexico coasts.

In many cases, physical and biological monitoring of borrow areas may be necessary to preclude adverse impacts to the marine environment. An appropriate "condition of approval" or "stipulation" to support a lease for these areas might be the monitoring of the biological and physical regime during operations to ensure that no adverse impacts are or will occur. The study outlined above would provide a blueprint for these monitoring operations. To date, proposed coastal erosion management projects have been examined on a case-by-case, project-specific basis. These resources must be managed on a long-term, system-wide basis in such a way as to ensure that environmental damage will not occur as a result of continual and prolonged use.

4.1.3.2.3. Marine Transportation

An extensive maritime industry exists in the northern Gulf of Mexico. Figure 3-11 showed the major ports and domestic waterways in the analysis area, while Tables 3-30 and 3-31 presented the 1999 channel depth, number of trips, and freight traffic of OCS-related waterways. Marine transportation within the analysis area should grow linearly based on historical freight traffic statistics given current conditions. Should any infrastructure changes occur, then the marine transportation would reflect these changes. For example, if a port in the analysis area (or outside the analysis area) deepened its channel or constructed new railroads or highways into the port area, then the number of trips and the volume of commodities into and out of the port would change accordingly. Or if a refinery near one of the ports were to close, then tanker traffic to that port may decrease.

Tanker imports and exports of crude and petroleum products into the Gulf of Mexico are projected to increase (USDOE, EIA, 2001a). In 2000, approximately 2.08 BBO of crude oil (38 percent of U.S. total) and 1.09 BBO of petroleum products (13 percent of U.S. total) moved through analysis area ports. By the year 2020, these volumes are projected to grow to 2.79 BBO of crude oil and 1.77 BBO of petroleum products. Crude oil will continue to be tankard into the Gulf of Mexico for refining from Alaska, California, and the Atlantic.

Proposed Action Scenario: Marine transportation is not expected to change as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: The number of trips and volume of commodities into and out of analysis area ports are expected to grow linearly based on historical freight traffic statistics. OCS Program activities over the 2003-2042 period are not expected to change marine transportation.

4.1.3.2.4. Military Activities

The air space over the Gulf of Mexico is used extensively by the Department of Defense (DOD) for conducting various air-to-air and air-to-surface operations. Nine military warning areas and five water test areas are located within the Gulf (Figure 2-1). These warning and water test areas are multiple-use areas where military operations and oil and gas development have coexisted without conflict for many years.

The Western Gulf has four warning areas that are used for military operations. The areas total approximately 21 million ac or 58 percent of the area of the WPA.

In addition, six blocks in the Western Gulf are used by the Navy for mine warfare testing and training. Mustang Island Area Blocks 793, 799, and 816 have been excluded from proposed action. Mustang Island Area Blocks 59, 147, 228, 602, 775, 790, 191, 798, 821, and 822; and Mustang Island Area, East Addition, Blocks 732, 733, and 734 will carry multiuse mitigation stipulations, if leased.

The CPA has five designated military warning areas that are used for military operations. These areas total approximately 11.3 million ac. Portions of the Eglin Water Test Areas (EWTA) comprise an additional 0.5 million ac in the CPA. The total 11.8 million ac is about 25 percent of the area of the CPA.

4.1.3.2.5. Artificial Reefs and Rigs-to-Reefs Development

Artificial reefs have been used along the coastline of the United States since the early 19th century. Stone (1974) documented that the use of obsolete materials to create artificial reefs has provided valuable habitat for numerous species of fish in areas devoid of natural hard bottom. Stone et al. (1979) found reefs in marine waters not only attract fish, but in some instances also enhance the production of fish.

All OCS platforms have the potential to serve as artificial reefs. Offshore oil and gas platforms began providing artificial reef substrate in the Gulf of Mexico with the first platform installation in 1942. At present, there are nearly 4,000 platforms operating on the Gulf OCS. Of these platforms, 87 percent are in the CPA and 13 percent are in the WPA. The number changes as platforms are installed and removed on a regular basis. Figure 9-5 shows the distribution of oil and gas platforms across the Gulf of Mexico. These platforms comprise a large percentage of hard substrate in the Gulf. Consequently, this hard substrate has created the most extensive *de facto* artificial reef system in the world (Dauterive, 2000; Reggio, 1987; Stanley 1994).

Historically, approximately 8 percent of the platforms decommissioned in the Gulf OCS have become used in the Rigs-to-Reefs (RTR) program. The RTR development anticipated for the OCS Program for the years 2003-2042 is expected to increase and to exceed the number of RTR's that have resulted since the initial artificial reef and RTR projects in 1979 and 1982, respectively (Dauterive, 2000). This projection is based on the fact that the number of platform removals (1,258) during the 10-year period 1990-1999 almost kept pace with the number of platforms installed (1,414) during the same period (Chapter 9.1.5). Also, the number of platform removals in 1990-1999 (1,258) exceeded the total number of platforms removed during the previous 16 years (the first platform removal occurred in 1974). The increased rate of removals in the 1990's provided a greater number of platforms available for RTR. This platform removal rate is projected to continue through the years 2003-2042. The exact number and percentage of the 4,149 platforms projected to be removed that will be available for RTR will be dependent on the location and water depth of the platforms.

Proposed Action Scenario: The number of platforms projected for a proposed action in the CPA is 28-50 and in the WPA it is 11-17 (Tables 4-2 and 4-3). All platforms installed and serving as *de facto* artificial reefs under a proposed action in the CPA or WPA are projected to be removed by the end of the analysis period. The maximum number of RTR's anticipated as a result of a proposed action in the CPA is 5 and in the WPA it is 2 (approximately 10% of the maximum number of platforms decommissioned and removed). This number could vary, however, depending on where and in what water depth the platforms are installed.

OCS Program Scenario: For the OCS Program for the years 2003-2042, a total of 4,149 platforms are projected to be installed. This number includes platforms projected to be installed in the WPA, CPA, and EPA during this 40-year period from past and future lease sales as well as from the proposed actions (Tables 4-2 through 4-7). If approximately 10 percent of these decommissioned platforms were to be used for RTR's, there may be as many as 400 additional RTR's Gulfwide.

4.1.3.3. Other Major Influencing Factors on Coastal Environments

4.1.3.3.1. Submergence of Wetlands

Submergence of wetlands along the Gulf Coast is caused by eustatic sea-level rise and land subsidence. Eustatic sea-level rise is caused by the reduction of the volume of water stored in the polar ice caps. Land subsidence is caused by a variety of localized natural and manmade events such as down-warping or horizontal movement of the earth's crust; weighted surface compression; and oxidation, consolidation, settling, and dewatering of surface sediments (Swanson and Thurlow, 1973). In localized areas, subsidence and sea-level rise can be offset by sedimentation, placement of dredged material, and peat formation.

During this century, the rate of eustatic sea-level rise along the Louisiana coast has been relatively constant at 2.3 mm/yr (23 cm/century), although the rate has varied from a sea-level decrease of 3 mm/yr to a maximum increase of 10 mm/yr over decade-long periods (Turner and Cahoon, 1988). Submergence in the Gulf is occurring most rapidly along the Louisiana coast and more slowly in other coastal states. Depending on local geologic conditions, the subsidence rate varies across coastal Louisiana from 3 to 10 mm/yr. One of the major factors causing greater submergence rates in Louisiana is reduced sedimentation, resulting from deltaic abandonment, flood control, and channelization of the Mississippi River.

Fluid withdrawal can cause localized subsidence above the producing reservoirs. In coastal Louisiana, about 400 km^2 of wetlands have a subsidence potential greater than 10 cm because of fluid withdrawal (Turner and Cahoon, 1988).

4.1.3.3.2. River Development and Flood Control Projects

In recent decades, alterations in the upstream hydrology of the rivers draining into the northern Gulf of Mexico have resulted in a variety of coastal impacts. Dams and reservoirs on upstream tributaries trap much of the sediment load in the rivers. The suspended sediment load of the Mississippi River has decreased nearly 60 percent since the 1950's, largely as a result of dam and reservoir construction upstream (Tuttle and Combe, 1981; Turner and Cahoon, 1988).

In a natural system, over-bank flooding introduces sediments into adjoining wetlands. Flood control on the Mississippi and other rivers has largely eliminated flood-borne sedimentation in the Gulf coastal wetlands, contributing to their deterioration.

Channelization of the Mississippi and other rivers in conjunction with flood control levees has also contributed to wetland loss and has interrupted wetland creation around the Gulf by preventing distribution of alluvial sediments across deltas and flood plains. Prior to channelization, the flow of rivers was distributed among several distributary channels that delivered sediment over a broad area during high river stages. Today, sediment from the Mississippi River is primarily discharged through the main channel directly to the deep waters of the continental slope. The only significant exception to this scenario is the diversion of approximately 30 percent of the Mississippi River flow to the Atchafalaya River; this diversion does not capture 30 percent of the sediment flow, however, since most of the sediment is restricted to the deeper river channel.

4.1.3.3.3. Dredging

Dredging operations include sediment and gravel harvesting; pipeline installation; canal installation, maintenance, and modifications; harbor installation and maintenance; and stream channelization.

Numerous channels are maintained throughout the onshore cumulative activity area by Federal, State, county, commercial, and private interests. Proposals for new and maintenance dredging projects are reviewed by Federal, State, and county agencies as well as by private and commercial interests to identify and mitigate adverse impacts upon social, economic, and environmental resources.

Typically, the COE schedules surveys every two years on each navigation channel under its responsibility to determine the need for maintenance dredging. Maintenance dredging is then performed on an as-needed basis. Dredging cycles vary broadly from channel to channel and from channel segment to channel segment. A cycle may be 1-6 years. The COE is charged with maintaining all larger navigation channels in the cumulative activity area. The COE dredges millions of m^3 of dredged material per year in the cumulative activity area. Some shallower port-access channels may be deepened over the next 10 years to accommodate deeper draft vessels. These vessels, which support deepwater OCS activities, may include those with drafts to about 7 m.

Materials from maintenance dredging are primarily disposed of on existing dredged-material disposal banks and in dredged-material disposal areas. Additional dredged-material disposal areas for maintenance or new-project dredging are developed as needed and must be evaluated and permitted by the COE and relevant State agencies prior to construction. Some dredged sediments are dispersed into offshore waters at established offshore disposal sites.

When placing the material on a typical dredged material disposal site, the usual fluid nature of the mud and subsequent erosion causes widening of the site, which may bury adjacent wetlands, submerged vegetation, or nonvegetated water bottoms. Consequently, adjacent soil surfaces may be elevated, converting wetlands to uplands, fringes of shallow waterbodies to wetlands, and some nonvegetated water bottoms to shallower water bottoms or emergent areas that may become vegetated due to increased light at the new soil surface.

Dredged materials from channels are often contaminated with toxic heavy metals, organic chemicals, pesticides, oil and grease, and other pollutants originating from municipal, industrial, and vessel discharges and nonpoint sources, and thus can result in contamination of areas formerly isolated from major anthropogenic sources (USEPA, 1979). The vicinities around harbors and industrial sites are most noted for this problem. Hence, sediment discharges from dredging operations can be major point sources of pollution in coastal waters in and around the Gulf. In addition, inland and shallow offshore disposal can change the navigability and natural flow or circulation of waterbodies.

In 1989, USEPA estimated that more than 90 percent of the volume of material dumped in the oceans around the U.S. consisted of sediments dredged from U.S. harbors and channels (USEPA, 1989a). As of February 1997, in response to the Marine Protection, Research, and Sanctuaries Act of 1972, USEPA had finalized the designation of eight dredged-material disposal sites in the cumulative activity area. Another four sites in the Gulf are considered interim sites for dredged-material disposal. These sites primarily facilitate the COE's bar-channel dredging program. Generally, each bar channel of navigation channels connecting the Gulf and inland regions has 1-3 disposal sites used for disposal of maintenance dredged material. These are usually located in State waters. Some designated sites have never been used.

Installation and maintenance of any navigation channel and many pipeline canals connecting two or more waterbodies changes the hydrodynamics in their vicinity. These changes are typically associated with saltwater intrusion, reduced freshwater retention, changed circulation patterns, changed flow velocities, and erosion. When these channels are permitted for construction through sensitive wetland habitats or when sites are permitted for dredged-material disposal, measures are required to mitigate unavoidable adverse environmental impacts. Structures constructed to mitigate adverse hydrodynamic impacts and accelerated erosion include dams, weirs, bulkheads, rip-rap, shell/gravel mats, and gobi mats.

Typically, little or no maintenance is performed on mitigation structures. Without maintenance, many mitigation facilities, particularly in regions where the soil is poorly consolidated and has a high organic content, are known to become ineffective within a few years of construction. The number of mitigation structures associated with navigation and pipeline channels is unknown.

4.1.3.4. Major Sources of Oil Contamination in the Gulf of Mexico

Petroleum hydrocarbons can enter the Gulf of Mexico from a number of offshore, coastal, and land-based sources. Major sources of petroleum hydrocarbons into Gulf waters include (1) natural seeps; (2) accidental spills; (3) operational discharges from oil industry and maritime operations; (4) atmospheric inputs; (5) coastal, municipal, and industrial waste discharges; and (6) urban and river runoff. Information on most of these sources is summarized below. The presence of petroleum hydrocarbons in the marine environment is, to some extent, unavoidable. Hydrocarbons in Gulf waters have been identified as generated by both natural geochemical processes and from anthropogenic inputs (pyrogenic and petrogenic). The onshore anthropogenic sources of hydrocarbons to Gulf waters (the small, chronic leaks, waste discharges from the daily activities of society, and accidents) far outweigh the sources from offshore domestic production of oil.

Mass Balance of Oil Inputs into Gulf Waters

The MMS completed a mass balance of the major sources of oil inputs entering Gulf waters in 1995. It is provided here to give a perspective of the relative contribution of OCS operations compared to other sources of oil that could enter Gulf waters. It is important to understand that this exercise provides only "order-of-magnitude" estimates. There are major problems associated with any attempt to establish values for the inputs and flux of oil into the Gulf. The approach taken here is to use the concepts, assumptions, and estimates (when applicable) developed by the National Academy of Sciences (NAS) (NRC, 1985) and to apply them to Gulf of Mexico values. When possible, any sources that revised NAS estimates or assumptions were also used. The numbers have been revised to reflect the current projections of spills (discussed below). The contribution from petroleum sources from Mexico and Cuba was not calculated.

At present, the National Research Council, Ocean Science Board of the NAS, is updating the NAS estimates for oil in the sea relied on for this analysis. The MMS is working with the subcommittee in updating the contribution of all sources to the world ocean. However, results are not available at this time. The mass balance shown in Table 4-16 was calculated in 1995. The MMS has recalculated the contribution from spills based on the calculations used in Table 4-17. Although minor changes to the total volumes have occurred, these changes do not modify Table 4-16.

4.1.3.4.1. Inputs from Natural Seeps

Naturally occurring hydrocarbon seepage has long been identified as a significant source of hydrocarbons. Tarballs coming from natural seeps were used by early indigenous man living along the Gulf Coast to construct hunting tools. Given that the Gulf is a prolific petroleum-producing province, its seafloor is pocketed with areas from which oil and gas seeps. Accurately calculating the volume of oil naturally seeping is problematic. Often the volume measured floating on the surface of the water or beached has been used as the best indicator of the volume originally seeped. MacDonald et al. (1993) estimated the volume of natural seepage for an area of the continental slope off Louisiana by using satellite imagery. He estimated a natural seepage rate of about 120,000 bbl per year (0.016 Mta) from a 23,000 km^2 area. Earlier estimates by Wilson et al. (1973) were based on the geologic potential of one area relative to another. Wilson estimated that the U.S. and Mexican Gulf areas could be seeping as much as 204,000 bbl of oil per year (0.027 Mta) (Table 4-15). Given that MacDonald's estimate would be a significant subset of Wilson's estimates, the numbers appear to be within reason. This mass balance relies on Wilson's earlier estimate, despite the limitations of its calculations.

4.1.3.4.2. Inputs from Spills

The total contribution of petroleum inputs to Gulf waters from spills is estimated to be about 80,000 bbl per year or 0.01 million metric tons annually (Mta). The projected contribution from non-OCS-related spills is an order of magnitude greater than the amount projected to be spilled annually from OCS-related spills.

Oil spills can happen from a large variety of sources, including tankers, barges, other vessels, pipelines, storage tanks and facilities, production wells, trucks, railcars, and mystery sources. Spills are usually accidental but can include intentional releases of oil cargo, fuel and bunker oils, machinery space, and bilge oil.

4.1.3.4.2.1. Trends in Spill Volumes and Numbers

Databases on spills that have occurred in the Gulf of Mexico are not completed. As almost 38 percent of all U.S. spills have occurred within the waters of the Gulf of Mexico and Gulf Coast States, the trends for all U.S. spills is assumed to be representative of trends in spills that have occurred in the northern Gulf of Mexico. The following is a summary of what is known about trends in U.S. spill risk and is derived from USGS data (USDOT, Coast Guard, 2001a):

- Volumes
  - The volume of spill incidents in U.S. waters has been on a steady downward trend since 1973. There has been a general downward trend in the number of spills over 1,000 gallons (24 bbl).
  - There have been no oil spills over a million gallons since 1991.
  - The majority of spills since 1973 involved discharges between 1 and 100 gallons.
  - The decline in oil-spill volume, particularly in the face of growing domestic demand for imported oil, represents the combined effects of an increasingly effective campaign of positive prevention and preparedness initiatives to protect U.S. coastal waters from oil pollution.
  - The total volume of oil spilled per year is significantly declining. The total volume spilled in 2000 is at the lowest amount in ove r25 years.
  - The total number of spill incidents remains relatively constant from year to year.
- Location
  - 75.1 percent of all spills from 1973 to 2000 occurred within 3 nmi of shore.
  - 83.8 percent of the volume of all spills occurred in waters within 3 nmi of shore.
  - Overall, the greater majority of spills and spill volumes occur in Gulf of Mexico coastal waters and rivers draining into the Gulf; 63.7% of all spills from 1973 to 2000 occurred on rivers, canals, harbors, and in the Gulf of Mexico.
- Sources
  - Spills from tank vessels (ships/barges) account for the majority of volume spilled.
  - 32 percent of the number of all spills from 1973 to 2000 occurred from non-tank vessels; 25.2 percent were "mystery" spills; 29.1 percent were from facilities and other non-vessels; 10.2 percent were from tank vessels (ships and barges carrying oil); and 3.5 percent were from pipelines.
  - 46.8 percent of the volume of oil spilled from 1973 to 2000 came from tank vessels; 22 percent from facilities and other non-vessels; 17.5 percent from pipelines; 7.7 percent from mystery spills; and 5.9 percent from non-tank vessels.
  - The rates for oil spills ≥ 1,000 bbl from OCS platforms, tankers, and barges continues to decline.
- Types of Oil
  - A combination of crude oil and heavy oil is the type of oil with the greatest volumes spilled (62%).
  - Crude oil and heavy oil were the most frequent types of oil spilled (36% of the number of spills from 1973 to 2000 were the discharge of crude oil or heavy oil).

4.1.3.4.2.2. Projections of Future Spill Events

Table 4-16 provides the estimated number of all spill events that the MMS projects will occur within coastal and offshore waters of the Gulf of Mexico area for a representative future year (around 15 years after the proposed action). No annual average for all spills is appropriate because the timeframes and peak years vary for the different types of activities that could spill oil. State oil production in the U.S. is expected to decline over the next 15 years or so. Because the energy needs of this Nation are projected to continue to increase dramatically, any decline in domestic oil production must be replaced by imports of both crude oil and petroleum products from outside this country or replaced by alternative energy sources.

The projections of future spill occurrences shown in Table 4-16 were formulated using the following sources: an MMS analysis of the USCG database on spill incidents in all navigable waters (USDOT, Coast Guard, 2001a), an analysis completed on MMS's database, an analysis of crude oil and petroleum product spills ≥ 1,000 bbl from OCS operations, and tanker and barge operations (Anderson and LaBelle, 2000); and a 1992 analysis of spills that projected tanker and barge spills as a function of volumes of oil moved in Gulf waters by various transport modes (Rainey, 1992). Database information was supplemented by personal communications with a number of individuals dealing with vessel transport and oil-spill incidents in the Gulf of Mexico area. See Table 4-18 for the spill occurrence rates for spills used in these calculations.

4.1.3.4.2.3. OCS-Related Offshore Oil Spills

Spills could happen because of an accident associated with future OCS operations. Spills estimated to occur as a result of a proposed action (Chapter 4.4.1.) are a subset of all potential OCS spills; therefore, the discussion and information found in Chapter 4.4.1.4 on MMS estimates of future spill sizes, characteristics, and fate is incorporated here by reference.

Probability of OCS Offshore Spills ≥ 1,000 bbl Occurring: The probabilities of one or more offshore spills ≥1,000 bbl occurring from future OCS operations are provided in Table 4-19. The last column in the table provides the chance of one or more spills occurring for each planning area and for Gulfwide OCS operations. For the Gulfwide OCS Program, there is a greater than 99 percent chance that there will be an offshore spill ≥1,000 bbl occurring in the next 40 years.

Probability of OCS Offshore Spills ≥ 10,000 bbl Occurring: The probabilities of one or more offshore spills ≥10,000 bbl occurring from future OCS operations are provided in Table 4-19. The last column in the table provides the chance of one or more spills occurring for each planning area and for Gulfwide OCS operations. For the Gulfwide OCS Program, there is greater than a 99 percent chance that one or more spills ≥10,000 bbl will occur in the next 40 years.

Mean Number of OCS Offshore Spills (OCS Program): Based on a statistical analysis of spill rates and projected sources, and using the low and high resource estimates, MMS projected the mean number of offshore oil-spill events estimated to occur and the likelihood that these events will occur from OCS Program activities. Table 4-19 provides the mean number of offshore spills ≥1,000 bbl and ≥10,000 bbl estimated by source and for each planning area, as well as the Gulfwide OCS Program. The mean number of spills ≥1,000 bbl that could happen from future Gulfwide OCS Program operations during a 40-year period is estimated to be between 23 and 33 spills; the mean number of spills >10,000 bbl for the Gulfwide OCS Program is estimated to be between 6 and 9 spills.

The estimated number of possible spills ≥1,000 bbl that could occur shows a widespread frequency distribution. Figures 4-7, 4-8, and 4-9 show that there is a great deal of uncertainty as to the number of future OCS spills that will occur. If the low resource estimate is realized, the number of possible spills ≥1,000 bbl that could occur ranges from 13 to 35, with a mean number of 23 spills estimated. For the high resource estimate, the number ranges from 21 to 40, with the mean number being 33. The mean number of spills that could occur was estimated by the MMS for different size categories for the Gulfwide OCS Program. The following table provides MMS's estimate of the mean number of spills to occur in each size grouping.

Estimated Number of Offshore Spill Events (mean)
by Size Category for Different OCS Oil Development Scenarios

Size Category	OCS Program – Gulfwide
≤1 bbl	51,550-74,050
>1 and <50 bbl	1,150-1,650
≥50 and <1,000 bbl	250-350
≥1,000 bbl and <10,000 bbl	17-24
≥10,000 bbl	6-9

Sources of OCS Offshore Spills: Table 4-19 also distinguishes spill occurrence risk by likely operation or source. Besides spills occurring from facilities and during pipeline transport, as was the only case for a proposed action, offshore spills could occur due to OCS future operations from an FPSO or from shuttle tankers transporting OCS crude oil into ports. Table 4-19 includes the likelihood of a spill from a shuttle tanker accident carrying OCS produced crude oil. The scenario with the highest risk of spill occurrence is the high-case resource estimate for the OCS Program in the CPA, which assumes some shuttle-tanker transport of OCS-produced oil. Under that scenario, there is a 49 percent chance that a spill ≥1,000 bbl and a 21 percent chance that a spill ≥10,000 bbl would occur from an OCS-related shuttle tanker during the 40-year analysis period.

Estimated Spill Size: Table 4-17 shows the estimated spill sizes for OCS spills. Offshore spill sizes were calculated based on historical records and shown in Table 4-20. For spills ≥ 1,000 bbl, the median spill size was used because it better represents a likely spill size rather than the average, which is skewed by a few very large events.

Annual Numbers: Using these numbers, MMS's estimates an annual number of spills that will occur in coastal waters or Federal offshore waters due to Gulfwide OCS-related mishaps. These numbers are provided in Table 4-17 for various size groups and for a representative future year.

4.1.3.4.2.4. Non-OCS-Related Offshore Spills

Most non-OCS offshore spills occur from vessel and barge operations. Transit spills occur from navigation-related accidents such as collisions and groundings. Intrinsic spills are those occurring from accidents associated with the vessel itself, such as leaks from hull cracks, broken seals, and bilge upsets. Transfer spills occur during cargo transfer from accidents such as hose ruptures, overflows, and equipment failures.

Collisions and groundings have occurred very infrequently, less than one per 1,000 trips (USDOT, Coast Guard, 1993) and do not usually result in an oil spill. However, these accidents have resulted in the largest spills. The frequency of vessel collisions, and thus associated spills, increases as the proximity to shore increases because of the often-congested waterways in the Gulf region.

Most small non-OCS offshore spills occur during the cargo transfer of fuel and crude oil. Lightering of oil (the transfer of crude oil from supertankers to smaller shuttle tankers) is a common occurrence in the Gulf of Mexico. There have been about 3-4 spills per 1,000 lightering transfers, with an average spill size of 3 bbl (USDOT, Coast Guard, 1993).

Table 4-17 provides the MMS's projections of spills that could occur offshore from non-OCS sources for a typical future year. It is assumed that all offshore spills ≥1,000 not related to OCS operations will occur from the extensive maritime barging and tankering operations that occur in offshore waters of the Gulf of Mexico. The analysis of spills from tankers and barges ≥ 1,000 bbl is based on an analysis of numbers of spills that occur annually from different modes of transportation of oil within the Gulf region (Rainey, 1992). A total of 3-4 spills ≥1,000 bbl is projected to occur for a typical future year from the extensive tanker and barge operations. Spill sizes for the spills projected ≥1,000 bbl are derived from median spill sizes for the particular sources found in Anderson and LaBelle (2000).

The estimate for spills <1,000 bbl that occur annually offshore and are not related to OCS operations was obtained from the Marine Safety Office, Pollution Response Department of the 8th USCG District (USDOT, Coast Guard, personal communication, 2001b). They estimated this number to be 200-250 spills <1,000 bbl occurring offshore annually from all non-OCS sources. The average spill size of 6 bbl was derived by an analysis of all USCG data of spills.

4.1.3.4.2.5. OCS-Related Coastal Spills

The MMS calculates the number of coastal spills that could occur as a result of future OCS operations as a subset of all coastal spills. The MMS does not regulate the operations that could spill oil in the coastal zone and does not maintain a database on these spills. MMS relies on spill data obtained from the USCG Marine Safety Information System database and from State agencies. However, these databases do not differentiate between spills associated with OCS and non-OCS activities. The MMS uses the total annual spill occurrence record for the Gulf area to estimate the number of coastal oil spills attributable to the OCS Program. All spills occurring in the Gulf of Mexico were proportioned by coastal area using the volumes of oil handled by the major oil-handling operations (Rainey, 1992). These operations include OCS support operations, State oil and gas production, intra-Gulf transport, and coastal import/export oil activities. The volume percentage related to OCS operations of the total volume of crude oil produced or transported in the Gulf area is then used to approximate the percentage of spills likely to have occurred as a result of OCS oil-handling operations. For pipeline spills, the number of known pipeline spills is proportioned by the two major sources of oil piped: State oil and gas operations, and OCS production. Based on these percentages, future spill risk is projected.

Table 4-17 provides the MMS's projections of the number of spills that will occur in the coastal waters of the Gulf of Mexico (State offshore and inland coastal waters) in a typical future year as a result of operations that support the OCS Program. About 1 spill ≥1,000 bbl and about 75-100 spills <1,000 bbl are estimated to occur each year. The one spill ≥1,000 bbl would likely be from a pipeline accident.

Some assumptions about the likely locations of these spills are made. Because the numbers are subsets of all spills, the numbers include spill events that would occur after the oil is offloaded at the primary onshore storage location, such as spills at refineries, from intra-Gulf barging of the oil, etc. Given this, it is assumed that the spill risk would be widely distributed in the coastal zone, but primarily within the Houston/Galveston area of Texas and the deltaic area of Louisiana. Based on an MMS analysis of the USCG data on all U.S. coastal spills, MMS estimates that 42 percent of OCS coastal spills will occur in State offshore waters 0-3 mi from shore, 1.5 percent will occur in State offshore waters 3-12 mi from shore, and 57 percent will occur in inland waters. It is assumed all offshore coastal spills will contact land and proximate resources.

For OCS coastal spills <1,000 bbl, a spill size of 6 bbl is assumed; for OCS coastal spills ≥1,000 bbl, a spill size of 4,200 bbl is assumed. These assumed sizes are based on analysis of the USCG spill database and on composites of the median size of a pipeline spill and a barge spill (Anderson and LaBelle, 2000), which are the two most likely sources of OCS-related spills that would occur in coastal waters and be ≥1,000 bbl.

4.1.3.4.2.6. Non-OCS-Related Coastal Spills

Using the same analysis described above, MMS also estimated the number of spills that are likely to occur in the coastal zone from non-OCS sources. These projections are included on Table 4-17.

Non-OCS-related coastal spills primarily occur from vessel accidents. Vessel accidents can spill oil from the tanks of import/export tankers while at ports or in bays and harbors; from the cargo tanks of barges and tank vessels that transport crude oil and petroleum products along channels, bayous, rivers, and especially while traversing the GIWW; and from fuel tanks of all other types of vessels, such as recreational boats or grain tankers. Other sources include spills during pipeline transport of petroleum products; crude oil; State oil and gas facilities; petrochemical refinery accidents; and from storage tanks at terminals.

The majority of spills ≥1,000 bbl occur near terminals and are associated with coastal barging operations of petroleum products (Rainey, 1992). Louisiana has experienced the majority of large spills. During 1974-1999, there have been 20 crude oil spills ≥ 1,000 bbl in the Louisiana and Texas area; none occurred in Florida, Mississippi, or Alabama. During 1974-1990, there were 19 petroleum product spills in Louisiana's coastal area (Rainey, 1992). The majority of these spills occurred on the Mississippi River, making the River the most likely location of coastal spills. Between 1993 and 1996, there have been approximately 12 spills ≥1,000 bbl from pipelines in Texas and Louisiana coastal waters.

For spills <1,000 bbl, most non-OCS coastal spills occur most frequently during transfer operations—about 5-6 spills per 1,000 transfers of oil at ports and terminals, with an average spill size of 18 bbl.

The MMS estimated the likely spill sizes for spills occurring in the coastal zone from non-OCS sources. For spills ≥1,000 bbl, the median spill size for tankers in-port and the median spill size for barges carrying petroleum products was used, based on an MMS published analysis of spill data (Anderson and LaBelle, 2000). For spills <1,000 bbl estimated to occur, MMS analyzed the USCG data on all U.S. spills less than 50,000 gallons (1,190 bbl) and determined the average size spill for this category was 6 bbl.

Based on an MMS analysis of U.S. spill data maintained by the USCG (USDOT, Coast Guard, 2001a), the historical percentages of coastal spill occurrences in different waterbody types were calculated to be as follows: 47 percent have occurred in rivers and canals; 18 percent in bays and sounds; and 35 percent in harbors. The data can also be broken down by relative location to Federal waters: 32 percent of all coastal spills occur in State offshore waters 0-3 mi from shore; 4 percent occur in State offshore waters 3-12 mi from shore; and 64 percent occur in inland waters.

4.1.3.4.3. Operational Discharges

While larger oil spills capture the public's attention and can cause short-term detrimental effects, it is the chronic, low-level inputs of petroleum hydrocarbons that represent the greatest source of petroleum released into the Gulf of Mexico. Major sources of hydrocarbon inputs include illegal operational discharges from tankers while at sea; natural seepage; and coastal, municipal, and industrial discharges and runoff. The MARPOL regulations have significantly reduced the levels of operational discharges associated with vessel operations. Terminals are now required to maintain onshore disposal facilities for receipt of this waste. The MMS expects that NAS's 1985 projection of the amount of oil entering the world ocean from operational discharges from vessels (47% of the total contribution) will be reduced significantly when they publish their updated projections. No estimate is therefore provided here. Besides oil spills from OCS operations, OCS operations are routinely discharging small amounts of oil in their wastewater discharges, primarily the discharge of produced waters. Produced water, when discharged overboard (after treatment that removes the majority of the entrained oil content), is limited by the USEPA effluent limitation guidelines to containing a monthly average of 29 mg/l oil content (USEPA, 1993a and b). The total amount of OCS produced-water discharged was projected (for amounts, see the Final EIS for Sales 157 and 161 [USDOI, MMS, 1995]) and multiplied by the monthly average to estimate the contribution to the petroleum levels in Gulf waters from OCS discharged of produced waters. This calculation results in 0.003 Mta of petroleum hydrocarbons entering Gulf waters from operational produced-water discharges associated with OCS production (Table 4-16).

4.1.3.4.4. Upriver Runoff

The Mississippi River is the major source of petroleum contamination in the Gulf of Mexico, carrying large quantities of petroleum hydrocarbons into Gulf waters from land-based drainage that eventually reaches the Mississippi River or its tributaries, as well as from coastal communities located directly along its route. Gulf of Mexico sediment samples collected within a broad crescent around the Mississippi River show petroleum contamination from the River's discharge (Bedding, 1981; Brooks and Giammona, 1988). The NAS (NRC, 1985) estimates that 0.013 Mta of hydrocarbons enter ocean water from river runoff, draining the interior of the United States. Using the fact that the Mississippi River drains two-thirds of the U.S., petroleum hydrocarbons in the River's discharge are calculated by taking two-thirds of 0.013 Mta; about 0.009 Mta. This estimate only includes runoff entering the Gulf from activities upriver from New Orleans, Louisiana. The hydrocarbon burden measured at the mouth of the Mississippi River is also from coastal inputs. Large quantities of petroleum hydrocarbons are also contributed by primarily urban runoff and by the routine, low-level effluents from industry wastewater and municipalities located along the river in the area near the Gulf of Mexico.. The contributions of these sources are calculated separately from river runoff and are accounted for in the following estimates of inputs from other chronic, low-level sources.

4.1.3.4.5. Urban Runoff and Municipal Wastewater from Coastal Communities

Man's extensive use of fossil fuels, as well as lack of recycling discarded oils, is reflected in the large contributions of petroleum hydrocarbons found in municipal wastewater and urban runoff. Significant volumes of petroleum hydrocarbons are deposited in urban areas from a variety of sources—asphaltic roads; the protective asphaltic coatings used for roofs, pipes, etc.; oil used in two-cycle engines, especially outboard boat motors; gas station runoff; and unburned hydrocarbons in car exhaust. These sources are either directly flushed by rainfall and runoff into storm drains and into coastal waters or rivers, or are weathered, broken down, and then dispersed. The Automotive Information Council estimated in 1990 that 8.3 MMbbl (approximately 1.2 Mta) of used motor oil is generated annually in the U.S. by do-it-yourselfers (Automotive Information Council, 1990). They estimated that 60 percent of this is poured on the ground, thereby adding 5.7 MMbbl of oil to the urban environment annually (0.814 Mta). Much of this discarded oil contributes to the petroleum loading found in municipal wastewater and urban runoff. The NRC (1985) determined that municipal wastewater and urban runoff contributes almost 26 percent of petroleum contamination to the world oceans. To determine an estimate of the amount of petroleum entering the Gulf from urban runoff and municipal wastewater, the NRC methodology was applied to Gulf of Mexico statistics. Multiplying the Gulf of Mexico U.S. coastal population of 14.7

million people (USDOC, NOAA, 1990) by an average input per person results in a rough estimate of 0.024 Mta from U.S. municipal wastewater and 5,000 Mta from urban runoff (Table 4-16).

4.1.3.4.6. Industrial Effluents

Other major land-based sources of petroleum hydrocarbons in Gulf waters include refineries and other industry effluents. Coastal refineries in the Gulf area have a total design capacity of 310,000 Mta. Using a discharge rate for U.S. refineries of 0.5 g/Mta capacity (NRC, 1985), the contribution of petroleum hydrocarbons from Gulf Coast refineries is 0.0000015 Mta, which is negligible when compared with other sources.

Industrial discharges enter coastal rivers (particularly the Mississippi River) that drain into the Gulf or directly into coastal waters. If one assumes that Gulf industries are evenly distributed in the coastal zone, and if the NRC's estimate of nonrefinery industrial waste input (0.2 Mta) is multiplied by one-third (the NRC's estimate of U.S. waters compared to world waters) and then multiplied by the ratio of the U.S. coastal population to the Gulf of Mexico's U.S. population, an estimate of 0.009 Mta of industrial effluent petroleum hydrocarbon contribution can be made (Table 4-16).

Summary

There are other sources of petroleum hydrocarbons not estimated in this exercise and, therefore, a complete mass balance cannot be done. Inputs from erosion of sedimentary rocks, atmospheric inputs, operational discharges from vessels (i.e., bilge and oily ballast, and fuel oil sludge), and dredged material disposal are not quantified. Although not all sources are accounted for here, comparisons between the quantitatively significant sources discussed above have been made.

4.2. ENVIRONMENTAL IMPACTS OF THE PROPOSED CENTRAL GULF SALES AND ALTERNATIVES

4.2.1. Alternative A – The Proposed Actions

The proposed actions are proposed Central Gulf Lease Sales 185, 190, 194, 198, and 201. The sales are scheduled to be held annually in March/April 2003 through 2007. Each sale will offer for lease all unleased blocks in the Central Planning Area (CPA). It is estimated that each proposed sale could result in the discovery and production of 0.276-0.654 billion barrels of oil (BBO) and 1.590-3.300 trillion cubic feet (tcf) of gas during the period 2003-2042. A description of the proposed actions is included in Chapter 2.3. Alternatives to the proposed actions and mitigating measures are also described in Chapter 2.3.

The analyses of the potential impacts are based on a scenario for a typical proposed action. These scenarios provide assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenarios and major impact-producing factors from routine activities associated with a proposed action is included in Chapters 4.1 and 4.4. The Live Bottom (Pinnacle Trend), Topographic Features, and Military Areas Stipulations are considered part of the proposed action(s) for analysis purposes.

The scenario and analysis of potential impacts of oil spills and other accidental events are discussed in Chapter 4.4. The Gulfwide OCS Program and cumulative scenarios are discussed in Chapters 4.1. The cumulative impact analysis is presented in Chapter 4.5.

4.2.1.1. Impacts on Sensitive Coastal Environments

Impacts to the general vegetation and physical aspects of coastal environments by activities resulting from a proposed action in the CPA are considered in Chapters 4.2.1.1.1, 4.2.1.1.2, and 4.2.1.1.3. Potential impacts to barrier islands seaward of the barrier-dune system are considered in the coastal barrier beaches and associated dunes analysis. Potential impacts to barrier islands landward of the barrier-dune system are considered in the wetlands analysis. Impacts to animals that use these environments, the recreational value of beaches, and archaeological resources found there are described in impact analysis sections for those specific resources.

The major, nonaccidental, impact-producing factors associated with a proposed action that could affect these environments include navigational traffic, maintenance dredging of navigational canals, and construction and expansions of navigational canals, port facilities, processing facilities, pipelines, and pipeline-support facilities. The MMS has no direct regulatory authority over potential impact-producing factors or mitigation activities that may occur or be needed in the States' coastal zones.

4.2.1.1.1. Coastal Barrier Beaches and Associated Dunes

This section considers impacts from a proposed action in the CPA to the physical shape and structure of barrier beaches and associated dunes. The major impact-producing factors associated with a proposed action that could affect barrier beaches and dunes include pipeline emplacements, navigation channel use and dredging, and use and construction of support infrastructure in these coastal areas.

Pipeline landfall sites on barrier islands could cause accelerated beach erosion and island breaching. Studies have shown that little to no impact to barrier beaches results from modern techniques used to bring pipelines to shore, such as directional boring (Wicker et al., 1989; LeBlanc, 1985; Mendelssohn and Hester, 1988).

Navigation channels through the sandbars at the mouths of flowing channels generally capture and remove sediments from the longshore sediment drift if the cross-sectional area of the channel is too large for natural tidal and storm exchanges to keep swept clear. Periodic maintenance dredging is expected in existing OCS-related navigation channels through barrier passes and associated bars. Jetties designed to reduce channel shoaling and maintenance dredging of bar channels affect the stability of barrier landforms if those jetties or the bar channel serve as sediment sinks that intercept sediment in longshore drift. Materials from maintenance dredging of bar and pass channels are typically discharged to nearby, ocean dump sites in the Gulf (Chapter 4.1.3.2.1). This dredging usually removes sediment from the littoral sediment drift or routes it around the beach immediately downdrift of the involved channel. Placement of dredged material in shallow coastal waters forms sandbars that can impair coastal navigation.

Adverse impacts of navigation channels can be mitigated by discharging dredged materials onto barrier beaches or strategically into longshore sediment currents downdrift of maintained channels. Adverse impacts of sediment sinks created by jetties can be further mitigated by reducing the jetty length to the minimum needed and by filling the updrift side of the jetty with appropriate sediment. Sediment traps that are created by unnecessarily large bar channels may also be mitigated by reassessing the navigational needs of the port and by appropriately reducing the depth of the channel. Mitigating adverse impacts should be addressed in accordance with requirements set forth by the appropriate Federal and State permitting agencies.

No new onshore infrastructure, except for pipeline landfalls, is expected to result from OCS Program activities in the CPA. In the past, OCS-related facilities were built in the vicinity of barrier shorelines of the CPA. The use of some existing facilities in support of a proposed action and subsequent lease sales in the CPA may extend the useful lives of those facilities. During that extended life, erosion-control structures may be installed to protect a facility. Although these measures may initially protect the facility as intended, such structures may accelerate erosion elsewhere in the vicinity. They may also cause the accumulation of sediments updrift of the structures, sediments that might have alleviated erosion downdrift of the structure. These induced erosion impacts would be most damaging locally. In Louisiana where the sediment supply is critically low, these impacts may be distributed much more broadly. These impacts will last as long as the interruption of the sediment drift continues, which may continue after the structure is removed if the hydrodynamics of the area are permanently modified.

Expansions of existing facilities located on barrier beaches or in associated dunes would cause loss and disturbance of additional habitat.

Abandoned facility sites must be cleared in accordance with Federal, State, and local government and landowner requirements. Materials and structures that would impair or divert sediment drift among the dunes and on the beach must be removed.

Proposed Action Analysis

Zero to one pipeline landfalls are projected as a result of a proposed action in the CPA. Should one be constructed, it will most likely be in Louisiana, where the large majority of the infrastructure exists for receiving oil and gas from the CPA. Such a landfall may occur in the immediate vicinity of a barrier beach and associated dunes. Wherever a landfall occurs, permitting processes encourage the use of directional boring technology to greatly reduce and perhaps eliminate impacts to barrier beaches or dunes.

The use of some existing facilities in support of activities resulting from a proposed action may extend the useful life and continued presence of those facilities. During that extended life, induced erosion impacts may occur from the use of erosion-control structures. These impacts would last as long as the interruption of the sediment drift continues, which may continue after the structure is removed if the hydrodynamics of the area are permanently modified. The severity of the impact will depend upon the site and will increase with the duration of the facility-accelerated erosion. Particularly in deltaic Louisiana, recoverability from these impacts will decrease with duration. Any impacts that result from armoring these would be proportionally attributable to a proposed action.

The average contribution of a proposed action to OCS-related vessel traffic in navigation canals is expected to be small (2%). Correspondingly, very little of the impacts resulting from maintenance dredging, wake erosion, and other secondary impacts of navigation traffic would result from a proposed action.

No new navigation channels are expected to be dredged as a result of a proposed action or OCS Program activities in the CPA. The administrators at Port Fourchon have expressed a need to further deepen the Belle Pass channel to 29 ft or greater to accommodate OCS-related supply boats that have a maximum draft of 27 ft. A small portion of this need is attributable to a proposed action.

Sediments from construction and maintenance dredging of bar channels and tidal inlets can benefit barrier beaches, if placed strategically downstream of the channel and in the interrupted longshore sediment drift. Strategic placement would help mitigate adverse impacts caused by the presence of jetties and artificially deepened tidal passes. Strategic placement of sediments may also offset adverse impacts resulting from a proposed action in the CPA. A percentage of any such benefits would be attributable to a proposed action.

Summary and Conclusion

The 0-1 pipeline landfalls projected in support of a proposed action are not expected to cause significant impacts to barrier beaches because of the use of nonintrusive installation methods. Existing facilities originally built inland may, through natural erosion and shoreline recession, be located in the barrier beach and dune zone and contribute to erosion there. A proposed action may contribute to the continued use of such facilities.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which combined with channel jetties, generally causes minor and very localized impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. The worst of these situations is found on the sediment-starved coasts of Louisiana, where sediments are largely organic. Based on use, a proposed action would account for a very small percentage of these impacts, which would occur whether a proposed action is implemented or not.

In conclusion, a proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. A proposed action may extend the life and presence of facilities in eroding areas, which can accelerate erosion there. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

4.2.1.1.2. Wetlands

At present, Louisiana has 3,800 mi^2 of marsh and more than 800 mi^2 of swamp, most of which is located along the coast. Coastal Louisiana is made up of two wetland-dominated ecosystems, the Deltaic Plain of the Mississippi River and the Chenier Plain extending from eastern Texas through Vermilion Parish, Louisiana; both are influenced by the Mississippi River. The wetlands of Louisiana are comprised of a broad range of wetland habitat including saline, brackish, intermediate, and fresh marsh wetlands, barrier islands, cheniers, mud flats, estuarine bays, and bayous. Less than 10 percent of this land is more than 3 ft above sea level, and only where five salt domes rise above the surrounding wetlands do natural elevations exceed 35 ft above mean sea level. This region contains 25 percent of the Nation's coastal wetlands and accounts for 40 percent of all salt marshes in the lower 48 states (Dunbar et al., 1992). Because more than 90 percent of the coast is less than 3 ft above sea level, an extra 1 or 2 ft of elevation loss through subsidence, lack of sediment supply, or erosion will have drastic effects on the available wetland habitat. Current estimates predict that nearly 640,000 acres of existing wetlands (an area nearly the size of Rhode Island) will be under water in less than 50 years (Louisiana Coastal Wetlands Conservation and Restoration Task, 1993).

The OCS oil and gas activities that could potentially impact these wetland types and their associated habitats include pipeline emplacement (construction and maintenance), new and maintenance dredging of navigation channels and canals, vessel usage of navigation channels, and construction and maintenance of inshore facilities. Other potential impacts that are indirectly associated with OCS oil and gas activities are wake erosion resulting from navigational traffic, levee construction that prevents necessary sedimentary processes, saltwater intrusion that changes the hydrology leading to unfavorable conditions for wetland vegetation, and vulnerability to storm damage from eroded wetlands.

Pipelines

Most disturbances associated with pipeline construction (Chapter 4.1.2.1.7) are expected to result in temporary adverse impacts that are expected to be partially corrected after approximately 6 years (Tabberer et al., 1985; Wicker et al., 1989). Pipelines can be emplaced using a variety of techniques, which, with incorporation of mitigation measures, can influence the extent of impact to the environment. The two major emplacement techniques used historically in wetland environments are the push-pull ditch and the flotation canal methods. Currently, trenchless, or directional drilling, is a more often required technique in sensitive habitats. Impacts from this technique are limited to the access and staging sites for the equipment. This method has been used successfully to place pipelines under scenic rivers so as not to disturb the bottom water or impact the banks of the river, as well as to traverse busy navigation canals without interrupting traffic. For example, the proposed 30-in Endymion Oil Pipeline would deliver crude oil from South Pass Block 89 to the LOOP storage facility near the Clovelly Oil and Gas Field. Based on a review of the data in the COE permit application (No. 20-020-1632), the emplacement of the pipeline would cause zero (0) impacts to marshes (emergent wetlands) and beaches because the operator would use horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive habitats. Additionally, the proposed route maximizes an open-water route to the extent possible (a comprehensive description of current mitigative measures is discussed in Chapter 4.5.1.2).

A proposed action in the CPA is expected to contribute approximately 2 percent of overall impacts to wetlands and associated coastal habitats from OCS-related coastal pipeline installation and the required maintenance of those installations. As previously discussed in Chapter 4.1.1.3.8.1, petroleum reservoirs in deepwater areas might require their own pipeline landfall. The projected numbers of coastal pipeline installations and the projected lengths of coastal pipelines related to a proposed action are presented in Table 4-13.

As of August 2001, there were more than 45,000 km of pipelines in Federal offshore lands and a few thousand kilometers of OCS pipelines extend into state waters and onshore. Many OCS pipelines make landfall on Louisiana's barrier island and wetland shorelines (Falgout, 1997). Louisiana wetlands protect pipelines from waves and ensure that the lines stay buried and in place.

A major concern associated with pipeline construction is disturbance caused by backfilling. Pipeline canals are backfilled with the materials originally dredged while digging the canal. The major factors determining the success of backfilling as a means of restoration are the depth of the canal, soil type, canal dimensions, locale, dredge operator skill, and permitting conditions (Turner et al., 1994). Plugging the canal has no apparent effect on water depth or vegetation cover, with one exception—submerged aquatic vegetation was more frequently observed behind backfilled canals with plugs than in backfilled canals without plugs. Canal length and percentage of backfill returned has the greatest effect on the recovery of vegetation (Turner et al., 1994). While investigating backfilling canals as a wetland restoration technique in coastal Louisiana, Turner et al. (1994) discovered that canals that have been backfilled as mitigation for dredging done at another location are typically more shallow if they are older or in soils lower in organic content. Vegetation recovery increases with increasing canal length and percentage of material returned.

In areas where soils have high organic content, as in the Deltaic Plain or the Chenier Plain, backfilling does not usually fill a canal completely. The extent of impact from the push-pull ditch technique may be influenced by whether the ditch is backfilled and/or dammed. Dredge deposits associated with push-pull ditches are considerably less than those with flotation canals, but both have potential for impacts related to the configuration of the deposits of dredged material. For both flotation and push-pull canals, a double-ditching technique can be used to ensure that the top soil is placed on top when the site is backfilled. This expedites revegetation and lessens the potential for detrimental impacts such as land loss due to erosion along the unvegetated right-of-way.

The real loss of wetlands is difficult to determine because it depends on the pipeline emplacement technique used, amount of backfilling, time of year, and duration of construction. After pipelines are constructed and backfilled in Texas or Mississippi, a shallow channel is expected to remain where the canal passes through wetlands. In coastal Subareas LA-1, LA-2, and LA-3, some open-water areas may remain. Approximately six years after backfilling, productivity of vegetation in areas directly over the pipeline is predicted to be reduced. Less than two-thirds of new OCS pipelines do not come ashore directly but rather link up to previously existing pipelines that already make landfall; hence, no landfall or onshore pipeline construction will result (Chapter 4.1.2.1.7).

Secondary or indirect impacts of pipeline channels can be even more damaging to coastal wetlands and associated habitats than the primary impacts (Tabberer et al., 1985). Secondary impacts include expansion of tidal influence, saltwater intrusion, hydrodynamic alteration, erosion, sediment export, flank subsidence, and habitat conversion. During reviews of pipeline projects for Federal and State permits, agencies consistently comment with concern upon the extent of these secondary impacts. As a result, structures engineered to mitigate secondary adverse impacts are included as permit requirements. The number of OCS-related mitigative structures around the Gulf Coast is unknown.

Frequently, the lack of maintenance of structures used to mitigate adverse impacts of pipeline construction allows the structures to deteriorate and eventually fail. Consequently, the indirect, adverse impacts upon wetlands that the structures were designed to prevent or mitigate could resume and possibly proceed at an accelerated rate. No known effort has been made to document the frequency or extent of these failures or the severity of the resulting impacts. Quantifying indirect impacts to wetlands is difficult and highly debatable. The widening of pipeline canals over time is one of the more obvious secondary impacts; however, extricating secondary impacts of canals from all other losses remains a challenge. A number of studies have examined the correlative evidence linking wetland loss to canal densities (Turner et al., 1982; Saife et al., 1983; Turner and Cahoon, 1988; Turner, 1987; Bass and Turner, 1997). In general, it appears that for most of the Louisiana coast a positive relationship exists between canal density and wetland loss. The limitation of this suggestion is that it fails to identify any cause and effect relationship; however, it may provide a basis upon which to support a hypothesis about the secondary impacts of canals on wetland loss rates.

The widening of pipeline canals over time is one of the more obvious secondary impacts. Craig et al. (1980) studied a series of canals in Louisiana and determined that the canals widened at rates of 2-14 percent per year. Dead-end canals with little vessel traffic or significant flow were shown to widen at rates within this range. Based on the 1980 study and due to their shallow nature, OCS-related pipeline canals are expected to widen at an average rate of about 4 percent per year.

Up to 10 km of onshore pipeline are projected to be constructed in support of a proposed action in the CPA. Based on preliminary historic landloss results from the MMS/USGS NWRC current coastal pipeline impacts study for the Louisiana study area, the predicted landloss (based on an average of 4 ha of conversion to open water per linear km of pipeline) from the estimated 0-10 km of new OCS pipeline construction from a proposed action in the CPA would be 0-40 ha. However, this estimate does not take into consideration the following variables:

- season of construction (growing vs. non-growing);
- precipitation and/or climatic conditions;
- mitigations applied by permitting agency;
- methods of construction/installation;
- size of pipeline; and

- location of construction and associated habitats impacted.

Also, the using of new technologies of pipeline construction, such as horizontal or trenchless directional drilling, would decrease impacts to sensitive habitat to as much as zero (0).

At present, there is no known study addressing the effectiveness or longevity of canal-related mitigation. The above-mentioned study is currently identifying and mapping onshore OCS-related pipelines in the coastal regions around the Gulf, including the Chenier Plain, to ascertain direct and secondary impacts to the extent possible.

Dredging

No new navigational channels are expected to be dredged/constructed as a result of a proposed action in the CPA. Deepwater activities are anticipated to increase, requiring use of larger service vessels for efficient operations. This may put a substantial emphasis on shore bases associated with deeper channels. Some of the ports that have navigation channels deep enough to accommodate deeper-draft vessels may expand the port infrastructure to accommodate these deeper-draft vessels. An example of a significant expansion of a service base is Port Fourchon in coastal Louisiana. Port Fourchon has deepened the existing channel and has dredged additional new channels to facilitate this expansion. The administrators at Port Fourchon have expressed a need to further deepen the Belle Pass Channel to 29 ft or greater to accommodate OCS-related supply boats that have a maximum draft of 27 ft; however, project plans have not been developed.

Dredging and dredged-material disposal can be detrimental to coastal wetlands and associated fish and wildlife that use these areas for nursery grounds, protection, etc. Periodic maintenance dredging of navigation channels deposits material on existing dredged-material disposal banks and disposal areas; the effects of dredged-material disposal banks on wetland drainage is expected to continue unchanged, although there may be some localized and minor exacerbation of existing problems. Typically, some dredged material intended for placement on a dredged-material disposal bank is placed in adjacent wetlands or shallow water. Wetland loss due to dredge material deposition is expected to be offset by wetland creation as adjacent margins of shallow water are filled. In both cases, areas impacted are considered small. Maintenance dredging will also temporarily increase turbidity levels in the vicinities of the dredging and disposal of materials, which can impact emergent wetlands, seagrass communities, and associated habitats.

Two different methods are generally used to dredge and transport sediments from channels to open-water sites: (1) hydraulic cutterhead suction dredge transfers sediments via connecting pipelines; and (2) clamshell bucket dredge transfers sediments via towed bottom-release scows. Each method produces a distinctly different deposit. Hydraulic dredging creates a slurry of sediment and water, which is pumped through a pipeline to the dredged-material disposal site. Coarser sediment settles to the bottom where it spreads outward under the force of gravity; finer sediments may remain in suspension longer. The clamshell dredge scoops sediments relatively intact into scows, which are then towed to the designated area. The dredged sediments are released into the area specified for disposal. This method usually produces positive relief features in the placement area.

Access canals, as well as pipeline canals, are commonly bordered by levees created using dredged materials (Rozas, 1992). Placement of this material alongside canals converts marsh to upland, an environment unavailable to aquatic organisms except during extreme tides. Dredge material can also form a barrier causing ponding behind levees and limiting circulation between canal waters and marshes to infrequent, high-water events (Swenson and Turner 1987; Cox et al., 1997). This and similar disruptions to marsh hydrology are believed to change coastal habitat structure as well as accelerate marsh erosion and conversion to open water (Kuhn et al., 1999; Turner et al., 1994; Rozas, 1992; Turner and Cahoon, 1987). The MMS/USGS-BRD study previously mentioned above (pipelines) will attempt to quantify the impacts of dredge material deposition as well as other canal-related impacts, which should provide insights for identifying past and future impacts.

Executive Order 11990 requires that material from maintenance dredging be considered for use as a sediment supplement in deteriorating wetland areas to enhance and increase wetland acreage, where appropriate. Disposal of dredged material for marsh enhancement has been done only on a limited basis (Chapter 4.1.2.1). Given the "mission statement" of the COE, which requires it to take environmental impacts into consideration during its decisionmaking processes, increased emphasis has been placed on the use of dredged material for marsh creation. For a proposed action, increased use of dredged material to enhance wetland habitats is encouraged as mitigation.

Vessel Traffic

Vessel traffic that may support a proposed action is discussed in Chapter 4.1.1.3.8.4. Navigation channels projected to be used in support of a CPA proposed action are discussed in Chapter 4.1.2.1.9. Navigation channels that support the OCS Program are listed in Table 3-30. Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by natural erosion process. An increase in the number of vessels creating wakes could potentially impact coastal habitat including wetlands.

According to Johnson and Gosselink (1982), canals that have high navigation usage in coastal Louisiana widen about 2.58 m/yr, compared with 0.95 m/yr for little used canals. The OCS-related navigation canals are assumed to generally widen at an average rate of 1.5 m/yr. Approximately 3,200 km of OCS-related navigation canals, bayous, and rivers are found in the coastal regions around the Gulf, exclusive of channels through large bays, sounds, and lagoons. About 700 km of these channels are found around the WPA; another 2,000 km is found in the CPA.

Specific to navigation channels are the effects from saltwater intrusion (Gosselink et al., 1979; Wang 1987). Wang (1987) developed a model demonstrating that, under certain environmental conditions, salt water penetrates farther inland in deep navigation channels than in shallower channels, suggesting that navigation channels act as "salt pumps." The Calcasieu Ship Channel is a good example of how saltwater intrusion, as a consequence of channelization, results in significant habitat transition from freshwater to brackish and ultimately to salt or open-water systems. Another example is the construction of the Mississippi River Gulf Outlet that led to the transition of many of the cypress swamps east of the Mississippi River below New Orleans to open water or areas largely composed of marsh vegetation (*Spartina)* with old, dead cypress tree trunks.

There are two major waterways that support vessel traffic associated with OCS activities: (1) the Gulf Intracoastal Waterway (GIWW) completed in 1949, and (2) the Mississippi River Gulf Outlet (MRGO) opened through the wetlands of St. Bernard Parish in 1963. The GIWW carries barges of crude oil, petroleum, bulk cargoes, and miscellaneous items along a 12-ft deep channel protected from the storms, waves, and winds of the Gulf of Mexico. Maintenance dredging of the MRGO has always been necessary, especially in areas such as Breton Sound where the channel crosses open water. Through continued use of this navigation channel, annual dredging, and the instability of the banks, the main channel of the MRGO has widened from 500 to 2,000 ft in some places.

Much of the service-vessel traffic that is a necessary component of OCS activities uses the channels and canals along the Louisiana coast. An increase in the number of vessels creating wakes could potentially increase impacts to coastal habitats including wetlands.

Disposal of OCS-Related Wastes

Produced sands, oil-based or synthetic-based drilling muds and cuttings, and some fluids from well treatment, workover, and completion activities will be transported to shore for disposal. Sufficient disposal capacity exists at the disposal site near Lacassine, Louisiana (coastal Subarea LA-1) and at other disposal sites under development or projected for future development in Subareas LA-1, LA-2, and MA-1 (Chapter 4.1.2.1.10). Discharging OCS-related produced water into inshore waters has been discontinued. All OCS-produced waters are discharged into offshore waters in accordance with NPDES permits or transported to shore for injection. Produced waters are not expected to affect coastal wetlands (Chapter 4.1.1.3.4.2).

Because of wetland protection regulations, no new waste disposal site will be developed in wetlands. Some seepage from waste sites into adjacent wetland areas may occur and result in damage to wetland vegetation. State requirements are expected to be enforced to prevent and correct such occurrences.

Onshore Facilities

Various kinds of onshore facilities service OCS development. These facilities are described in Chapter 4.1.2.1 and Table 4-8. State and Federal permitting agencies discourage the placement of new facilities and the expansion of existing facilities in wetlands. Any impacts upon wetlands are usually mitigated. All projected new facilities are attributed to the OCS Program, with an appropriate proportion attributed to a proposed action.

Proposed Action Analysis

The 1990 estimates of coastal Louisiana wetland acreage in a nine-basin area based on the U.S. Army Corps of Engineers database is described below:

Basin	Acres of Marsh in 1990	Acres of Marsh Lost by 2050 without Restoration	Acres of Marsh Preserved by the Breaux Act and Diversions	Net Acres of Marsh Lost by 2050 at Current Restoration Levels	Acres of Swamp in 1990	Acres of Swamp Lost by 2050 at Current Restoration Levels
Pontchartrain	253,000	50,330	4,720	45,610	213,570	105,100
Breton Sound	171,100	44,480	17,900	26,580	0	0
Mississippi Delta	64,100	24,730	18,340	6,390	0	0
Barataria	423,500	134,990	42,420	92,570	146,360	80,000
Terrebonne	488,800	145,250	5,170	140,080	152,400	46,700
Atchafalaya	48,800	(30,030)*	8,080	(38,110)*	12,600	0
Teche/ Vermilion	234,300	32,160	3,360	28,800	18,390	0
Mermentau	441,000	61,710	2,600	59,110	370	0
Calcasieu/ Sabine	317,100	50,840	12,440	38,400	170	0

Source: Louisiana Coastal Wetlands Conservation and Restoration Task Force, 1993.

Direct causes of wetland loss along the Louisiana coast potentially associated with a proposed action areas as follows:

- dredging and stream channelization for navigation channels and pipeline canals;
- filling by dredged material and other solid-waste disposal;
- roads and highways;
- industrial development and infrastructure improvement; and
- accidental discharge of pollutants into wetlands.

Indirect causes of wetland loss may be attributed to

- subsidence due to lack of natural sediment replenishment of the deltaic/wetland system caused by channel and river controls;
- sediment diversion by dams, deep channels, and other structures;
- hydrologic alterations by canals, dredged-material disposal banks, roads, and other structures; and
- subsidence due to extraction of groundwater, oil, gas, sulfur, and other minerals.

With regard to oil specifically, a proposed action is projected to represent about 2 percent of oil production and transport by the OCS Program in the Gulf during the period of 2003-2042 (derived from Table 4-1). Oil production from a proposed action is expected to be commingled in pipelines with other

OCS production before going ashore. Table 4-13 shows the distribution of projected new, OCS-related pipeline landfalls and inland pipeline lengths for a proposed action.

On average, 10 percent of traffic using OCS-related navigation channels is related to the OCS Program, and a proposed action is expected to contribute 2 percent to this usage; therefore, impact related to a proposed action should remain minimal. Since the number of OCS-related mitigative structures is unknown, impacts creditable to a proposed action cannot be calculated. Impacts associated with canals and mitigation structures include altered hydrology and flank subsidence, for which methods of projecting rates of occurrence and extent of influence have not yet been developed. An MMS study of canal-impact issues began during the summer of 1997; a final report is expected in the spring of 2002.

Summary and Conclusion

Loss of 0-40 ha of habitat is estimated as a result of 0-10 km of new pipelines projected as a result of a proposed action. Secondary impacts, such as continued widening of existing pipeline and navigation channels and canals, and failure of mitigation structures, are also expected to affect the rate at which wetlands convert to open water.

Maintenance dredging of navigation channels and canals is expected to occur with minimal impacts; a proposed action is expected to contribute minimally to the need for this dredging. Alternative dredged-material disposal methods can be used to enhance and create coastal wetlands. By artificially keeping navigation channels open and with larger dimensions than would the region's natural hydrodynamic processes, maintenance dredging maintains tidal and storm flushing potential of inland regions at maximum capacities as they relate to the described needs of the canal project. Without maintenance dredging, these channels would naturally fill in, reducing the channels' cross-sectional areas and their capacities to flush or drain a region when under the influences of storms and tides.

In conclusion, adverse initial impacts and more importantly secondary impacts of installation, maintenance, continued existence, and the failure of mitigation structures for pipeline and navigation canals are considered the most significant OCS-related and proposed-action-related impacts to wetlands. Although initial impacts are considered locally significant and largely limited to where OCS-related canals and channels pass through wetlands, secondary impacts may have substantial, progressive, and cumulative adverse impacts to the hydrologic basin or subbasin in which they are found. Impacts related to a proposed action represent a low percentage of OCS Program impacts. The broad and diffuse distribution of OCS-related activities offshore and along the Central Gulf Coast makes it difficult to distinguish proposed action impacts from other ongoing OCS and non-OCS impacts to wetlands. The MMS has initiated studies to better evaluate these impacts and related mitigative efforts.

4.2.1.1.3. Seagrass Communities

Seagrasses in the CPA are restricted to small shallow areas behind barrier islands in Mississippi and Chandeleur Sounds and to smaller, more scattered populations elsewhere. Lower-salinity, submerged seagrass beds are found inland and discontinuously throughout the coastal zone. Most beds of submerged aquatic vegetation located between the Southwest Pass of the Mississippi River and Cape San Blas, Florida, are inland of the barrier shorelines. Most submerged vegetation in this region usually remains submerged because of the micro-tidal regime of the northern Gulf. Only during extremely low, wind-driven tidal events would seagrass beds be exposed to the air. Even then, their roots and rhizomes remain buried in sediment. Activities that may result from a proposed action that could adversely affect submerged vegetation beds include pipeline construction, maintenance dredging of navigational channels, vessel traffic, oil spills, and spill response and cleanup. The potential impacts of oil spills and spill-response and cleanup activities are discussed in Chapter 4.4.3.1.3.

Pipelines

The installation of 0-1 pipeline landfalls is projected as a result of a CPA proposed action (Chapter 4.1.2.1.7). Pipeline construction methods and disturbances are discussed in Chapters 4.1.1.3.8.1 and 4.1.2.1.7. Jetting for pipeline installation displaces sediments. The denser sediments fall out of suspension quickly; the finer sediments that decrease water clarity remain in suspension longer. Reduced water clarity can decrease plant density in the seagrass beds, which in turn can further increase turbidity as the root, thatch, and leaf coverage decreases (Wolfe et al., 1988). The amount of light reaching the bottom of a seagrass bed is the crucial factor determining seagrass meadow extent and productivity. As in maintenance dredging activities discussed below, activities from pipeline emplacement could reduce light, which is linked to reductions of both seagrass cover and productivity (Orth and Moore, 1983; Kenworthy and Haunert, 1991; Dunton, 1994; Czerny and Dunton, 1995).

The COE and State agencies take possible impacts to submerged vegetation into consideration during their review of pipeline permits. The permits for constructing pipelines require that turbidity impacts be mitigated through the use of turbidity screens and other turbidity reduction or confinement equipment. The permits also require surveying to locate beds of submerged vegetation, monitoring of turbidity and reporting to the COE and State agencies, and taking immediate action to correct turbidity problems.

Although the majority of materials resuspended by jetting return to the water bottom within a few meters of the trench, lighter materials can be carried for several kilometers, depending upon the currents, weather, and the density of the dredged materials. Hence, pipeline installation has the potential to bury nearby submerged vegetation; coat the leaves of plants farther away with lighter, light-blocking sediments; and temporarily elevate turbidity in these beds.

Maintenance Dredging

No new navigational channels are expected to be dredged as a result of a proposed action or OCS Program activities in the CPA. Maintenance dredging schedules vary from yearly to rarely, and will continue indefinitely into the future. Deepwater activities are anticipated to increase, which will likely require greater use of larger service vessels for efficient operations and may cause greater use of shore bases associated with deeper channels.

Some of the ports that have navigation channels deep enough to accommodate deeper-draft vessels may expand the port infrastructure to accommodate these deeper-draft vessels. An example of a significant expansion of a service base is Port Fourchon in coastal Louisiana. Port Fourchon has deepened the existing channel and has dredged additional new channels to facilitate this expansion. The administrators at Port Fourchon have expressed a need to further deepen the Belle Pass Channel to 29 ft or greater to accommodate OCS-related supply boats that have a maximum draft of 27 ft; however, project plans have not been developed.

Some of the ports that house OCS-related service bases and that can presently accommodate deeper-draft vessels have expanded their accommodations. (Service bases are discussed in Chapter 4.1.2.1.1.) In coastal Louisiana, Port Fourchon has deepened the existing channels and have dredged additional channels to facilitate this expansion. The administrators at Port Fourchon have expressed a need to further deepen the Belle Pass channel to 29 ft or greater to accommodate OCS-related supply boats that have a maximum draft of 27 ft; however, project plans have not been developed. A small portion of this need would be attributable to a proposed action.

Light attenuation is responsible for most landscape-level losses. The amount of light reaching the bottom of a seagrass bed is the crucial factor determining seagrass meadow extent and productivity. Reduced light has been linked to reductions of both seagrass cover and productivity (Orth and Moore 1983; Kenworthy and Haunert 1991; Dunton 1994; Czerny and Dunton 1995). Dredging has been determined to be one of the major causes of light reduction that results in changes in seagrass cover, composition, and biomass. Changes in species composition are usually the result of natural processes (i.e., succession), but they can be caused by moderation of salinity resulting from dredging. Changes in species composition resulting from dredging activities may affect resource availability for some fish and waterfowl that use seagrass habitat as nursery grounds. Turbidity caused by maintenance dredging has been implicated in the decline of shoalgrass and increased bare areas in the lower Laguna Madre (Onuf, 1994) located behind the south Texas barrier islands.

Maintenance dredging keeps navigation channels open and artificially maintains larger channel dimensions than would occur naturally under regional hydrodynamics. Dredging also increases the potential for tidal and storm flushing of inland regions. Without maintenance dredging, these channels would naturally fill, reducing the channels' cross-sectional areas and their capacities to flush or drain a region when under the influences of exceptionally high storms and tides.

Vessel Traffic

Navigation traffic that may support a proposed action is discussed in Chapter 4.1.2.1.9. Most navigation channels projected to be used for the CPA proposed actions are shallow and currently used by vessels that support the OCS Program (Table 3-33). For example, the GIWW is dredged to 4 m, but it is actually about 5.5 m deep between the Pascagoula Channel and the Bayou LaBatre Channel and generally about 3.7 m deep between the Bayou LaBatre and Mobile Bay Channels. Prop wash of shallow navigation channels by vessel traffic dredges up and resuspends sediments, increasing the turbidity of nearby coastal waters.

Proposed Action Analysis

Pipelines

All of the gas production and most of the oil production from a CPA proposed action is expected to be mingled in pipelines with other OCS production at sea before going ashore. Seagrasses are not abundant in the Federal OCS waters where most of the length of any pipeline supporting a proposed action would be installed. For a proposed action in the CPA, any pipelines that made landfall would most likely go ashore in Mobile County, Alabama; Jackson County, Mississippi; or Plaquemines Parish, Louisiana. Many sparse and scattered beds of seagrasses and other submerged vegetation are found around the islands of these counties and parishes. Scattered and sparse beds of seagrasses are also associated with the Chandeleur and Breton Islands, through which a pipeline might pass on its way to make a landfall in Plaquemines Parish, Louisiana, or to link up with an existing pipeline. Although the majority of materials dredged by jetting return to the water bottom within a few meters of the trench, lighter materials can be carried for several kilometers, depending upon the currents, weather, and density of the dredged materials. Hence, pipeline installation has the potential to bury nearby submerged vegetation; coat the leaves of plants farther away with lighter, light-blocking sediments; and temporarily elevate turbidity in these beds. Permit requirements of the COE and State agencies are expected to require the reduction of turbidity impacts to within tolerable limits for submerged aquatic vegetation, if implemented (Chapter 4.1.2.1.7). Hence, significant direct impacts to submerged vegetation by pipeline installation are expected to be very small and short term if they occur.

Maintenance Dredging

Because much of the dredged material resulting from maintenance dredging will be placed on existing dredged-material disposal sites or used for other mitigative projects, no significant adverse impacts are expected to occur to seagrass communities from maintenance dredging related to a proposed action.

Vessel Traffic

Most of the navigation channels to be used in support of proposed action activities are shallow, therefore allowing for possible impacts to associated seagrass and submerged vegetation from propeller scarring and resuspension of sediments from propwash. Navigational traffic through the GIWW between the Bayou LaBatre Channel and Mobile Bay Channel would resuspend sediments. A proposed action would contribute to a percentage of traffic through that stretch. However, beds of submerged vegetation within the area of influence of that channel and other channels have already adjusted their configurations in response to turbidity generated there.

Vessels that vary their inland route from established navigation channels can directly scar beds of submerged vegetation with their props, keels (or flat bottoms), and anchors. Many vessel captains will cut corners of channel intersections or navigate across open water where they may unexpectedly encounter shallow water where beds of submerged aquatic vegetation may occur. Propellers may damage a bed superficially by leaving a few narrow cuts. Damage may be as extensive as broadly plowed scars from the keel of a large boat accompanied by extensive prop washing; trampling by waders; and additional keel, prop, and propwash scars left by other vessels that assisted in freeing the first boat.

Depending upon the submerged plant species involved, scars about 0.25 m wide cut through the middle of beds would take 1-7 years to recover. Similar scars through sparser areas would take 10 years or more to recover. The broader the scar, the longer the recovery period. Extensive damage to a broad area may never be corrected (Sargent et al., 1995; Durako et al., 1992).

Denser dredged materials fall out of suspension more quickly. Less dense sediments settle to the water bottom more slowly, which concentrates at the surface of the water bottom. These lighter bottom sediments are generally more easily resuspend by storms than were the original surface sediments. Hence, for a period of time after dredging occurs, water turbidity will be greater than usual in the vicinity of the dredging. With time, this reoccurring, increased turbidity will decrease to pre-project conditions, as the lighter materials are either dispersed to deeper water by currents, where they are less available for resuspension, or they are consolidated into or under denser sediments.

For estuarine species that thrive in salinities of about 0.5-25 ppt, this elevated turbidity may not pose a significant problem, since they have adapted to turbid, estuarine conditions. For seagrasses in higher salinities and even freshwater submerged aquatic vegetation that require clearer waters, significantly reduced water clarity or shading, as may be caused by an oil slick, for longer than about 4 days will decrease chlorophyll production. If such conditions continue for longer than about 2 weeks, plant density in the bed will begin to decrease. If plant density reduces significantly in turn, further increases in turbidity will occur as the root, thatch, and leaf coverage decline. Such impacts can be mitigated in several ways. For cleaning up slicks resting over a submerged vegetation bed, wheeled or treaded vehicles should be prohibited. Cleanup methods using other vehicles that dig into the water bottom of the bed (e.g., boat anchors, boat bottoms, props, and booms that require water depths greater than that available over the bed) should be not be used. Vehicles and equipment that require minimum water depths of about 6-10 in should be used instead. Activities over grass beds should be closely monitored to avoid digging into the bed. Trampling or repeatedly walking over a path through the bed should be avoided.

Summary and Conclusion

Most seagrass communities located between the Southwest Pass of the Mississippi River and Cape San Blas, Florida, are inland of the barrier shorelines. Because of the location of most seagrass communities, inshore oil spills pose the greatest threat (discussed in Chapters 4.4.1.1.2 and 4.4.3.1.3).

Pipeline construction in coastal waters would temporarily elevate turbidity in nearby submerged vegetation beds, depending upon currents. If constructed, the pipeline landfall would temporarily elevate turbidity in submerged vegetation beds near the pipeline routes. The COE and State permit requirements are expected to require pipeline routes that avoid beds of high-salinity, submerged vegetation and to reduce turbidity impacts to within tolerable limits. Hence, impacts to submerged vegetation by pipeline installation are projected to be very small and short term.

After bottom sediments are disturbed by pipeline installation, they will be generally more easily suspended by storms than before the disturbance. In estuaries, this increase is not projected to be a problem. Due to tidal flushing, this increased turbidity is projected to be below significant levels and to continue after storms for up to one month.

Beds of submerged vegetation within a channel's area of influence will have already adjusted to bed configurations in response to turbidity generated there. Very little, if any, damage would then occur as a result of typical channel traffic. Generally, propwash will not resuspend sediments in navigation channels beyond pre-project conditions.

Depending upon the submerged plant species involved, narrow scars in dense portions of the beds will take 1-7 years to recover. Scars through sparser areas will take 10 years or more to recover. The broader the scar, the longer the recovery period. Extensive damage to a broad area may never be corrected.

Maintenance dredging will not have a substantial impact on existing seagrass habitat given that no new channels are expected to be dredged as a result of a CPA proposed action.

4.2.1.2. Impacts on Sensitive Offshore Resource

4.2.1.2.1. Pinnacle Trend

Seventy blocks are within the region defined as the pinnacle trend, which contains live bottoms that may be sensitive to oil and gas activities. These blocks are located in the northeastern portion of the CPA and adjacent areas of the EPA, and are located between 53 and 110 m water depths in the Main Pass and Viosca Knoll lease areas. Leases in past sales have contained a live-bottom stipulation to protect such areas. The proposed Live Bottom (Pinnacle Trend) Stipulation is presented in Chapter 2.3.1.3.2 as a potential mitigating measure for leases resulting from a proposed action. The stipulation is designed to prevent drilling activities and anchor emplacement (the major potential impacting factors on these live bottoms resulting from offshore oil and gas activities) from damaging the pinnacles. Under the stipulation, both EP and DOCD plans will be reviewed on a case-by-case basis to determine whether a proposed operation could impact a pinnacle feature. If it is determined from site-specific information derived from MMS studies, published information from other research programs, geohazards survey information, or another source that the operation would impact a pinnacle feature, the operator will be required to relocate the proposed operation. Although the Live Bottom Stipulation is regarded as a highly effective protection measure, infrequent accidental impacts are possible. Accidental impacts may be caused by operator positioning errors or when studies and/or geohazards information are inaccurate or fail to note the presence of pinnacle features. One such incident has been documented and is discussed in further detail below. While investigating sites of previous oil and gas drilling activities, Shinn et al. (1993) documented that a lease operator had located an exploratory well adjacent to a medium-relief pinnacle feature; the reason for this occurrence is still undetermined. In spite of this documented instance, the stipulation is still considered effective since it allows MMS flexibility to request any surveys or monitoring information necessary to ensure protection of these sensitive areas. The impact analysis presented below is for a typical proposed action in the CPA and includes the proposed Live Bottom (Pinnacle Trend) Stipulation.

A number of OCS-related factors may cause adverse impacts on the pinnacle trend communities and features. Damage caused by, anchoring, infrastructure and pipeline emplacement, infrastructure removal, blowouts, drilling discharges, produced-water discharges, the disposal of domestic and sanitary wastes, and oil spills can cause the immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible. Impacts from oil spills and blowouts are discussed in Chapter 4.4.

Anchoring may damage lush biological communities or the structure of the pinnacles themselves, which attract fish and other mobile marine organisms. Anchor damage from support boats and ships, floating drilling units, and pipeline-laying vessels greatly disturb areas of the seafloor and are the greatest threats to live-bottom areas at these depths. The size of the affected area would depend on water depth, anchor and chain sizes, chain length, method of placement, wind, and current. Anchor damage includes, but is not limited to, crushing and breaking of the pinnacles and associated communities. Anchoring often destroys a wide swath of habitat by being dragged over the seafloor, or the vessel swings at anchor, causing the anchor chain to drag the seafloor.

The emplacement of infrastructure, including drilling rigs and platforms, on the seafloor will crush the organisms directly beneath the legs or mat used to support the structure. The areas affected by the placement of the platforms and rigs are predominantly soft-bottom regions where the infaunal and epifaunal communities are not unique. Pipeline emplacement directly affects the benthic communities through burial and disruption of the benthos and through resuspension of sediments. These resuspended sediments may obstruct filter-feeding mechanisms and gills of fishes and sedentary invertebrates.

Both explosive and nonexplosive structure removal operations will disturb the seafloor and potentially affect nearby pinnacle communities. Structure removal using explosives (the most common removal method in these water depths) will suspend sediments throughout the water column impacting the nearby habitats. Deposition of these sediments will occur much in the same manner as discussed for muds and cuttings discharges (Chapter 4.1.1.3.4.1). Explosive structure removals create shock waves, which also harm resident biota in the immediate vicinity. O'Keeffe and Young (1984) have described the impacts of underwater explosions on various forms of sea life. They found that sessile organisms of the benthos (such as barnacles and oysters) and many motile forms of life (such as shrimp and crabs) that do not possess swim bladders are remarkably resistant to the blast effects from underwater explosions. Many of these organisms not in the immediate blast area should survive. Benthic organisms would be further protected from the impacts of explosive detonations by the rapid attenuation of the underwater shock wave through the seabed. The shock wave attenuation is significantly less in mud than in the water column, where it is known to impact fish up to 60 m (20 ft) away from a 11.3-kg charge detonated at a 100-m depth (Baxter et al., 1982).

Drilling discharges can affect biological communities and organisms by mechanisms such as the smothering or choking of organisms through deposition of discharged materials and the less obvious sublethal toxicological impacts (e.g., depressed growth and reproduction). During oil and gas drilling operations, the discharged drilling muds and cuttings cause turbidity and literally choke the benthos in proximity to the drill site. Shinn et al. (1993) surveyed an exploratory well site located immediately adjacent to a 4-5 m high pinnacle feature, located at a 103 m depth. Cuttings and drill debris were documented within 6,070 m^2 (1.5 ac) surrounding the drill site. In spite of being inundated by drill muds and cuttings 15 months prior to the investigation, the pinnacle feature was found to support a diverse community, which included gorgonian or soft corals, sponges, non-reef-building corals, a species of horn coral, and abundant meter-long whiplike antipatharians characteristic of tropical hard-bottom communities in water 30 m or more in depth. Shinn et al. (1993) concluded the following: "Gorgonians, antipatharians, crinoids, and non-reef-building corals attached to the pinnacle feature adjacent to the drill site as well as nearby rock bottom did not appear to be affected."

Shinn et al. (1993) acknowledged that their evaluation of the drill site was constrained both by the lack of baseline data on the live-bottom community prior to inundation by drilling discharges and by the need for a study on long-term changes (e.g., 10 years). Continental Shelf Associates (CSA) and Texas A&M University, Geochemical and Environmental Research Group (2001) suggest that recovery of hard-bottom communities following a disturbance will be slow. Hard-bottom communities studied during the recently completed Mississippi/Alabama Pinnacle Trend Ecosystem Monitoring Program exhibits a dynamic sedimentary environment with relatively little net growth of the epibiota associated with the pinnacle features. Additionally, epibiont recruitment studies performed during this same survey showed relatively slow development of fouling community constituents on recruitment plates. Basically, only the earliest successional stages were observed by the end of the study (27 months of exposure), and the epibiota typically associated with nearby hard-bottom features were rare on the plates. It is not known whether the results would have differed if the substrate had consisted of exposed patches of natural hard bottom; however, analysis of larger substrates such as artificial reefs exposed for months to several years also indicates slow community development (Marine Resources Research Institute, 1984). Drilling discharges are still considered to have a deleterious impact on the live-bottom communities of the pinnacle trend, and the stipulation will continue to be applied to minimize the possibility of similar occurrences.

Produced water, described in detail in Chapter 4.1.1.3.4.2, usually contains high amounts of dissolved solids and total organic carbon, and low amounts of dissolved oxygen. Other common components include heavy metals, elemental sulfur and sulfide, organic acids, treating chemicals, and emulsified and particulate crude oil constituents. Salinity of produced water can vary from 0 to 300 ppt. The constituents of produced water have the potential to adversely impact the live-bottom organisms of the pinnacle trend if the constituents reach them in high enough concentrations. Domestic and sanitary wastes originate from sinks, showers, laundries, and galleys, as well as waste water from safety showers, eye-wash stations, and fish-cleaning stations. Human wastes, which contain fecal coliform bacteria, are treated by approved marine sanitation devices prior to discharge. A more complete description of domestic and sanitary wastes can be found in Chapter 4.1.1.3.4.6. The proposed Live Bottom Stipulation would prevent the placement of oil and gas facilities upon the pinnacle trend and live-bottom areas. Consequently, the stipulation prevents the discharge of produced water and domestic and sanitary wastes from occurring directly on top of the live-bottom areas. Dispersion of these wastes should occur rapidly (less than 24 hours) upon discharge.

Proposed Action Analysis

The pinnacles in the CPA are located in the Main Pass and Viosca Knoll lease areas off Mississippi and Alabama within offshore Subareas C0-60 (east of the Mississippi River Delta) and C60-200. Table 4-2 provides information regarding the level of proposal-related activities.

For a CPA proposed action, 77-138 exploration/delineation and development wells and 7-11 production structures are projected for offshore Subareas C0-60 east of the Mississippi River and C60-200. It is unlikely that many of the wells or production structures would be located in the pinnacle trend area, because pinnacle blocks make up only 2 percent of the blocks in Subarea C0-60 (eastern) and 6 percent of the blocks Subarea C60-200. If the Live Bottom Stipulation is implemented, pinnacle features would incur few incidences of anchor damage from support vessels. Furthermore, as noted above, any platforms in this region would be placed so as to avoid pinnacle features for safety reasons. Thus, anchoring events are not expected to impact the resource. Accidental anchor impacts, however, could be extensive, with recovery taking 5-10 years depending on the severity. No such accidents have been recorded to date.

Pipeline emplacement also has the potential to cause considerable disruption to the bottom sediments in the vicinity of the pinnacles (Chapter 4.1.1.3.8.1); however, the implementation of the proposed Live Bottom Stipulation, or a similar protective measure, would restrict pipeline-laying activities as well as oil and gas activities in the vicinity of the pinnacle communities. Data gathered for the Mississippi-Alabama Continental Shelf Ecosystem Study (Brooks, 1991) and the Mississippi/Alabama Pinnacle Trend Ecosystem Monitoring, Final Synthesis Report (Continental Shelf Associates, Inc. and Texas A&M University, Geochemical and Environmental Research Group, 2001) document dense biological communities (i.e., live-bottom communities, fish habitat, etc.) on the high- and medium-relief pinnacle features themselves and live-bottom organisms more sparsely distributed in unconsolidated bottom sediments surrounding the pinnacles. The actual effect of pipeline-laying activities on the biota of the pinnacle communities would be restricted to the resuspension of sediments. The enforcement of the Live Bottom Stipulation will help to minimize the impacts of pipeline-laying activities throughout the pinnacle region. As previously stated, few pipelines in the vicinity of the pinnacle trend are projected to result under a proposed action. The severity of these actions has been judged at the community level to be slight, and impacts from these activities to be such that there would be no measurable interference to the general ecosystem.

Oil and gas operations discharge drilling muds and cuttings that generate turbidity, potentially smothering benthos near the drill sites. Deposition of drilling muds and cuttings in the pinnacle trend area would not greatly impact the biota of the pinnacles or the surrounding habitat. The biota of the seafloor surrounding the pinnacles are adapted to turbid (nepheloid) conditions and high sedimentation rates of the central portion of the pinnacle trend. The pinnacles themselves are coated with a veneer of sediment. Regional surface currents and water depth would largely dilute any effluent. Additional deposition and turbidity caused by a nearby well are not expected to adversely affect the pinnacle environment because such fluids would be discharged into very large volumes of water and would disperse. Mud contaminants measured in the pinnacle trend region reached background levels within 1,500 m of the discharge point (Shinn et al., 1993). Toxic impacts on benthos are limited to within 100 m as a result of the NPDES permit requirements. Such an event would rarely impact the pinnacle trend, live-bottom communities.

The toxicity of the discharged produced waters and domestic and sanitary wastes has the potential to adversely impact the live-bottom organisms of the pinnacle trend; however, as previously stated, the proposed Live Bottom Stipulation would prevent the placement of oil and gas facilities upon (and consequently would prevent the discharge of produced water and domestic and sanitary wastes from occurring directly over) the pinnacle trend, live-bottom areas.

Platform removals have the potential to impact nearby habitats. As previously discussed, the platforms are unlikely to be constructed directly on the pinnacles because of the restraints placed by the Live Bottom Stipulation. Structure removal activities should not deleteriously impact the pinnacle trend area considering the following:

- benthic organisms are resilient to blasts, so only restricted regions would be affected by shock waves from explosives;
- the resuspension of sediments would be limited both in time and space (24 hr for the water column 4 m off the bottom and above, and 7-10 days for the water layer contained in the first 4 m off the seafloor; resuspension of sediments would extend about 1,000 m away from the blasts);

- only a few structures would be removed (2 anticipated removals in the pinnacle area); and
- structures to be removed would have been placed away from any sensitive resources.

It is also anticipated that any damage to the benthic resources of the pinnacle trend area that may occur as a result of structure removals would be followed by a recovery to preinterference conditions within two years.

Summary and Conclusion

Activities resulting from a proposed action in the CPA are not expected to adversely impact the pinnacle trend environment because of implementation of the Live Bottom Stipulation. No community-wide impacts are expected. The inclusion of the Live Bottom Stipulation would minimize the potential for mechanical damage. The impacts of a proposed action are expected to be infrequent because of the few operations in the vicinity of the pinnacles and the small size and dispersed nature of many of the features. Potential impacts from blowouts, pipeline emplacement, mud and cutting discharges, and structure removals would be minimized because of the proposed Live Bottom Stipulation and the low levels of oil and gas activities anticipated in the area. The frequency of impacts on the pinnacles would be rare, and the severity should be slight because of the widespread nature of the features. Impacts from accidents involving anchor placement on pinnacles (those actually crushed or subjected to abrasions) could be severe in a few areas.

Effects of the Proposed Action Without the Proposed Stipulation

Activities resulting from a proposed action without the protection of the proposed Live Bottom (Pinnacle Trend) Stipulation (Chapter 2.3.1.3.2) could have an extremely deleterious impact on portions of the pinnacle trend. Mechanical damage from anchoring, drilling operations, and other activities is potentially the most damaging impact because these activities could destroy biological communities or damage the structure of the pinnacles themselves, reducing the habitat or shelter areas occupied by commercial and recreational fishes. The unevenness of the seafloor associated with the larger pinnacle features would reduce the likelihood that rigs or platforms would be placed directly over a pinnacle. In addition, the pinnacles are widespread throughout the region, so that the potential loss of a few features (or areas within a feature) would cause only slight community-wide impacts on the pinnacle trend as a whole. Because of the low levels of projected OCS activities in the pinnacle trend area and the small size of many features, occurrences of damage would be infrequent. Those areas actually subjected to mechanical disruption would be severely impacted, however. Potential impacts on the pinnacle trend, live-bottom areas from other impact-producing factors associated with OCS activities (pipeline emplacement, discharges of muds and cuttings, explosive structure removals, and oil spills and blowouts) would be infrequent because of the low projected levels of OCS activities. In addition, the widespread occurrence of these pinnacles would further restrain these impacts.

4.2.1.2.2. Topographic Features

The topographic features sustaining sensitive offshore habitats in the CPA are listed and described in Chapter 3.2.2.3. A Topographic Features Stipulation similar to the one described in Chapter 2.3.1.3.1 has been included in appropriate leases since 1973 and may, at the option of the Secretary, be made a part of appropriate leases resulting from this proposal. The impact analysis presented below for a proposed action in the CPA includes the proposed biological lease stipulation. As noted in Chapter 2.3.1.3.1, the stipulation establishes a No Activity Zone within which no bottom-disturbing activities would be allowed and areas around the No Activity Zones (in most cases) within which shunting of drill cuttings and drilling fluids to near the bottom would be required.

The potential impact-producing factors on topographic features of the Central Gulf are anchoring (Chapter 4.1.1.3.2.1), infrastructure emplacement (Chapters 4.1.1.3.1 and 4.1.1.3.2), drilling-effluent and produced-water discharges (Chapter 4.1.1.3.4), and infrastructure removal (Chapter 4.1.1.4). Impacts from oil spills and blowouts are discussed in Chapter 4.4.3.2.2. These disturbances have the potential to disrupt and alter the environmental, commercial (fisheries), recreational, and aesthetic values of topographic features in the CPA.

The anchoring of pipeline lay barges, drilling rigs, or service vessels, as well as the emplacement of structures (e.g., pipelines, drilling rigs, or production platforms), results in mechanical disturbances of the benthic environment. Anchor damage has been shown to be the greatest threat to the biota of the offshore banks in the Gulf (Bright and Rezak, 1978; Rezak et al., 1985). Such anchoring damage, however, would be prevented within any given No Activity Zone by the observation of the Topographic Features Stipulation.

Infrastructure emplacement and pipeline emplacement are other oil and gas activities that could resuspend sediments. The proposed stipulation would also prevent these activities from occurring in the No Activity Zone, thus preventing most of these resuspended sediments from reaching the biota of the banks.

Considering the relatively elevated amounts of drilling muds and cuttings discharged per well (10,542 bbl/exploratory well; 7,436 bbl/development well) (USEPA, 1993a and b), potential impacts on biological resources of topographic features should be expressly considered if drill sites occur in blocks directly adjacent to No Activity Zone boundaries (Topographic Features Stipulation). Potential impacts could be incurred through increased water-column turbidity, the smothering of sessile benthic invertebrates, and local accumulations of contaminants. The USEPA general NPDES permit sets special restrictions on discharge rates for muds and cuttings adjacent to topographic features bound by a No Activity Zone. Chapters 4.1.1.3.4 and 4.2.1.3.2 detail the NPDES permit's general restrictions and the impacts of drilling muds and cuttings on marine water quality and seafloor sediments. The levels and areal extent of discharged contaminants measured in the water column or sediments will be reduced from levels and extent measured in the past because current USEPA regulations and NPDES permits contain more restrictive limits (Chapter 4.2.1.3.2). The effects of past muds and cutting discharges are also discussed in Chapter 4.2.1.3.2. A brief overview of the potential impacts on topographic features by drilling discharges follows.

Water-column turbidity and the smothering of sessile invertebrates on topographic features caused by drilling muds and cuttings are of little significance for two reasons. First, the Topographic Features Stipulation limits impact through the No Activity Zone shunting restrictions imposed within the 1-Mile Zone and 1,000-Meter Zone, as well as the USEPA general NPDES permit special restrictions on discharge rates in blocks adjacent to a No Activity Zone or sensitive areas, which necessitates photodocumentation by industry. Secondly, studies have shown the rapid dispersion of drilling fluid plumes in the OCS within a 1,000-m range of the discharge point and the resilience of sessile invertebrates exposed or smothered with an extreme range of concentrations of drilling muds (Kendall, 1983). For local accumulation of contaminants, assumptions are that trace-metal and petroleum contamination resulting from drilling muds and cuttings will occur mainly within a few hundred to a couple of thousand meters downcurrent from the discharge point and can be found up to 3,000 m downcurrent in shallow waters. Concentrations of contaminants decrease with an increasing distance from the drilling site. By examining sediments surrounding three gas production platforms (within a 100-m radius), Kennicutt et al. (1996) found low concentrations of petroleum and trace metal contaminants that would unlikely induce a biological response in benthic organisms. The highest trace metal concentrations originating from discharged drilling fluids and found around platforms were strongly correlated with the presence of sand-size sediments. Shallow sites are subject to comparatively greater sediment removal and resuspension due to a high-energy environment. Contaminants from previous discharges under less restrictive conditions have been found to remain in sediments surrounding drill sites for as long as 10 years (Kennicutt et al., 1996). Toxic effects could be incurred by benthic organisms on topographic features found in the vicinity of a No Activity Zone boundary if the plume flow of an operation is consistently directed toward that boundary. Should effects occur, they would potentially persist for as long as 10 years following the onset of discharges.

Produced waters could also represent a significant potential source of impact to the biota of topographic features, considering produced water constitutes the largest single discharge during routine oil and gas operations. The USEPA general NPDES permit restrictions on the discharge of produced water help to limit the impacts on biological resources of topographic features. Past evaluation of the bioaccumulation of offshore produced-water discharges conducted by the Offshore Operators Committee (1997) assessed that metals discharged in produced water would, at worst, affect living organisms found in the immediate vicinity of the discharge, particularly those attached to the submerged portion of platforms. Naturally occurring radioactive material in produced water was not found to bioaccumulate in marine animals (2 species of molluscs and 5 species of fish). Because high-molecular, polycyclic aromatic hydrocarbons (PAH's) are usually in such dilute concentrations in produced water, they pose little threat to marine organisms and their constituents, and were not anticipated to biomagnify in marine food webs. Monocyclic hydrocarbons and other miscellaneous organic chemicals are known to be moderately toxic, but they do not bioaccumulate to high concentrations in marine organisms and are not known to pose a risk to their consumers. A detailed description of the impacts of produced waters on water quality and seafloor sediments is presented in Chapter 4.2.1.3.

The impacts of structure removal on topographic features can include water turbidity, sediment deposition, and explosive shock-wave impacts. Both explosive and nonexplosive removal operations would disturb the seafloor by generating considerable turbidity. The deposition of resuspended sediments would occur much in the same manner as discussed for discharges of muds and cuttings, choking and causing mortality of sessile benthic organisms. Turbidity could both reduce light levels and obstruct filter-feeding mechanisms, leading to reduced productivity, susceptibility to infection, and mortality. The shock waves produced by the explosive structure removals could also harm associated biota. Corals and other sessile invertebrates have a supposedly high resistance to shock. O'Keeffe and Young (1984) described the impacts of underwater explosions on various forms of sea life using, for the most part, open-water explosions much larger than those used in typical structure removal operations. They found that sessile benthic organisms, such as barnacles and oysters, and many motile forms of life, such as shrimp and crabs, that do not possess swim bladders were remarkably resistant to shock waves generated by underwater explosions. Oysters located 8 m away from the detonation of 135-kg charges in open water incurred a 5 percent mortality. Crabs distanced 8 m away from the explosion of 14-kg charges in open water had a 90 percent mortality rate. Few crabs died when the charges were detonated 46 m away. O'Keeffe and Young (1984) also noted ". . . no damage to other invertebrates such as sea anemones, polychaete worms, isopods, and amphipods." Benthic organisms appear to be further protected from the impacts of subbottom explosive detonations by rapid attenuations of the underwater shock wave traversing the seabed away from the structure being removed. The shock-wave attenuation is significantly less in mud than in the water column where it is known to impact fish up to 60 m away from a 11.3-kg charge blasted at a 100-m depth (Baxter et al., 1982). Theoretical predictions suggest that the shock waves of explosives set 5 m below the seabed as required by MMS regulations would further attenuate blast effects. Charges used in OCS structure removals are typically much smaller than some of those cited by O'Keeffe and Young. The *Programmatic Environmental Assessment for Structural Removal Activities* (USDOI, MMS, 1987) predicts low impacts on the sensitive offshore habitats from platform removal precisely because of the effectiveness of the proposed stipulation in preventing platform emplacement in the most sensitive areas of the topographic features of the Gulf of Mexico. Impacts on the biotic communities, other than those on or directly associated with the platform, would be conceivably limited by the relatively small size of individual charges (normally 22.7 kg or less per well piling and per conductor jacket) and by the fact that charges are detonated 5 m below the mudline and at least 0.9 seconds apart (timing needed to prevent shock waves from becoming additive). The stipulation discussed above would preclude platform installation in the No Activity Zone, thus preventing adverse effects from nearby removals.

Proposed Action Analysis

All of the 16 topographic features (shelf edge banks, mid-shelf banks, and low-relief banks) in the CPA are found in waters less than 200 m deep. They represent a small fraction of the Central Gulf area.

As noted above, the proposed Topographic Features Stipulation could prevent most of the potential impacts from oil and gas operations on the biota of topographic features, including direct contact during pipeline, rig, and platform emplacements and anchoring activities. Yet, operations outside the No Activity Zones could still affect topographic features through drilling-effluent and produced-water discharges, blowouts, and oil spills. Potential impacts from oil spills and blowouts are discussed in Chapter 4.4.3.2.2.

For a CPA proposed action, 181-312 exploration/delineation and development wells are projected for offshore Subareas C0-60 and C60-200. With the inclusion of the proposed Topographic Features Stipulation, no discharges would take place within the No Activity Zones. Drilling discharges would be shunted to within 10 m of the seafloor either within a radius of 1,000 m, 1 mi (1,609 m), 3 mi (4,828 m), or 4 mi (6,437 m) (depending on the topographic feature) around the No Activity Zone. This procedure would essentially prevent the threat of large amounts of drilling effluents reaching the biota of a given topographic feature. It has been estimated, however, that drilling effluents and produced waters could reach and impact topographic features 5-10 times during the life of this proposal. The severity of such impacts would probably be primarily sublethal such that there may be a disruption or impairment of a few elements at the regional or local scale, but no interference to the general system performance. Recovery to pre-impact conditions should take place within 2 years.

For a CPA proposed action, 23-39 production structures are projected in offshore Subareas C0-60 and C60-200. Between 11 and 20 structure removals using explosives are projected for Subarea C0-60 and between 2 and 4 for Subarea C60-200. The explosive removals of platforms should not impact the biota of topographic features because the Topographic Features Stipulation restricts the emplacement of platforms to locations most certainly farther than 100 m away from No Activity Zone boundaries. This emplacement would prevent shock-wave impacts and resuspended sediments from reaching the biota of topographic features.

Summary and Conclusion

The proposed Topographic Features Stipulation could prevent most of the potential impacts on live-bottom communities from bottom-disturbing activities (structure removal and emplacement) and operational discharges. Recovery from impact incidences of operational discharges would take place within 10 years.

Effects of the Proposed Action Without the Proposed Stipulation

The topographic features and associated coral reef biota of the Central Gulf could be adversely impacted by oil and gas activities resulting from a proposed action should they be unrestricted by the absence of the proposed Topographic Features Stipulation. This would be particularly true should operations occur directly on top of or in the immediate vicinity of otherwise protected Central Gulf topographic features.

The No Activity Zone would probably be the area of the topographic features most susceptible to adverse impacts if oil and gas activities are unrestricted by the Topographic Feature Stipulation and not followed up by mitigating measures. These impacting activities could include vessel anchoring and infrastructure emplacement, discharges of drilling muds and cuttings, and ultimately the explosive removal of structures. All of the above-listed activities have the potential to considerably alter the diversity, cover, and long-term viability of the reef biota found within the No Activity Zone. In most cases, recovery from disturbances would take 10 years or more. Long-lasting and possibly irreversible change would be caused mainly by vessel anchoring and structure emplacement (pipelines, drill rigs, and platforms). Indeed, such activities would physically and mechanically alter benthic substrates and their associated biota over areas, possibly ranging from tens to thousands of square meters per impact. Operational discharges would cause substantial and prolonged turbidity and sedimentation, possibly impeding the well-being and permanence of the biota and causing the decrease of live benthic cover.

Finally, the unrestricted use of explosives to remove platforms installed in the near vicinity of or on the topographic features could cause turbidity, sedimentation, and shock-wave impacts that would affect reef biota.

The shunting of cuttings and fluids, which would be required by the Topographic Features Stipulation, is intended to limit the smothering and crushing of sensitive benthic organisms by depositing the foreign substances in areas where they could not be displaced by currents onto the topographic features. The impacts from unshunted exploration and development discharges of drill cuttings and drilling fluids within the 1,000-Meter Zone and the 1-Mile Zone would definitely impact the biota of topographic features. Specifically, the discharged materials would cause prolonged events of turbidity and sedimentation, which could have long-term deleterious effects on local primary production, predation, and consumption by benthic and pelagic organisms, biological diversity, and benthic live cover. The unrestricted discharge of drilling cuttings and fluids during development operations within the 3-Mile Zone would be a further source of impact to the sensitive biological resources of the topographic features.

Therefore, in the absence of the Topographic Features Stipulation, a proposed action could cause long-term (10 years or more) adverse impacts to the biota of the topographic features, located in most cases on those portions of the topographic features that are in 85 m and less water depth.

4.2.1.2.3. Chemosynthetic Deepwater Benthic Communities

Physical

The greatest potential for adverse impacts on deepwater chemosynthetic communities would come from those OCS-related, bottom-disturbing activities associated with pipelaying (Chapter 4.1.1.3.8.1), anchoring (Chapter 4.1.1.3.2.1), and structure emplacement (Chapter 4.1.1.3.1), as well as from an accidental seafloor blowout (Chapter 4.4.1.2). Potential impacts from blowouts are discussed in Chapter 4.4.3.2.2. These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area.

Considerable mechanical damage could be inflicted upon the bottom by routine OCS drilling activities. The physical disturbance by structures related to a drilling operation itself affect a small area of the sea bottom. The presence of a conventional structure can also cause scouring of the surficial sediments by near-bottom ocean currents (Caillouet et al., 1981), although this phenomena has not been demonstrated around structures in deep water.

Anchors from support boats and ships (or, as assumed for deeper water depths, from any buoys set out to moor these vessels), floating drilling units, barges used for construction of platform structures, and pipelaying vessels also cause severe disturbances to small areas of the seafloor. The 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. Excessive scope and the movement of the mooring chain could disturb a much larger bottom area than an anchor alone, depending on the variety of prevailing wind and current directions. A 50-m radius of chain movement on the bottom around a mooring anchor could destroy chemosynthetic communities in an area of nearly 8,000 m^2. A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the central drilling structure. Larger anchors, longer anchor chains/cables and mooring lines, and greater scope for anchoring configurations are expected for operations in deep water as compared to operations on the shelf. Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, are expected to be greater for operations that employ anchoring in deep water. Many oil and gas support operations involving ships and boats would not result in anchor impacts on deepwater chemosynthetic communities because the vessels would tie-up directly to rigs, platforms, or mooring buoys. In addition, there are drillships, construction barges, and pipelaying vessels operating in the Gulf of Mexico that rely on dynamic positioning rather than conventional anchors to maintain their position during operations (anchoring would not be a consideration in these situations). The area affected by anchoring operations will depend on the water depth, length of the chain, size of the anchor, and current. Anchoring will destroy those sessile organisms actually hit by the anchor or anchor chain during anchoring and anchor weighing, or it could cause destruction of underlying carbonate structures on which organisms rely for dispersion of hydrocarbon sources. While such an area of disturbance may be small in absolute terms, it may be large in relation to the area inhabited by dense chemosynthetic communities.

Normal pipelaying activities in deepwater areas could destroy large areas of chemosynthetic organisms (it is assumed that 0.32 ha of bottom is disturbed per kilometer of pipeline installed). Since pipeline systems are not as established in deepwater as in shallow water, new installations are required, which will tie into existing systems or bring production directly to shore. Pipelines will also be required to transport product from subsea systems to fixed platforms.

In addition to physical impacts, structure removals and other bottom-disturbing activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cutting discussed below.

The impacts from bottom-disturbing activities are expected to be relatively rare. Should they occur, these impacts could be quite severe to the immediate area affected, with recovery times as long as 200 years for mature tube-worm communities, with the possibility of the community never recovering.

Discharges

In deep water, discharges of drilling fluids and cuttings at the surface are spread across broader areas of the seafloor and are, in general, distributed in thinner accumulations than in shallower areas on the continental shelf. Recent information about the effects of surface discharge of drilling fluids (muds) and cuttings at a well in 565 m have been reported by Gallaway and Beaubien (1997). In this instance, a veneer of cuttings was observed scattered over the bottom, in some cases as thick as 20-25 cm. Chemical evidence of SBF components (used during this operation) was found at distances of at least 100 m from the well site (sampling distance was limited by the ROV tether length). Other information from a geophysical survey documented the extent of drilling discharges at several previously drilled oil and gas sites in about 400 m water depths (Nunez, personal communication, 1994). At these sites, the areal coverage of cuttings was found extending from the previous well locations in splay or finger-like projections to a maximum of about 610 m, with an average of about 450 m. An examination of side-scan-sonar records of these splays indicates that they were distributed in accumulations less than 30 cm thick. Effluents from routine OCS operations (not muds or cuttings) in deep water would be subject to rapid dilution and dispersion and are not projected to reach the seafloor at depths greater than 100 m.

Impacts from muds and cuttings are also expected from two additional sources: (1) initial well drilling and installation of casing prior to the use of a riser to circulate returns to the surface; and (2) the potential use of various dual-gradient or subsea mudlift drilling techniques in the deep sea. Pre-riser casing installation typically involves 36-in (91-cm) casing that may be set to a depth of 300 ft (91 m) and 26-in (66-cm) casing that may be set to a depth of 1,600 ft (488 m). Jetted or drilled cuttings from the initial wellbore could total as much as 226 m^3 (Halliburton Company, 1995). With dual-gradient drilling techniques, the upper portion of the wellbore will be "drilled" similar to conventional well initiation techniques with cuttings being discharged at the seafloor. After the BOP stack is installed, subsea mudlift pumps will circulate the drilling fluid and cuttings to the surface for conventional well solids control. Discharges from the dual-gradient drilling operations are expected to be similar to conventional drilling operations. Although the full areal extent and depth of burial from these initial activities are not known, the potential impacts are expected to be localized and short term. Since these areas would occupy a minuscule portion of the available seafloor in the deepwater Gulf of Mexico, these impacts are not considered significant provided that sensitive communities (e.g., chemosynthetic communities) are avoided.

MacDonald et al. (1995) indicates that the vulnerability of chemosynthetic communities to oil and gas impacts may depend on the type of community present. Tube-worm and mussel communities may be more vulnerable than clam communities because clam communities are vertically mobile (preventing burial) and sparsely distributed. The primary concern related to muds and cuttings discharges is that of burial. Although chemosynthetic organisms thrive with some part of their anatomy located next to or inside of toxic and/or anoxic environments, all chemosynthetic biota (including the symbiotic bacteria) also require oxygen to live. Burial by sediments or rock fragments originating from drilling fluids and cuttings discharges would smother and kill most chemosynthetic organisms (motile clams being one possible exception). Depending on the organism type, just a few centimeters of burial could cause mortality.

The tolerance of various community components to burial is not completely understood and would depend on the depth of burial. Detrimental effects due to burial are expected to decrease exponentially in the same manner that the depth of accumulations of discharges decrease exponentially with distance from the origin. The severity of these impacts is such that there may be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

High-density, Bush Hill-type communities are areas that are considered to be most at risk from oil and gas operations. The disturbance of a Bush Hill-type environment could lead to the destruction of a community from which recovery would occur only over long time intervals (200+ years for a mature tube-worm colony and 25-50 years for a mature mussel community) or would not occur at all. A long span of time is required for the precipitation of enough carbonate rock to support a large population of tube worms. As dense tube-worm communities require hard substrate as well as very active seepage at any point in space, existing communities covered by sediment that are physically damaged would likely never recover (Fisher, 1995).

Information is limited about the vulnerability of tube worms to sedimentation/smothering impact. Individual tube worms are often found buried for more than half the length of their tubes by hemipelagic sediment (MacDonald, 1992). Presumably, this burial occurs over long time intervals. Evidence of catastrophic burial of high-diversity chemosynthetic communities can be found in the paleorecord as documented by Powell (1995), but the importance of this in causing local extinctions was reported as minor. These burials were probably caused by catastrophic seismic events.

Methanotrophic mussel communities have strict chemical requirements that tie them directly to areas of the most active seepage. Physical disturbance of an active mussel bed is thought not to have a long-lasting effect on the community due to high growth rates of individuals (Fisher, 1995). Catastrophic mud burial would be one possible cause of a mussel community death. It is predicted that a mussel community completely eliminated by physical disturbance could be resettled and mature within 20 years.

Reservoir Depletion

There has been some speculation about the potential impact to chemosynthetic communities as a result of oil and gas withdrawal, causing a depletion of the energy source (hydrocarbons) sustaining the chemosynthetic organisms. There is evidence that both removal and reinjection of material into reservoirs that supply seeps on land in California affect the seepage rates. Quigley et al. (1996) reported evidence that suggested offshore California oil production resulted in reduced seepage due to reduction in reservoir pressure. The seeps and faults around which chemosynthetic animals live are supplied from the deep reservoirs that transport the gas or oil to the seafloor through combined effects of buoyancy and pressure. When all of the recoverable hydrocarbons from these reservoirs are withdrawn by production operations (the amount that can be economically extracted by current technology is estimated to be 30% or less of the total hydrocarbons), it is possible that oil and gas venting or seepage would also slow or (less likely) stop. Based on current information, it is not possible to determine whether reduced reservoir pressure would actually reduce the seepage (as observed onshore) or whether there may be enough oil already in the conduit to the surface to continue adequate levels of seepage for long periods, perhaps thousands of years or more. The distribution of chemosynthetic communities is known to occur in association with precise levels and types of chemical gradients at the seafloor; alterations to these gradients may potentially impact the type and distribution of the associated community.

Proposed Action Analysis

Because high-density chemosynthetic communities are generally found only in water depths greater than 400 m, they would not be found in shallow-water areas of the CPA (Subareas C0-60 or C60-200, Table 4-2). Chemosynthetic communities could be found in the deeper water areas (Subareas C200-800, C800-1600, C1600-2400 and C>2400, Table 4-2). Of the 45 known communities, a total of 26 documented chemosynthetic communities are known to exist in the CPA: 1 in the Viosca Knoll lease area; 2 in the Ewing Bank lease area; 1 in the Mississippi Canyon lease area; and 22 in the Green Canyon lease area. The levels of projected impact-producing factors for deepwater Subareas C200-800, C800-1600, C1600-2400 and C>2400 are shown in Table 4-2. A range of 5-10 oil and gas production structures ranging from small subsea developments to large developments involving floating, fixed, or subsea structures are estimated to be installed between 2003 and 2042 in the deepwater portions of the CPA as a result of a proposed action. These deepwater production structures are expected to be installed between 5 and 20 years after a proposed lease sale, with a peak annual installation rate of 2-3.

Notice to Lessees (NTL) 98-11(superseded by NTL 2000-G20) has been a measure for the protection of chemosynthetic communities since February 1, 1989. Now, NTL 2000-G20 makes mandatory the search for and avoidance of dense chemosynthetic communities (such as Bush Hill-type communities) or areas that have a high potential for supporting these community types, as interpreted from geophysical records. The NTL is exercised on all applicable leases and is not an optional protective measure. Under the provisions of this NTL, lessees operating in water depths greater than 400 m are required to conduct geophysical surveys of the area of proposed activities and to evaluate the data for indications of conditions that may support chemosynthetic communities; if such conditions are indicated, the lessee must either move the operation to avoid the potential communities or provide photodocumentation of the presence or absence of dense chemosynthetic communities of the Bush Hill type. If such communities are indeed present, no drilling operations or other bottom-disturbing activities may take place in the area;

if the communities are not present, drilling, anchoring, etc. may proceed. To date, in almost all cases, operators have chosen to avoid any areas that show the potential to support chemosynthetic communities. The basic assumptions underlying the provisions of this mitigation measure are (1) that dense chemosynthetic communities are associated with gas-charged sediments or seeps, (2) that the gas-charged sediment zones or seeps have physical characteristics that will allow them to be identified by geophysical surveys, and (3) that dense chemosynthetic communities are not found in areas where gas-charged sediments or seeps are not indicted on the geophysical survey data. These assumptions have not been totally verified. A definitive correlation between the geophysical characteristics recorded by geophysical surveys and the presence of chemosynthetic communities has not been proven.

Although there are few examples of field verification, the requirements set forth in NTL 2000-G20 are considered effective in identifying potential areas of chemosynthetic communities. Although there has generally been compliance with NTL 2000-G20, compliance does not guarantee avoidance of high-density communities without visual confirmation in every case. On rare occasions, high-density chemosynthetic community areas may not be properly identified using the geophysical systems and indicators specified in the existing NTL. Oil- or gas-saturated sediments and other related characteristic signatures cannot be determined without high-resolution acoustic records or the interpretation of subsurface 3D seismic data.

Improved definitions and avoidance distances have been released in a new Chemosynthetic Community NTL 2000-G20. Requirements for specific separation distance between potential high-density chemosynthetic communities and both anchors (250-500 ft) and drilling discharge points (1,500 ft) have been included in the revision of the NTL. These new guidelines have also been released in the new Interim Plans NTL (NTL 2000-G10), which became effective May 31, 2000. The potential for any impact could also be lessened by the refinement of techniques used in the interpretations of geophysical records. The use of differential global positioning system (GPS) has also been required on anchor handling vessels when placing anchors near an area that has potential for supporting chemosynthetic communities. As new information becomes available, the NTL will be further modified as necessary.

High-density, Bush Hill-type communities are, as noted above, largely protected from direct physical impacts by the provisions of NTL 2000-G20. A limited number of these communities have been found to date, but it is probable that additional communities exist. Observations of the surface expression of seeps from space images indicate numerous other communities may exist (MacDonald et al., 1993 and 1996). Most chemosynthetic communities are of low density and are relatively widespread throughout the deepwater areas of the Gulf. Physical disturbance or destruction of a small, low-density area would not result in a major impact to chemosynthetic communities as an ecosystem. Low-density communities may occasionally sustain major or minor impacts from discharges of drill muds and cuttings, bottom-disturbing activities, or resuspended sediments. Areas so impacted could be repopulated from nearby undisturbed areas (although this process may be quite slow, especially for vestimentiferans). In light of probable avoidance of all chemosynthetic communities (not just high-diversity types) as required by NTL 2000-G20, the frequency of such impact is expected to be low, and the severity of such an impact is judged to result in minor disturbance to ecological function of the community, with no alteration of ecological relationships with the surrounding benthos. Recolonization after a disturbance would not exactly reproduce the preexisting community prior to the impact, but it could be expected that some similar pattern and species composition would eventually reestablish if similar conditions of sulfide or methane seepage persist after the disturbance.

Summary and Conclusion

Chemosynthetic communities are susceptible to physical impacts from structure placement (including templates or subsea completions), anchoring, and pipeline installation. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement.

If the presence of a high-density community were missed using existing procedures, potentially severe or catastrophic impacts could occur due to raking of the sea bottom by anchors and anchor chains and partial or complete burial by muds and cuttings associated with pre-riser discharges or some types of riserless drilling. Variations in the dispersal and toxicity of synthetic-based drilling fluids may contribute to the potential areal extent of these impacts. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type), although it may reappear relatively quickly once the process begins, as in the case of a mussel community. Tube-worm communities may be the most sensitive of all communities because of the combined requirements of hard substrate and active hydrocarbon seepage. Mature tube-worm bushes have been found to be several hundred years old. There is evidence that substantial impacts on these communities would permanently prevent reestablishment.

A proposed action in the CPA is expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience minor impacts from drilling discharges or resuspended sediments located at more than 1,500 ft away as required by NTL 2000-G20.

4.2.1.2.4. Nonchemosynthetic Deepwater Benthic Communities

Physical

Benthic communities other than chemosynthetic organisms could be impacted by OCS-related, bottom-disturbing activities associated with pipelaying (Chapter 4.1.1.3.8.1.), anchoring (Chapter 4.1.1.3.2.1), and structure emplacement (Chapter 4.1.1.3.1), as well as from a seafloor blowout (Chapter 4.4.1.4). Potential impacts from blowouts are discussed in Chapter 4.4.3.2.2. These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area. Considerable mechanical damage can be inflicted upon the bottom by routine OCS drilling activities. The physical disturbance by structures related to a drilling operation itself affects a small area of the sea bottom. These impacts are the same as those encountered in shallower continental shelf waters.

Anchors from support boats and ships (or, as assumed in these water depths, from any buoys set out to moor these vessels), floating drilling units, and pipelaying vessels also cause severe disturbances to small areas of the seafloor with the areal extent related to the size of the mooring anchor and length of chain that would rest on the bottom. Excessive scope (length) and movement of the mooring chain could disturb a much larger area of the bottom than would an anchor alone, depending on the prevailing wind and current directions. A 50-m radius of chain movement on the bottom around a mooring anchor could destroy communities in an area of nearly 8,000 m^2. A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the central drilling structure. Larger anchors and additional scope of anchor chain are expected for operations in deep water as compared to operations on the shelf. Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, are expected to be greater for operations that employ anchoring in deep water. The area affected by anchoring operations will depend on the water depth, length of the chain, size of the anchor, and current. (Many OCS-support operations and activities will not result in anchor impacts to deepwater benthic communities because vessels will tie-up directly to rigs, platforms, or mooring buoys or will use dynamic positioning.) Anchoring will not necessarily directly destroy small infaunal organisms living within the sediment; the bottom disturbance would most likely change the environment to such an extent that the majority of the directly impacted infauna community would not survive (e.g., burial or relocation to sediment layers without sufficient oxygen). In cases of carbonate outcrops or reefs with attached epifauna, the impacted area of disturbance may be small in absolute terms, but it could be large in relation to the area inhabited by hard corals or other organisms that rely on exposed rock substrate.

As described in the previous section for chemosynthetic communities, normal pipelaying activities in deepwater areas could destroy large areas of benthic communities (it is assumed that 0.32 ha of bottom is disturbed per kilometer of pipeline installed.); although, without consideration of chemosynthetic organisms, there are no differences between this activity in deep water as compared to shallow-water operations.

In addition to direct physical impacts, structure removals and other bottom-disturbing activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cuttings discussed below.

Discharges

In deep water, discharges of drilling muds and cuttings at the surface are spread across broader areas of the seafloor and are, in general, distributed in thinner accumulations than in shallower areas on the continental shelf. Recent information about the effects of surface discharge of muds and cuttings at a well in 565 m is reported by Gallaway and Beaubien (1997) and is described in the previous section on chemosynthetic communities. In this instance and in another deepwater survey reported by Nunez (personal communication, 1994), muds and cuttings were documented in accumulations ranging up to 30 cm thick at distances up to 610 m from the well site.

Impact from muds and cuttings are also expected from two additional sources: (1) initial well drilling prior to the use of a riser to circulate returns to the surface; and (2) the potential use of various riserless drilling techniques in the deep sea. Jetted or drilled cuttings discharged at the bottom from the initial wellbore would total as much as 226 m^3 (Halliburton Company, 1995). In the case of some riserless drilling practices, all muds and cuttings from well spudding through total depth would be discharged at the seafloor. Although the full areal extent and depth of burial from these activities is not known, the potential impacts are expected to be localized and short term. Since these areas would occupy only a minuscule portion of the available seafloor in the deepwater Gulf of Mexico, these impacts are not considered significant provided that sensitive communities (e.g., chemosynthetic communities) are avoided.

Burial by sediments or rock fragments originating from drilling muds and cuttings discharges could smother and kill almost all community components of benthic organisms, with the exception of highly motile fish and possibly some crustaceans such as shrimp capable of moving away from the impacted area. Depending on the organism type, just a few centimeters of burial could cause death. The damage would be both mechanical and toxicological. Some types of macrofauna could burrow through gradual accumulations of overlying sediments depending on the toxicological effects of those added materials. Information on the potential toxic effects on various benthic organisms is limited and essentially nonexistent for deepwater taxa.

It can be expected that detrimental effects due to burial would decrease exponentially with distance from the origin. The physical properties of the naturally occurring surface sediment (grain size, porosity, and pore water) could also be changed as a result of discharges such that recolonizing benthic organisms would be comprised of different species than inhabited the area previous to the impact. Although the impacts could be considered severe to the nonmotile benthos in the immediate area affected, they would be considered very temporary. Due to the proximity of undisturbed bottom with similar populations of benthic organisms from microbenthos to megafauna, these impacts would be very localized and reversible at the population level and are not considered significant.

Carbonate outcrops not associated with chemosynthetic communities, such as the deepwater coral "reef" or habitat reported by Moore and Bullis (1960), are considered to be most at risk from oil and gas operations. Due to the fact that deepwater corals require hard substrate, existing communities completely buried by some amount of sediment would likely never recover.

Effluents other than muds or cuttings from routine OCS operations in deep water would be subject to rapid dilution and dispersion and are not projected to reach the seafloor at depths greater than 100 m.

Proposed Action Analysis

For a proposed action in the CPA, 5-10 oil and gas structures ranging from small subsea developments to large developments involving floating, fixed, or subsea structures are estimated to be installed between 2001 and 2040 in Subareas C200-800, C800-1600, C1600-2400, and C>2400 (Table 4-2). These deepwater production structures are expected to be installed 5-10 years after a proposed lease sale, with a peak annual rate of 1-2. Physical disturbance or destruction of a limited area of benthos or to a limited number of megafauna organisms, such as brittle stars, sea pens, or crabs, would not result in a major impact to the deepwater benthos ecosystem as a whole. Surface discharge of muds and cuttings, as opposed to seafloor discharge, would reduce or eliminate the impact of smothering the benthic communities on the bottom.

Under the current review procedures for chemosynthetic communities, carbonate outcrops are targeted as one possible indication (surface anomaly on 3D seismic survey data) that chemosynthetic seep communities are nearby. Unique communities that may be associated with any carbonate outcrops or other topographical features could be identified via this review along with the chemosynthetic communities. Typically, all areas suspected of being hard bottom are avoided as a geological hazard for any well sites. Any proposed activity in water depth greater than 400 m would automatically trigger the NTL 2000-G20 evaluation described above.

Summary and Conclusion

Some impact to benthic communities from drilling and production activities would occur as a result of physical impact from structure placement (including templates or subsea completions), anchoring, and installation of pipelines regardless of their locations. Megafauna and infauna communities at or below the sediment/water interface would be impacted from the muds and cuttings normally discharged at the seafloor at the start of every new well prior to riser installation. The impact from muds and cuttings discharged at the surface are expected to be low in deep water. Drilling muds would not be expected to reach the bottom beyond a few hundred meters from the surface-discharge location, and cuttings would be dispersed. Even in situations where substantial burial of typical benthic communities occurred, recolonization from populations from neighboring substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of days for bacteria and probably less than one year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be very rare. These unique communities are distinctive and similar in nature to protected pinnacles and topographic features on the continental shelf. Any hard substrate communities located in deep water would be particularly sensitive to impacts from OCS activities. Impacts to these sensitive habitats could permanently prevent recolonization with similar organisms requiring hard substrate.

A proposed action in the CPA is expected to cause little damage to the ecological function or biological productivity of the widespread, typical deep-sea benthic communities.

4.2.1.3. Impacts on Water Quality

Activities that are projected to result from a single lease sale in the CPA are given in Table 4-2. The routine activities that will impact water quality include the following:

- discharges during drilling of exploration and development wells;
- workover of a well;
- structure installation and removal;
- discharges during production;
- installation of pipelines;
- service vessel discharges; and
- discharges from support facilities.

The current NPDES General Permit for OCS discharges in USEPA Regions 4 (eastern CPA and EPA) and 6 (WPA and western CPA) will expire in October 2003 and April 2004, respectively.

4.2.1.3.1. Coastal Waters

Proposed Action Analysis

In coastal waters, the water quality will be impacted by the discharges from the service vessels in port. The types of discharges and regulations were discussed in Chapters 4.1.1.3.4.8 and 4.1.2.1.10.2. Most discharges are treated prior to release, with the exception of ballast water. In coastal waters, bilge water may be discharged with an oil content of 15 ppm or less. The discharges will affect the water quality locally. Estimates of the volume of bilge water that may be discharged are not available.

Supporting infrastructure also discharge into local waterways during routine operations. The types of onshore facilities are discussed in Chapter 4.1.2.1.10.1. All point-source discharges are regulated by the USEPA, which is the agency responsible for coastal water quality. The USEPA NPDES storm-water effluent limitations regulate storm-water discharges from supporting facilities. Nonpoint source run-off, such as rainfall that has drained from a public road, may contribute hydrocarbon and trace-metal pollutants. Data are not available to make estimates of the impact from nonpoint-source discharges.

The dredging of navigation channels and the installation of pipelines will result in a temporary increase in the suspended sediment load.

Summary and Conclusion

The primary impacting sources to water quality in coastal waters are point-source and nonpoint-source discharges from support facilities and vessel discharges. The impacts to coastal water quality from a proposed action in the CPA should be minimal as long as all regulatory requirements are met.

4.2.1.3.2. Marine Waters

Proposed Action Analysis

Drilling Muds and Cuttings

The primary effects on water quality during the drilling of exploratory and development wells result from the discharges of drilling fluids, called "muds," and cuttings. Table 4-9 gives estimated volumes of muds and cuttings that may be discharged from drilling of an "average" well. The MMS estimates that each lease sale in the CPA will result in 111-247 exploratory and delineation wells and 178-352 development wells being drilled over 35 years. Using the data in Table 4-9, discharges of 1,000,000-2,300,000 bbl of water-based drilling fluids (WBF) and 160,000-330,000 bbl of associated cuttings are estimated from drilling these wells. The direct discharge of synthetic-based drilling fluids (SBF) is prohibited; however, some fluid adheres to the cuttings and an estimated 70,000-150,000 bbl of SBF may be discharged with the estimated 60,000-130,000 bbl of SBF-associated cuttings.

Drill cuttings deposited on the seafloor are representative of the geological formations below the seafloor. The cuttings will include clastic (e.g., sand, silt, and clay), carbonate (e.g., limestone), and evaporite (e.g., salt) rock fragments. They may contain a variety of naturally occurring metals. Silicon, aluminum, iron, and calcium are typically abundant in cuttings, while elements such as cadmium, vanadium, and mercury are found in trace quantities. These elements are unlikely to leach from cuttings into water in any appreciable amounts because they are chemically bound within the rock minerals and therefore not available for biological assimilation. Of environmental concern is the physical impact of the cuttings deposition to the benthic habitat and the potential toxicity of drilling fluid adhered to the cuttings.

The fate and effects of WBF have been extensively studied throughout the world (Engelhardt et al., 1989). The primary concerns for WBF are the increased turbidity in the water column, alteration of sediment characteristics because of coarse material in cuttings, and trace metals. Occasionally, formation fluids may be discharged with the cuttings, adding hydrocarbon contamination. The WBF are rapidly dispersed in the water column immediately after discharge, and the solids descend to the seafloor (Neff, 1987). The greatest effects to the benthos are within 100-200 m, primarily due to the increased coarsening of the sediment by cuttings. Most of the components of the WBF have low toxicity with the exception of some trace metals. Barium is the major element in the mud because of the high barite level, but trace amounts of chromium, copper, cadmium, mercury, lead, and zinc are also present. Significant elevations of all these metals except chromium were observed within 500 m of six Gulf of Mexico drilling sites on the continental shelf (Boothe and Presley, 1989). The USEPA guidelines limit the levels of cadmium and mercury in stock barite to 3.0 milligrams/kilogram (mg/kg) and 1.0 mg/kg (dry weight), respectively. A study of chronic impacts from oil and gas activities (Kennicutt, 1995) determined that metals from discharges, including mercury and cadmium, were localized to within 150 m of the structure. Highest levels of metal contaminants were attributed to a platform where discharges are shunted to within 10 m of the bottom.

A recent literature review (Neff et al., 2000) discusses the current knowledge about the fate and effects of SBF on the seabed. Like oil-based drilling fluids (OBF), the SBF do not disperse in the water column and therefore are not expected to adversely affect water quality. They do, however, settle very close to the discharge point, thus affecting the local sediments. Unlike OBF, the SBF do not typically contain toxic aromatic compounds. The primary affects are smothering, alteration of grain size, and addition of organic matter, which can result in localized anoxia while the SBF degrade. Different formulations of SBF use different base fluids that degrade at different rates, thus affecting the impact. The SBF cuttings could pass the current discharge criterion for WBF because of their low toxicity. Bioaccumulation tests also indicate that SBF and their degradation products should not significantly bioaccumulate. It is expected that discharged cuttings should degrade within 2-3 years after cessation of discharge. The MMS is currently jointly funding a study of the spatial and temporal effects of discharged cuttings to evaluate the effects. In deep water (>400 m), the use of dual density drilling techniques may result in the discharge of cuttings at the seafloor. The cuttings will not have undergone any cleaning process to remove the drilling fluids, and the impacts of these discharges are not known.

Produced Water

During production, produced water is the primary discharge and will impact water quality by adding hydrocarbons and trace metals to the environment. As discussed in Chapter 4.1.1.3.4.2, the volume of produced water from a facility ranges from 2 to 150,000 bbl/day. With a monthly average of 29 milligrams/liter (mg/l), the volume of added hydrocarbons would be 5.8 x 10^{-5} bbl/day. As a result of a single lease sale in the CPA, MMS estimates that 28-49 production structures will be installed (Table 4-2). Examination of historical data for produced water extracted from blocks in the Gulf of Mexico (Table 4-10) demonstrates that, on average for the past five years, 7,580 bbl of produced water are generated per block per year. As can be seen in Figure 4-3, most of the produced water is extracted in the CPA. Assuming that each production structure produces an average of 7,580 bbl/yr of water and the discharge averages 29 mg/l hydrocarbon content, then approximately 0.2-0.3 bbl/yr of hydrocarbons are added to the environment from each structure. This amount is negligible relative to natural sources of hydrocarbons. Discharges from workovers and other activities are generally mixed with the produced water and therefore must meet the same criteria.

Several studies have been conducted to evaluate the effects of produced-water discharges from platforms on the surrounding water column, sediments, and biota (e.g., Rabalais et al., 1991; Kennicut, 1995; CSA, 1997b). The GOOMEX study (Kennicutt, 1995) examined the effects of discharges at three natural gas platforms. Effects, including increased hydrocarbons, trace metals, and coarser grain size sediments, were observed within 150 m of the platforms. Localized hypoxia was observed during the summer months and attributed to stratification of the water column and increased organic material near the platform. The distribution of contaminants was patchy and there were several variables that could contribute to the observations, specifically sand from cuttings, hydrocarbons, and trace metals in the porewater. It was not possible to make a definitive judgement as to the precise source of observed toxic effects in the benthic community.

A bioaccumulation study (CSA, 1997b) examined trace metals and hydrocarbons in several fish and invertebrate species near platforms on the continental shelf. The produced-water discharge and ambient seawater were also analyzed for the same compounds. Of the 60 target chemicals, only 2 (arsenic and cadmium) were measured in the edible tissues of mollusks at levels above the USEPA risk-based concentrations. The target organic compounds were not present in most tissue samples above the target level. However, radium isotopes were measured in 55 percent of the samples, but at low concentrations.

Measurements of radium in formation water range from 40 to 1,000 picocuries/liter (pCi/l). These values are greater than marine waters, but when formation waters are discharged offshore, the radium is rapidly diluted to ambient concentrations and the higher levels are not seen as a problem (Reid, 1980).

Other Impacting Activities

Platform installation and removal results in localized sediment suspension. Also, the installation of pipelines can increase the local total suspended solids. These activities result in only a temporary adverse effect on water quality.

Supply-vessel traffic affects water quality through discharges of bilge water, ballast water, and domestic and sanitary wastes. Bilge water and sanitary wastes are treated before discharge. Ballast water is uncontaminated water but may come from a source with properties, such as lower or higher salinity, different from those of the receiving waters. Estimates of the volumes of these discharges are not available.

Summary and Conclusion

During exploration and development drilling activities, the primary impacting sources to marine water quality are discharges of drilling fluids and cuttings. Impacting discharges during production activities are produced water and supply-vessel discharges. Impacts to marine waters from a proposed action in the CPA should be minimal as long as all regulatory requirements are followed.

4.2.1.4. Impacts on Air Quality

The following activities will potentially degrade air quality: platform construction and emplacement; platform operations; drilling activities; flaring; seismic-survey and support-vessel operations; pipeline laying and burial operations; evaporation of volatile petroleum hydrocarbons during transfers and from surface oil slicks; and fugitive emissions. Supporting materials and discussions are presented in Chapters 3.1.1 (description of the coastal air quality status of the Gulf coastal area), 4.1.1.3.6 (air emissions), 4.1.1.3.9 (hydrogen sulfide), and 9.1.3 (description of the meteorology of the northern Gulf of Mexico). The parameters of this analysis are emission rates, surface winds, atmospheric stability, and the mixing height.

Emissions of certain air pollutants are known to be detrimental to public health and welfare. Some of these pollutants are directly emitted into the air, while others are formed in the atmosphere through chemical reactions. Nitric oxide and nitrogen dioxide constitute nitrogen oxide (NO_x) emissions. Nitrogen oxide, a by-product of all combustion processes, is emitted from sources such as internal combustion engines, natural gas burners, and flares. Nitrogen dioxide is a precursor pollutant involved in photochemical reactions that yield ozone. Nitrogen dioxide is an irritating gas that may increase susceptibility to infection and may constrict the airways of people with respiratory problems. Further, nitrogen dioxide can react with water to form nitric acid, which is harmful to vegetation and materials, as a result of increased acidity in precipitation (i.e., acid rain).

Carbon monoxide (CO) is a by-product of incomplete combustion, primarily contained in engine exhaust. Carbon monoxide is readily absorbed into the body through the lungs, where it reacts with hemoglobin in the blood, reducing the transfer of oxygen within the body. CO particularly affects people with cardiovascular and chronic lung diseases.

Sulfur dioxide (SO_2) may cause constriction of the airways and particularly affects individuals with respiratory diseases. Sulfur dioxide reacts in the atmosphere, principally with water vapor and oxygen, producing sulfuric acid, which along with nitric acid are the major constituents of acid rain. Acid rain can be harmful to animals, vegetation, and materials. The flaring of natural gas containing hydrogen sulfide (H_2S) and the burning of liquid hydrocarbons containing sulfur (Chapter 4.1.1.3.9) result in the formation of SO_2. The amount of SO_2 produced is directly proportional to the sulfur content of the hydrocarbons being flared or burned.

The concentration of the H_2S varies substantially from formation to formation and even varies to some degree within the same reservoir. Natural gas from the Norphlet Formation in the northeastern portion of the CPA, just south of Alabama and Mississippi, tends to range between 40 and 140 ppm on the OCS. Nevertheless, two wells are known to have H_2S concentrations of 1.8 and 2.5 percent (18,000 ppm and 25,000 ppm, respectively) in the OCS. Higher concentrations do occur within the Norphlet Formation farther north under State territorial waters and below land.

Additionally, the area around the Mississippi River Delta is a known sulfur-producing area. The natural gas in deepwater reservoirs has been mainly sweet (i.e., low in sulfur content), but the oil averages between 1 and 4 percent sulfur content by weight. By far, most of the documented production of sour gas (i.e., high sulfur content) lies within 150 km of the Breton Wilderness Area.

Flaring of sour gas is of concern because it could significantly impact onshore areas, particularly when considering the short-duration averaging periods (3 and 24 hr) for SO_2. The combustion of liquid hydrocarbon fuel is the primary source of sulfur oxides (SO_x), when considering the annual averaging period; however, impacts from high-rate well cleanup operations can generate significant SO_2 emissions. To prevent inadvertently exceeding established criteria for SO_2 for the 3-hr and 24-hr averaging periods, all incinerating events involving H_2S or liquid hydrocarbons are evaluated individually during the postlease process.

Volatile organic compounds (VOC's) are precursor pollutants involved in a complex photochemical reaction with NO_x in the atmosphere to produce ozone. The primary sources of VOC's result from venting and evaporative losses that occur during the processing and transporting of natural gas and petroleum products. A more concentrated source of VOC's is the vents on glycol dehydrator stills.

Particulate matter is comprised of finely divided solids or liquids such as dust, soot, fumes, and aerosols. The PM_{10} particles are small enough to bypass the human body's natural filtration system and can be deeply inhaled into the lungs, affecting respiratory functions. The PM_{10} can also affect visibility, primarily due to the scattering of light by the particles and, to a lesser extent, light absorption by the particles. This analysis considers mainly total suspended particulate (PM_{10}) matter.

Ozone is a nearly colorless gas with a faint but distinctive odor, somewhat similar to chlorine. It is formed in the troposphere (i.e., lower level of the atmosphere) from complex chemical reactions involving VOC's and NO_x in the presence of sunlight. At ground level, ozone can cause or aggravate respiratory problems, interfere with photosynthesis, and can damage vegetation and crack rubber. Children, the elderly, and healthy people who work or exercise strenuously outdoors are particularly sensitive to elevated ozone concentrations. In the upper atmosphere (i.e., above the troposphere), ozone is essential to life as we know it. The upper ozone layer shields the Earth's surface from harmful ultraviolet radiation. Depletion of the upper ozone layer is one of the most complex environmental issues facing the world today. This analysis will not include impacts on upper atmospheric ozone.

Emissions of air pollutants will occur during exploration, development, and production activities. The profile of typical emissions for exploratory and development drilling activities (Chapter 4.1.1.3.6) shows that emissions of NO_x are the most prevalent pollutant of concern. These emission estimates are based on a drilling scenario of a 4,115-m (13,500-ft) hole during exploration activities and a 3,050-m (10,000-ft) hole during development activities. Emissions during exploration are higher than emissions during development due to power requirements for drilling a deeper hole.

Platform emission rates for the Gulf of Mexico region (Chapter 4.1.1.3.6.) are provided from the 1992 emission inventory of OCS sources compiled by MMS (Steiner et al., 1994). This compilation was based on information from a survey of 1,857 platforms, which represented an 85 percent response rate. Since these responses included all the major oil and gas production facilities, they were deemed representative of the type of emissions to be associated with a platform. The NO_x and VOC's are the primary pollutants of concern, since both are considered to be precursors to ozone. Emission factors for other activities such as support vessels, helicopters, tankers, and loading and transit operations were obtained from Jacobs Engineering Group, Inc. (1989) and USEPA AP-42 (1985).

Flaring is the venting and/or burning of natural gas from a specially designed boom. Flaring systems are also used to vent gas during well testing or during repair/installation of production equipment. The MMS operating regulations provide for some limited volume, short duration flaring or venting of some natural gas volumes upon approval by MMS. These operations may occur for short periods (typically 2-14 days) as part of unloading/testing operations that are necessary to remove potentially damaging completion fluids from the well bore, to provide sufficient reservoir data for the operator to evaluate a reservoir and development options, and in emergency situations. Emissions from flaring were included in the emissions tables and in the modeling analysis (since platform emissions included flaring along with all other sources).

Accidents, such as oil spills, blowouts and pipeline ruptures, are another source of emissions related to OCS operations. The potential impacts from these accidental events are discussed in Chapter 4.4.3.4.

Once pollutants are released into the atmosphere, atmospheric transport and dispersion processes begin circulating the emissions. Transport processes are carried out by the prevailing net wind circulation. During summer, the wind regime in the CPA is predominantly onshore at mean speeds of 3-5 m/sec (6.7-11.2 mph). Average winter winds are predominantly offshore at speeds of 4-8 m/sec (8.9-17.9 mph).

Dispersion depends on emission height, atmospheric stability, mixing height, exhaust gas temperature and velocity, and wind speed. For emissions inside the atmospheric boundary layer, the vertical heat flux, which includes effects from wind speed and atmospheric stability (via air-sea temperature differences), is a better indicator of turbulence available for dispersion (Lyons and Scott, 1990). Heat flux calculations in the CPA (USDOI, MMS, 1988) indicate an upward flux year-round, being highest during winter and lowest in summer.

The mixing height is very important because it determines the space available for spreading the pollutants. The mixing height is the height, above the surface, of the top of the layer through which vigorous vertical mixing occurs. Vertical mixing is most vigorous during unstable conditions. Vertical motion is suppressed during stable conditions; these stagnant conditions generally result in the worst periods of air quality. Although mixing height information throughout the Gulf of Mexico is scarce, measurements near Panama City (Hsu, 1979) show that the mixing height can vary between 400 and 1,300 m, with a mean of 900 m. The mixing height tends to be higher in the afternoon, more so over land than over water. Further, the mixing height tends to be lower in winter, with daily changes smaller than in summer.

Proposed Action Analysis

The emissions in tons of the criteria pollutants over the 40-year life of a proposed action are indicated in Table 4-21. The major pollutant emitted is NO_x, while PM_{10} is the least emitted pollutant. Combustion-intensive operations such as platform operations, well drilling, and service-vessel activities contribute mostly NO_x; platform operations are also the major contributors of VOC emissions. Platform construction emissions contribute appreciable amounts of all pollutants over the life of a proposed action. These emissions are temporary in nature and generally occur for a period of 3-4 months. Typical construction emissions result from the derrick barge placing the jacket and various modular components and from various service vessels supporting this operation. The drilling operations contribute considerable amounts of all pollutants. These emissions are temporary in nature and typically occur over a 40-day drilling period. Support activities for OCS activities include crew and supply boats, helicopters, and pipeline vessels; emissions from these sources consist mainly of NO_x and CO. These emissions are directly proportional to the number and type of OCS operations requiring support activities. Most emissions from these support activities occur during transit between the port and the offshore facilities; a smaller percentage of the emissions occur during idling at the platform. Platform and well emissions were calculated using the integration of projected well and platform activities over time.

Total emissions for each offshore subarea in the CPA due to a proposed action are presented in Table 4-22. Activities projected for Subarea C0-60 would generate the greatest amounts of emissions, while the other five subareas are estimated to generate lower amounts of pollutants. Pollutants are attributed to offshore subareas proportional to the projected number of production structure installations for each subarea.

The total pollutant emissions per year are not uniform. During the early years of a proposed action, emissions would be small. Emissions increase over time with platform emplacements and increasing production. After reaching a maximum, emissions would decrease as wells are depleted and abandoned, platforms are removed, and service-vessel trips and other related activities are no longer needed.

The peak-year emissions in tons per year for the criteria pollutants are indicated in Table 4-23. The peak-year emissions for a proposed action in the CPA are projected to occur in the year 2016. The peak emissions are calculated by combining peak-year activity total emissions for exploratory wells, development wells, and platforms over the life of a proposed action, and superimposing projected peak activity for support vessels and other emissions into that peak year. Peak well-drilling activities and platform emissions are not necessarily simultaneous. It is assumed for this analysis that total well and platform peak-year emissions combined with vessels and other emissions occur simultaneously. Use of the peak emissions provides the most conservative estimates of potential impacts to onshore air quality. The main pollutant emitted is NO_x, with platforms and service vessels being the primary source.

Projected peak-year activities would generate the greatest amounts of emissions in offshore Subarea C0-60 (Table 4-24). Pollutants are attributed to offshore subareas proportional to the projected number of production structure installations for each subarea.

The MMS regulations (30 CFR 250.44) do not establish annual significance levels for CO and VOC. For CO, a comparison of the projected emission rate to the MMS exemption level will be used to assess impacts. The formula to compute the emission rate in tons/yr for CO is $3{,}400 \bullet D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility. The CO exempt emission level is 7,072 tons/yr at the State boundary line of 3 mi, which is greater than CO peak emissions from the whole CPA.

The VOC emissions are best addressed as their corresponding ozone impacts, which were studied in the Gulf of Mexico Air Quality Study (GMAQS). The GMAQS indicated that OCS activities have little impact on ozone exceedance episodes in coastal nonattainment areas including the Houston/Galveston, Port Arthur/Lake Charles, and Baton Rouge areas. Total OCS contributions to the exceedance (greater than 120 ppb) episodes studied were less than 2 ppb. In the GMAQS, the model was also run using double emissions from OCS petroleum development activities and the resulting attributable ozone concentrations, during modeling exceedance episodes, were still small, ranging 2-4 ppb. The activities under a proposed action will not result in a doubling of the emissions, and because the proposed activities are substantially smaller than this worst-case scenario, it is logical to conclude that their impact would be substantially smaller as well (Systems Applications International et al., 1995). Additionally, 30 CFR 250.303(f)(2) requires that if a facility would significantly impact (defined as exceeding the MMS significance levels) an onshore nonattainment area, then it would have to reduce its impact fully through the application of the best available control technology (BACT) and possibly through offsets as well.

The implementation of the new 8-hour ozone standard, a Federal standard that is still pending court action, may affect the ozone level in coastal areas from OCS emissions. The new 8-hour ozone standard (0.08 ppm) is more stringent than the existing 1-hour standard. Thus, if the new 8-hour standard is implemented, it could result in more areas being classified as nonattainment for ozone. This may include a number of parishes in Louisiana as well as counties in Mississippi and the Florida Panhandle.

A new modeling analysis will be conducted using OCS emissions data of the year 2000. The results will be used to investigate the potential effects of OCS emissions on 8-hour average ozone levels in the near future. However, it is expected that the impact on ozone level due to contribution from OCS emissions sources would be minor, because the emission from all sources would remain about the same level or less (see also the Draft EIS on the proposed OCS Oil and Gas Leasing Program: 2002-2007; USDOI, MMS, 2001c).

It is estimated that over 99 percent of the gas and oil will be piped to shore terminals. Thus, fugitive emissions associated with tanker and barge loadings and transfer will be small, as will the associated exhaust emissions. Safeguards to ensure minimum emissions from any offloading and loading operations of OCS crude oil production from surface vessels at ports have been adopted by the State of Louisiana (Marine Vapor Recovery Act, 1989: LAC: III.2108). Current industry practice is to transport OCS-produced oil and gas via pipeline whenever feasible.

The MMS studied the impacts of offshore emissions using the Offshore and Coastal Dispersion (OCD) Model. Three large areas in the CPA were modeled. The limiting factor on the size of each area was the run time needed to process the number of sources. The areas modeled were a 150-km circle centered over Breton Island, a 100-km circle centered over the Grand Isle area, and a 150-mi circle over the Vermilion area. Receptors were set along the coastline and also a short distance inland in order to capture coastal fumigation. Circular areas were chosen to reduce edge effect. The Breton area was chosen to capture the Class I area. The other two areas were selected to best capture most of the offshore sources and to focus on the highly concentrated areas of development. Emissions for a proposed action were projected and compared to the emission inventory for the GMAQS. Ratios between these two sets of total emission rates were developed and applied to the GMAQS inventory; this modified inventory was then used as the database for the sources for the OCD modeling. Only the onshore maximum concentrations reported for all of the runs are discussed. The results of the runs are reported in the Tables 4-25 and 4-26. The results are also compared with the federally allowable increases in ambient concentrations as regulated by 30 CFR 250.45(g) and 40 CFR 51.166(c).

Tables 4-25 and 4-26 list the highest predicted contributions to onshore pollutant concentrations from OCS activities, as well as the maximum allowable increases over a baseline concentration established under the air quality regulations. While the tables show that a proposed lease sale alone would result in concentration increases that are well within the maximum allowable limits for Class I and Class II areas, a direct comparison between the two sets of figures is not possible. This is because the actual maximum allowable increase depends on the net change in emissions from all other sources in the area, both offshore and onshore, since the date the baseline level was established. Sources that were already in place at the applicable baseline date are included in the establishment of the baseline and corresponding concentration and do not count in the determination of the maximum allowable increment. The PM_{10} are emitted at a substantially smaller rate than NO_2 and SO_2; hence, impacts from PM_{10} would be expected to be small. As a proposed action in the CPA would represent approximately 2 percent of OCS activities in the CPA, emissions from activities resulting from a proposed action would be substantially below the maximum allowable limits for a Class II area.

Suspended particulate matter is important because of its potential in degrading the visibility in national wildlife refuges or recreational parks designated as PSD Class I areas. The impact depends on emission rates and particle size. Particle size represents the equivalent diameter (diameter of a sphere) that will have the same settling velocity as the particle. Particle distribution in the atmosphere has been characterized as being largely trimodal (Godish, 1991), with two peaks located at diameters smaller than 2 µm and a third peak with diameters larger than 2 µm. Particles with diameters of 2 µm or larger settle very close to the source (residence time of approximately ½ day, Lyons and Scott, 1990). For particles smaller than 2 µm, which do not settle fast, wind transport determines their impacts. Projected PM_{10} concentrations are expected to have a low impact on the visibility of PSD Class I areas.

Gaseous and fine particulate matter in the atmosphere can potentially degrade the atmospheric visibility. The visibility degradation is primarily due to the presence of particulates with the size in the range of 1 to 2 microns. The sources of these particulates may come from fuel burning and the chemical transformation of the atmospheric constituents. The chemical transformation of NO_2, SO_2, and VOC may produce nitrates, sulfates, and carbonaceous particles. High humidity also may contribute tot he visibility impairment in the Gulf coastal areas. Visibility is considered an important resource in the Breton National Wilderness Area, a Federal Class I area. Because, future air emission from all sources in the area are expected to be about the same level or less. Thus, it is expected that the impact on visibility due to the presence of fine particulates would be minor.

The Breton National Wilderness Area is a Class I air quality area administered by U.S. Fish and Wildlife Service (FWS). Under the Clean Air Act, MMS will notify the FWS and National Park Service if emissions from proposed projects may impact the Breton Class I area. Mitigating measures, including low sulphur diesel fuels and stricter air emissions monitoring and reporting requirements, are required for sources that are located within 100 km of the Breton Class I Area and that exceed emission levels agreed upon by the administering agencies.

Summary and Conclusion

Emissions of pollutants into the atmosphere from the activities associated with a proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. Emissions from proposed-action activities are not expected to have concentrations that would change onshore air-quality classifications. The OCD modeling results show that increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than the maximum increases allowed in the PSD Class I area and the PSD Class II areas.

4.2.1.5. Impacts on Marine Mammals

The major impact-producing factors affecting marine mammals as a result of routine OCS activities include the degradation of water quality from operational discharges; noise generated by helicopters, vessels, operating platforms, and drillships; vessel traffic; explosive structure removals; seismic surveys; and jetsam and flotsam from service vessels and OCS structures. These major factors may affect marine mammals in the Gulf at several temporal and spatial scales that result in acute or chronic impacts.

Discharges

Produced waters, drill muds, and drill cuttings are routinely discharged into offshore marine waters and are regulated by the USEPA's NPDES permits. Most operational discharges are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API, 1989; NRC, 1983; Kennicutt, 1995). Any potential impacts from drilling fluids would be indirect, either as a result of impacts to prey species or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of marine mammals or species lower in the marine food web. Marine mammals generally are inefficient assimilators of petroleum compounds in prey (Neff, 1990). Analyses of samples from stranded Gulf of Mexico bottlenose dolphins showed high levels of organochlorides and heavy metals (e.g., Salata et al., 1995; Kuehl and Haebler, 1995). Many heavy metals presumably are acquired from food, but the ultimate sources are poorly known (API, 1989). Adequate baseline data is not available to determine the significant sources of contaminants that accumulate in Gulf cetaceans or their prey, due in no small part to the fact that contaminants are introduced into the Gulf of Mexico from a suite of national and international watersheds. Many cetaceans are wide-ranging animals, which also compounds the problem. It is known that neritic cetacean species tend to have higher levels of some metals than those frequenting oceanic waters (Johnston et al., 1996). Oceanic cetaceans feeding on cephalopods have higher levels of cadmium in their tissues than comparable fish-eating species (Johnston et al., 1996). There also is, in many cases, a striking difference between the relatively high mercury levels in the toothed whales and the lower levels found in baleen whales, which is probably attributable to the different prey species consumed by baleen whales, as well as differences in the habitat (Johnston et al., 1996).

Aircraft

Aircraft overflights in proximity to cetaceans can elicit a startle response. Whales often react to aircraft overflights by hasty dives, turns, or other abrupt changes in behavior. Responsiveness varies widely depending on factors such as the activity the animals are engaged in and water depth (Richardson et al., 1995). Whales engaged in feeding or social behavior are often insensitive to overflights. Whales in confined waters, or those with calves, sometimes seem more responsive. This behavioral response could be a result of noise and/or visual disturbance. The effects appear to be transient, and there is no indication that long-term displacement of whales occur. Absence of conspicuous responses to an aircraft does not show that the animals are unaffected; it is not known whether these subtle effects are biologically significant (Richardson and Würsig, 1997).

Vessel Traffic

Of 11 species known to have been hit by vessels, fin whales are struck most frequently, sperm whales are hit commonly, and records of collisions with Bryde's whales are rare (Laist et al., 2001). (Fin whales are rare, sperm whales are common, and Bryde's whales are uncommon in the Gulf of Mexico.) Data compiled of 58 collisions indicate that all sizes and types of vessels can collide with whales; the majority of collisions appear to occur over or near the continental shelf; most lethal or severe injuries are caused by ships 80 m or longer; whales usually are not seen beforehand or are seen too late to be avoided; and most lethal or severe injuries involve ships traveling 14 kn or faster. Vessel collisions can significantly affect small populations of whales, such as northern right whales in the western North Atlantic (Laist et al., 2001).

Increased traffic from support vessels involved in survey, service, or shuttle functions will increase the probability of collisions between vessels and marine mammals occurring in the area. These collisions can cause major wounds on cetaceans and/or be fatal (e.g., northern right whale, Kraus, 1990, and Knowlton et al., 1997; bottlenose dolphin, Fertl, 1994; sperm whale, Waring et al., 1997). Debilitating injuries may have negative effects on a population through impairment of reproductive output. Slow-moving cetaceans (e.g., northern right whale) or those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., sperm whale) might be expected to be the most vulnerable. Smaller delphinids often approach vessels that are in transit to bow-ride. It would seem that delphinids are agile enough to easily avoid being struck by vessels. However, there are occasions that dolphins are either not attentive (due to behaviors they are engaged in or perhaps because of their age/health) or there is too much vessel traffic around them, and they are struck by screws. Nowacek and Wells (2001) found that bottlenose dolphins had longer interbreath intervals during boat approaches compared to control periods (no boats present within 100 m) in a study conducted in Sarasota Bay, Florida. They also found that dolphins decreased interanimal distance, changed heading, and increased swimming speed significantly more often in response to an approaching vessel than during control periods.

Toothed whales (and baleen whales, to a lesser extent) show some tolerance of vessels, but may react at distances of several kilometers or more when confined by environmental features or when they learn to associate the vessel with harassment. Evidence suggests that certain whales have reduced their use of certain areas heavily utilized by ships (Richardson et al., 1995), possibly avoiding or abandoning important feeding areas, breeding areas, resting areas, or migratory routes. The continued presence of various cetacean species in areas with heavy boat traffic indicates a considerable degree of tolerance to ship noise and disturbance. An experiment involving playback of low-frequency sound in the Canary Islands suggests that sperm whales from an area that has heavy vessel traffic have a high tolerance for noise (Andre et al., 1997). There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or growth, unless they occur frequently.

Long-term displacement of animals, in particular baleen whales, from an area is also a possibility. It is not known whether toothed whales exposed to recurring vessel disturbance are stressed or otherwise affected in a negative, but inconspicuous way (Richardson et al., 1995). Stress or "alert" responses could occur quite early during an encounter. For example, Myrick and Perkins (1995) found stress responses occurring as early as the chase stage in purse-seine netting on dolphins.

It is possible that manatees could occur in coastal areas where vessels traveling to and from the leased sites could affect them. If a manatee should be present where there is vessel traffic, they could be injured or killed by a boat striking them (Wright et al., 1995). Inadequate hearing sensitivity at low frequencies may be a contributing factor to the manatees' inability to effectively detect boat noise and avoid collisions with boats (Gerstein et al., 1999).

Drilling and Production Noise

Exploration, delineation, and production structures, as well as drillships, produce an acoustically wide range of sounds at frequencies and intensities that can be detected by cetaceans. Some of these sounds could mask cetaceans' reception of sounds produced for echolocation and communication. Odontocetes use sounds at frequencies that are generally higher than the dominant sounds generated by offshore drilling and production activities. Low-frequency hearing has not been studied in many species, but bottlenose dolphins can hear sounds at frequencies as low as 40-125 Hz. Below 1 kHz, where most OCS-industry noise energy is concentrated, sensitivity seems poor (Richardson et al., 1995). Pilot whales and sperm whales changed their behavior (in particular, ceased vocalizations) during low-frequency transmissions from the Heard Island Feasibility Test in the southern Indian Ocean (Bowles et al., 1994); this throws doubt on the assumed insensitivity of odontocete hearing at low frequencies. Baleen whales mainly utter low-frequency sounds that overlap broadly with the dominant frequencies of many OCS-industry sounds. There are indirect indications that baleen whales are sensitive to low- and moderate-frequency sounds (Richardson et al., 1995). Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies, averaging 5 Hz and 10-500 Hz, respectively (Richardson et al., 1995). There is particular concern for baleen whales that are apparently more dependent on low-frequency sounds than are other marine mammals; many industrial sounds are concentrated at low frequencies. Drillships produce higher levels of underwater noise than other types of platforms. There are few published data on underwater noise levels near production platforms and on the marine mammals near those facilities (Richardson et al., 1995). However, underwater strong noise levels may often be low, steady, and not very disturbing (Richardson et al., 1995). Stronger reactions would be expected when sound levels are elevated by support vessels or other noisy activities (Richardson et al., 1995).

Human-made sounds may affect the ability of marine mammals to communicate and to receive information about their environment (Richardson et al., 1995). Such noise may interfere with or mask the sounds used and produced by these animals and thereby interfere with their natural behavior. These sounds may frighten, annoy, or distract marine mammals and lead to physiological and behavioral disturbances. The response threshold may depend on whether habituation (gradual waning of behavioral responsiveness) or sensitization (increased behavioral responsiveness) occurs (Richardson et al., 1995). Sounds can cause reactions that might include disruption of marine mammals' normal activities (behavioral and/or social disruption) and, in some cases, short- or long-term displacement from areas important for feeding and reproduction (Richardson et al., 1995). The energetic consequences of one or more disturbance-induced periods of interrupted feeding or rapid swimming, or both, have not been evaluated quantitatively. Energetic consequences would depend on whether suitable food is readily available. Of the animals responding to noise, females in late pregnancy or lactating would probably be most affected. Human-made noise may cause temporary or permanent hearing impairment in marine mammals if the noise is strong enough. Such impairment would have the potential to diminish the individual's chance for survival. Tolerance of noise is often demonstrated, but this does not prove that the animals are unaffected by noise; for example, they may become stressed, making the animal(s) more vulnerable to parasites, disease, environmental contaminants, and/or predation. Noise-induced stress is possible, but little studied in marine mammals. Aversive levels of noise might cause animals to become irritable, affecting feed intake, social interactions, or parenting; all of these effects might eventually result in population declines (Bowles, 1995).

Structure Removals

A limited amount of information is available on the effects of explosions on marine mammals (O'Keeffe and Young, 1984; Ketten, 1998). The shock wave produced by explosions can cause physical damage to nearby animals. The potential for injury is associated with gas-containing internal organs, such as the lungs and intestines (Yelverton et al., 1973). Data are limited regarding blast-induced auditory damage. Explosions and shock waves and their intense transient sound field have the ability to produce blast injury and acoustic trauma in marine mammals (Ketten, 1995 and 1998). Consequences of hearing damage may range from subtle modification of certain behaviors that require a modicum of hearing ability to acute, where concussive effects may lead to death (Ketten, 1995).

For example, two humpback whales were found with damage to their ear bones following an explosion in Newfoundland (Ketten et al., 1993). Yet other humpback whales in Newfoundland, foraging in an area of explosive activity, showed little behavioral reaction to the detonations in terms of decreased residency, overall movements, or general behavior, though orientation ability appeared to be affected (Todd et al., 1996). Todd et al. (1996) suggested caution in interpretation of the lack of visible reactions as indication that whales are not affected or harmed by an intense acoustic stimulus; both long- and short-term behavior as well as anatomical evidence should be examined. The researchers interpreted increased entrapment rate of humpback whales in nets as the whales being influenced by the long-term effects of exposure to deleterious levels of sound.

Odontocetes cannot hear well in the frequencies emitted by explosive detonations (Richardson et al., 1995). The animals may not be able to hear the pulse generated from open-water detonations of explosive charges because it is very brief (*Federal Register*, 1995a). Sublethal effects would include a startle response. Even if dolphins are not capable of hearing the acoustic signature of the explosion, physiological, pathological, or behavioral responses to detonations may still result. The NMFS (USDOC, NMFS, 1995) cites such examples as detection of low-frequency sound by some mechanism other than conventional hearing and harassment due to tactile stings from the shock wave accompanying detonations. Impacts resulting from resuspension of bottom sediments due to explosive detonation include increased water turbidity and mobilization of sediments containing hydrocarbon extraction waste (*Federal Register*, 1995a). Because of its temporary effect, no impacts to higher life forms are expected, and, because of its temporary and localized nature, biomagnification is unlikely.

The extent of potential injury is dependent upon the amount of explosive used, distance from the charge, and body mass of the cetacean. As explained in detail in the USDOC, NMFS (1995), it may be assumed that marine mammals more than 3,000 ft (910 m) from structures to be removed would avoid injury caused by explosions. There is no evidence linking dolphin injuries or deaths in the Gulf to explosive removal of structures (Klima et al., 1988; Gitschlag et al., 1997). In October 1995, NMFS issued regulations authorizing and governing the taking of bottlenose and spotted dolphins incidental to the removal of gas drilling and production structures in State waters and on the Gulf of Mexico OCS for a period of five years (*Federal Register*, 1995a). Those regulations are currently being reviewed and revised by MMS and NOAA Fisheries.

In order to minimize the likelihood of removals occurring when cetaceans may be nearby, MMS has issued guidelines (NTL 2001-G08) for removing offshore structures with explosives to offshore operators. These guidelines specify explosive removals only during daylight hours, staggered detonation of explosive charges, placement of charges 5 m below the seafloor, and pre- and post-detonation aerial surveys within one hour before and after detonation. Trained observers watch for sea turtles and marine mammals in the vicinity of the structures to be removed.

Seismic Surveys

The MMS has almost completed a programmatic EA on G&G permit activities in the Gulf of Mexico (USDOI, MMS, in preparation). The EA includes a detailed description of the seismic surveying technologies, energy output, and operations; these descriptions are incorporated here by reference. Seismic surveys use a high-energy noise source. During Irish Sea seismic surveys, pulses were audible on hydrophone recordings above the highly elevated background ship noise at least up to the 20-km range (Goold and Fish, 1998). Although the output of airgun arrays is usually tuned to concentrate low-frequency energy, a broad frequency spectrum is produced, with significant energy at higher frequencies (e.g., Goold and Fish, 1998). These energies encompass the entire audio frequency range of 20 Hz to 20 kHz (Goold and Fish, 1998) and extend well into the ultrasonic range up to 50 kHz.

Baleen whales seem quite tolerant of low- and moderate-level sound pulses from distant seismic surveys but exhibit behavioral changes in the presence of nearby seismic activity (Richardson et al., 1995). Subtle effects on surfacing, respiration, and dive cycles have been noted (Richardson et al., 1995; Richardson, 1997). Response appears to diminish gradually with increasing distance and decreasing sound level (Richardson, 1997). Bowhead and gray whales often show strong avoidance within 6-8 km of an airgun array. Humpback whales off western Australia were found to change course at 3-6 km from an operating seismic survey vessel, with most animals keeping a standoff range of 3-4 km (McCauley et al., 1998a and b). Humpback whale groups containing females involved in resting behavior in key habitat types were more sensitive than migrating animals and showed an avoidance response estimated at 7-12 km from a large seismic source (McCauley et al., 2000). Whales exposed to sound from distant seismic survey ships may be affected even though they remain in the area and continue their normal activities (Richardson et al., 1995). For baleen whales, in particular, it is not known (1) whether the same individuals return to areas of previous seismic exposure, (2) whether seismic work has caused local changes in distribution or migration routes, or (3) whether whales that tolerate strong seismic pulses are stressed (Richardson et al., 1995). Individually identified gray whales remained in Puget Sound long after the seismic survey (as is normal), despite being exposed to noise (Calambokidis and Osmek, 1998; Bain et al., 1999).

Goold (1996) found that acoustic contacts with common dolphins in the Irish Sea dropped sharply as soon as seismic activity began, suggesting a localized disturbance of dolphins. It was also estimated that seismic energy from the 2,120-in^3 airgun array in a shelf sea environment was safe to common dolphins at a radius from the gun array of 1 km (Goold and Fish, 1998). Given the high, broadband seismic-pulse power levels across the entire recorded bandwidth and the known auditory thresholds for several dolphin species, Goold and Fish (1998) considered such seismic emissions to be clearly audible to dolphins across a bandwidth of tens of kilohertz and at least out to the 8-km range.

Sperm whales during the Heard Island Feasibility Test were found to cease calling during some (but not all) times when seismic pulses were received from an airgun array more than 300 km away (Bowles et al., 1994) (whether sperm whales were responding directly to the seismic pulses is not known). In contrast, there are observations of sperm whales in the Gulf continuing to vocalize while seismic pulses are ongoing (Evans, personal communication, 1999). One report of Gulf of Mexico sperm whales suggested that the animals may have moved 50+ km away in response to seismic pulses (Mate et al., 1994), but further work suggests that the animals may not have moved in response to the sound, but perhaps relative to oceanographic features and prey distribution. It is unclear whether the well-documented, continued occurrence of sperm whales in the area off the mouth of the Mississippi River is a consequence of low sensitivity to seismic sound or a high motivation to remain in the area. Sperm whales have historically occupied this area; their continued presence might suggest habituation to the seismic signals. During the MMS-sponsored GulfCet II study on marine mammals, results showed that the cetacean sighting rate did not change significantly due to seismic exploration signals (Davis et al., 2000). The analysis of the results was unable to detect small-scale (<100 km) changes in cetacean distribution. Results of passive acoustic surveys to monitor sperm whale vocal behavior and distribution in relation to seismic surveys in the northeast Atlantic revealed few, if any, effects of airgun noise (Swift et al., 1999). The authors suggested that sperm whales in that area may be habituated to seismic surveys and/or responses may occur at scales to which the research was not sensitive.

No obvious behavior modifications relative to the seismic activity were recorded during the majority of the small odontocete observations made during marine mammal monitoring carried out during a 3D seismic survey offshore California in late 1995 (Arnold, 1996). There was also no observable behavior modification or harassment of large whales attributable to the sound effects of the survey (Arnold, 1996).

There are no data on auditory damage in marine mammals relative to received levels of underwater sound pulses (Richardson et al., 1995). Indirect "evidence" suggests that extended or repeated exposure to seismic pulses is unlikely to cause permanent hearing damage in marine mammals given a study of damage risk criteria; the transitory nature of seismic exploration; the presumed ability of marine mammals to tolerate exposure to strong calls from themselves or other nearby mammals; and the avoidance responses that occur in at least some baleen whales, when exposed to certain levels of seismic pulses (Richardson et al., 1995).

Flotsam and Jetsam

In recent years, there has been increasing concern about manmade debris (discarded from offshore and coastal sources) and its impact on the marine environment (e.g., Shomura and Godfrey, 1990; Laist, 1997). Both entanglement in and ingestion of debris has caused the death or serious injury of marine mammals (Heneman and the Center for Environmental Education, 1988; MMC, 1998). The debris items most often found entangling animals are net fragments and monofilament line from commercial and recreational fishing boats, as well as strapping bands and ropes probably from all types of vessels. Plastic bags and small plastic fragments are the most commonly reported debris items in the digestive tracts of cetaceans and manatees (e.g., Barros and Odell, 1990; Tarpley and Marwitz, 1993; Laist, 1997; MMC, 1998). Many types of plastic materials are used during drilling and production activities; the offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore (Miller et al., 1995). The MMS prohibits the disposal of equipment, containers, and other materials into coastal and offshore waters by lessees (30 CFR 250.40). Prohibition of the discharge and disposal of vessel- and offshore structure-generated garbage and solid waste items into both offshore and coastal waters was established January 1, 1989, via the enactment of MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which the USCG enforces. Accidental release of debris from OCS activities is known to occur offshore, and such flotsam may injure or kill cetaceans.

Proposed Action Analysis

The major impact-producing factors affecting marine mammals as a result of routine OCS activities include the degradation of water quality from operational discharges; noise generated by helicopters, vessels, operating platforms, and drillships; vessel traffic; explosive structure removals; seismic surveys; and jetsam and flotsam from service vessels and OCS structures.

Information on drilling fluids, drill cuttings, and produced waters that would be discharged offshore as a result of a proposed action is provided in Chapter 4.1.1.3.4. Some effluents are routinely discharged into offshore marine waters. It is expected that cetaceans may have some interaction with these discharges. Direct effects to cetaceans are expected to be sublethal. It should be noted, however, that any pollution in the effluent could poison and kill or debilitate marine mammals and adversely affect the food chains and other key elements of the Gulf ecosystem (Tucker & Associates, Inc., 1990). Because OCS discharges are diluted and dispersed in the offshore environment, impacts to cetaceans are expected to be negligible.

Helicopter activity projections are 220,000-870,000 trips over the life of a proposed action (Table 4-2) or 5,641-22,308 trips annually. The FAA Advisory Circular 91-36C encourages pilots to maintain higher than minimum altitudes (noted below) over noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. In addition, guidelines and regulations promulgated by NOAA Fisheries under the authority of the Marine Mammal Protection Act do include provisions specifying helicopter pilots to maintain an altitude of 1,000 ft within 100 yd (91 m) of marine mammals. It is unlikely that cetaceans would be affected by routine OCS helicopter traffic operating at these altitudes, provided pilots do not alter their flight patterns to more closely observe or photograph marine mammals that they see. It is expected that about 10 percent of helicopter trips would occur at altitudes below the specified minimums listed above as a result of inclement weather. Routine overflights may elicit a startle response from, and interrupt cetaceans nearby (depending on the activity of the animals) (Richardson et al., 1995). Occasional overflights probably have no long-term consequences on cetaceans; however, frequent overflights could have long-term consequences if they repeatedly disrupt vital functions, such as feeding and breeding. Frequent overflights are expected in coastal and Federal neritic waters. Generally, overflights become less frequent as the distance from shore of the OCS facilities being serviced increases; however, many offshore fields are supported by resident helicopters, resulting in increased localized overflights. The area supported by a resident helicopter is dependent in part on the size of the field that it supports. Temporary disturbance to cetaceans may occur on occasion as helicopters approach or depart OCS facilities, if animals are near the facility. Such disturbance is believed negligible.

An estimated 63,000-111,000 OCS-related, service-vessel trips are expected to occur over the life of a proposed action (Table 4-2). The rate of trips would be about 1,615-2,846 trips/yr. Noise from service-vessel traffic may elicit a startle and/or avoidance reaction from cetaceans or mask their sound reception. There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity. Long-term displacement of animals from an area is also a consideration. It is not known whether toothed whales exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased ship traffic could increase the probability of collisions between ships and marine mammals, resulting in injury or death to some animals. Smaller delphinids may approach vessels that are in transit to bow-ride. Limited observations on an NMFS cruise off the mouth of the Mississippi River in the summer of 2000 indicated that sperm whales appeared to avoid passing service vessels. However, marine mammalogists conducting surveys in the CPA during the summer of 2001 documented an adult killer whale that bore conspicuous and aged scarring across its back that were indubitably the result of a collision with a motor vessel. A manatee was unintentionally hit and killed by a boat off Louisiana (Schiro et al., 1998). Another manatee was killed by vessel traffic (type of vessel unknown) in Corpus Christi Bay in October 2001 (Beaver, personal communication, 2001). It appears there is limited threat posed to smaller, coastal delphinids where the majority of OCS vessel traffic occurs; however, as exploration and development of petroleum resources in oceanic waters of the northern Gulf increases, OCS vessel activity will increase in these waters, thereby increasing the risk of vessel strike to sperm whales and other deep-diving cetaceans (e.g., *Kogia* and beaked whales). Deep-diving whales are more vulnerable to vessel strikes because of the extended surface period required to recover from extended deep dives. Manatees are rare in the western and central Gulf, consequently, there is little risk posed by OCS vessel traffic.

A total of 111-247 exploration wells and 178-352 development wells are projected to be drilled as a result of a proposed action (Table 4-2). A total of 28-49 production structures are projected to be installed as a result of a proposed action (Table 4-2). These wells and platforms could produce sounds at intensities and frequencies that could be heard by cetaceans. It is expected that noise from drilling activities would be relatively constant and last no longer than four months per well. Odontocetes echolocate and communicate at higher frequencies than the dominant sounds generated by drilling platforms. Sound levels in this range are not expected to be generated by drilling operations (Gales, 1982). Bottlenose dolphins, one of the few species in which low-frequency sound detection has been studied, have been found to have poor sensitivity levels at the level where most industrial noise energy is concentrated. There is some concern for baleen whales since they are apparently more dependent on low-frequency sounds than other marine mammals; however, except for the Bryde's whale, baleen whales are extralimital or accidental in occurrence in the Gulf. During GulfCet surveys, Bryde's whale was sighted only in the EPA; these sightings were in waters deeper than 100 m (Davis et al., 2000). Therefore, Bryde's whale would not likely be subjected to OCS drilling and production noise. Potential effects on Gulf of Mexico marine mammals include disturbance (subtle changes in behavior, interruption of previous activities, or short- or long-term displacement); masking of calls from conspecifics, reverberations from own calls, and other natural sounds (e.g., surf, predators); stress (physiological); and hearing impairment (permanent or temporary) by explosions and strong nonexplosive sounds.

Potential impacts to marine mammals from the detonation of explosives include lethal and injurious incidental take, as well as physical or acoustic harassment. Injury to the lungs and intestines and/or auditory system could occur. Harassment of marine mammals as a result of a noninjurious physiological response to the explosion-generated shock wave as well as to the acoustic signature of the detonation is also possible. It is estimated that 16-29 production structures resulting from a proposed action would be removed using explosives (Table 4-2). It is expected that structure removals would cause only minor behavioral changes and noninjurious physiological effects on cetaceans as a result of the implementation of MMS guidelines and NOAA Fisheries Observer Program for explosive removals (Chapter 4.1.1.3.3).

To date, there are no documented "takes" of marine mammals resulting from explosive removals of offshore structures.

Many types of materials, including plastics, are used during drilling and production operations. Some of this material is accidentally lost overboard where cetaceans can consume it. The result of ingesting some materials lost overboard could be lethal. The relationship between the occurrence of these waste products and the quantities ingested that produce a lethal effect are unknown.

Summary and Conclusion

Small numbers of marine mammals could be killed or injured by chance collision with service vessels and by eating indigestible debris, particularly plastic items, lost from service vessels, drilling rigs, and fixed and floating platforms. Deaths due to structure removals are not expected due to existing mitigation measures or those being developed for structures placed in oceanic waters. There is no conclusive evidence whether anthropogenic noise has or has not caused long-term displacements of, or reductions in, marine mammal populations. Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification, although the scope of effects and their magnitude are not known.

The routine activities of a proposed action is not expected to have long-term adverse effects on the size and productivity of any marine mammal species or population stock endemic to the northern Gulf of Mexico.

4.2.1.6. Impacts on Sea Turtles

The major impact-producing factors resulting from the routine activities associated with a proposed action that may affect loggerhead, Kemp's ridley, hawksbill, green, and leatherback turtles include water-quality degradation from operational discharges; noise from helicopter and vessel traffic, operating platforms, and drillships; vessel collisions; brightly-lit platforms; explosive platform removals; and OCS-related trash and debris.

Discharges

Produced waters, drill muds, and drill cuttings are routinely discharged into offshore marine waters and are regulated by USEPA NPDES permits. Most operational discharges, as regulated, are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API, 1989; Kennicutt, 1995). Any potential that might exist for impact from drilling fluids would seem to be indirect, either by impact on prey items or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of sea turtles or species lower in the marine food web (for further information on bioaccumulation, see Chapter 4.1.1.3.4). Sea turtles may bioaccumulate chemicals such as heavy metals that occur in drilling mud. This might ultimately reduce reproductive fitness in the turtles, an impact that the already diminished population(s) cannot tolerate. Samples from stranded turtles in the Gulf of Mexico carry high levels of organochlorides and heavy metals (Sis et al., 1993).

Noise

There are no systematic studies published of the reactions of sea turtles to aircraft overflights, and anecdotal reports are scarce. However, it is assumed that aircraft noise could be heard by a sea turtle at or near the surface and cause the animal to alter its normal behavior pattern (Advanced Research Projects Agency, 1995). Noise from service-vessel traffic may elicit a startle reaction from sea turtles and produce a temporary sublethal stress (NRC, 1990). Startle reactions may result in increased surfacings, possibly causing an increase in risk of vessel collision. Reactions to aircraft or vessels, such as avoidance behavior, may disrupt normal activities, including feeding. Important habitat areas (e.g., feeding, mating, and nesting) may be avoided due to noise generated in the vicinity. There is no information regarding the consequences that these disturbances may have on sea turtles in the long term. If sound affects any prey species, impacts to sea turtles would depend on the extent that prey availability might be altered.

Drilling and production facilities produce an acoustically wide range of sounds at frequencies and intensities that could possibly be detected by turtles. Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies (Richardson et al., 1995). Sea turtle hearing sensitivity is not well studied. A few preliminary investigations using adult green, loggerhead, and Kemp's ridley turtles suggest that they are most sensitive to low-frequency sounds (Ridgway et al., 1969; Lenhardt et al., 1983; Moein Bartol et al., 1999). It has been suggested that sea turtles use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Lenhardt et al., 1983). Bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving structures (Lenhardt et al., 1983).

Noise-induced stress has not been studied in sea turtles. Captive loggerhead and Kemp's ridley turtles exposed to brief, audio-frequency vibrations initially showed startle responses of slight head retraction and limb extension (Lenhardt et al., 1983). Sound-induced swimming has been observed for captive loggerheads and greens (O'Hara and Wilcox, 1990; Moein Bartol et al., 1993; Lenhardt, 1994). Some loggerheads exposed to low-frequency sounds responded by swimming towards the surface at the onset of the sound, presumably to lessen the effects of the transmissions (Lenhardt, 1994). Sea turtles have been seen to begin to noticeably increase their swimming in response to an operating seismic source at 166 dB re-1µPa-m (measurement of sound level in water) (McCauley et al., 2000). The MMS haas almost completed a programmatic EA on G&G permit activities in the Gulf of Mexico (USDOI, MMS, in preparation). The EA includes a detailed description of the seismic surveying technologies, energy output, and operations; these descriptions are incorporated here by reference. An anecdotal observation of a free-ranging leatherback's response to the sound of a boat motor suggests that leatherbacks may be sensitive to low-frequency sounds, but the response could have been to mid- or high-frequency components of the sound (Advanced Research Projects Agency, 1995). The potential direct and indirect impacts of sound on sea turtles include physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on the food chain. Low-frequency sound transmissions could potentially cause increased surfacing and avoidance from the area near the sound source (Lenhardt et al., 1983; O'Hara and Wilcox, 1990; McCauley et al., 2000). The potential for increased surfacing could place turtles at greater risk of vessel collisions and potentially greater vulnerability to natural predators.

Vessel Collisions

Data show that vessel traffic is one cause of sea turtle mortality in the Gulf (Lutcavage et al., 1997). Stranding data for the U.S. Gulf of Mexico and Atlantic coasts, Puerto Rico, and the U.S. Virgin Islands show that between 1986 and 1993 about 9 percent of living and dead stranded sea turtles had boat strike injuries (n=16, 102) (Lutcavage et al., 1997). However, vessel-related injuries were noted in 13 percent of stranded turtles examined from strandings in the Gulf of Mexico and on the Atlantic Coast during 1993 (Teas, 1994), but this figure includes those that may have been struck by boats post-mortem. In Florida, where coastal boating is popular, 18 percent of strandings documented between 1991 and 1993 were attributed to vessel collisions (Lutcavage et al., 1997). Large numbers of loggerheads and 5-50 Kemp's ridley turtles are estimated to be killed by vessel traffic per year in the U.S. (NRC, 1990; Lutcavage et al., 1997). Numbers of OCS-related vessel collisions with sea turtles offshore are unknown, but it is expected that some sea turtles will be impacted.

Brightly-lit Platforms

Brightly-lit, offshore drilling facilities present a potential danger to hatchlings (Owens, 1983). Hatchlings are known to be attracted to light (Raymond, 1984; Witherington and Martin, 1996; Witherington, 1997) and may orient toward lighted offshore structures (Chan and Liew, 1988). If this occurs, hatchling predation might increase dramatically since large birds and predatory fishes also congregate around structures (Owens, 1983; Witherington and Martin, 1996).

Structure Removals

Offshore structures serve as artificial reefs and are sometimes used by sea turtles (Gitschlag and Herczeg, 1994). The dominant species of turtle observed at explosive structure removals is the loggerhead, but leatherback, green, Kemp's ridley, and hawksbill have also been observed (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997). Loggerheads may reside at specific offshore structures for extended periods of time (Rosman et al., 1987b; Gitschlag and Renaud, 1989). The probability of occupation by sea turtles increases with the age of the structures (Rosman et al., 1987b). Sea turtles probably use platforms as places to feed and rest. Offshore structures afford refuge from predators and stability in water currents, and loggerheads have been observed sleeping under platforms or beside support structures (Hastings et al., 1976; Rosman et al., 1987b; Gitschlag and Renaud, 1989). Only near the Chandeleur and Breton Islands were sea turtles positively associated with platforms (Lohoefener et al., 1989 and 1990).

Information about the effects of underwater explosions on sea turtles is limited. O'Keeffe and Young (1984) assumed that shock waves would injure the lungs and other organs containing gas, expected that ear drums of turtles would be sensitive, and suggested that smaller turtles would suffer greater injuries from the shock wave than larger turtles. The NMFS conducted several studies before and after an explosive platform removal to determine its effects on sea turtles in the immediate vicinity (Duronslet et al., 1986; Klima et al., 1988). Immediately after the explosion, turtles within 3,000 ft of the platform were rendered unconscious (Klima et al., 1988), although they resumed apparently normal activity 5-15 minutes post-explosion (Duronslet et al., 1986). One of these turtles also sustained damage to the cloacal lining (it was everted) (Klima et al., 1988). Dilation of epidermal capillaries was a condition that continued for three weeks, after which time all turtles appeared normal. Effects on their hearing were not determined. Impacts of explosive removals on sea turtles are not easily assessed, primarily because turtle behavior makes observations difficult. Sea turtles in temperate latitudes generally spend less than 10 percent of their time at the surface, and dive durations can exceed one hour. Injured turtles that are capable of swimming may return to the surface, while moribund turtles may sink to the seafloor or drift away from the work site. Unconsciousness renders a turtle more susceptible to predation; effects of submergence on stunned turtles is unknown (Klima et al., 1988). The number of documented sea turtles impacted by explosives is two loggerheads during 1986-1994 (Gitschlag and Herczeg, 1994; NRC, 1996), one loggerhead in 1997 (Gitschlag, personal communication, 1999), one loggerhead in 1998 (Shah, personal communication, 1998), and one loggerhead in 2001 (Gitschlag, personal communication, 2001). A total of six additional sea turtles have been captured prior to detonation of explosives and saved from possible injury or death (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997). The low number of turtles affected by explosive removal of structures may be due to the few turtles that occur in harm's way at the time explosives are detonated, the effectiveness of the monitoring program established to protect sea turtles, and/or the inability to adequately assess and detect impacted animals.

In 1987, in response to 51 dead sea turtles that washed ashore on Texas beaches (explosions were identified as the primary cause by Klima et al., 1988), NMFS initiated an observer program at explosive removals of structures in State and Federal waters of the Gulf of Mexico. For at least 48 hours prior to detonation, NOAA Fisheries observers watch for sea turtles at the surface. Helicopter surveys within a 1-mi radius of the removal site are conducted a minimum of 30 minutes prior to and after detonation (Gitschlag and Herczeg, 1994). If sea turtles are observed, detonations are delayed until the turtles have been safely removed or have left the area. Monitoring the water's surface for sea turtles is not 100 percent effective. Once observed, there is currently no practical and efficient means of removing a sea turtle from the area that will be impacted by explosives (Gitschlag and Herczeg, 1994). Although divers have had some success in capturing sea turtles, this procedure is limited to animals resting or sleeping beneath structures.

Even if turtles are not capable of hearing the acoustic properties of an explosion, physiological or behavioral responses (startle) to detonations may still result (USDOC, NMFS, 1995). Impacts resulting from resuspension of bottom sediments due to explosive detonation include increased water turbidity and mobilization of sediments containing hydrocarbon extraction waste (*Federal Register*, 1995a). Because of its temporary effect and localized nature, biomagnification is unlikely.

Jetsam and Flotsam

A wide variety of trash and debris is commonly observed in the Gulf. Marine trash and debris comes from a variety of land-based and ocean sources (Cottingham, 1988). Some material is accidentally lost during drilling and production operations. From March 1, 1994, to February 28, 1995, a total of 40,580 debris items were collected in a 16-mi transect made along the Padre Island National Seashore (Miller et al., 1995). The offshore oil and gas industry was shown to contribute 13 percent of the trash and debris found in the transect. Turtles may become entangled in drifting debris and ingest fragments of synthetic materials (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988). Entanglement usually involves fishing line or netting (Balazs, 1985). Once entangled, turtles may drown, incur impairment to forage or avoid predators, sustain wounds and infections from the abrasive or cutting action of attached debris, or exhibit altered behavior that threaten their survival (Laist, 1987). Both entanglement and ingestion have caused the death or serious injury of individual sea turtles (Balazs, 1985). Balazs (1985) compiled dozens of records of sea turtle entanglement, ingestion, and impaction of the alimentary canal by ingested plastics, although tar was the most common item ingested. The marked tendency of leatherbacks to ingest plastic has been attributed to misidentification of the translucent films as jellyfish. Lutz (1990) concluded that turtles will actively seek out and consume plastic sheeting. Ingested debris may block the digestive tract or remain in the stomach for extended periods, thereby lessening the feeding drive, causing ulcerations and injury to the stomach lining, or perhaps even providing a source of toxic chemicals (Laist, 1987). Weakened animals are then more susceptible to predators and disease; they are also less fit to migrate, breed, or nest successfully.

The initial life history of sea turtles involves the hatching of eggs, evacuation of nests, and commencement of an open-ocean voyage. Some hatchlings spend their "lost years" in sargassum rafts; ocean currents concentrate or trap floating debris in sargassum (Carr, 1987). Witherington (1994) studied post-hatchling loggerheads in drift lines 8-35 nmi east of Cape Canaveral and Sebastian Inlet, Florida. Out of 103 turtles captured, 17 percent of the animals contained plastic or other synthetic fibers in their stomachs or mouths. The Gulf of Mexico had the second highest number of turtle strandings affected by debris (35.9%) (Witzell and Teas, 1994). Although the Kemp's ridley is the second most commonly stranded turtle, they are apparently less susceptible to the adverse impacts of debris than the other turtle species for some unknown reason (Witzell and Teas, 1994). The MMS prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458) prohibits the disposal of any plastics at sea or in coastal waters.

Proposed Action Analysis

Information on drilling fluids, drill cuttings, and produced waters that would be discharged offshore as a result of a proposed action is provided in Chapter 4.1.1.3.4. These effluents are routinely discharged into offshore marine waters and are regulated by the USEPA's NPDES permits. Turtles may be affected by these discharges. Very little information exists on the impact of drilling muds on Gulf sea turtles (Tucker and Associates, Inc., 1990).

Structure installation, pipeline placement, dredging, blowouts, and water quality degradation can impact seagrass bed and live-bottom sea turtle habitats. These impacts are analyzed in detail in Chapter 4.2.1.1. A discussion of the causes and magnitude of wetland loss as a result of a proposed action can be found in Chapter 4.2.1.1.2. The seagrass and high-salinity marsh components of wetland loss would be indirectly important for sea turtles by reducing the availability of forage species that rely on these sensitive habitats. Little or no damage is expected to the physical integrity, species diversity, or biological productivity of live-bottom marine turtle habitat as a result of a proposed action because these sensitive resources are protected by several mitigation measures established by MMS.

An estimated 63,000-111,000 OCS-related, service-vessel trips are expected to occur over the life of a proposed action (Table 4-2). The rate of trips would be about 1,615-2,846 trips/yr. Transportation corridors would be through areas where sea turtles have been sighted. Helicopter activity projections are 220,000-870,000 trips over the life of a proposed action (Table 4-2) or 5,641-22,308 trips annually. Noise from service-vessel traffic and helicopter overflights may elicit a startle reaction from sea turtles; there is the possibility of short-term disruption of activity patterns. Sounds from approaching aircraft are detected in the air far longer than in water. For example, an approaching Bell 214ST helicopter became audible in the air more than four minutes before passing overhead, while it was detected underwater for only 38 seconds at 3-m depth and for 11 seconds at 18-m depth (Greene, 1985 *in* Richardson et al., 1995). There are no systematic studies published concerning the reactions of sea turtles to aircraft overflights, and anecdotal reports are scarce. It is assumed that aircraft noise could be heard by a sea turtle at or near the surface and cause it to alter its activity (Advanced Research Projects Agency, 1995). In the wild, most sea turtles spend at least 3-6 percent of their time at the surface. Despite the brevity of their respiratory phases, sea turtles sometimes spend as much as 19-26 percent of their time at the surface, engaged in surface basking, feeding, orientation, and mating (Lutcavage et al., 1997). Sea turtles located in shallower waters have shorter surface intervals, whereas turtles occurring in deeper waters have longer surface intervals. It is not known whether turtles exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased vessel traffic will increase the probability of collisions between vessels and turtles, potentially resulting in injury or death to some animals.

A total of 111-247 exploratory wells and 178-352 development wells are projected to be drilled as a result of a proposed action (Table 4-2). A total of 28-49 production structures are projected as a result of a proposed action (Table 4-2). These structures could generate sounds at intensities and frequencies that could be heard by turtles. There is some evidence suggesting that turtles may be receptive to low-frequency sounds, which is at the level where most industrial noise energy is concentrated. Potential effects on turtles include disturbance (subtle changes in behavior, interruption of activity), masking of other sounds (e.g., surf, predators, vessels), and stress (physiological).

It is estimated that 16-29 production structures would be removed by explosives as a result of a proposed action (Table 4-2). Potential impacts to sea turtles from the detonation of explosives include death, injury, stress, and physical or acoustic harassment. Injury to the lungs and intestines, and/or auditory system could occur. It is expected that structure removals would cause chiefly sublethal effects on sea turtles as a result of MMS guidelines for explosive removals (Chapter 4.1.1.4.2). Since 1986 when explosive removals were identified as a potential source of "take" of sea turtles, there have been only five documented "takes" of loggerhead sea turtles attributed to explosive removals.

Sea turtles can become entangled in or ingest debris produced by exploration and production activities resulting from a proposed action. Leatherback turtles that mistake plastics for jellyfish may be more vulnerable to gastrointestinal blockage than other sea turtle species. The probability of plastic ingestion/entanglement is unknown.

Summary and Conclusion

Routine activities resulting from a proposed action have the potential to harm individual sea turtles. These animals could be impacted by the degradation of water quality resulting from operational discharges; noise generated by helicopter and vessel traffic, platforms, and drillships; brightly-lit platforms; explosive removals of offshore structures; vessel collisions; and jetsam and flotsam generated by service vessels and OCS facilities. Lethal effects are most likely to be from chance collisions with OCS service vessels and ingestion of plastic materials. "Takes" due to explosive removals are expected to be rare due to mitigation measures already established (e.g., NMFS Observer Program) and in development. Most OCS activities are expected to have sublethal effects. Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification; there is uncertainty concerning the possible effects. Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas could cause declines in survival or fecundity, and result in either population declines, however, such declines are not expected. The routine activities of a proposed action are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or population in the Gulf of Mexico.

4.2.1.7. Impacts on Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

The Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice are designated as protected species under the Endangered Species Act of 1973 (Chapter 1.3). The mice occupy restricted habitat behind coastal foredunes of Florida and Alabama (Ehrhart, 1978; USDOI, FWS, 1987). Portions of the beach mouse habitat have been designated as critical.

Proposed Action Analysis

The major impact-producing factors associated with a proposed action in the CPA that may affect beach mice include beach trash and debris, efforts undertaken for the removal of marine debris or for beach restoration, offshore and coastal oil spills, and spill-response activities. The potential impacts from spills and spill-response activities are discussed in Chapter 4.4.3.7.

Trash and debris may be mistakenly consumed by beach mice. Mice may become entangled in the debris. A proposed action in the CPA is expected to contribute negligible marine debris or disruption to beach mice areas. Efforts undertaken for the removal of marine debris or for beach restoration, such as sand replenishment, may temporarily scare away beach mice, destroy their food resources such as sea oats, or collapse the tops of their burrows.

Summary and Conclusion

An impact from a proposed action in the CPA on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice is possible but unlikely. Impact may result from consumption of beach trash and debris by beach mice, and efforts to clean up trash and debris.

4.2.1.8. Impacts on Coastal and Marine Birds

This section discusses the possible effects of a proposed action in the CPA on coastal and marine birds of the Gulf of Mexico and its contiguous waters and wetlands. Major, potential impact-producing factors for marine birds in the offshore environment include OCS-related helicopter and service-vessel traffic and noise, air emissions, degradation of water quality, habitat degradation, and discarded trash and debris from service-vessels and OCS structures. Any effects are especially grave for intensively managed populations. For example, endangered and threatened species may be harmed by any impact on viable reproductive population size or disturbance of a few key habitat factors.

Proposed Action Analysis

Noise

The transportation or exchange of supplies, materials, and personnel between coastal infrastructure and offshore oil and gas structures is accomplished with helicopters, aircraft, and boats and a variety of service vessels. It is projected that 220,000-870,000 helicopter flights related to a proposed action in the CPA would occur over the life of a proposed action; this is a rate of 5,500-21,750 annual helicopter trips. Service vessels would use selected nearshore and coastal (inland) navigation waterways, or corridors, and adhere to protocol set forth by the USCG for reduced vessel speeds within these inland areas. It is projected that 63,000-111,000 service-vessel trips related to a proposed action in the CPA would occur in the life of a proposed action; this is a rate of 1,575-2,775 service-vessels trips annually.

Major concerns related to helicopter and service-vessel traffic are intense aversion, panic, and head injury following a bird's collision with helicopters or vessels. Disturbances from OCS-related helicopter or service-vessel traffic to coastal birds can result from the mechanical noise or physical presence (or wake) of the vehicle. The degree of disturbance exhibited by groups of coastal birds to the presence of air or vessel traffic is highly variable, depending upon the bird species in question, type of vehicle, altitude or distance of the vehicle, the frequency of occurrence of the disturbance, and the season. Helicopter and service-vessel traffic related to OCS activities could sporadically disturb feeding, resting, or nesting behavior. Disturbance can also lead to a permanent desertion of active nests or of critical or preferred habitat, which could contribute to the relocation of a species or group to less favorable areas or to a decline of species through reproductive failure resulting from nest abandonment. When birds are flushed prior to or during migration, the energy cost could be great enough that they might not reach their destination on schedule or they may be more susceptible to diseases (Anderson, 1995).

Waterfowl are more overtly responsive to noise than other birds and seem particularly responsive to aircraft, possibly because aerial predators frequently harass them (Bowles, 1995). The FAA and corporate helicopter policy advise helicopters to maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas or across coastlines and 2,000 ft over populated areas and biologically sensitive areas such as wildlife refuges and national parks. Many undisturbed coastal areas and refuges provide preferred and/or critical habitat for feeding, resting (or staging), and nesting birds.

The effect of low-flying aircraft within the vicinity of aggregations of birds on the ground or on the water typically results in mass disturbance and abandonment of the immediate area. However, pilots traditionally have taken great pride in not disturbing birds. Compliance to the specified minimum altitude requirements greatly reduces effects of aircraft disturbance on coastal and marine birds. Routine presence of aircraft at sufficiently high altitudes results in acclamation of birds to routine noise. As a result of inclement weather, about 10 percent of helicopter trips would occur at altitudes somewhat below the minimums listed above. Although these incidents are seconds in duration and sporadic in frequency, they can disrupt coastal bird behavior and, at worst, possibly result in habitat or nest abandonment. Birds in flight over water typically avoid helicopters. Low-flying aircraft may temporarily disrupt feeding or flight paths. Routine presence and low speeds of service vessels within inland and coastal waterways would diminish the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. Birds can lose eggs and young when predators attack nests after parents are flushed into flight by service-vessel noise.

Air Quality Degradation

Contamination of wildlife by air emissions can occur in three ways: inhalation, absorption, and ingestion. Inhalation is the most common mode of contamination for birds (Newman, 1980). The major effects of air pollution include direct mortality, debilitating injury, disease, physiological stress, anemia, hypocalcemic condition, bioaccumulation of air pollutants with associated decrease in resistance to debilitating factors, and population declines (Newman, 1979). Direct effects can be either acute, such as sudden mortality from hydrogen sulfide, or chronic, such as fluorosis from fluoride emissions. The magnitude of effect, acute or chronic, is a function of the pollutant, its ambient concentration, pathway of exposure, duration of exposure, and the age, sex, reproductive condition, nutritional status, and health of the animal at the time of exposure (Newman, 1980). For metals in air emissions, chemical composition as well as size of particulate compounds has been shown to influence the toxicity levels in animals. Particulate size affects retention time and clearance from and deposition in the respiratory tract (Newman, 1981).

Levels of sulfur oxide (mainly sulfur dioxide, SO_2) emissions from hydrocarbon combustion from OCS-related activities are of concern in relation to birds. Research specific to birds has elucidated both acute and chronic effects from SO_2 inhalation (Fedde and Kuhlmann, 1979; Okuyama et al., 1979). Due to their lack of tracheal submucosal glands, birds appear to have more tolerance for inhaled SO_2 than most mammals (Llacuna et al., 1993; Okuyama et al., 1979). This suggestion stems from laboratory investigations where the test subject was the domestic chicken and results from these studies are not necessarily applicable to wild bird species. Acute exposure of birds to 100 ppm SO_2 produced no alteration in heart rate, blood pressure, lung tidal volume, respiratory frequency, arterial blood gases, or blood pH.

Exposure to 100 ppm or less of SO_2 did not affect respiratory mucous secretion. Exposure to 1,000 ppm SO_2 caused mucus to increase and drip from the mouths of birds, but lungs appeared normal. Exposure to 5,000 ppm resulted in gross pathological changes in airways and lungs, and then death (Fedde and Kuhlmann, 1979). Chronic (two week) exposure of birds to three concentrations of SO_2 for 16 hr/day for various total periods showed a statistical change in 10 cellular characteristics and resulted in cellular changes characteristic of persistent bronchitis in 69 percent of the tests done (Okuyama et al., 1979).

The indirect effects of air emissions on wildlife include food web contamination and habitat degradation, as well as adverse synergistic effects of air emissions with natural and other manmade stresses. Air emissions can cause shifts in trophic structure that alter habitat structure and change local food supplies (Newman, 1980).

Air pollutants may cause a change in the distribution of certain bird species (e.g., Newman, 1977; Llacuna et al., 1993). Migratory bird species will avoid potentially suitable habitat in areas of heavy air pollution in favor of cleaner areas if available (Newman, 1979). The abundance and distribution of passerine birds, both active and sedentary, and migratory species, as well as nonpasserine and nonmigratory varieties, are also greatly affected by natural factors such as weather and food supply.

Therefore, any reduction in the numbers of birds within a given locale does not have a diagnostic certainty pointing to air emissions (Newman, 1980).

Chapter 4.2.1.4 provides an analysis of the effects of a proposed action in the CPA on air quality. Emissions of pollutants into the atmosphere from the activities associated with a proposed action would have minimum effects on offshore and onshore air quality because of the prevailing atmospheric conditions, emission heights and rates, and pollutant concentrations. Estimated increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} would be less than 0.29, 0.03, and 0.01 micrograms/m^3, respectively, per modeled steady state concentrations. These concentrations are far below concentrations that could harm coastal and marine birds.

Water Quality Degradation

Chapter 4.2.1.3 provides an analysis of the effects of a proposed action in the CPA on water quality. Expected degradation of coastal and estuarine water quality resulting from of OCS-related discharges may affect coastal birds directly by means of acute or chronic toxic effects from ingestion or contact, or indirectly through the contamination of food sources. Operational discharges or runoff in the offshore environment could also affect seabirds (e.g., laughing gulls) that remain and feed in the vicinity of offshore OCS structures and platforms. These impacts could also be both direct and indirect.

Maintenance dredging operations remove several million cubic feet of material, resulting in localized impacts (primarily increased turbidity and resuspended contaminants) during the duration of the operations. Water clarity will decrease over time within navigation channels used for vessel operations and within pipeline canals due to continuous sediment influx from bank erosion, natural widening, and reintroduction of dredged material back into surrounding waters. A proposed action would result in very small incremental contribution to the need for channel maintenance. Coastal and marine birds that feed exclusively within these locations would likely experience chronic, sublethal physiological stress. Some coastal and marine birds would experience a decrease in viability and reproductive success that would be indistinguishable from natural population variations.

Habitat Degradation

The greatest negative impact to coastal and marine birds is loss or degradation of preferred or critical habitat. The extent of bird displacement resulting from habitat loss is highly variable between different species, based upon specific habitat requirements and availability of similar habitat in the area. Habitat requirements for most bird species are incompletely known. Generally, destruction of habitat from OCS pipeline landfalls and onshore construction displaces localized groups or populations of these species. As these birds move to undisturbed areas of similar habitat, their presence may augment habitat utilization pressure on these selected areas as a result of intra- and interspecific competition for space and food. Pipeline landfalls and terminals, and other onshore OCS-related construction, can destroy coastal bird feeding or nesting habitat and can displace coastal bird populations from affected areas. Onshore pipelines cross a wide variety of coastal environments, including freshwater marsh and canals, and can therefore affect certain species generally not associated with marine or estuarine systems. These include certain waders, marsh birds, shorebirds, and waterfowl.

The analysis of the potential impacts to coastal environments (Chapter 4.2.1.1) concludes that a proposed action in the CPA is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. Initial adverse impacts and more secondary impacts of pipeline and navigation canals are the most significant OCS-related and proposed-action-related impacts to wetlands. Initial impacts are locally significant and largely limited to where OCS-related canals and channels pass through wetlands. Secondary impacts may have substantial, progressive, and cumulative adverse impacts to the hydrologic basin or subbasin in which they are found.

Debris

Coastal and marine birds are susceptible to entanglement in floating, submerged, and beached marine debris; specifically in plastics discarded from both offshore sources and land-derived litter and waste disposal (Heneman and the Center for Environmental Education, 1988). Studies in Florida reported that

80 percent of brown pelicans showed signs of injury from entanglement with fishing gear (Clapp and Buckley, 1984). In addition, seabirds ingest plastic particles and other marine debris more frequently than do any other taxon (Ryan, 1990). Interaction with plastic materials may lead to permanent injuries and death. Ingested debris may have three basic effects on seabirds: irritation and blockage of the digestive tract, impairment of foraging efficiency, and release of toxic chemicals (Ryan, 1990; Sileo et al., 1990a). Effects of plastic ingestion may last a lifetime and may include physical deterioration due to malnutrition; plastics often cause a distention of the stomach, thus preventing its contraction and simulating a sense of satiation (Ryan, 1988). Some birds also feed plastic debris to their young, which could reduce survival rates. The chemical toxicity of some plastics can be high, posing a hazard in addition to obstruction and impaction of the gut (Fry et al., 1987). Sileo et al. (1990b) found that the prevalence of ingested plastic found within the gut of examined birds varied greatly among species. Species that seldom regurgitate indigestible stomach contents are most prone to the aforementioned adverse effects (Ryan, 1990). Within the Gulf of Mexico, these include the phalaropes, petrels, storm petrels, and shearwaters. It is expected that coastal and marine birds will seldom become entangled in or ingest OCS-related trash and debris as a result of MMS prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics, garbage, and other solid wastes at sea or in coastal waters, went into effect January 1, 1989, and is enforced by the USCG.

Summary and Conclusion

The majority of effects resulting from a proposed action in the CPA on endangered/threatened and nonendangered/nonthreatened coastal and marine birds are expected to be sublethal: behavioral effects, sublethal exposure to or intake of OCS-related contaminants or discarded debris, temporary disturbances, and displacement of localized groups from impacted habitats. Chronic sublethal stress, however, is often undetectable in birds. As a result of stress, individuals may weaken, facilitating infection and disease; then migratory species may not have the strength to reach their destination. No significant habitat impacts are expected to occur directly from routine activities resulting from a proposed action. Secondary impacts to coastal habitats will occur over the long-term and may ultimately displace species from traditional sites to alternative sites.

4.2.1.9. Impacts on the Gulf Sturgeon

Effects on Gulf sturgeon from routine activities associated with a proposed action in the CPA could result from degradation of estuarine and marine water quality, pipeline installation, and drilling and produced water discharges. Potential impacts from accidental oil spill are discussed in Chapter 4.4.3.9.

Proposed Action Analysis

Drilling mud discharges may contain chemicals that are toxic to Gulf sturgeon at concentrations four of five orders of magnitude higher than concentrations found a few meters from the discharge point. Offshore discharges of drilling muds are expected to dilute to background levels within 1,000 m of the discharge point.

Produced-water discharges may contain components potentially detrimental to Gulf sturgeon. Moderate heavy-metal and hydrocarbon contamination of sediments and the water column are expected to occur out to several hundred meters downcurrent from the discharge point (CSA, 1997b); however, offshore discharges of produced water are expected to disperse and dilute to background levels within 1,000 m of the discharge point.

It is assumed that about 5 m^2 of sediments per kilometer of pipeline would be resuspended during the installation of 160-480 km of pipelines in water depths less than 60 m. Gulf sturgeon are expected to avoid lay-barge equipment and resuspended sediments.

Minor degradation of estuarine water quality is expected in the immediate vicinity of shorebases and other OCS-related facilities as a result of routine effluent discharges and runoff. Only a small amount of the routine dredging done in coastal areas will be directly or indirectly due to a proposed action.

Platform removal may kill some Gulf sturgeon, but the fish is not typically drawn to underwater structures.

Summary and Conclusion

Potential impacts on Gulf sturgeon may occur from resuspended sediments and OCS-related discharges, as well from non-point runoff from estuarine OCS-related facilities. The low toxicity of this pollution and almost absent overlap between individual Gulf sturgeon and occurrence of contamination is expected to result in little impact of a proposed action on Gulf sturgeon. Routine activities resulting from a proposed action in the CPA are not expected to have little potential effects on Gulf sturgeon.

4.2.1.10. Impacts on Fish Resources and Essential Fish Habitat

Effects on fish resources and essential fish habitat (EFH) from activities associated with a proposed action could result from coastal environmental degradation, marine environmental degradation, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters. Potential effects from routine activities resulting from a proposed action in the CPA on fish resources and EFH are described below. Potential effects on the three habitats of particular concern for Gulf of Mexico fish resources (the Flower Garden Banks National Marine Sanctuary, Weeks Bay National Estuarine Research Reserve in Alabama, and Grand Bay in Mississippi and Alabama) are included under the analyses for topographic features (Chapter 4.2.1.2.2) and wetlands (Chapter 4.2.1.1.2). Potential effects from accidental events (blowouts and spills) are described in Chapter 4.4.3.10. Potential effects on commercial fishing from a proposed action are described in Chapter 4.2.1.11.

Healthy fish resources and fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Because of the wide variation of habitat requirements for all life history stages (as described in Chapter 3.2.9) for managed fish species in the CPA, the EFH for the Gulf of Mexico includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ). Collectively, the adverse impacts on coastal EFH and marine EFH are called, respectively, coastal and marine environmental degradation in this analysis.

Since the majority of fish species within CPA are estuary dependent, coastal environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. The environmental deterioration and effects on EFH and fish resources result from the loss of Gulf wetlands and coastal estuaries as nursery habitat and from the functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992).

Wetlands and estuaries within Texas, Louisiana, Mississippi, and Alabama may be affected by activities resulting from a proposed action (Chapters 4.2.1.1.2, 4.3.1.1.2, and 4.4.3.1.2). These activities include construction or expansion of onshore facilities in wetland areas, pipeline emplacement in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, inshore disposal of OCS-generated petroleum-field wastes, and spills from both coastal and offshore OCS-support activities.

Coastal water quality (Chapters 4.2.1.3.1 and 4.4.3.3.1) may be adversely affected by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic and cause degradation of coastal water quality. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions.

Since many of the fish species within the CPA are dependent on offshore water and live bottoms, marine environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. Offshore EFH includes both high- and low-relief live bottoms (pinnacles) and both natural (topographic features) and artificial reefs. Natural banks within the CPA are listed in Table 3-4. A detailed discussion of artificial reefs appears in Appendix 9.1.4. A proposed action could impact soft-bottom communities, hard-bottom communities (on high- and low-relief features), sand-bottom algal communities, and organisms colonizing scattered anthropogenic debris and artificial reefs. Impact-producing factors that could affect EFH include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, blowouts, and pipeline trenching. The impacts could include immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

The Live Bottom (Pinnacle Trend) and Topographic Features Stipulations (Chapter 2.3.1.3) would prevent most of the potential impacts from a proposed action on pinnacle trend and live-bottom communities (EFH) from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills.

Impact-producing factors from routine offshore activities that could result in marine water quality degradation include platform and pipeline installation, platform removal, and the discharge of operational wastes (Chapter 4.2.1.3.2). Offshore accidents including blowouts and spills from platforms, service vessels, and pipelines could also occur and potentially alter offshore water quality (Chapter 4.4.3.3.2). Coastal operations could indirectly affect marine water quality; offshore water quality can be impacted through migration of contaminated coastal waters (Chapter 4.2.1.3.1).

Lessees are required to remove all structures and underwater obstructions from their leases in the Federal OCS within one year of the lease relinquishment or termination of production (Chapter 4.1.1.4). Seventy percent of the platforms in water depths less than 200 m are removed by severing their pilings with explosives placed 5 m below the seafloor. The concussive force is lethal to fish that have internal air chambers (swim bladders), are demersal, or are in close association with the platform being removed (Gitschlag et al., 2000; Scarborough-Bull and Kendall, 1992; Young, 1991).

Within the past decade, stocks of reef fish have declined in the Gulf. There is concern over a possible connection between this decline and the explosive removal of platforms. To examine this issue of concern, MMS entered into a formal Interagency Agreement with NOAA and NMFS and has investigated fish death associated with structure removal. This study reported the evaluation of fish deaths from platform removals related to the status of reef fish stocks in the Gulf of Mexico. Results indicated that the number of red snapper and other commercial species killed during explosive platform removals is less than 1 percent of the annual harvest of those species from the Gulf of Mexico (Gitschlag et al., 2000). One significant result determined that for red snapper, even when mortality estimates were doubled, impacts were estimated to be small and would not alter current determinations of status or current management recovery strategies.

Chronic, low-level pollution is a persistent and recurring event resulting in frequent but sublethal physiological irritation to fish resources that lie within the range of impact and that are likely to be adversely affected by the pollution. The geographic range of the pollutant effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question (in this case hydrocarbons).

Drilling muds contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources; however, the discharge plume disperses rapidly, is very near background levels at a distance of 1,000 m, and is usually undetectable at distances greater than 3,000 m (Kennicutt, 1995) (Chapter 4.1.1.3.4.1). Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 part per million (ppm) and 3 ppm, respectively, in the stock barite used to make drilling muds. There has recently been increased media focus on mercury uptake in fish and other marine species. An MMS-funded study titled *Gulf of Mexico Offshore Operations Monitoring Experiment* (Kennicutt, 1995) analyzed sediments at three sites in the GOM. Results of this study indicated that mercury levels were slightly elevated in sediments or organisms at one platform site (High Island, East Addition, South Extension Block A-389 (HI A-389)). The average concentration of mercury at HI A-389 was twice as high as the other two platforms. The highest average concentration (0.41 ug/g) was found within 50 m of the platform but decreased to 0.12 ug/g at 100 m. Although these concentrations were the highest found, they were low relative to the probable effects level (0.7) believed to cause biological effects. This platform used the relatively rare practice of shunting drilling muds and cuttings to within 10 m of the seafloor to avoid dispersal and prevent impact to the nearby East Flower Garden Bank.

Metal concentrations were measured in tissues for 37 marine species. Fish tissue concentrations were generally low; for example, the average concentration was 0.45 ug/g for all flounder species, 0.39 ug/g all hake species, and 0.24 ug/g for all snapper species. Shrimp had statistically higher tissue concentrations (0.36 ug/g) near platforms than far (0.19 ug/g) from platforms. These values are well below the Federal guidelines set by the Food and Drug Administration (FDA) to protect human health, which is 1 ppm. Additional discussion of mercury in drilling muds can be found in Chapter 4.1.1.3.4.1.

In addition to toxic trace elements and hydrocarbons in produced waters, there are additional components and properties, such as hypersalinity and organic acids, that have a potential to adversely affect fishery resources. Produced waters that are discharged offshore are diluted and dispersed to very near background levels at a distance of 1,000 m and are undetectable at a distance of 3,000 m from the discharge point (Harper, 1986; Rabalais et al., 1991; Kennicutt, 1995).

Proposed Action Analysis

The effects of a proposed action on coastal wetlands and coastal water quality, with the exception of accidental events, are analyzed in detail in Chapters 4.2.1.1.2 and 4.2.1.3.1, respectively. Collectively, the adverse impacts from these effects are called coastal environmental degradation in this EIS. The effects of a proposed action on offshore live bottoms and marine water quality are analyzed in detail in Chapters 4.2.1.2.1 and 4.2.1.3.2, respectively. Collectively, the adverse impacts from these effects are called marine environmental degradation in this EIS. The direct and/or indirect effects from coastal and marine environmental degradation on fish resources and EFH are summarized and considered below.

Coastal Environmental Degradation

A proposed action is projected to increase traffic in navigation channels to and from service bases from Texas to Alabama. This may result in some erosion of wetlands along the channels, particularly in Louisiana. Little erosion along the navigation channels in Mississippi and Alabama is expected because the channels are in upland areas and the banks are developed. Additional information regarding erosion along navigation channels is provided in the wetland analysis (Chapter 4.2.1.1.2).

One new pipeline landfall is projected in support of a proposed action. Depending on the site of this projected pipeline landfall, the activities associated with the installation could result in localized impacts to the coastal environment including degradation of water quality, and potential erosion and loss of wetlands habitat.

Localized, minor degradation of coastal water quality is expected in waterbodies in the immediate vicinity of coastal shore bases, commercial waste-disposal facilities, and oil refineries or gas processing plants as a result of routine effluent discharges and runoff. A proposed action in the CPA is projected to contribute about 2 percent of the OCS-Program-related use of these facilities.

Maintenance dredging of waterways and channels would result in decreased water clarity and some resuspension of contaminants. This could preclude, in rare instances, uses of those waters directly affected by the dredging operations for up to several months. The periods between projected dredging operations, ranging from 1-2 years, should generally allow for the recovery of affected areas. Only a small amount of the routine dredging done in coastal areas will be directly or indirectly due to a proposed action.

It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH. Wetlands that could be impacted for some period of time or converted to open water are discussed in the wetlands analysis (Chapter 4.2.1.1.2). Recovery of fish resources or EFH can occur from more than 99 percent, but not all, of the potential coastal environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation and most EFH can recuperate quickly, but the loss of wetlands as EFH could be permanent. At the expected level of effect, the resultant influence on fish resources or EFH from a proposed action would be negligible and indistinguishable from natural population variations.

Marine Environmental Degradation

The Live Bottom (Pinnacle Trend) and Topographic Features Stipulations would prevent most of the potential impacts on pinnacle-trend live-bottom or topographic-feature communities (EFH) from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills resulting from a proposed action. For any activities associated with a proposed action, USEPA's Region 6 will regulate discharge requirements for the majority of the CPA through their NPDES permits. The USEPA's Region 4 would regulate a small area in the northeastern CPA, including the Mobile and Viosca Knoll lease areas. Contaminant levels in the CPA are generally low, reflecting the lack of pollution sources and high-energy environment of much of the region. The primary water quality impact from any increased turbidity would be decreased water clarity. Bottom disturbance from emplacement operations associated with a proposed action would produce localized, temporary increases in suspended sediment loading, resulting in decreased water clarity and little reintroduction of pollutants.

The major sources of discharges associated with a proposed action to marine waters are the temporary discharge of drilling muds and cuttings and the long-term discharge of produced-water effluent. Both of these discharges contain various contaminants of concern (e.g., trace metals and petroleum-based organic) that may have environmental consequences on marine water quality and aquatic life. Drilling mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than the concentrations found a few meters from the discharge point. Offshore discharges of drilling muds are expected to dilute to background levels within 1,000 m of the discharge point.

Produced-water discharges contain components and properties potentially detrimental to fish resources. Moderate petroleum and metal contamination of sediments and the water column are expected to occur out to several hundred meters downcurrent from the discharge point (CSA, 1997a). Offshore discharges of produced water are expected to disperse and dilute to background levels within 1,000 m of the discharge point and amount to less than 1 percent of the annual harvest of surveyed commercial species.

The projected total number of platform installations resulting from a proposed action in the CPA is 28-49 for all water depths. Ten years after a platform is installed, the structure would be acting as an artificial reef. About 99 percent of the species present would be residents and not new transients from nearby live bottoms. All structures associated with a proposed action are expected to be removed by the year 2037. Structure removal results in loss of artificial-reef habitat and cause fish kills when explosives are used. Most multi-leg platforms in water depths less than 156 m are removed by severing their pilings with explosives placed 5 m below the seafloor. It is projected that 16-28 structures in water depths <200 m in the CPA will be removed using explosives as a result of a proposed action. It is expected that structure removals would have a negligible effect on fish resources because these activities kill only those fish proximate to the removal site.

The projected length of pipeline installations for a proposed action is 560-1,040 km. Trenching for pipeline burial has the potential to adversely affect fish resources. It is assumed that 5.02 m^2 of sediments per kilometer of pipeline would be resuspended during the installation of 160-480 km of pipelines in water depths less than 60 m. Where pipeline burial is necessary, a jetting sled is generally used. Water jets are directed downward to dig a trench and the apparatus can lay pipe at an average of 1.6 km/day (See Chapters 4.1.1.3.8.1 and 4.1.2.1.7 for additional discussion of pipelaying activities.). Sandy sediments would be quickly redeposited within 400 m of the trench or blowout site, and finer sediments would be widely dispersed and redeposited within a few thousand meters over a period of 30 days or longer. Any affected population is expected to recover to predisturbance condition in one generation. At the expected level of impact, the resultant influence on fish resources would be negligible and indistinguishable from other natural population variations.

It is expected that marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of marine environmental degradation is expected to cause an undetectable decrease in fish populations. Recovery of fish resources or EFH can occur from 100 percent of the potential marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation. Offshore live bottoms are not expected to be impacted. Offshore discharges and subsequent changes to marine water quality will be regulated by USEPA NPDES permits. At the expected level of effect, the resultant influence on fish resources or EFH would be negligible and indistinguishable from natural population variations.

Summary and Conclusion

It is expected that coastal and marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of coastal and marine environmental degradation is expected to cause an undetectable decrease in fish resources or in EFH. Fish resources and EFH are expected to recover from more than 99 percent, but not all, of the expected coastal and marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation, but any loss of wetlands as EFH would be permanent.

Offshore live bottoms will not be impacted. Offshore discharges and subsequent changes to marine water quality will be regulated by NPDES permits. At the expected level of impact, the resultant influence on fish resources and EFH would be negligible and indistinguishable from natural population variations.

Activities such as pipeline trenching and OCS discharge of drilling muds and produced water would cause negligible impacts and would not deleteriously affect fish resources or EFH. At the expected level of impact, the resultant influence on fish resources would cause less than a 1 percent change in fish populations or EFH. As a result, there would be little disturbance to fish resources or EFH.

A proposed action is expected to result in less than a 1 percent decrease in fish resources and/or standing stocks or in EFH. It would require one generation for fish resources to recover from 99 percent of the impacts. Recovery from the loss of wetlands habitat would probably not occur.

4.2.1.11. Impacts on Commercial Fisheries

Effects on commercial fishing from activities associated with a proposed action could result from installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, subsurface blowouts, pipeline trenching, and petroleum spills. Potential effects from routine activities resulting from a proposed action in the CPA on fish resources and EFH are described in Chapter 4.2.1.10. Potential effects from accidental events (spills and blowouts) are described in Chapter 4.4.3.11. Potential effects on commercial fishing from routine activities resulting from a proposed action are described below.

Healthy fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Due to the wide variation of habitat requirements for all life history stages (as described in Chapter 3.2.9) for managed species in the CPA, the EFH for the Gulf of Mexico includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ). Collectively, the adverse impacts on coastal EFH and marine EFH are called, respectively, coastal and marine environmental degradation in this analysis.

Since the majority of the commercial species harvested within the CPA are estuary dependent, coastal environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and commercial fisheries. Environmental deterioration and effects on EFH and commercial fisheries result from the loss of Gulf wetlands and coastal estuaries as nursery habitat and from the functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992).

Wetlands and estuaries within Texas, Louisiana, Mississippi, and Alabama may be affected by activities resulting from a proposed action (Chapters 4.2.1.1.2 and 4.4.3.1.2). These activities include construction or expansion of onshore facilities in wetland areas, pipeline emplacement in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, inshore disposal of OCS-generated petroleum-field wastes, and spills from both coastal and offshore OCS-support activities.

Coastal water quality (Chapters 4.2.1.3.1 and 4.4.3.3.1) may be adversely affected by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic and cause degradation of coastal water quality. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions.

Since many of the fish species harvested within the CPA are dependent on offshore water and live bottoms, marine environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. Offshore EFH includes both high- and low-relief live bottoms (pinnacles) and both natural (topographic features) and artificial reefs. Natural banks within the CPA are listed in Table 3-4. A detailed discussion of artificial reefs appears in Appendix 9.1.4. A proposed action could impact soft-bottom communities, hard-bottom communities (on high- and low-relief features), sand-bottom algal communities, and organisms colonizing scattered anthropogenic debris and artificial reefs. Impact-producing factors that could affect EFH include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, blowouts, and pipeline trenching. The impacts could include immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

The Live Bottom (Pinnacle Trend) and Topographic Features Stipulations (Chapter 2.3.1.3) would prevent most of the potential impacts from a proposed action on live-bottom communities/EFH from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills.

Impact-producing factors from routine offshore activities that could result in degradation of marine water quality include platform and pipeline installation, platform removal, and the discharge of operational wastes (Chapter 4.2.1.3.2). Offshore accidents including blowouts and spills from platforms, service vessels, and pipelines could also occur and potentially alter marine water quality (Chapter 4.4.3.3.2). Coastal operations could indirectly affect marine water quality; offshore water quality can be impacted through migration of contaminated coastal waters (Chapter 4.4.3.3.1).

The area occupied by structures, anchor cables, and safety zones associated with a proposed action would be unavailable to commercial fishermen and could cause space-use conflicts. Exploratory drilling rigs would spend approximately 30-150 days onsite and would cause short-lived interference to commercial fishing. A bottom-founded, major production platform in shallow water, with a surrounding 100-m navigational safety zone, requires approximately 6 ha of space. A floating production system in deeper water requires as much as 5 ha of space. The use of FPSO's is not projected for a proposed action, and the USCG has not yet determined what size of a navigational safety zone would be required for an FPSO during normal or offloading operations.

Underwater OCS obstructions, such as pipelines, can cause loss of trawls and catch, business downtime, and vessel damage. Pipelines in water depths less than 61 m (200 ft) are required to be buried, and their locations made public knowledge. Although Gulf fishermen are experiencing some economic loss from gear losses, the economic loss for a fiscal year has historically been less than 0.1 percent of the value of that same fiscal year's commercial fisheries landings. In addition, most financial losses from gear losses are covered by the Fishermen's Contingency Fund (FCF).

Lessees are required to remove all structures and underwater obstructions from their leases in the Federal OCS within one year of the lease relinquishment or termination of production (Chapter 4.1.1.4). Seventy percent of the platforms in water depths less than 200 m are removed by severing their pilings with explosives placed 5 m below the seafloor. The concussive force is lethal to fish that have internal air chambers (swim bladders), are demersal, or are in close association with the platform being removed (Gitschlag et al., 2000; Scarborough-Bull and Kendall, 1992; Young, 1991). Within the past decade, stocks of reef fish have declined in the Gulf. There is concern over a possible connection between this decline and the explosive removal of platforms. To examine this issue of concern, MMS entered into a formal Interagency Agreement with NOAA and NMFS and has investigated fish death associated with structure removal. This study reported the evaluation of fish deaths from platform removals related to the status of reef fish stocks in the Gulf of Mexico. Results indicated that the number of red snapper and other commercial species killed during explosive platform removals is less than 1 percent of the annual harvest of those species from the Gulf of Mexico (Gitschlag et al., 2000). One significant result determined that for red snapper, even when mortality estimates were doubled, impacts were estimated to be small, and would not alter current determinations of status or current management recovery strategies.

Chronic, low-level pollution is a persistent condition, resulting in frequent but sublethal physiological irritation to those resources that lie within the range of impact and that are likely to be adversely affected. The geographic range of the effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource.

Drilling muds contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources; however, the plume disperses rapidly, is very near background levels at a distance of 1,000 m, and is usually undetectable at distances greater than 3,000 m (Kennicutt, 1995) (Chapter 4.1.1.3.4.1). Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make drilling muds.

In addition to toxic trace elements and hydrocarbons in produced waters, there are additional components and properties, such as hypersalinity and organic acids, that have a potential to adversely affect commercial fishery resources. Produced waters that are discharged offshore are diluted and dispersed to very near background levels at a distance of 1,000 m and are undetectable at a distance of 3,000 m from the discharge point (Harper, 1986; Rabalais et al., 1991; Kennicutt, 1995).

Proposed Action Analysis

Installation of offshore structures may cause space-use conflicts with commercial fishing activities. The total projected number of production structure installation for a proposed action ranges from 28 to 49. Using the 100-m navigational safety zone figure (although to date very few operators have elected to apply to the USCG for a safety zone around production platforms), the possible area excluded from commercial trawl fishing or longlining would range from 168 to 294 ha. The maximum excluded area represents only a very small fraction (0.0015%) of the total area of the CPA. All structures associated with a proposed action are projected to be removed by the year 2037.

In water depths less than 200 m, the area of concentrated bottom trawl fishing, 23-39 platforms would be installed under a proposed action, eliminating 128-234 ha from the area available for commercial fishing. There is no use of FPSO's projected for a proposed action. It is assumed that space-use conflicts will seldom occur. The effect of space loss to trawl fishing resulting from the construction of platforms in support of a proposed action in the CPA would be negligible; the maximum extent of the area lost to commercial trawling would be less than 0.01 percent of the available trawl fishing area in water depths less than 200 m. Two large areas in the DeSoto Canyon Area have been designated by NOAA Fisheries as swordfish nursery areas and are closed to longline fishing activities. The boundaries of the closed areas are described in Chapter 3.3.1 and are shown on Figure 3-9. The longline closure areas are located largely in the EPA. A small portion of the northern closed area includes 174 blocks in the CPA in the Mississippi Canyon, Main Pass, Viosca Knoll, and Mobile lease areas. The closed areas cover nearly 845,000 km^2 and will displace commercial longlining, which may increase activity in the CPA and possibly the WPA.

Underwater OCS obstructions such as pipelines may cause fishing gear loss and additional user conflicts. The area of concentrated bottom trawl fishing is in water depths less than 200 m. For a proposed action, it is projected that 160-480 km of pipeline will be installed in water depths less than 60 m; no projection of the length of installed pipelines has been made for water depths of 60-200 m. Gear loss and user conflicts are mitigated by the FCF. Direct payments for claims in FY 1997 totaled $238,404 and total payments for FY 1998 were $311,290. The amount available for Gulf of Mexico FCF claims in FY 1999 was $1,212,969. The majority of claims are resolved within six months of filing. The economic loss from gear loss and user conflicts has historically been less than 0.1 percent of the same year's value of Gulf commercial fisheries landings. It is assumed that installed pipelines will seldom conflict with bottom trawl or other fishing activities, and they are expected to have a negligible effect on commercial fishing.

Structure removals result in loss of artificial-reef habitat and cause fish kills when explosives are used. It is projected that 16-28 structure removals using explosives will occur in water depths of <200 m as a result of a proposed action. It is expected that structure removals will have a negligible effect on commercial fishing because of the inconsequential number of removals and the consideration that removals kill only those fish proximate to the removal site.

Seismic surveys will occur in both shallow and deepwater areas of the CPA. Usually, fishermen are precluded from a very small area for several days. This should not impact the annual landings or value of landings for commercial fisheries in the Gulf. Gulf of Mexico species can be found in many adjacent locations and Gulf commercial fishermen do not fish in one locale. Loss of fishing gear because of seismic surveys are also mitigated (see above) by the FCF. All seismic survey locations and schedules are published in the USCG *Local Notice to Mariners,* a free publication available to all fishermen. Seismic surveys will have a negligible effect on commercial fishing.

Summary and Conclusion

Activities such as seismic surveys and pipeline trenching will cause negligible impacts and will not deleteriously affect commercial fishing activities. Operations such as production platform emplacement, underwater OCS impediments, and explosive platform removal, will cause slightly greater impacts on commercial fishing. At the expected level of impact, the resultant influence on commercial fishing will be indistinguishable from variations due to natural causes. As a result, there would be very little impact on commercial fishing. A proposed action is expected to result in less than a 1 percent change in activities, in pounds landed, or in the value of landings. It will require less than six months for fishing activity to recover from any impacts.

4.2.1.12. Impacts on Recreational Beaches

This section discusses the possible effects of a proposed action in the CPA on recreational beaches. Millions of annual visitors attracted to these resources are responsible for thousands of local jobs and billions of dollars in regional economic activity. Major recreational beaches are defined as those frequently visited sandy areas along the shoreline that are exposed to the Gulf of Mexico and that support a multiplicity of recreational activities, most of which is focused at the land and water interface. Included are Gulf Islands National Seashore, State parks and recreational areas, county and local parks, urban beaches, private resort areas, and State and private environmental preservation and conservation areas. The general locations of these beaches are indicated on MMS Visual 2—Multiple Use (USDOI, MMS, 2001d).

The primary impact-producing factors to the enjoyment and use of recreational beaches are trash and debris, and oil spills. Additional factors such as the physical presence of platforms and drilling rigs can affect the aesthetics of beach appreciation, and noise from OCS-related aircraft can adversely affect a beach-related recreation experience. All these factors, either individually or collectively, may adversely affect the number and value of recreational beach visits. The potential impacts from oil spills and other accidental events are discussed in Chapter 4.4.3.12.

The value of recreation and tourism in the Gulf of Mexico coastal zone from Texas through Florida has been estimated in the tens of billions of dollars annually (USDOI, MMS, 2001g; pages III-101 and III-102). A significant portion of these expenditures is made in coastal counties, where major shoreline beaches are primary recreational attractions. Over one million people visit the mainland unit and barrier island beaches of the Gulf Island National Seashore in Mississippi and Florida annually, demonstrating the popularity of destination beach parks throughout the Gulf Coast region east of the Mississippi River. Trash and debris from OCS operations can wash ashore on Gulf of Mexico recreational beaches. Recreational beaches west of the Mississippi River are the most likely to be impacted by waterborne trash from OCS activities. Litter on recreational beaches from OCS operations could adversely affect the ambience of the beach environment, detract from the enjoyment of beach activities, and increase administrative costs on maintained beaches. Some trash items, such as glass, pieces of steel, and drums with chemical residues, can also be a health threat to users of recreational beaches. Current industry waste management practices; training and awareness programs focused on the beach litter problem; and the OCS industry's continuing efforts to minimize, track, and control offshore wastes are expected to minimize potential for accidental loss of solid wastes from OCS oil and gas operations.

The physical presence of platforms and drilling rigs visible from shore, and noise associated with vessels and aircraft traveling between coastal shore bases and offshore operation sites can adversely affect the natural ambience of primitive coastal beaches. Drilling rigs and platforms placed 3-10 mi from shore are within sight range of shoreline recreational beaches. Federal and State oil and gas operations are already occurring on nearshore tracts off Louisiana, Mississippi, and Alabama.

Although these factors may affect the quality of recreational experiences, they are unlikely to reduce the number of recreational visits to coastal beaches in the Central and Western Gulf.

Proposed Action Analysis

A proposed action in the CPA is projected to result in the drilling of 123-205 exploration and production wells and the installation of 19-33 platforms in water depths <60 m. In water depths of 60-200 m, a proposed action is projected to result in 58-107 wells and 4-6 platforms. Marine debris will be lost from time to time from OCS operations associated with drilling activities and production facilities projected to result from a proposed action in the CPA. Waste management practices and training programs are expected to minimize the level of accidental loss of solid wastes from activities resulting from a proposed action. Recreational beaches in Louisiana and Texas are most likely to be impacted by any waterborne trash. Beached litter and debris from a proposed action is unlikely to be perceptible to beach users or administrators because a proposed action would constitute only a small percentage of the total OCS Program activity in the CPA.

A proposed action is expected to result in 63,000-111,000 service-vessel trips over the life of the leases or about 1,575-2,775 trips annually. A proposed action is also expected to result in 220,000-870,000 helicopter trips, which is about 5,500-21,750 trips annually. Service vessels are assumed to use established nearshore traffic lanes and helicopters are assumed to comply with areal clearance restrictions at least 90 percent of the time. This additional helicopter and vessel traffic will add very little noise pollution likely to affect beach users.

Summary and Conclusion

Marine debris will be lost from time to time from operations resulting from a proposed action. The impact on Gulf Coast recreational beaches is expected to be minimal. The incremental increase in helicopter and vessel traffic is expected to add very little additional noise that may affect beach users. A proposed action is expected to result in nearshore operations that may adversely affect the enjoyment of some Gulf Coast beach uses; however, these will have little effect on the number of beach users.

4.2.1.13. Impacts on Archaeological Resources

Blocks with a high probability for the occurrence of prehistoric, prehistoric and historic, or historic archaeological resources are found in the Central Gulf. Blocks with a high probability for prehistoric archaeological resources are found landward of a line that roughly follows the last geologic still-stand before inundation at approximately 13,000 B.P. (years before present). This 13,000-B.P. still-stand also roughly follows the 45-m bathymetric contour. Because of inherent uncertainties in both the depth of historic sea level stands and the entry date of prehistoric man into North America, MMS has adopted the 12,000 B.P. and 60-m water depth as the seaward extent of the high-probability area for prehistoric archaeological resources.

The areas of the northern Gulf of Mexico that are considered to have a high probability for historic period shipwrecks were redefined as a result of an MMS-funded study (Garrison et al., 1989; LTL's dated November 30, 1990, and September 5, 1995). The study expanded the shipwreck database in the Gulf of Mexico from 1,500 to more than 4,000 wrecks. Statistical analysis of shipwreck location data identified two specific types of high-probability areas—the first within 10-km of the shoreline and the second proximal to historic ports, barrier islands, and other loss traps. High-probability search polygons associated with individual shipwrecks were created to afford protection to wrecks located outside the two aforementioned high-probability areas (cf. Visual 3—Offshore Regulatory Features, USDOI, MMS, 2001e). The historic archaeological high-probability areas are under MMS review at the time of this writing. The MMS requires a 50-m remote-sensing, survey linespacing density for historic shipwreck surveys in water depths of 200 m or less. The current NTL – NTL 2002-G01, effective in March 2002 – supersedes all other archaeological NTL's and LTL's. The NTL updates requirements to reflect current technology.

An Archaeological Resources Stipulation was included in all Gulf of Mexico lease sales from 1974 through 1994. The stipulation was incorporated into operational regulations at 30 CFR 250.26 with few changes, and all protective measures offered in the Stipulation have been adopted in the regulation.

Additional supportive material for the archaeological resources analysis is provided in Chapter 3.3.2 (Description of the Affected Environment) and Chapters 4.2.1.13, 4.3.1.1.11, 4.4.3.13, and 4.5.13 (Environmental Consequences).

Several OCS-related, impact-producing factors may cause adverse impacts to archaeological resources. Offshore development could result in a drilling rig, platform, pipeline, dredging activity or anchors having an impact on an historic shipwreck. Direct physical contact with a wreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the period from which the ship dates.

The placement of drilling rigs and production platforms has the potential to cause physical impact to prehistoric and/or historic archaeological resources. It is assumed that the standard rig in less than 400 m of water will directly disturb 1.5 ha of soft bottom; the average platform under the same conditions, 2 ha. Pile driving associated with platform emplacement may also cause sediment liquefaction an unknown distance from the piling, disrupting stratigraphy in the area of liquefaction.

Pipeline placement has the potential to cause a physical impact to prehistoric and/or historic archaeological resources. Pipelines placed in water depths of less than 61 m must be buried. Burial depths of 1 m are required with the exception of shipping fairways and anchorage areas, where the requirements are 3.0 m and 4.6 m, respectively.

The dredging of new channels, as well as maintenance dredging of existing channels, has the potential to cause a physical impact to historic shipwrecks (Espey, Huston, & Associates, 1990a). There are many navigation channels that provide OCS access to onshore facilities. Most of these are located in the Central Gulf.

Anchoring associated with platform and pipeline emplacement, as well as with service-vessel and shuttle-tanker activities, may also physically impact prehistoric and/or historic archaeological resources. It is assumed that during pipeline emplacement, an array of eight 20,000-lb anchors is continually repositioned around the pipelaying barge.

Activities resulting from a proposed action will generate ferromagnetic structures and debris, which will tend to mask magnetic signatures of significant historic archaeological resources. The task of locating historic resources through an archaeological survey is, therefore, made more difficult as a result of leasing activity.

4.2.1.13.1. Historic Archaeological Resources

Proposed Action Analysis

The likely locations of archaeological sites cannot be delineated without first conducting a remote-sensing survey of the seabed and near-surface sediments. The MMS has issued regulations at 30 CFR 250.194, 250.203(b)(15), 250.203(o),. 250.204(b)(8)(v)(A), 250.204(s), and 250.1007(a)(5) that require OCS lessees and operators and applicants for pipeline rights-of-way to conduct an archaeological survey prior to proposed activities within areas determined to have a high probability for historic and/or prehistoric archaeological resources. Generally, in the eastern part of the CPA, where unconsolidated sediments are thick, it is likely that side-scan sonar will not detect shipwrecks buried beneath the mud. In this area, which begins nearshore around the Vermilion Area (USDOI, MMS, 1984) and extends eastward, the effectiveness of the survey for detecting historic shipwrecks of composite and wooden construction would depend on the capability of a magnetometer to detect ferromagnetic masses of the size characteristically associated with shipwrecks. It is assumed that the required 50-m line spacing (as specified in NTL 2002-G01) is a highly effective survey methodology, allowing detection of approximately 90 percent of historic shipwrecks within the survey area. The survey would therefore reduce the potential for an impact to occur by an estimated 90 percent.

According to estimates presented in Table 4-6, 289-599 exploration, delineation, and development wells will be drilled and 28-49 production platforms will be installed in support of a proposed action. Of these, 181-312 exploration, delineation, and development wells will be drilled, and 23-39 platforms will be installed in water depths of 200 m or less, where the majority of blocks with a high probability for historic period shipwrecks are located. The location of any proposed activity within a lease that has a high probability for historic shipwrecks requires archaeological clearance prior to operations. Considering that the expanded database contains 508 historic period shipwrecks in the entire Central Gulf OCS, the probability of an OCS activity contacting and damaging a shipwreck is very low. If an oil and gas structure contacted a historic resource, however, there could be a loss of significant or unique archaeological information.

Because there is only a thin Holocene sediment veneer overlying an overconsolidated Pleistocene surface in the western part of the CPA, shipwrecks are more likely to be detected by side-scan sonar; therefore, the 50-m survey linespacing is expected to be even more effective (95%) for reducing the potential for a direct physical contact between an impact-producing factor and a shipwreck in the western CPA. There is a very small possibility that a historic shipwreck could be impacted by OCS activities. Should such an impact occur, however, significant or unique archaeological information could be lost.

Onshore historic properties include sites, structures, and objects such as historic buildings, forts, lighthouses, homesteads, cemeteries, and battlefields. Sites already listed on the National Register of Historic Places and those considered eligible for the Register have already been evaluated as being able to make a unique or significant contribution to science. At present, unidentified historic sites may contain unique historic information and would have to be assessed after discovery to determine the importance of the data.

Onshore development could result in the direct physical contact between the construction of new onshore facilities or pipeline canals and previously unidentified historic sites. This direct physical contact with a historic site could cause physical damage to, or complete destruction of, information on the history of the region and the Nation. It is assumed that 2 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action. Table 4-8 shows the projected coastal infrastructure related to OCS Program activities. Facilities that are projected to be constructed must receive approval from the pertinent Federal, State, county/parish, and/or communities. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes involved. There is, therefore, no expected impact to onshore historic sites in the CPA from onshore development.

Maintenance dredging associated in support of activities resulting from a proposed action has the potential to impact a historic shipwreck. For instance, maintenance dredging in the Port Mansfield Entrance Channel is believed to impact the *Santa Maria de Yciar*, which sank on April 29, 1554 (Espey, Huston & Associates, 1990a) and is expected to impact the *SS Mary*, which sank on November 30, 1876, in Aransas Pass (Espey, Huston & Associates, 1990b). Impacts from maintenance dredging can be attributed proportionally to the users of the navigation channels. The MMS assessment indicates that, under a proposed action, less than 1 percent of the ship traffic through the Port Mansfield Cut is related to OCS use. Therefore, the impact to the *Santa Maria de Yciar* and *SS Mary* directly attributable to traffic and maintenance dredging as a result of the OCS Program is negligible. While the specific example falls within coastal Subarea TX-1, an area unlikely to be affected by activities resulting from a proposed action in the CPA, it serves to illustrate that the potential exists for historic shipwrecks to be impacted by dredging. As these shipwrecks are unique historic archaeological resources, maintenance dredging, in general, is responsible for impacts to historic shipwrecks. Proposed action activities represent <1 percent of the usage of the major navigation channels for the Central Gulf.

The loss of ferromagnetic debris during exploration and production activities has the potential to mask the magnetic signatures of historic shipwrecks. Under a proposed action, it is expected that hundreds of tons of ferromagnetic debris will be lost overboard. It is expected that most ferromagnetic debris associated with OCS structures will be removed from the seafloor during site-clearance activities. Site clearance, however, takes place after the useful life of the structure is complete. It has been noted that such debris has the potential to be moved from the area of initial deposition as a result of trawling activities (Garrison et al., 1989). Also, no site-clearance activities are required for pipeline emplacement operations. Therefore, there remains the potential for masking the signatures of historic shipwrecks as a result of ferromagnetic debris from OCS oil and gas activities.

Since all platform locations within the high-probability areas for the occurrence of offshore historic and prehistoric archaeological resources are given archaeological clearance prior to setting the structure, removal of the structure should not result in any adverse impact to archaeological resources. This is consistent with the findings of the *Programmatic Environmental Assessment: Structure Removal Activities, Central and Western Gulf of Mexico Planning Areas* (USDOI, MMS, 1987).

Summary and Conclusion

The greatest potential impact to a historic archaeological resource as a result of a proposed action in the CPA would result from direct contact between an offshore activity (platform installation, drilling rig emplacement, and dredging or pipeline project) and a historic shipwreck. An MMS-funded study (Garrison et al., 1989) resulted in the redefinition of the high-probability areas for the location of historic period shipwrecks. An MMS review of the historic high-probability areas is occurring at the time of this writing. The NTL for archaeological resource surveys in the Gulf of Mexico Region, NTL 2002-G01, mandates a 50-m linespacing for remote-sensing surveys of leases within the high probability areas for historic shipwreck.

Ferromagnetic debris has the potential to mask the magnetic signatures of historic shipwrecks.

Maintenance dredging of navigation channels may result in impacts to historic shipwrecks; however, the percentage of OCS use of these channels under a proposed action is less than 1 percent.

Most other routine activities associated with a proposed action in the CPA are not expected to impact historic archaeological resources. It is conservatively assumed that about 2 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action (Table 4-8). It is expected that archaeological resources will be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities.

Offshore oil and gas activities resulting from a proposed action could contact a shipwreck because of incomplete knowledge on the location of shipwrecks in the Gulf. Although this occurrence is not probable, such an event would result in the disturbance or destruction of important historic archaeological information. Other factors associated with a proposed action in the CPA are not expected to affect historic archaeological resources.

4.2.1.13.2. Prehistoric Archaeological Resources

Offshore development as a result of a proposed action could result in an interaction between a drilling rig, a platform, a pipeline, dredging, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy fragile artifacts or site features and could disturb artifact provenance and site stratigraphy. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for North America, Central America, South America, and the Caribbean.

Proposed Action Analysis

According to projections presented in Table 4-2, under a proposed action, 289-599 exploration, delineation, and development wells will be drilled, and 28-49 production platforms will be installed as a result of a proposed action in the CPA. Relative-sea-level data for the Gulf of Mexico indicates that there is no potential for the occurrence of prehistoric archaeological sites in water depths greater than 60 m. If only the area likely to contain prehistoric sites (shallower than 60 m) is considered, 123-195 exploration, delineation, and development wells and 23-39 production platforms are projected to be installed (Table 4-2). The limited amount of impact to the seafloor throughout the CPA, the required archaeological survey, and archaeological clearance are sufficient to assume a low potential for impacting a prehistoric archaeological site. Should such an impact occur, damage to or loss of significant or unique prehistoric archaeological information could occur.

Onshore prehistoric archaeological resources include sites, structures, and objects such as shell middens, earth middens, campsites, kill sites, tool manufacturing areas, ceremonial complexes, and earthworks. At present, unidentified onshore prehistoric sites would have to be assessed after discovery to determine the uniqueness or significance of the information that they contain. Sites already listed in the National Register of Historic Places and those considered eligible for the Register have already been evaluated as having the potential for making a unique or significant contribution to science. Of the unidentified coastal prehistoric sites that could be impacted by onshore development, some may contain unique information.

Onshore development as a result of a proposed action could result in direct physical contact between construction of new onshore facilities or a pipeline landfall and a previously unidentified prehistoric site. Direct physical contact with a prehistoric site could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast region. It is assumed that 2 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action. Table 4-8 shows the projected coastal infrastructure related to OCS Program activities. Each facility projected to be constructed must receive approval from the pertinent Federal, State, county/parish, and/or community involved. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes involved. There should, therefore, be no impact to onshore CPA prehistoric sites from onshore development related to a proposed action.

Each platform location within the high-probability areas for the occurrence of historic and prehistoric archaeological resources requires archaeological clearance prior to setting the structure; therefore, removal of the structure should not result in any adverse impact to archaeological resources. This is consistent with the findings of the *Programmatic Environmental Assessment: Structural Removal Activities, Central and Western Gulf of Mexico Planning Areas* (USDOI, MMS, 1987).

Summary and Conclusion

Several impact-producing factors may threaten the prehistoric archaeological resources of the Central Gulf. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric site located on the continental shelf. The archaeological survey and archaeological clearance of sites required prior to an operator beginning oil and gas activities on a lease are expected to be highly effective (90%) at identifying possible prehistoric sites. Since the survey and clearance provide a significant reduction in the potential for a damaging interaction between an impact-producing factor and a prehistoric site, there is a very small possibility of an OCS activity contacting a prehistoric site. Should such contact occur, there would be damage to or loss of significant and/or unique archaeological information.

Onshore development as a result of a proposed action could result in the direct physical contact from new facility construction, pipeline trenching, and new navigation canal dredging. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes of the Federal, State, and local agencies involved.

A proposed action in the CPA is not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost.

4.2.1.14.Impacts on Human Resources and Land Use

This proposed action analysis considers the effects of OCS-related, impact-producing activities from a proposed CPA lease sale in relation to the continuing baseline of non-OCS-related factors. Non-OCS factors include fluctuations in workforce, net migration, relative income, oil and gas activity from State waters, wetland loss, and tropical storms. Unexpected events that may influence oil and gas activity within the analysis area but that cannot be predicted are not considered in this analysis.

4.2.1.14.1. Land Use and Coastal Infrastructure

Proposed Action Analysis

Chapters 3.3.3.3 and 3.3.3.8 discuss land use and OCS-related oil and gas infrastructure associated with the analysis area. The existing oil and gas infrastructure is expected to be sufficient to handle development associated with a proposed action. A proposed CPA lease sale would not alter the current land use of the area.

Summary and Conclusion

A proposed action in the CPA would not require additional coastal infrastructure or alter the current land use of the analysis area.

4.2.1.14.2. Demographics

In this section, MMS projects how and where future demographic changes will occur and whether they correlate with a proposed CPA lease sale. The addition of any new human activity, such as oil and gas development resulting from a proposed action, can affect local communities in a variety of ways. Typically, these effects are in the form of people and money, which can translate into changes in the local social and economic institutions and land use.

Proposed Action Analysis

Population

Population projections related to activities resulting from a proposed action are expressed as total population numbers and as a percentage of the population levels that would be expected if the proposed lease sale was not held (Tables 4-29 and 4-30). Chapter 3.3.3.4.1 discusses baseline population projections for the analysis area. Because the baseline projections assume the continuation of existing social, economic, and technological trends, they also include population changes associated with the continuation of current patterns in OCS Program activities. Population impacts from a proposed action in the CPA mirror the assumptions for employment impacts described in Chapter 4.2.1.14.3 below. Projected population changes reflect the number of people dependent on income from OCS-related employment for their livelihood, which is based on the ratio of population to employment in the analysis area over the life of a proposed lease sale. Note that Subareas LA-1, LA-2, LA-3, and MA-1 correspond to the offshore CPA; TX-1 and TX-2 correspond to the WPA; and FL-1, FL-2, FL-3 and FL-4 correspond to the EPA.

Population associated with a proposed CPA lease sale is estimated at about 14,200-20,700 persons during the peak year of impact (year 11) for the low- and the high-case scenarios, respectively. While population associated with a typical CPA lease sale as proposed is projected to peak in year 11, year 6 also displays close to peak levels of population. During the years of peak or near-peak population, a substantial amount of platform and pipeline installations are projected in association with a proposed CPA lease sale. Platform fabrication and installation, and pipeline installation activities are labor intensive and tend to occur concurrently, therefore, leading to employment and population impacts.

Population impacts from a proposed action in the CPA are expected to be minimal, i.e., less than 1 percent of total population for any coastal subarea. The mix of males to females is expected to remain unchanged. The increase in employment is expected to be met primarily with the existing population and available labor force with the exception of some in-migration (some of whom may be foreign) projected to move into focal areas, such as Port Fourchon.

Age

If a proposed CPA lease sale is held, the age distribution of the analysis area is expected to remain virtually unchanged. Given both the low levels of population growth and industrial expansion associated with a proposed action, the age distribution pattern discussed in Chapter 3.3.3.4.2 is expected to continue through the year 2040. Activities relating to a proposed action in the CPA are not expected to affect the analysis area's median age.

Race and Ethnic Composition

The racial distribution of the analysis area is expected to remain virtually unchanged if a proposed CPA lease sale is held. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the racial distribution pattern described in Chapter 3.3.3.4.3 is expected to continue through the year 2040.

Education

Activities relating to a proposed CPA lease sale are not expected to significantly affect the analysis area's educational levels. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the analysis area's education status, described in Chapter 3.3.3.4.4, is expected to continue through the year 2040. Activities relating to a proposed action in the CPA are not expected to affect the analysis area's educational attainment.

Summary and Conclusion

Activities relating to a proposed CPA lease sale are expected to minimally affect the analysis area's land use, infrastructure, and demography. These impacts are projected to mirror employment effects that are estimated to be negligible to any one subarea. Baseline patterns and distributions of these factors, as described in Chapter 3.3.3, are expected to maintain. Changes in land use throughout the analysis area are expected to be contained and minimal. The OCS-related infrastructure is in place and will not change as a result of a proposed action. Current baseline estimates of population growth for the analysis area show a continuation of growth, but at a slower rate.

4.2.1.14.3. Economic Factors

The importance of the oil and gas industry to the coastal communities of the Gulf of Mexico is significant, particularly in south Louisiana, eastern Texas, and coastal Alabama. Dramatic changes in the level of OCS oil and gas activity over recent years have resulted in parallel fluctuations in population, labor, and employment in the analysis area. The economic analysis for a proposed lease sale in the CPA focuses on the potential direct, indirect, and induced impacts of the OCS oil and gas industry on the population and employment of the counties and parishes in the analysis region defined in Chapter 3.3.3.1. To improve regional economic impact assessments and to make them more consistent with each other, MMS developed a new methodology for estimating changes to employment and other economic factors.

The methodology developed to quantify these impacts on population and employment takes into account changes in OCS-related employment, along with population impacts resulting from these employment changes within each individual subarea.

The Gulf of Mexico region model has two steps.

(1) Because there are no publicly available models that estimate the expenditures resulting from offshore oil and gas activities, the model first estimates expenditures for 10 scenario activities projected to result from a proposed action in the CPA. These activities include exploratory drilling, development drilling, production operations and maintenance, platform fabrication and installation, pipeline construction, pipeline operations and maintenance, gas processing and storage construction, gas processing and storage operations and maintenance, workovers, and platform removal and abandonment. The model then assigns these expenditures to industrial sectors in the 10 subareas defined in Chapter 3.3.3.1.

(2) The second step in the model uses multipliers from the commercial input-output model IMPLAN (using 1999 data, the latest available data) to translate these expenditures into direct, indirect, and induced employment and other economic factors. Direct employment results from the first round of industry spending. It is the employment that results from the initial dollars spent by the oil and gas industry on the 10 scenario activities (listed above). Indirect employment results as the initial spending reverberates through the economy. First, the suppliers of the goods and services for the 10 activities spend the initial direct dollars from the industry. Then, these dollars are re-spent by other suppliers until the initial dollars have trickled throughout the economy. Households spending the resulting labor income creates induced employment.

Both the level (the amount spent) and the sectoral (the industry in which it is spent) allocation of expenditures can vary considerably by the phase of OCS activity and by the water depth of the OCS activities. For example, an exploratory well in 0-60 m of water is expected to be drilled using a jack-up rig and cost about $4 million, whereas an exploratory well in 800 m or greater water depth is expected to be drilled using a drillship and to cost in excess of $10 million to complete. In addition, spending on materials such as steel will be much higher for platform fabrication and installation than for operations and maintenance once production begins. Therefore, the model estimates and allocates expenditures for the 10 scenario activities in four water-depth categories: 0-60 m, 61-200 m, 201-800 m, and >800 m. Because local economies vary, a separate set of IMPLAN multipliers is used for each coastal subarea to which expenditures are assigned. Each set of multipliers is based on the actual historical patterns of economic transactions in the area. Model results for employment are presented in the number of jobs per year, where one job is defined as a year of employment. This does not necessarily mean only one person occupies the position through out the year. One job may be equal to two part-time positions occupied over the year or one person occupying a position for 6 months, while another person occupies it for the other 6 months.

The projections in this section are not statements of what will happen but of what might happen, given the assumptions and methodologies used. The projections are business-as-usual trend forecasts, given known technology, technological and demographic trends, and current laws and regulations. Because energy markets are complex, models are simplified representations of energy production and consumption, regulations, and producer and consumer behavior. Projections are highly dependent on the data, methodologies, model structures, and assumptions used in their development. Energy projections are subject to much uncertainty. Many of the events that shape energy markets are random and cannot be anticipated, including severe weather, political disruptions, strikes, and technological breakthroughs. In addition, future developments in technologies, demographics, and resources cannot be foreseen with any degree of certainty. Given this, MMS has endeavored to make these projections as objective, reliable, and useful as possible (USDOE, EIA, 2001b).

Proposed Action Analysis

Total employment projections for activities resulting from a proposed action are expressed as absolute numbers and as a percentage of the employment levels expected if no development occurs (Tables 4-31 and 4-32). Note that coastal Subareas LA-1, LA-2, LA-3, and MA-1 correspond to the offshore CPA; Subareas TX-1 and TX-2 correspond to the offshore WPA; and Subareas FL-1, FL-2, FL-3, and FL-4 correspond to the EPA. The baseline projections of population and employment used in this analysis are described in Chapters 3.3.3.4 and 3.3.3.5 (Tables 3-12 to 3-27). Because these baseline projections assume the continuation of existing social, economic, and technological trends, they also include employment resulting from the continuation of current patterns in OCS Program activities. Population impacts, described in Chapter 4.2.1.14.2 (Tables 4-29 and 4-30), mirror those assumptions associated with employment. Projected population changes reflect the number of people dependent on income from oil- and gas-related employment for their livelihood. This figure is based on the ratio of population to employment in the impact region over the life of a proposed lease sale.

Based on model results, direct employment associated with a proposed CPA lease sale is estimated at about 4,700-6,900 jobs during peak impact year 11 for the low- and high-case scenarios, respectively. Indirect employment is projected at about 1,700-2,500 jobs, while induced employment is calculated to be about 1,900-2,800 jobs, for the low- and high-case scenarios, respectively. Therefore, total employment resulting from a proposed CPA lease sale is not expected to exceed 8,300-12,200 jobs in any given year over a proposed action's 40-year lifetime. While employment associated with a proposed CPA lease sale is projected to peak in year 11, year 6 also displays close to peak levels of employment. The projected peak years for platform and pipeline installation activities in support of a proposed action determine the periods of peak or near-peak employment. Platform fabrication and installation, and pipeline installation activities are labor intensive and tend to occur concurrently.

Although most of the employment related to a proposed action is expected to occur in Subarea TX-2, employment is not expected to exceed 1 percent of the total employment in any given subarea of Texas, Louisiana, Mississippi, or Alabama (Table 4-32). On a percentage basis, Subarea LA-1is projected to have the greatest employment impact at 0.3 percent; Subareas LA-2, LA-3, and MA-1 are projected to have the next greatest employment impacts at 0.2 percent each. Considering Florida's current opposition to oil and gas development in offshore waters and the scarcity, if not absence, of onshore supporting service bases, MMS anticipates that very few OCS-related activities will be staged from Florida. Model results concur there would be little to no economic stimulus to the Florida analysis region as a result of a proposed CPA lease sale.

Summary and Conclusion

Should a proposed CPA lease sale occur, there would be only minor economic changes in the Texas, Louisiana, Mississippi, and Alabama subareas. A proposed action is expected to generate less than a 1 percent increase in employment in any of these subareas. This demand will be met primarily with the existing population and available labor force. There would be very little to no economic stimulus in the Florida subareas.

While a proposed CPA lease sale will not significantly impact the analysis area, OCS activities from past and future OCS lease sales will continue to occur and impact the analysis area. In other words, even if a proposed action were not held, there would still be impacts from past and future OCS lease sales in the analysis area. The OCS-related impacts will continue even in the absence of a proposed action.

4.2.1.14.4. Environmental Justice

The analysis of environmental justice concerns is divided into those related to routine operations (below) and those related to oil spills (Chapter 4.4.3.14.2). Concerns related to routine operations center on increases in onshore activity (such as employment, migration, commuter traffic, and truck traffic) and on additions to the infrastructure supporting this activity (such as fabrication yards, supply ports, and onshore disposal sites for offshore waste). Chapter 3.3.3.5 describes the widespread presence of an extensive OCS support system and associated labor force, as well as economic factors related to OCS activities. The MMS estimates that production from a proposed action in the CPA will be 0.276-0.654 BBO and 1.590-3.300 tcf of gas.

Proposed Action Analysis

Environmental justice issues involve questions of disproportionate and negative effects on minority and low-income populations. A proposed action in the CPA is expected to increase slightly employment opportunities in a wide range of businesses along the Gulf Coast. These conditions preclude a prediction of where much of this employment will occur or who will be hired. Figures 3-15 and 3-16 provide distributions of census tracts of high concentrations of minority groups and low-income households. As stated in Chapter 3.3.3.11, pockets of concentrations of these populations are scattered throughout the Gulf of Mexico coastal counties and parishes. Many of these populations are in large urban areas where the complexity and dynamism of the economy and labor force preclude a measurable effect. Low-income populations are almost exclusively minority and urban. Because the distribution of low-income and minority populations does not parallel the distribution of industry activity, effects of a proposed action are not expected to be disproportionate.

The widespread economic effects of a proposed action on minority and low-income populations are not expected to be negative. Ongoing MMS research includes gathering information on race and employment. Offshore workers in the production sector are almost entirely male and white (Rosenberg, personal communication, 2001). Other sectors, such as the fabrication industry and support industries (e.g., trucking), employ minority workers and provide jobs across a wide range of pay levels and educational/skill requirements (Austin et al., 2002a and b; Donato et al., 1998). A study of oil industry trends between 1980 and 1990 found that downsizing was concentrated in the production sector; therefore, it affected white male employment more than that of women or minorities (Singelmann, in press). Evidence also suggests that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations. One MMS study in Louisiana found income inequality decreased during the oil boom and increased with the decline (Tolbert, 2001). Another MMS-funded study found that reemployment rates for poorly educated black and white women laid off in the closing of an OCS-related plant in one rural town were much higher than reemployment rates related to similar closings elsewhere because Louisiana's oil industry had created a complex local economy (Tobin, 2001). While a proposed action will provide little additional employment, it will have the effect of maintaining current activity levels, which is expected to be beneficial to low-income and minority populations.

Environmental justice often concerns the possible siting of infrastructure in places that will have disproportionate and negative effects on minority and low-income populations. Since a proposed action will help to maintain ongoing levels of activity rather than expand them, no one proposed lease sale will generate significant new infrastructure demand. For this reason, this EIS considers infrastructure projections only for the cumulative analysis (Chapter 4.4.3.14.4). The cumulative analysis concludes that, as with the analysis of employment effects of a proposed action, infrastructure effects are expected to be widely and thinly distributed. Since the siting of new infrastructure will reflect the distribution of the petroleum industry and not that of minority and low-income populations, the OCS activity in the CPA is not expected to disproportionately effect these populations. Again, Lafourche Parish is identified as a location of more concentrated effects. Each OCS-related facility constructed onshore must first receive approval by the relevant Federal, State, county or parish, and community involved, and MMS assumes that new construction will be approved only if consistent with appropriate land-use plans, zoning regulations, and other State/regional/local regulatory mechanisms.

Because of Louisiana's extensive oil-related support system (Chapter 3.3.3.5.1), that State is likely to experience more employment effects related to a proposed action in the CPA than are the other coastal states. Lafourche Parish, Louisiana, is likely to experience the greatest concentration and is the only parish where the additional OCS-related activities and employment are sufficiently concentrated to increase stress to its infrastructure. Even so, the effects of a proposed action are not expected to be significant in the long term.

The concentrated socioeconomic impacts in Lafourche Parish are not expected to have disproportionate effects on minority and low-income populations for several reasons. The parish is not predominately minority or low income (Figures 3-15 and 3-16). The Houma, a Native American tribe recognized by the State of Louisiana, have been identified by MMS as a possible environmental justice concern. The MMS is currently funding a study focused on Lafourche Parish and the Houma, although available information indicates that the Houma are not expected to be disproportionately affected because they are not residentially segregated but, rather, live interspersed among the nonminority population (Fischer, 1970).

Two local infrastructure issues described in Chapter 3.3.3.2 could possibly have related environmental justice concerns—traffic on LA Hwy. 1 and the Port Fourchon expansion. The most serious concern raised during scoping for this multisale EIS is the high-level of traffic on LA Hwy. 1. Increased traffic may have health risks (e.g., increased accident rates). As described in Chapter 3.3.3.1, human settlement patterns in the area (on high ground along LA Hwy. 1 and Bayou Lafourche) mean that rich and low-income alike would be affected by any increased traffic. Port Fourchon is relatively new and is surrounded by mostly uninhabited land. Existing residential areas close to the port are also new and not considered low-income areas. Any expansion of infrastructure at Port Fourchon is not expected to disproportionately affect minority or low-income populations. Lafourche Parish is an area of relatively low unemployment because of the concentration of petroleum-related industry in the area (Hughes, in press). While the minority and low-income populations of Lafourche Parish will share with the rest of the parish population any negative impacts related to a proposed action in the CPA, most effects related to a proposed action would be economic and positive.

Summary and Conclusion

Because of the existing extensive and widespread support system for OCS-related industry and associated labor force, the effects of a proposed action in the CPA are expected to be widely distributed and little felt. In general, who will be hired and where new infrastructure might be located is impossible to predict. Impacts related to a proposed action are expected to be economic and have a limited but positive effect on low-income and minority populations. Given the existing distribution of the industry and the limited concentrations of minority and low-income peoples, a proposed action is not expected to have a disproportionate effect on these populations.

Lafourche Parish will experience the most concentrated effects of a proposed action; however, because the Parish is not heavily low-income or minority, because the Houma are not residentially segregated, and because the effects of road traffic and port expansion will not occur in areas of low-income or minority concentration, these groups will not be differentially affected. In general, the effects in Lafourche Parish are expected to be mostly economic and positive. A proposed action would help to maintain ongoing levels of activity rather than expand them. Future changes in activity levels will most likely be caused by fluctuations in oil prices and imports, and not by activities related to a proposed action. A proposed action is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people.

4.2.2. Alternative B – The Proposed Actions Excluding the Blocks Near Biologically Sensitive Topographic Features

Description of the Alternative

Alternative B differs from Alternative A (proposed action) by not offering the 34 unleased blocks of the 167 total blocks that are possibly affected by the proposed Topographic Features Stipulation (Chapter 2.3.1.3.1). All of the assumptions (including the two other potential mitigating measures) and estimates are the same as for a proposed action (Alternative A). A description of Alternative A is presented in Chapter 2.3.1.1.

The Federal offshore area is divided into subareas based on water depths in meters (C0-60, C60-200, C200-800, C800-1600, C1600-2400, and C>2400), and the adjacent coastal region is divided into four coastal subareas (LA-1, LA-2, LA-3, and MA-1). These subareas are delineated on Figure 4-1.

Effects of the Alternatives

The following analyses are based on the scenario for a proposed action in the CPA (Alternative A). The scenario provides assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. These are estimates only and not predictions of what will happen as a result of holding a proposed sale. A detailed discussion of the scenario and related impact-producing factors is presented in Chapter 4.1.

The analyses of impacts to the various resources under Alternative B are very similar to those for Alternative A. The reader should refer to the appropriate discussions under Alternative A for additional and more detailed information regarding impact-producing factors and their expected effects on the various resources. Impacts under Alternative B are expected to be the same as those under a typical proposed action in the CPA (Chapter 4.2.1) for the following resources:

–Sensitive Coastal Environments
–Sensitive Offshore Resources
–Live Bottoms (Pinnacle Trend)
–Deepwater Benthic Communities
–Water Quality
–Air Quality
–Marine Mammals
–Alabama, Choctawhatchee, and Perdido Key Beach Mice
–Coastal and Marine Birds
–Gulf Sturgeon
–Fish Resources and Essential Fish Habitat
–Commercial Fisheries
–Recreational Beacheshes
–Archaeological Resources
–Socioeconomic Conditions

The impacts to some Gulf of Mexico resources under Alternative B would be different from the impacts expected under a proposed action. These impacts are described below.

Impacts on Sensitive Offshore Resources

Topographic Features

The sources and severity of impacts associated with this alternative are those sale-related activities discussed for a proposed action. As noted in Chapter 4.2.1.2.2, the potential impact-producing factors to the topographic features of the Central Gulf are anchoring and structure emplacement, effluent discharge, blowouts, oil spills, and structure removal. A more detailed discussion of these potential impact-producing factors is presented in Chapter 4.2.1.2.2.

All of the 16 topographic features of the Central Gulf are located within water depths less than 200 m. These features occupy a very small portion of the entire area. Of the potential impact-producing factors that may affect the topographic features, anchoring, structure emplacement, and structure removal will be eliminated by the adoption of this alternative. Effluent discharge and blowouts will not be a threat to the topographic features because blocks near enough to the banks for these events to have an impact on the biota of the banks will have been excluded from leasing under this alternative. Thus, the only impact-producing factor remaining from operations in blocks included in this alternative (i.e., those blocks not excluded by this alternative) is an oil spill. The potential impacts from oil spills are summarized below and are discussed further in Chapter 4.4.3.2.2.

A subsurface spill would have to come into contact with a biologically sensitive feature to have an impact. The chance of one or more subsurface pipeline spills ≥1,000 bbl occurring in the Central Gulf is 32-59 percent. The chance of a substantial amount of oil being release during a blowout is less than 8 percent. A subsurface spill is expected to rise to the surface, and any oil remaining at depth will be swept clear of the banks by currents moving around the banks (Rezak et al., 1983). Deepwater subsurface spills may travel along the sea bottom or in the water column for some distance before rising to the surface. The fact that the topographic features are widely dispersed in the Central Gulf, combined with the random nature of spill events, would serve to limit the likelihood of a spill occurring proximate to a topographic feature. Chapter 4.4.1.1.8 discussed the risk of spills interacting with topographic features, especially the Flower Garden Banks, in more detail. The currents that move around the banks will likely steer any spilled oil around the banks rather than directly upon them, lessening impact severity. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for most of the adult sessile biota. Lethal effects would probably be limited to a few coral colonies (in the case of the Flower Garden Banks National Marine Sanctuary) (CSA, 1992b and 1994). It is anticipated that recovery from a mostly sublethal exposure would occur within a period of 2 years. In the unlikely event that oil from a subsurface spill contacted a coral-covered area (in the case of the Flower Garden Banks), the areal extent of coral mortality would be limited, but long-lasting sublethal effects may be incurred by organisms surviving the initial effects of a spill (Jackson et al., 1989). Indeed, the stress resulting from the oiling of reef coral colonies could affect their resilience to natural disturbances (e.g., elevated water temperature, diseases) and may hamper their ability to reproduce. A complete recovery of such an affected area could take in excess of 10 years.

Conclusion

Alternative B is expected to cause little or no damage to the physical integrity, species diversity, or biological productivity of the habitats of the topographic features. In the unlikely event that oil from a subsurface spill contacts the biota of a topographic feature, the effects would be localized and primarily sublethal for most of the adult sessile biota. Some lethal effects would probably occur upon oil contact to coral colonies (in the case of the Flower Garden Banks National Marine Sanctuary); recovery from such an event is anticipated to occur within a period of 2 years.

Impacts on Sea Turtles

The level of activity associated with Alternative B is the same as the infrastructure and activity described for a proposed action (Chapter 4.1 and Table 4-2). The sources and severity of impacts to sea turtles under Alternative B are the same as under a proposed action (Chapter 4.2.1.6). The major impact-producing factors related to Alternative B that may affect Gulf sea turtles, including structure installation, dredging, operational discharges, and explosive platform removals, would not occur within the area excluded under Alternative B. The effects of these activities would occur in the remainder of the CPA and are expected to be primarily nonlethal, with few lethal impacts; the probability of an interaction is low.

Conclusion

Alternative B is expected to temporarily disturb some sea turtles and their habitats; however, it is unlikely to have significant long-term adverse effects on the size and productivity of any turtle species or population stock in the northern Gulf of Mexico.

4.2.3. Alternative C — The Proposed Action Excluding Unleased Blocks within 15 Miles of the Baldwin County, Alabama, Coast

Description of the Alternative

Alternative C differs from Alternative A (a proposed action) by not offering any unleased blocks within 15 mi of the Baldwin County, Alabama, coast (as of January 1997, 6 blocks were unleased). All the assumptions (including potential mitigating measures) and estimates are the same those under Alternative A (Chapters 2.3.1.3 and 4.1.1). A description of Alternative A is presented in Chapter 2.3.1.1.

The Federal offshore area is divided into subareas based on water depths in meters (C0-60, C60-200, C200-800, C800-1600, c1600-2400, and C>2400). The coastal region adjacent to the area considered under Alternative C is designated coastal Subarea MA-1. These subareas are delineated on Figure 4-1.

Effects of the Alternatives

The following analyses are based on the scenario for a proposed action in the CPA (Alternative A). A detailed discussion of the scenario and related impact-producing factors is present in Chapter 4.1.

The analyses of impacts to the various resources under Alternative C are very similar to those for Alternative A. The reader should refer to the appropriate discussions under Alternative A for additional and more detailed information regarding impact-producing factors and their effects on the various resources. Impacts are expected to be the same as those estimated under a typical proposed action in the CPA (Chapter 4.2.1) for the following resources:

–Sensitive Coastal Environments
–Sensitive Offshore Resources
–Live Bottoms (Pinnacle Trend and Topographic Features)
–Deepwater Benthic Communities
–Air Quality
–Marine Mammals
–Alabama, Choctawhatchee, and Perdido Key Beach Mice
–Coastal and Marine Birds
–Gulf Sturgeon
–Commercial Fisheries
–Socioeconomic Conditions

Impacts to some Gulf of Mexico resources would be different from the impacts of a proposed action. These impacts are described below.

Impacts on Water Quality

Bottom-area disturbance resulting from platform emplacement and removal, drilling activities, and blowouts result in some level of increased water-column turbidity in overlying offshore waters. Generally, each of these operations has been shown to produce localized, temporary impacts on water quality conditions in the immediate vicinity of the emplacement operation (Chapter 4.1.1.3.2). Alternative C would eliminate impacts associated with platform emplacement in the areas within 15 mi off the coast of Baldwin County, Alabama.

The oil-spill events related to a proposed action under Alternative A were projected to be mostly very small events, to be very infrequent for spills greater than 50 bbl, to have effects for only a short-duration (from a few days to three months), and to affect only a small area of offshore waters at any one time (Chapter 4.4). These events would not be eliminated as a result of Alternative C. The risk of spills due to exploration and development would be eliminated within the deferral area.

Conclusion

Bottom disturbances from platform emplacements and removals, drilling activities, and blowouts would not occur within the excluded area under Alternative C. Localized, temporary impacts to water quality due to sediment resuspension would be eliminated in the area within 15 miles of the Baldwin County coast, if Alternative C is adopted. Additionally, the risk of oil-spill impacts would be slightly reduced as exploration and development operations would not occur in the excluded area.

Impacts on Sea Turtles

The major impact-producing factors that may affect Gulf sea turtles, including structure installation, dredging, operational discharges, and explosive platform removals, would not occur within the excluded area. The effects of these activities would occur in the remainder of the CPA and are expected to be primarily nonlethal, with few lethal impacts; the probability of an interaction is low.

Conclusion

Alternative C is expected to temporarily disturb some sea turtles and their habitats, but deaths are expected to be rare. All disturbances are expected to be temporary, and sea turtles are expected to recover from within a period of weeks to months.

Impacts on Archaeological Resources

As a result of a typical proposed action in the CPA, Federal waters offshore Alabama were assumed to have new exploration, delineation, and development wells drilled. There would be platform installations and pipelines laid in the area. The location of any proposed activity within a lease block that has a high probability for historic shipwrecks requires archaeological clearance prior to operations. The probability of an OCS activity contacting and damaging a shipwreck is low; the required clearance measures are considered to be 90 percent effective at protecting potential unknown historic shipwrecks. If an OCS structure did contact a historic resource, unique archaeological information contained within a site or resource could be lost. Under Alternative C, drilling activities and installation of platforms within

15 mi of the shoreline of Baldwin County, Alabama, would not occur. Any potential impacts from drilling activities or platform emplacement to historic shipwrecks would be eliminated in OCS blocks within 15 mi of the Baldwin County shoreline.

Conclusion

The probability of an OCS activity contacting and damaging a shipwreck is low because of existing mitigation in the form of archaeological clearance requirements for proposed activities. Alternative C would eliminate the potential for impacts from drilling or platform emplacement to historic archaeological resources within the area excluded under Alternative C.

Impacts on Recreational Beaches

The major impact-producing factors that could potentially affect recreational beaches include the presence of offshore structures, pipelaying activities, support helicopter and vessel traffic, trash and debris, and oil spills. Exploratory rig activity and platforms associated with OCS development activity could be viewed from coastal communities along the Gulf of Mexico when they are closer than approximately 10 mi from shore; beyond that, structures appear very small and barely discernable to the naked eye, eventually disappearing from view. Alternative C would exclude those blocks within 15 mi of the shoreline from leasing. No OCS structures would be constructed within the excluded area. Any visual impact due to OCS structures in the area off Baldwin County, Alabama, would be eliminated. Pipelaying activities, support helicopter and vessel traffic, trash and debris, and oil spills from the remaining areas offered from lease would continue to present potential impacts to recreational beaches.

Conclusion

Alternative C would exclude blocks within 15 mi of the Baldwin County, Alabama, coast from leasing. No OCS structures would be constructed within the excluded area. Therefore, any visual impact due to OCS structures in the area off Baldwin County would be eliminated.

4.2.4. Alternative D — No Action

Description of the Alternative

Alternative D is equivalent to cancellation of a sale scheduled for a specific period in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007.* The OCS lease sales in the Central Gulf are scheduled on an annual basis. By canceling a proposed Central Gulf sale, the opportunity is postponed or foregone for development of the estimated 0.276-0.654 billion barrels of oil (BBO) and 1.590-3.300 trillion cubic feet (tcf) of gas.

Effects of the Alternative

Under Alternative D, the U.S. Dept. of the Interior cancels a planned Central Gulf of Mexico sale. Therefore, the oil expected from a sale would remain undiscovered and undeveloped. The environmental effects of Alternative A (proposed action) also would not occur. Other sources of energy would need to substitute for the lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have significant environmental impacts of their own.

This section briefly discusses the most likely alternative sources, the quantities expected to be needed, and the environmental impacts associated with the alternatives. The discussion is based on material from the following MMS publications: *Proposed Final Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002, Decision Document* (USDOI, MMS, 1996a); *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002, Final Environmental Impact Statement* (USDOI, MMS, 1996b); and *Energy Alternatives and the Environment* (USDOI, MMS, 2001f). These sources are incorporated into this document by reference.

Most Important Substitutes for Production Lost Through No Lease Sale

Energy Alternatives and the Environment discusses a long list of potential alternatives to natural gas and oil. However, most substitutes for the natural gas and oil from the sale will come from four sources:

- additional imports;
- conservation;
- additional domestic production; and
- fuel switching.

Additional domestic production and imports will augment supply, while conservation and switching to alternative fuels shift demand downward. The table below shows the percentage and range of quantities expected to be needed to substitute for the lost natural gas and oil production. The quantities for conservation and fuel switching are in equivalent energy units.

Substitutes for Natural Gas and Oil Lost Because of No Lease Sale

Source	Percent of Lost Oil Production	Range of Oil Quantity (MMbbl)	Percent of Lost Gas Production	Range of Gas Quantity (Bcf)
Additional Imports	88%	134-385	12%	184-527
Conservation	5%	8-22	14%	214-615
Additional Domestic Production	4%	6-18	41%	627-1,800
Fuel Switching	3%	5-13	33%	505-1,449
Total Production Lost through No Sale	100%	153-438	100%	1,530-4,391

Environmental Impacts from the Most Important Substitutes

Additional Imports: Significant environmental impacts from an increase in oil imports include the following:

- generation of greenhouse gases and air pollutants from both transport and dockside activities (emissions of NO_x, SO_x, and VOC's have an impact on acid rain, tropospheric ozone formation, and stratospheric ozone depletion);
- degradation of water quality from oil spills related to accidental discharges or tanker casualties;
- oil-spill contact with flora, fauna, or recreational and scenic land and water areas; and
- increasing public concern about increasing imports of foreign oil and the potential for unauthorized interdiction or terrorist attacks on oil tankers..

Imported oil may also impose negative environmental impacts in producing countries and in countries along trade routes. Additional imports of natural gas would require construction of new pipelines from the most likely sources—Canada and Mexico. Pipeline construction can disrupt wildlife habitat, lead to increased erosion, and add to the siltation of streams and rivers.

Conservation: Conservation is composed of two major components:

- substituting energy-saving technology, often embodied in new capital equipment, for energy resources (e.g., adding to home insulation); and
- consuming less of an energy-using service (e.g., turning down the thermostat in an office during the winter)

Consuming less of an energy service is positive from an environmental perspective. Substituting energy-saving technology will tend to result in positive net gains to the environment. The amount of gain will depend on the extent of negative impacts from capital equipment fabrication.

Additional Domestic Production: Onshore oil and gas production has notable negative impacts on surface water, groundwater, and wildlife. It can also cause negative impacts on soils, air pollution, vegetation, noise, and odor. Offshore oil and gas production imposes the risk of oil spills affecting water quality, localized degradation of air quality, potential impacts on coastal wetlands dependent wildlife, and shoreline erosion from additional supply boat traffic. Offshore activities may also have negative impacts on social, cultural, and economic measures such as recreation.

Fuel Switching: The most likely substitutes for natural gas are oil, which will further increase imports, and coal for use in electricity generation. Coal mining causes severe damage to land and wildlife habitat. It also is a major contributor to water quality deterioration through acid drainage and siltation. Alternative transportation fuels may constitute part of the oil substitution mix. The mix depends on future technical and economic advances. No single alternative fuel appears to have an advantage at this time. Every fuel alternative imposes its own environmental effects.

Other Substitutes

Government could also impose other substitutes for natural gas and oil. The most likely sectors to target would be transportation, electricity generation, or various chemical processes. *Energy Alternatives and the Environment* discusses many of the alternatives at a level of detail impossible here.

Summary and Conclusion

Canceling a sale would eliminate the effects described for Alternative A (Chapter 4.2.1). Other sources of energy would substitute for the lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have significant environmental impacts of their own.

4.3. Environmental Impacts of the Proposed Western Gulf Sales and Alternatives

4.3.1. Alternative A — The Proposed Actions

The proposed actions are proposed Western Gulf Lease Sales 187, 192, 196, and 200. The sales are scheduled to be held annually in August 2003 through 2006. Each sale will offer for lease all unleased blocks in the Western Planning Area (WPA). It is estimated that each proposed sale could result in the discovery and production of 0.136-0.262 billion barrels of oil (BBO) and 0.810-1.440 trillion cubic feet (tcf) of gas during the period 2003-2042. A description of the proposed actions is included in Chapter 2.4. Alternatives to the proposed actions and mitigating measures are also described in Chapter 2.4.

The analyses of the potential impacts are based on a scenario for a typical proposed action. These scenarios provide assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenarios and major impact-producing factors from routine activities associated with a proposed action is included in Chapters 4.1 and 4.2. The three proposed mitigating measures (Topographic Features, Military Areas, and Naval Mine Warfare Areas Stipulations) are considered part of the proposed action(s) for analysis purposes.

The scenario and analysis of potential impacts of oil spills and other accidental events are discussed in Chapter 4.4. The Gulfwide OCS Program and cumulative scenarios are discussed in Chapters 4.1, 4.2, and 4.3. The cumulative impact analysis is presented in Chapter 4.5.

4.3.1.1. Impacts on Sensitive Coastal Environments

Impacts to the general vegetation and physical aspects of coastal environments by activities resulting from a proposed action in the WPA are considered in Chapters 4.3.1.1.1, 4.3.1.1.2, and 4.3.1.1.3.

Potential impacts to barrier islands seaward of the barrier-dune system are considered in the coastal barrier beaches and associated dunes analysis. Potential impacts to barrier islands landward of the barrier-dune system are considered in the wetlands analysis. Impacts to animals that use these environments, the recreational value of beaches, and archaeological resources found there are described in impact analysis sections for those specific resources.

The major, nonaccidental, impact-producing factors associated with a proposed action that could affect these environments include navigational traffic, maintenance dredging of navigational canals, and construction and expansions of navigational canals, port facilities, processing facilities, pipelines, and pipeline-support facilities. The MMS has no direct regulatory authority over potential impact-producing factors or mitigation activities that may occur or be needed in the States' coastal zones.

4.3.1.1.1. Coastal Barrier Beaches and Associated Dunes

This section considers impacts from a proposed action in the WPA to the physical shape and structure of barrier beaches and associated dunes. The major impact-producing factors associated with a proposed action that could affect barrier beaches and dunes include pipeline emplacements, navigation channel use and dredging, and use and construction of support infrastructure in these coastal areas.

Pipeline landfall sites on barrier islands could accelerate beach erosion and island breaching. Studies have shown that little to no impact to barrier beaches results from pipeline landfalls employing modern installation techniques, such as directional boring (Wicker et al., 1989; LeBlanc, 1985; Mendelssohn and Hester, 1988).

Navigation channels through the sandbars at the mouths of flowing channels generally capture and remove sediments from the longshore sediment drift, if the cross-sectional area of the channel is too large for natural tidal and storm exchanges to keep swept clear. Periodic maintenance dredging is expected in existing OCS-related navigation channels through barrier passes and associated bars. Jetties designed to reduce channel shoaling and maintenance dredging of bar channels affect the stability of barrier beaches and dunes if those jetties or bar channels serve as sediment sinks that intercept sediment in longshore drift. Materials from maintenance dredging of bar and pass channels are typically discharged to nearby, ocean dump sites in the Gulf (Chapter 4.1.3.2.1.). This dredging usually removes sediment from the littoral sediment drift or routes it around the beach immediately downdrift of the involved channel. Placement of dredged material in shallow coastal waters forms sandbars that can impair coastal navigation.

Adverse impacts of navigational channels can be mitigated by discharging dredged materials either onto barrier beaches or strategically into longshore sediment currents, downdrift of maintained channels. Adverse impacts of sediment sinks created by jetties can be further mitigated by reducing the jetty length to the minimum needed and by filling the updrift side of the jetty with appropriate sediment. Sediment traps that are created by dredging artificially large bar channels may be mitigated by reassessing the navigational needs of the port and reducing the depth of the channel, if the present depth is not needed. Mitigating adverse impacts should be addressed in accordance with requirements set forth by the appropriate Federal and State permitting agencies.

No onshore infrastructure used to support OCS operations has been constructed recently on barrier beaches in Texas or Louisiana, except for pipeline landfalls. The use of some existing facilities in support of a proposed action and subsequent lease sales in the WPA may extend the useful lives of those facilities. During that extended life, erosion-control structures may be installed to protect a facility. Although these measures may initially protect the facility as intended, such structures may accelerate erosion elsewhere in the vicinity. They may also cause the accumulation of sediments updrift of the structures, sediments that might have alleviated erosion downdrift of the structure. These induced erosion impacts would be most damaging locally. In Louisiana where the sediment supply is critically low, these impacts may be distributed much more broadly. These impacts will last as long as the interruption of the sediment drift continues, which may continue after the structure is removed if the hydrodynamics of the area are permanently modified.

Expansions of existing facilities located on barrier beaches or in associated dunes would cause loss and disturbance of additional habitat.

Abandoned facility sites must be cleared in accordance with Federal, State, and local governmental and landowner requirements. All materials and structures that would impair or divert sediment drift among the dunes and on the beach must be removed.

Proposed Action Analysis

No new coastal infrastructure is projected to be built on barrier beaches and dunes. Zero to one pipeline landfalls are projected as a result of a proposed action in the WPA. Should one be constructed, it will most likely be in coastal Subarea TX-2, where the large majority of the pipelines from the WPA come ashore. Such a landfall may occur in the immediate vicinity of a barrier beach and associated dunes. Wherever a landfall occurs, permitting processes encourage the use of directional boring technology to greatly reduce and perhaps eliminate impacts to barrier beaches or dunes.

No new navigation channels are expected to be dredged as a result of a proposed action or OCS Program activities in the WPA. No deepening of existing navigation channels is expected as a result of a proposed action. Current channel depths in Texas are adequate to accommodate activities expected to result from a proposed action.

The average contribution of a proposed action to vessel traffic in navigation canals is expected to be small (less than 1%). Correspondingly, the percentage of beach erosion caused by interrupted littoral sediment drift by channels and their jetties as a result of a proposed action would be very low.

Summary and Conclusion

The 0-1 pipeline landfalls projected in support of a proposed action are not expected to cause significant impacts to barrier beaches because of the use of nonintrusive installation methods. Existing facilities originally built inland may, through natural erosion and shoreline recession, be located in the barrier beach and dune zone and contribute to erosion there. A proposed action may contribute to the continued use of such facilities.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which combined with channel jetties, generally causes minor and very localized impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. Based on use, a proposed action would account for a very small percentage of these impacts, which would occur whether a proposed action is implemented or not.

In conclusion, a proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. A proposed action may extend the life and presence of facilities in eroding areas, which can accelerate erosion there. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

4.3.1.1.2. Wetlands

The Texas Gulf Coast is comprised of a broad range of saline, brackish, intermediate, and fresh marsh wetlands, including wet prairies, forested wetlands, barrier islands, mud flats, estuarine bays, bayous, and riparian wooded areas. Saline and brackish marshes are most widely distributed south of the Galveston Bay area, while intermediate marshes are the most extensive marsh type east of Galveston Bay. The most extensive wetlands along the Texas coast are located in the Strandplain-Chenier Plain System that runs from eastern Chambers County, Texas, through Vermilion Parish, Louisiana.

The OCS oil and gas activities that could potentially impact these wetland types and their associated habitats include pipeline emplacement (construction and maintenance), new and maintenance dredging of navigation channels and canals, vessel usage of navigation channels, and construction and maintenance of inshore facilities. Other potential impacts that are indirectly associated with OCS oil and gas activities are wake erosion resulting from navigation traffic and additional onshore development encouraged by increased capacities of navigation channels.

Pipelines

Most disturbances associated with pipeline construction (Chapter 4.1.2.1.7) are expected to result in temporary adverse impacts that are expected to be partially corrected after approximately 6 years (Tabberer et al., 1985; Wicker et al., 1989). Pipelines can be emplaced using a variety of techniques, which, with incorporation of mitigation measures, can influence the extent of impact to the environment. The two major emplacement techniques used historically in wetland environments are the push-pull ditch and the flotation canal methods.

A WPA proposed action will potentially contribute to approximately 1 percent of overall impacts to wetlands and associated coastal habitats by OCS-related coastal pipeline implementation and required maintenance of those installations. As previously discussed in Chapter 4.1.1.3.8.1, petroleum reservoirs in deepwater areas might require their own pipeline landfall. The projected numbers of coastal pipeline installations and the projected lengths of coastal pipelines related to a proposed action are presented Table 4-13.

A major concern associated with pipeline construction is disturbance caused by backfilling. Pipeline canals are backfilled with the materials originally dredged while digging the canal. The major factors determining the success of backfilling as a means of restoration are the depth of the canal, soil type, canal dimensions, locale, dredge operator skill, and permitting conditions (Turner et al., 1994). Plugging the canal has no apparent effect on water depth or vegetation cover, with one exception—submerged aquatic vegetation was more frequently observed behind backfilled canals with plugs than in backfilled canals without plugs. Canal length and percentage of backfill returned has the greatest effect on the recovery of vegetation cover (Turner et al., 1994). While investigating backfilling canals as a wetland restoration technique in coastal Louisiana, Turner et al. (1994) discovered that canals backfilled as mitigation for dredging done at another location are typically more shallow if they are older or in soils lower in organic matter. Vegetation recovery increases with an increased canal length and percentage of material returned. In areas where soils have high organic content, as in deltaic plains or the Chenier Plain, backfilling does not usually fill a canal completely.

The extent of impact from the push-pull ditch technique also may be influenced by whether the ditch is backfilled and/or dammed. Dredge deposits associated with push-pull ditches are considerably less than those with flotation canals, but both have potential for impact related to the configuration of the deposits of dredge materials. For both flotation and push-pull canals, a double-ditching technique can be used to ensure that the top soil is placed on top when the site is backfilled. This expedites revegetation and lessens the potential for detrimental impacts such as land loss due to erosion along the unvegetated right-of-way.

The real loss of wetland habitat is difficult to determine because it depends on the pipeline emplacement technique used, amount of backfilling, time of year, and duration of construction. After pipelines are constructed and backfilled in Texas wetlands, a shallow channel is expected to remain where the canal passes through the wetland; after backfilling in the coastal subareas of Louisiana, some open-water areas may remain. Approximately six years after backfilling has occurred, productivity of vegetation in areas directly over the pipeline is expected to be reduced. It is estimated that wetland habitat could be reduced by as much as 25 percent in Texas. For the same period of time (approximately six years), productivity of vegetation in a 2- to 3-m-wide strip of wetland on either side of the pipeline is expected to be reduced as much as 11 percent in Texas. A substantial number of new OCS pipelines that cross the offshore Federal/State boundary do not come ashore directly but rather link up to previously existing pipelines that already make landfall; hence, no landfall or onshore pipeline construction will result (Chapter 4.1.2.1.7).

Secondary impacts of pipeline channels can be even more damaging to coastal wetlands and associated habitats than the primary impacts (Tabberer et al., 1985). Secondary impacts include expansion of tidal influence, saltwater intrusion, hydrodynamic alteration, erosion, sediment export, flank subsidence, and habitat conversion. During reviews of pipeline projects for Federal and State permits, agencies consistently comment with concern upon the extent of these secondary impacts. As a result, structures engineered to mitigate secondary adverse impacts are included as permit requirements. The number of OCS-related mitigative structures around the Gulf is unknown.

Frequently, the lack of maintenance of structures used to mitigate adverse impacts of pipeline construction allows the structures to deteriorate and eventually fail. Consequently, the indirect and adverse impacts upon wetlands that the structures were designed to prevent or mitigate could resume and possibly proceed at an accelerated rate. No known effort has been made to document the frequency or extent of these failures or the severity of the resulting impacts.

The widening of pipeline canals over time is one of the more obvious secondary impacts. Craig et al. (1980) studied a series of canals in Louisiana and determined that the canals widened at rates of 2-14 percent per year. Dead-end canals with little traffic or significant flow were shown to widen at rates within this range. Based on the 1980 study due to their shallow nature, OCS-related pipeline canals are expected to widen at an average rate of about 4 percent per year.

The MMS is presently conducting a study in conjunction with USGS Biological Resources Division to investigate coastal wetland impacts from the widening of OCS-related pipeline canals and the effectiveness of mitigation. For a proposed action in the WPA, 0-1 pipeline landfalls are projected. Up to 40 km of onshore pipeline are projected to be constructed in coastal Texas and western coastal Louisiana in support of a proposed action in the WPA. In Subareas TX-1 and TX-2, about 25 percent of each pipeline is assumed to occur in wetlands. Associated canals through wetlands will probably widen by 4 percent each year.

The MMS is presently conducting a study in conjunction with USGS-BRD to investigate coastal wetland impacts from the widening of OCS-related canals rates and the effectiveness of mitigation. At present, there is no known study addressing the effectiveness or longevity of canal-related mitigation. Also, MMS is currently identifying and mapping onshore OCS-related pipelines in the coastal regions around the Gulf including those in wetland habitats in Kenedy, Aransas, Calhoun, Matagorda, Brazoria, Galveston, and Orange Counties of Texas. With the OCS pipelines identified, this study will provide basic information for environmental impact assessments and for mitigation development by MMS and other Federal agencies.

Dredging

No new navigational channels are expected to be dredged as a result of a proposed action in the WPA. An increase in OCS deepwater activities, which require larger service vessels for efficient operations, is expected. This may shift some deepwater support activities to shore bases associated with deeper channels. Some of the ports that have navigation channels that can presently accommodate deeper-draft vessels may expand port facilities to accommodate these deeper-draft vessels, e.g., Port of Galveston.

Dredging and dredged-material disposal can be detrimental to coastal wetlands and associated fish and wildlife that use these areas for nursery grounds, protection, etc. Periodic maintenance dredging of navigation channels results in additional deposits material on existing dredged-material disposal banks; the effects of dredged-material disposal banks on wetland drainage is expected to continue unchanged, although there may be some localized and minor aggravation of existing problems. Typically, some material intended for placement on a dredged-material disposal bank is placed in adjacent wetlands or shallow water. Wetland loss due to dredge material deposition is expected to be offset by wetland creation as adjacent margins of shallow water are filled. In both cases, areas impacted are considered small. Maintenance dredging will also temporarily increase turbidity levels in the vicinity of the dredging and disposal of materials, which can impact emergent wetlands, seagrass communities and associated habitats. Two different methods are generally used to dredge and transport sediments from channels to open-water sites: (1) hydraulic cutterhead suction dredge transfers sediments via a connecting pipelines; and (2) clamshell bucket dredge transfers sediments via towed bottom-release scows. Each method produces a distinctly different deposit. Hydraulic dredging creates a slurry of sediment and water, which is pumped through a pipeline to the dredged material disposal site. Coarser sediment settles to the bottom where it spreads outward under the force of gravity; finer sediments may remain in suspension longer. The clamshell dredge scoops sediments relatively intact into scows, which are then towed to the designated area. The dredged sediments are released into the area specified for disposal. This method usually produces positive relief features in the placement area.

Access canals, as well as pipeline canals, are commonly bordered by levees created using dredged material (Rozas, 1992). Placement of this material alongside canals converts marsh to upland, an environment unavailable to aquatic organisms except during extreme tides. Dredge material can also form a barrier causing ponding behind levees and limiting circulation between canal waters and marshes to infrequent, high-water events (Swenson and Turner 1987; Cox et al., 1997). This and similar disruptions to marsh hydrology are believed to change coastal habitat structure as well as accelerate marsh erosion and conversion to open water (Kuhn et al., 1999; Turner et al., 1994; Rozas, 1992; Turner and Cahoon, 1987). The MMS/USGS-BRD study previously mentioned above (pipelines) will attempt to quantify the impacts of dredged-material deposition as well as other canal-related impacts, which should provide insights for identifying past and future impacts.

Executive Order 11990 requires that material from maintenance dredging be considered for use as a sediment supplement in deteriorating wetland areas to enhance and increase wetland acreage, where appropriate. Disposal of dredged material for marsh enhancement has been done only on a limited basis (Chapter 4.1.2.1). Given the “mission statement” of the COE, which requires it to take environmental impacts into consideration during its decisionmaking processes, increased emphasis has been placed on the use of dredged material for marsh creation. For a proposed action, increased use of dredged material to enhance wetland habitats is encouraged as mitigation.

Vessel Traffic

Vessel traffic that may support a proposed action is discussed in Chapter 4.1.1.3.8.4. Most navigation channels projected to be used in support a WPA proposed action (Chapter 4.1.2.1.10) are shallow and are currently used by vessels that support the OCS Program (Table 3-30). Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by the natural erosion process as evident along the Texas coast where heavy traffic using the Gulf Intracoastal Waterway (GIWW) has accelerated erosion of existing salt marsh habitat (Cox et al. 1997).

According to Johnson and Gosselink (1982), canals that have high navigation usage in coastal Louisiana widen about 2.58 m/yr, compared with 0.95 m/yr for little used canals. The OCS-related navigation canals are assumed to generally widen at an average rate of 1.5 m/yr. Approximately 2,020 km of OCS-related navigation canals, bayous, and rivers are found in the coastal regions around the Gulf, exclusive of channels through large bays, sounds, and lagoons. About 440 km of these channels are found around the WPA; another 810 km is found in Subarea LA-1.

Specific to navigation channels are the effects from saltwater intrusion (Gosselink et al., 1979; Wang 1987). Wang (1987) developed a model demonstrating that under certain environmental conditions, salt water penetrates farther inland in deep navigation channels than in shallower channels, suggesting that navigation channels act as "salt pumps." The Calcasieu Ship Channel is a good example of how saltwater intrusion, as a consequence of channelization, results in significant habitat transition from freshwater to brackish and ultimately to salt or open-water systems. Another example is the construction of the Mississippi River Gulf Outlet that led to the transition of many of the cypress swamps east of the Mississippi River below New Orleans to open water or areas largely composed of marsh vegetation (*Spartina)* with old, dead cypress tree trunks.

The GIWW, completed in 1949, carries barges of crude oil, petroleum, bulk cargoes, and miscellaneous items along a 12-ft deep channel protected from the storms, waves, and winds of the Gulf of Mexico. In 1994, vessels navigating the GIWW between the Harvey Canal in New Orleans and the Sabine River in Texas carried more than 67 million tons of goods, including 36.1 million tons of petroleum and petroleum products and 12.8 million tons of chemicals.

Service-vessel traffic is a necessary component of the OCS activities. An increase in the number of vessels creating wakes could potentially increase impact to coastal habitats including wetlands.

Disposal of OCS-Related Wastes

Produced sands, oil-based or synthetic-based drilling muds and cuttings, and some fluids from well treatment, workover, and completion activities will be transported to shore for disposal. Sufficient disposal capacity is assumed to be available in support of a proposed action (Chapter 4.1.2.1.11). Discharging OCS-related produced water into inshore waters has been discontinued; all OCS-produced waters are discharged into offshore Gulf waters in accordance with NPDES permits or are transported to shore for injection. Produced waters are not expected to affect coastal wetlands (Chapter 4.1.2.1.9).

Because of wetland-protection regulations, no new waste disposal site will be developed in wetlands. Some seepage from waste sites into adjacent wetland areas may occur and result in damage to wetland vegetation. State requirements are expected to be enforced to prevent and correct such occurrences.

Onshore Facilities

Various kinds of onshore facilities service OCS development. These facilities are described in Chapter 4.1.2.1 and Table 4-8. All projected new facilities are attributed to the OCS Program, with an appropriate proportion attributed to a proposed action; none will be in wetland areas. State and Federal permitting agencies discouraged the placement of new facilities or expansion of existing facilities in wetlands. Any impacts upon wetlands from existing facilities are expected to be mitigated.

Proposed Action Analysis

Estimates of wetland acreage in the 19 coastal counties in 1979 range from 611,760 ac of fresh, brackish, and salt marshes (Texas Parks and Wildlife Dept., 1988) to approximately 1.8 million acres of salt, brackish, fresh, forest, and scrub-shrub wetlands (Field et al., 1991). The Texas Parks and Wildlife Dept. estimates that 35 percent of the State's coastal marshes were lost between 1950 and 1979 (Texas Parks and Wildlife Dept., 1988; Texas General Land Office, 2001). The total loss of marshes in the river deltas since the 1950's amounts to about 21,000 ac, or 29 percent, of the river-delta marsh (White and Calnan, 1990). In the Galveston Bay system, from the 1950's to 1989, there was a net loss of 33,400 ac, which amounts to 19 percent of the wetlands that existed in the 1950's (White et al., 1993). This rate of loss has declined over time, from about 1,000 ac per year between 1953 and 1979 to about 700 ac per year between 1979 and 1989.

Direct causes of wetland loss along the Texas coast potentially associated with a proposed action are

- dredging and stream channelization for navigation channels and pipeline canals;
- filling by dredged material and other solid waste disposal;
- roads and highways;
- industrial development and infrastructure improvement; and
- accidental discharge of pollutants into wetlands.

Indirect causes of wetland loss may be attributed to

- subsidence due to lack of natural sediment replenishment of the deltaic/wetland system caused by channel and river controls;
- sediment diversion by dams, deep channels, and other structures;
- hydrologic alterations by canals, dredge banks, roads, and other structures; and
- subsidence due to extraction of groundwater, oil, gas, sulphur, and other minerals.

Table 4-13 shows the distribution of projected new, OCS-related pipeline landfalls and inland pipeline lengths for a proposed action. On average, 12 percent of traffic using OCS-related navigation channels is related to the OCS Program; therefore, impacts related to a proposed action should remain minimal. Since the number of OCS-related mitigative structures is unknown, impacts creditable to a proposed action cannot be calculated. Impacts associated with mitigation structures and canals are altered hydrology and flank subsidence, for which methods of projecting rates of occurrence and extent of influence have not yet been developed. An MMS study of canal-impact issues began during the summer of 1997; a final report is expected in the Fall of 2002. These projections will be updated for subsequent EIS's using data presently being developed.

Summary and Conclusion

A proposed action is projected to contribute to the construction of 1 new onshore pipeline in the WPA; therefore, the projected impact to wetlands from pipeline emplacement is expected to be minimal. As a secondary impact, some wetlands could potentially be converted to open water by continued widening of existing pipeline and navigational canals.

Maintenance dredging of navigation channels related to a proposed action are expected to occur with minimal impacts. Alternative dredged-material disposal methods can be used to enhance and create coastal wetlands.

Deepening an existing channel to accommodate larger service vessels may occur within the previously described environment(s) and could generate the creation of a small area of wetland that would be attributable to a proposed action.

In conclusion, adverse impacts of installation, maintenance, continued existence, and the failure of mitigation structures of pipeline and especially navigation canals are considered the most significant continuing OCS-related and proposed action-related impacts to wetlands. Although the OCS-related impacts discussed for a proposed action are regarded as considerable locally, where OCS-related canals and channels pass through wetlands, proposed action-related impacts are seen as less substantial because of their low representative percentages of the OCS Program. Their broad and diffuse distribution over coastal Texas makes it difficult to distinguish these impacts from other ongoing, OCS-related impacts to wetlands.

4.3.1.1.3. Seagrass Communities

Seagrasses in the WPA are widely scattered beds in shallow, high-salinity coastal lagoons and bays. The most extensive seagrass bed communities are found in both the Upper and Lower Laguna Madre along the Texas coast, as well as Baffin Bay. In the Texas Laguna Madre, seagrass meadows are the most common submerged habitat type. Although permanent meadows of perennial species occur in nearly all bay systems along the Texas Gulf Coast, the majority (79%) of the State's seagrass cover is found in the Laguna Madre (Pulich, 1998), with seagrasses currently covering about 243 km^2 in the upper portion of the Laguna Madre (Quammen and Onuf, 1993). Seagrass communities are largely excluded from bays north of Pass Cavallo where rainfall and inflows are high and salinity averages less than 20 ppt, as well as from the upper, fresher portions of most estuaries. Seagrass communities in the Laguna Madre constitute a unique resource that cannot be duplicated elsewhere on the Texas coast (Withers, 2001). Lower-salinity, submerged beds of aquatic vegetation are found inland and discontinuously in coastal lakes, rivers, and the most inland portions of some coastal bays.

The OCS oil and gas activities that could adversely affect seagrass communities include pipeline construction and canals, dredging of new navigation channels, maintenance dredging and vessel usage of navigation channels (propeller scars, etc.), construction and maintenance of inshore facilities, oil spills, and spill-response and cleanup activities. The potential impacts of oil spills and spill-response and cleanup activities are discussed in Chapter 4.4.3.1.3.

Pipelines

The installation of 0-1 pipeline landfalls is projected as a result of a WPA proposed action (Chapter 4.1.2.1.8). Pipeline construction methods and disturbances are discussed in Chapters 4.1.1.3.8.1 and 4.1.2.1.8. Jetting displaces sediments with denser sediments falling out of suspension quickly; the finer sediments that decrease water clarity remain in suspension longer. Reduced water clarity can decrease plant density in seagrass beds, which in turn can further increase turbidity as the root, thatch, and leaf coverage decreases (Wolfe et al., 1988). The amount of light reaching the bottom of a seagrass bed is the crucial factor determining seagrass meadow or community extent and productivity. As in maintenance dredging activities discussed below, activities from pipeline emplacement will reduce light, which is linked to reductions of both seagrass cover and productivity (Orth and Moore, 1983; Kenworthy and Haunert, 1991; Dunton, 1994; Czerny and Dunton, 1995).

The COE and State agencies take possible impacts to submerged vegetation into consideration during their review of pipeline permits. The permits for constructing pipelines require that turbidity impacts be mitigated through the use of turbidity screens and other turbidity reduction or confinement equipment. The permits also require surveys to locate seagrass beds of submerged vegetation, turbidity monitoring with reporting to the COE and State agencies, and immediate action taken to correct turbidity problems.

Maintenance Dredging

No new navigation channels are expected to be dredged as a result of a proposed action or OCS Program activities in the WPA. The ports that support these service bases presently accommodate deeper-draft vessels that support the OCS Program. The service bases are discussed in Chapter 4.1.2.1.1.

Impacts to seagrass and associated habitat can occur from periodic maintenance dredging of navigation channels. Changes in species composition are mostly the result of natural processes (i.e., succession) but were set in motion by moderation of salinity resulting from dredging of the Gulf Intracoastal Waterway (GIWW) and Mansfield Pass. However, decreases in cover and biomass have also been occurring. In the upper Laguna Madre, shoalgrass cover decreased by 3.8 percent (9.4 km^2 [3.6 mi^2]) between 1988 and 1994, and shoalgrass biomass at depths >1.4 m (4.6 ft) decreased by 60 percent (Onuf, 1996b). For the most part, these decreases have been attributed to brown tide occurrences that started in 1990 and continues in some parts of the system today. Changes in species composition due to succession have been most pronounced in the lower Laguna Madre, but a more troubling change is increased bare area. Overall, bare area has increased to 190 km^2 (73 mi^2), up 280 percent between 1965 and 1988 (Quammen and Onuf, 1993). Turbidity caused by maintenance dredging has been implicated in the decline of shoalgrass and increased bare areas in the lower Laguna Madre (Onuf, 1994). Light attenuation is responsible for most landscape-level losses, with scarring by vessel traffic also a concern. The amount of light reaching the bottom of a seagrass bed is the crucial factor determining seagrass meadow extent and productivity. Reduced light has been linked to reductions of both seagrass cover and productivity (Orth and Moore, 1983; Kenworthy and Haunert, 1991; Dunton, 1994; Czerny and Dunton, 1995). Dredging has been determined to be one of the major causes of light reduction that results in changes in seagrass cover, composition, and biomass. Changes in species composition resulting from dredging activities may affect resource availability for some fish and waterfowl that use seagrass habitat as nursery grounds.

Deepwater activities are anticipated to increase, requiring use of larger service vessels for efficient operations, which may shift greater emphasis to shore bases associated with deeper channels. Maintenance dredging schedules vary from yearly to rarely and will continue indefinitely into the future.

Vessel Traffic

Navigation traffic that may support a proposed action is discussed in Chapter 4.1.2.1.1.0. Most navigation channels projected to be used for a WPA proposed action are shallow and are currently used by vessels that support the OCS Program (Table 3-30). For example, the GIWW is dredged to an average depth of 4 m, but varies in depth between ports. Propwashing of shallow navigation channels by vessel traffic dredges up and resuspends sediments, increasing the turbidity of nearby coastal waters.

Vessels that vary their inland route from established navigation channels can directly scar beds of submerged vegetation with their props, keels (or flat bottoms), and anchors.

Proposed Action Analysis

Pipelines

Gas production and the great majority of oil production from a WPA proposed action is expected to be commingled in pipelines with other OCS production at sea before going ashore. Seagrass communities are not abundant in the Federal OCS waters, where most of the pipeline supporting a proposed action would be installed. The installation of 0-1 pipeline landfalls is projected as a result of a proposed action in the WPA (Chapter 4.1.2.1.8) with a potential landfall likely to be in or around Galveston County.

Although the majority of materials dredged by jetting return to the water bottom within a few meters of the trench, lighter materials can be carried for several kilometers, depending upon the currents, weather, and density of the dredged materials. Hence, pipeline installation has the potential to bury nearby submerged vegetation; coat the leaves of plants farther away with lighter, light-blocking sediments; and temporarily elevate turbidity in these beds. Permit requirements of the COE and State agencies are expected to require the reduction of turbidity impacts to within tolerable limits for submerged aquatic vegetation. Therefore, significant direct impacts to submerged vegetation by pipeline installation are expected to be very small and short term if they occur.

Maintenance Dredging

Because much of the dredged material resulting from maintenance dredging will be placed on existing dredged material disposal sites or used for other mitigative projects, no significant adverse impacts are expected to occur to seagrass communities from maintenance dredging credited to a proposed action. By artificially keeping navigation channels open and with larger dimensions than the region hydrodynamics would, maintenance dredging maintains tidal and storms flushing potential of inland regions at maximum capacities as they relate to the described needs of the canal projects. Without maintenance dredging, these channels would naturally fill in, reducing the channels' cross-sectional areas and their capacities to flush or drain a region when under the influences of storms and tides.

Vessel Traffic

Most of the navigation channels to be used for a proposed action are shallow, therefore allowing for possible scarring impacts to associated seagrass and submerged vegetation. For that reason, propwashing related to a proposed action may substantially resuspend sediments in these areas. Navigational traffic using the GIWW along the Texas coast would resuspend sediments in numerous areas. A proposed action would represent a substantial percentage of existing traffic along the Texas coast. However, beds of submerged vegetation within the area of influence and other channels have already adjusted their configurations in response to turbidity generated there.

Many vessel captains will cut corners of channel intersections or navigate across open water where they may unexpectedly encounter shallow water where beds of submerged aquatic vegetation may occur. Propellers may damage a bed superficially by leaving a few narrow cuts. Damage may be as extensive as broadly plowed scars from the keel of a large boat accompanied by extensive propwashing; trampling by waders; and additional keel, prop, and propwash scars left by other vessels that assisted in freeing the first boat.

Depending upon the submerged plant species involved, scars about 0.25 m wide cut through the middle of beds would take 1-7 years to recover. Similar scars through sparser areas would take 10 years or more to recover. The broader the scar, the longer the recovery period. Extensive damage to a broad area may never be corrected (Sargent et al., 1995).

Denser dredged materials fall out of suspension more quickly. Less dense sediments settle to the water bottom more slowly, which concentrates at the surface of the water bottom. These lighter bottom sediments are generally more resuspendable by storms than were the original surface sediments. Therefore, for a period of time after dredging occurs, water turbidity will be greater than usual in the vicinity of the dredging. With time, this reoccurring, increased turbidity will decrease to pre-project conditions, as the lighter materials are either dispersed to deeper water by currents, where they are less available for resuspension, or they are consolidated into or under denser sediments.

For estuarine species that thrive in salinities of about 0.5-25 ppt, this elevated turbidity may not pose a significant problem because they have adapted to turbid, estuarine conditions. For seagrass beds in higher salinities and even freshwater submerged aquatic vegetation that require clearer waters, significantly reduced water clarity or shading, as may be caused by an oil slick, for longer than about 4 days will decrease chlorophyll production. If such conditions continue for longer than about 2 weeks, plant density in the bed will begin to decrease. If plant density reduces significantly in turn, further increases in turbidity will occur as the root, thatch, and leaf coverage decline.

Such impacts can be mitigated in several ways. For cleaning up slicks resting over a submerged vegetation bed, wheeled or treaded vehicles should be prohibited. Cleanup methods using other vehicles that dig into the water bottom of the bed (e.g., boat anchors, boat bottoms, props, and booms that require water depths greater than that available over the bed) should be not be used. Vehicles and equipment that require minimum water depths of about 6-10 in should be used instead. Activities over grass beds should be closely monitored to avoid digging into the bed. Trampling or repeatedly walking over a path through the bed should be avoided.

Summary and Conclusion

Most seagrass communities located within a WPA proposed action are located behind the barrier islands, sparsely distributed in bays and estuaries along coastal Louisiana and Texas, including the Tamaulipas, Mexico Laguna Madre. Because of the location of most seagrass communities, inshore oil spills pose the greatest threat. The potential impacts from oil spills are discussed in Chapter 4.4.3.2.1.

Pipeline construction in coastal waters would temporarily elevate turbidity in nearby submerged vegetation beds, depending upon currents. If constructed, the pipeline landfall would temporarily elevate turbidity in submerged vegetation beds near the pipeline routes. The COE and State permit requirements are expected to require pipeline routes that avoid beds of high-salinity, submerged vegetation and to reduce turbidity impacts to within tolerable limits. Therefore, impacts to submerged vegetation by pipeline installation are projected to be very small and short term. As previously discussed in Chapter 4.1.2.1.5, petroleum reservoirs in deepwater areas could require their own pipeline landfall. Table 4-8 lists the projected number of additional OCS pipeline landfalls and their inshore lengths to be constructed during a WPA proposed action.

After bottom sediments are disturbed by pipeline installation, they will be generally more easily suspended by storms than before the disturbance. In estuaries, this increase is not projected to be a problem. Due to tidal flushing, this increased turbidity is projected to be below significant levels and to continue after storms for up to one month.

Beds of submerged vegetation within a channel's area of influence will have already adjusted to bed configurations in response to turbidity generated there. Very little, if any, damage would then occur as a result of typical channel traffic. Generally, propwash will not resuspend sediments in navigation channels beyond pre-project conditions.

Depending upon the submerged plant species involved, narrow scars in dense portions of the beds will take 1-7 years to recover. Scars through sparser areas will take 10 years or more to recover. The broader the scar, the longer the recovery period. Extensive damage to a broad area may never be corrected.

Maintenance dredging will not have a substantial impact on existing seagrass habitat given that no new channels are expected to be dredged as a result of a WPA proposed action.

4.3.1.2. Impacts on Sensitive Offshore Resources

4.3.1.2.1. Live Bottoms (Topographic Features)

The topographic features sustaining sensitive offshore habitats in the WPA are listed and described in Chapter 3.2.2.2. A Topographic Features Stipulation similar to the one described in Chapter 2.3.1.3.1 has been included in appropriate leases since 1973 and may, at the option of the Secretary, be made a part of appropriate leases resulting from this proposal. The impact analysis presented below for a proposed action in the WPA includes the proposed biological lease stipulation. As noted in Chapter 2.3.1.3.1, the stipulation establishes a No Activity Zone in which no bottom-disturbing activities would be allowed and areas around the No Activity Zones (in most cases) within which shunting of drill cuttings and drilling fluids to near the bottom would be required.

The potential impact-producing factors on topographic features of the Western Gulf are anchoring (Chapter 4.1.1.3.2.1), infrastructure emplacement (Chapters 4.1.1.3.1 and 4.1.1.3.2), drilling-effluent and produced-water discharges (Chapter 4.1.1.3.4), and infrastructure removal (Chapter 4.1.1.3.3). Impacts from oil spills and blowouts are discussed in Chapter 4.4.3.2.1. These disturbances have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of topographic features in the WPA.

The anchoring of pipeline lay barges, drilling rigs, or service vessels, as well as the emplacement of structures (e.g., pipelines, drilling rigs, or production platforms), results in mechanical disturbances of the benthic environment. Anchor damage has been shown to be the greatest threat to the biota of the offshore banks in the Gulf (Bright and Rezak, 1978; Rezak et al., 1985). Such anchoring damage, however, would be prevented within any given No Activity Zone by the observation of the Topographic Feature Stipulation.

Infrastructure emplacement and pipeline emplacement could resuspend sediments. The proposed stipulation would also prevent these activities from occurring in the No Activity Zone, thus preventing most of these resuspended sediments from reaching the biota of the banks.

Considering the relatively elevated amounts of drilling muds and cuttings discharged per well (10,542 bbl/exploratory well; 7,436 bbl/development well) (USEPA, 1993a and b), potential impacts on biological resources of topographic features should be expressly considered if drill sites occur in blocks directly adjacent to No Activity Zone boundaries (Topographic Features Stipulation). Potential impacts could be incurred through increased water-column turbidity, the smothering of sessile benthic invertebrates, and local accumulations of contaminants. The USEPA general NPDES permit sets special restrictions on discharge rates for muds and cuttings adjacent to topographic features bound by a No Activity Zone. Chapters 4.1.1.3.4 and 4.2.1.3.2 detail the NPDES permit's general restrictions and the impacts of drilling muds and cuttings on marine water quality and seafloor sediments. The levels and areal extent of discharged contaminants measured in the water column or sediments will be reduced from levels and extent measured in the past because current USEPA regulations and NPDES permits contain more restrictive limits (Chapter 4.2.1.3.2). The effects of past muds and cutting discharges are discussed in Chapter 4.2.1.3.2. A brief overview of the potential impacts on topographic features by drilling discharges follows.

Water-column turbidity and the smothering of sessile invertebrates of topographic features caused by drilling muds and cuttings are of little significance for two reasons. First, the Topographic Features Stipulation limits impact through the No Activity Zone shunting restrictions imposed within the 1-Mile Zone and 1,000-Meter Zone, as well as the USEPA general NPDES permit special restrictions on discharge rates in blocks adjacent to a No Activity Zone or sensitive areas, which necessitates photodocumentation by industry. Secondly, studies have shown the rapid dispersion of drilling fluid plumes in the OCS within a 1,000-m range of the discharge point and the resilience of sessile invertebrates exposed or smothered with an extreme range of concentrations of drilling muds (Kendall, 1983). For local accumulation of contaminants, assumptions are that trace-metal and petroleum contamination resulting from drilling muds and cuttings will occur mainly within a few hundred to a couple of thousand meters downcurrent from the discharge point and can be found up to 3,000 m downcurrent in shallow waters. Concentrations of contaminants decrease with an increasing distance from the drilling site. By examining sediments surrounding three gas production platforms (within a 100-m radius), Kennicutt et al. (1996) found low concentrations of petroleum and trace metal contaminants that would unlikely induce a biological response in benthic organisms. The highest trace metal concentrations originating from discharged drilling fluids found around platforms were strongly correlated with the presence of sand-size sediments. Shallow sites are subject to comparatively greater sediment removal and resuspension due to a high-energy environment. Contaminants from previous discharges under less restrictive conditions have been found to remain in sediments surrounding drill sites for as long as 10 years (Kennicutt et al., 1996). Toxic effects could be incurred by benthic organisms of topographic features found in the vicinity of a No Activity Zone boundary if the plume flow of an operation is consistently directed toward that boundary. Should effects occur, they would potentially persist for as long as 10 years following the onset of discharges.

Produced waters could also represent a significant potential source of impact to the biota of topographic features, considering produced water constitutes the largest single discharge during routine oil and gas operations. The USEPA general NPDES permit restrictions on the discharge of produced water help to limit the impacts on biological resources of topographic features. Past evaluation of the bioaccumulation of offshore produced-water discharges conducted by the Offshore Operators Committee (1997) assessed that metals discharged in produced water would, at worst, affect living organisms found in the immediate vicinity of the discharge, particularly those attached to the submerged portion of platforms. Naturally occurring radioactive material in produced water was not found to bioaccumulate in marine animals (2 species of molluscs and 5 species of fish). Because high-molecular, polycyclic aromatic hydrocarbons (PAH's) are usually in such dilute concentrations in produced water, they pose little threat to marine organisms and their constituents, and they were not anticipated to biomagnify in marine food webs. Monocyclic hydrocarbons and other miscellaneous organic chemicals are known to be moderately toxic, but they do not bioaccumulate to high concentrations in marine organisms and are not known to pose a risk to their consumers. A detailed description of the impacts of produced waters on water quality and seafloor sediments is presented in Chapter 4.2.1.3.

The impacts of structure removal on topographic features can include water turbidity, sediment deposition, and explosive shock-wave impacts. Both explosive and nonexplosive removal operations would disturb the seafloor by generating considerable turbidity. The deposition of resuspended sediments would occur much in the same manner as discussed for discharges of muds and cuttings, choking and causing mortality of sessile benthic organisms. Turbidity could both reduce light levels and obstruct filter-feeding mechanisms, leading to reduced productivity, susceptibility to infection, and mortality. The shock waves produced by the explosive structure removals could also harm associated biota. Corals and other sessile invertebrates have a supposedly high resistance to shock. O'Keeffe and Young (1984) described the impacts of underwater explosions on various forms of sea life using, for the most part, open-water explosions much larger than those used in typical structure removal operations. They found that sessile benthic organisms, such as barnacles and oysters, and many motile forms of life, such as shrimp and crabs, that do not possess swim bladders were remarkably resistant to shock waves generated by underwater explosions. Oysters located 8 m away from the detonation of 135-kg charges in open water incurred a 5-percent mortality rate. Crabs distanced 8 m away from the explosion of 14-kg charges in open water had a 90-percent mortality rate. Few crabs died when the charges were detonated 46 m away. O'Keeffe and Young (1984) also noted ". . . no damage to other invertebrates such as sea anemones, polychaete worms, isopods, and amphipods." Benthic organisms appear to be further protected from the impacts of subbottom explosive detonations by rapid attenuations of the underwater shock wave traversing the seabed away from the structure being removed. The shock-wave attenuation is significantly less in mud than in the water column, where it is known to impact fish up to 60 m away from a 11.3-kg charge blasted at a 100-m depth (Baxter et al., 1982). Theoretical predictions suggest that the shock waves of explosives set 5 m below the seabed, as required by MMS regulations, would further attenuate blast effects. Charges used in OCS structure removals are typically much smaller than some of those cited by O'Keeffe and Young. The *Programmatic Environmental Assessment for Structural Removal Activities* (USDOI, MMS, 1987) predicts low impacts on the sensitive offshore habitats from platform removal precisely because of the effectiveness of the proposed stipulation in preventing platform emplacement in the most sensitive areas of the topographic features of the Gulf of Mexico. Impacts on the biotic communities, other than those on or directly associated with the platform, would be conceivably limited by the relatively small size of individual charges (normally 22.7 kg or less per well piling and per conductor jacket) and by the fact that charges are detonated 5 m below the mudline and at least 0.9 seconds apart (timing needed to prevent shock waves from becoming additive). The stipulation discussed above would preclude platform installation in the No Activity Zone, thus preventing adverse effects from nearby removals.

Proposed Action Analysis

All of the 23 topographic features (shelf edge banks, low-relief banks, and south Texas banks) in the WPA are found in waters less than 200 m deep. They represent a small fraction of the Western Gulf area.

As noted above, the proposed Topographic Features Stipulation could prevent most of the potential impacts from oil and gas operations on the biota of topographic features, including direct contact during pipeline, rig, and platform emplacements and anchoring activities. Yet, operations outside the No Activity Zones could still affect topographic features through drilling effluent discharges and produced-water discharges, blowouts, and oil spills. Potential impacts from oil spills and blowouts are discussed in Chapter 4.4.3.2.1.

For a WPA proposed action, 63-104 exploration/delineation and development wells are projected for offshore Subareas W0-60 and W60-200. With the inclusion of the proposed Topographic Features Stipulation, no discharges would take place within the No Activity Zones. Drilling discharges would be shunted to within 10 m of the seafloor either within a radius of 1,000 m, 1 mi (1,609 m), 3 mi (4,828 m), or 4 mi (6,437 m) (depending on the topographic feature) around the No Activity Zone. This procedure would essentially prevent the threat of large amounts of drilling effluents reaching the biota of a given topographic feature. It has been estimated, however, that drilling effluents and produced waters could reach and impact topographic features 5-10 times during the life of this proposal. The severity of such impacts would probably be primarily sublethal such that there may be a disruption or impairment of a few elements at the regional or local scale but no interference to the general system performance. Recovery to pre-impact conditions should take place within 2 years.

For a WPA proposed action, 7-10 production structures are projected in offshore Subareas W0-60 and W60-200. Between 4 and 6 structure removals using explosives are projected for the W0-60 subarea and 1 is projected in Subarea W60-200. The explosive removals of platforms should not impact the biota of topographic features because the Topographic Features Stipulation restricts the emplacement of platforms to locations most certainly farther than 100 m from No Activity Zone boundaries. This emplacement would prevent shock-wave impacts and resuspended sediments from reaching the biota of topographic features.

Summary and Conclusion

The proposed Topographic Features Stipulation could prevent most of the potential impacts on live-bottom communities from bottom-disturbing activities (structure removal and emplacement) and operational discharges. Recovery from impact incidences of operational discharges would take place within 10 years.

Effects of the Proposed Action Without the Proposed Stipulation

The topographic features and associated coral reef biota of the Western Gulf could be adversely impacted by oil and gas activities resulting from a proposed action should they be unrestricted by the absence of the proposed Topographic Features Stipulation. This would be particularly true should operations occur directly on top of or in the immediate vicinity of otherwise protected Western Gulf topographic features.

The No Activity Zone would probably be the area of the topographic features most susceptible to adverse impacts if oil and gas activities are unrestricted by the Topographic Feature Stipulation and not followed up by mitigating measures. These impacting activities could include vessel anchoring and infrastructure emplacement, discharges of drilling muds and cuttings, and ultimately the explosive removal of structures. All the above-listed activities have the potential to considerably alter the diversity, cover, and long-term viability of the reef biota found within the No Activity Zone. In most cases, recovery from disturbances would take 10 years or more. Long-lasting and possibly irreversible change would be caused mainly by vessel anchoring and structure emplacement (pipelines, drill rigs, and platforms). Indeed, such activities would physically and mechanically alter benthic substrates and their associated biota over areas possibly ranging from tens to thousands of square meters per impact. Operational discharges would cause substantial and prolonged turbidity and sedimentation, possibly impeding the well-being and permanence of the biota and causing the decrease of live benthic cover.

Finally, the unrestricted use of explosives to remove platforms installed in the vicinity of or on the topographic features could cause turbidity, sedimentation, and shock-wave impacts that would affect reef biota.

The shunting of cuttings and fluids, which would be required by the Topographic Features Stipulation, is intended to limit the smothering and crushing of sensitive benthic organisms by depositing the foreign substances in areas where they could not be displaced by currents onto the topographic features. The impacts from unshunted exploration and development discharges of drill cuttings and drilling fluids within the 1,000-Meter Zone and the 1-Mile Zone would definitely impact the biota of topographic features. Specifically, the discharged materials would cause prolonged events of turbidity and sedimentation, which could have long-term deleterious effects on local primary production, predation, and consumption by benthic and pelagic organisms, biological diversity, and benthic live cover. The unrestricted discharge of drilling cuttings and fluids during development operations within the 3-Mile Zone would be a further source of impact to the sensitive biological resources of the topographic features.

Therefore, in the absence of the Topographic Features Stipulation, a proposed action could cause long-term (10 years or more) adverse impacts to the biota of the topographic features, located in most cases on those portions of the topographic features that are in 85 m and less water depth.

4.3.1.2.2. Chemosynthetic Deepwater Benthic Communities

Physical

The greatest potential for adverse impacts on deepwater chemosynthetic communities would come from those OCS-related, bottom-disturbing activities associated with pipelaying (Chapter 4.1.1.3.8.1), anchoring (Chapter 4.1.1.3.2.1), and structure emplacement (Chapter 4.1.1.3.2), as well as from an accidental seafloor blowout (Chapter 4.4.1.2). Potential impacts from blowouts are discussed in Chapter 4.4.3.2.2. These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area.

Considerable mechanical damage could be inflicted upon the bottom by routine OCS drilling activities. The physical disturbance by structures related to a drilling operation itself affect a small area of the sea bottom. The presence of a conventional structure can also cause scouring of the surficial sediments by near-bottom ocean currents (Caillouet et al., 1981), although this phenomena has not been demonstrated around structures in deep water.

Anchors from support boats and ships (or, as assumed for deeper water depths, from any buoys set out to moor these vessels), floating drilling units, barges used for construction of platform structures, and pipelaying vessels also cause severe disturbances to small areas of the seafloor. The 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. Excessive scope and the movement of the mooring chain could disturb a much larger bottom area than an anchor alone, depending on the variety of prevailing wind and current directions. A 50-m radius of chain movement on the bottom around a mooring anchor could destroy chemosynthetic communities in an area of nearly 8,000 m^2. A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the central drilling structure. Larger anchors, longer anchor chains/cables and mooring lines, and greater scope for anchoring configurations are expected for operations in deep water as compared to operations on the shelf. Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, are expected to be greater for operations that employ anchoring in deep water. Many oil and gas support operations involving ships and boats would not result in anchor impacts on deepwater chemosynthetic communities because the vessels would tie-up directly to rigs, platforms, or mooring buoys. In addition, there are drillships, construction barges, and pipelaying vessels operating in the Gulf of Mexico that rely on dynamic positioning rather than conventional anchors to maintain their position during operations (anchoring would not be a consideration in these situations). The area affected by anchoring operations will depend on the water depth, length of the chain, size of the anchor, and current. Anchoring will destroy those sessile organisms actually hit by the anchor or anchor chain during anchoring and anchor weighing, or it could cause destruction of underlying carbonate structures on which organisms rely for dispersion of hydrocarbon sources. While such an area of disturbance may be small in absolute terms, it may be large in relation to the area inhabited by dense chemosynthetic communities.

Normal pipelaying activities in deepwater areas could destroy large areas of chemosynthetic organisms (it is assumed that 0.32 ha of bottom is disturbed per kilometer of pipeline installed). Since pipeline systems are not as established in deepwater as in shallow water, new installations are required, which will tie into existing systems or bring production directly to shore. Pipelines will also be required to transport product from subsea systems to fixed platforms.

In addition to physical impacts, structure removals and other bottom-disturbing activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cutting discussed below.

The impacts from bottom-disturbing activities are expected to be relatively rare. Should they occur, these impacts could be quite severe to the immediate area affected, with recovery times as long as 200 years for mature tube-worm communities, with the possibility of the community never recovering.

Discharges

In deep water, discharges of drilling fluids and cuttings at the surface are spread across broader areas of the seafloor and are, in general, distributed in thinner accumulations than in shallower areas on the continental shelf. Recent information about the effects of surface discharge of drilling fluids (muds) and cuttings at a well in 565 m have been reported by Gallaway and Beaubien (1997). In this instance, a veneer of cuttings was observed scattered over the bottom, in some cases as thick as 20-25 cm. Chemical evidence of SBF components (used during this operation) was found at distances of at least 100 m from the well site (sampling distance was limited by the ROV tether length). Other information from a geophysical survey documented the extent of drilling discharges at several previously drilled oil and gas sites in about 400 m water depths (Nunez, personal communication, 1994). At these sites, the areal coverage of cuttings was found extending from the previous well locations in splay or finger-like projections to a maximum of about 610 m, with an average of about 450 m. An examination of side-scan-sonar records of these splays indicates that they were distributed in accumulations less than 30 cm thick. Effluents from routine OCS operations (not muds or cuttings) in deep water would be subject to rapid dilution and dispersion and are not projected to reach the seafloor at depths greater than 100 m.

Impacts from muds and cuttings are also expected from two additional sources: (1) initial well drilling and installation of casing prior to the use of a riser to circulate returns to the surface; and (2) the potential use of various dual-gradient or subsea mudlift drilling techniques in the deep sea. Pre-riser casing installation typically involves 36-in (91-cm) casing that may be set to a depth of 300 ft (91 m) and 26-in (66-cm) casing that may be set to a depth of 1,600 ft (488 m). Jetted or drilled cuttings from the initial wellbore could total as much as 226 m^3 (Halliburton Company, 1995). With dual-gradient drilling techniques, the upper portion of the wellbore will be "drilled" similar to conventional well initiation techniques with cuttings being discharged at the seafloor. After the BOP stack is installed, subsea mudlift pumps will circulate the drilling fluid and cuttings to the surface for conventional well solids control.

Discharges from the dual-gradient drilling operations are expected to be similar to conventional drilling operations. Although the full areal extent and depth of burial from these initial activities are not known, the potential impacts are expected to be localized and short term. Since these areas would occupy a minuscule portion of the available seafloor in the deepwater Gulf of Mexico, these impacts are not considered significant provided that sensitive communities (e.g., chemosynthetic communities) are avoided.

MacDonald et al. (1995) indicates that the vulnerability of chemosynthetic communities to oil and gas impacts may depend on the type of community present. Tube-worm and mussel communities may be more vulnerable than clam communities because clam communities are vertically mobile (preventing burial) and sparsely distributed. The primary concern related to muds and cuttings discharges is that of burial. Although chemosynthetic organisms thrive with some part of their anatomy located next to or inside of toxic and/or anoxic environments, all chemosynthetic biota (including the symbiotic bacteria) also require oxygen to live. Burial by sediments or rock fragments originating from drilling fluids and cuttings discharges would smother and kill most chemosynthetic organisms (motile clams being one possible exception). Depending on the organism type, just a few centimeters of burial could cause mortality.

The tolerance of various community components to burial is not completely understood and would depend on the depth of burial. Detrimental effects due to burial are expected to decrease exponentially in the same manner that the depth of accumulations of discharges decrease exponentially with distance from the origin. The severity of these impacts is such that there may be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

High-density, Bush Hill-type communities are areas that are considered to be most at risk from oil and gas operations. The disturbance of a Bush Hill-type environment could lead to the destruction of a community from which recovery would occur only over long time intervals (200+ years for a mature tube-worm colony and 25-50 years for a mature mussel community) or would not occur at all. A long span of time is required for the precipitation of enough carbonate rock to support a large population of tube worms. As dense tube-worm communities require hard substrate as well as very active seepage at any point in space, existing communities covered by sediment that are physically damaged would likely never recover (Fisher, 1995).

Information is limited about the vulnerability of tube worms to sedimentation/smothering impact. Individual tube worms are often found buried for more than half the length of their tubes by hemipelagic sediment (MacDonald, 1992). Presumably, this burial occurs over long time intervals. Evidence of catastrophic burial of high-diversity chemosynthetic communities can be found in the paleorecord as documented by Powell (1995), but the importance of this in causing local extinctions was reported as minor. These burials were probably caused by catastrophic seismic events.

Methanotrophic mussel communities have strict chemical requirements that tie them directly to areas of the most active seepage. Physical disturbance of an active mussel bed is thought not to have a long-lasting effect on the community due to high growth rates of individuals (Fisher, 1995). Catastrophic mud burial would be one possible cause of a mussel community death. It is predicted that a mussel community completely eliminated by physical disturbance could be resettled and mature within 20 years.

Reservoir Depletion

There has been some speculation about the potential impact to chemosynthetic communities as a result of oil and gas withdrawal, causing a depletion of the energy source (hydrocarbons) sustaining the chemosynthetic organisms. There is evidence that both removal and reinjection of material into reservoirs that supply seeps on land in California affect the seepage rates. Quigley et al. (1996) reported evidence that suggested offshore California oil production resulted in reduced seepage due to reduction in reservoir pressure. The seeps and faults around which chemosynthetic animals live are supplied from the deep reservoirs that transport the gas or oil to the seafloor through combined effects of buoyancy and pressure. When all of the recoverable hydrocarbons from these reservoirs are withdrawn by production operations (the amount that can be economically extracted by current technology is estimated to be 30% or less of the total hydrocarbons), it is possible that oil and gas venting or seepage would also slow or (less likely) stop. Based on current information, it is not possible to determine whether reduced reservoir pressure would actually reduce the seepage (as observed onshore) or whether there may be enough oil already in the conduit to the surface to continue adequate levels of seepage for long periods, perhaps thousands of years or more. The distribution of chemosynthetic communities is known to occur in association with precise levels and types of chemical gradients at the seafloor; alterations to these gradients may potentially impact the type and distribution of the associated community.

Proposed Action Analysis

Because high-density chemosynthetic communities are generally found only in water depths greater than 400 m, they would not be found in shallow-water areas of the WPA (Subareas W0-60 or W60-200, Table 4-3). Chemosynthetic communities could be found in the deeper water areas (Subareas W200-800, W800-1600, W1600-2400 and W>2400, Table 4-3). Of the 45 known communities, a total of 19 documented chemosynthetic communities are known to occur in the WPA: 1 in the Alaminos Canyon lease area; 5 in the East Breaks lease area; and 13 in the Garden Banks lease area. The levels of projected impact-producing factors for deepwater Subareas W200-800, W800-1600, W1600-2400 and W>2400 are shown in Table 4-3. A range of 4-5 oil and gas production structures ranging from small subsea developments to large developments involving floating, fixed, or subsea structures are estimated to be installed between 2003 and 2042 in the deepwater portions of the WPA as a result of a proposed action. These deepwater production structures are expected to be installed 5-10 years after a proposed lease sale, with a peak annual rate of 1-2.

Notice to Lessees (NTL) 98-11 (superseded by NTL 2000-G20) has been a measure for the protection of chemosynthetic communities since February 1, 1989. Now, NTL 2000-G20 makes mandatory the search for and avoidance of dense chemosynthetic communities (such as Bush Hill-type communities) or areas that have a high potential for supporting these community types, as interpreted from geophysical records. The NTL is exercised on all applicable leases and is not an optional protective measure. Under the provisions of this NTL, lessees operating in water depths greater than 400 m are required to conduct geophysical surveys of the area of proposed activities and to evaluate the data for indications of conditions that may support chemosynthetic communities; if such conditions are indicated, the lessee must either move the operation to avoid the potential communities or provide photodocumentation of the presence or absence of dense chemosynthetic communities of the Bush Hill type. If such communities are indeed present, no drilling operations or other bottom-disturbing activities may take place in the area; if the communities are not present, drilling, anchoring, etc. may proceed. To date, in almost all cases, operators have chosen to avoid any areas that show the potential to support chemosynthetic communities. The basic assumptions underlying the provisions of this mitigation measure are (1) that dense chemosynthetic communities are associated with gas-charged sediments or seeps, (2) that the gas-charged sediment zones or seeps have physical characteristics that will allow them to be identified by geophysical surveys, and (3) that dense chemosynthetic communities are not found in areas where gas-charged sediments or seeps are not indicted on the geophysical survey data. These assumptions have not been totally verified. A definitive correlation between the geophysical characteristics record by geophysical surveys and the presence of chemosynthetic communities has not been proven.

Although there are few examples of field verification, the requirements set forth in NTL 2000-G20 are considered effective in identifying potential areas of chemosynthetic communities. Although there has generally been compliance with NTL 2000-G20, compliance does not guarantee avoidance of high-density communities without visual confirmation in every case. On rare occasions, high-density chemosynthetic community areas may not be properly identified using the geophysical systems and indicators specified in the existing NTL. Oil- or gas-saturated sediments and other related characteristic signatures cannot be determined without high-resolution acoustic records or the interpretation of subsurface 3D seismic data.

Improved definitions and avoidance distances have been released in a new Chemosynthetic Community NTL 2000-G20. Requirements for specific separation distance between potential high-density chemosynthetic communities and both anchors (250-500 ft) and drilling discharge points (1,500 ft) have been included in the revision of the NTL. These new guidelines have also been released in the new Interim Plans NTL (NTL 2000-G10), which became effective May 31, 2000. The potential for any impact could also be lessened by the refinement of techniques used in the interpretations of geophysical records. The use of differential global positioning system (GPS) has also been required on anchor handling vessels when placing anchors near an area that has potential for supporting chemosynthetic communities. As new information becomes available, the NTL will be further modified as necessary.

High-density, Bush Hill-type communities are, as noted above, largely protected from direct physical impacts by the provisions of NTL 2000-G20. A limited number of these communities have been found to date, but it is probable that additional communities exist. Observations of the surface expression of seeps from space images indicate numerous other communities may exist (MacDonald et al., 1993 and 1996). Most chemosynthetic communities are of low density and are relatively widespread throughout the deepwater areas of the Gulf. Physical disturbance or destruction of a small, low-density area would not result in a major impact to chemosynthetic communities as an ecosystem. Low-density communities may occasionally sustain major or minor impacts from discharges of drill muds and cuttings, bottom-disturbing activities, or resuspended sediments. Areas so impacted could be repopulated from nearby undisturbed areas (although this process may be quite slow, especially for vestimentiferans). In light of probable avoidance of all chemosynthetic communities (not just high-diversity types) as required by NTL 2000-G20, the frequency of such impact is expected to be low, and the severity of such an impact is judged to result in minor disturbance to ecological function of the community, with no alteration of ecological relationships with the surrounding benthos. Recolonization after a disturbance would not exactly reproduce the preexisting community prior to the impact, but it could be expected that some similar pattern and species composition would eventually reestablish if similar conditions of sulfide or methane seepage persist after the disturbance.

Summary and Conclusion

Chemosynthetic communities are susceptible to physical impacts from structure placement (including templates or subsea completions), anchoring, and pipeline installation. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement.

If the presence of a high-density community were missed using existing procedures, potentially severe or catastrophic impacts could occur due to ranking of the sea bottom by anchors and anchor chains and partial or complete burial by muds and cuttings associated with pre-riser discharges or some types of riserless drilling. Variations in the dispersal and toxicity of synthetic-based drilling fluids may contribute to the potential areal extent of these impacts. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type), although it may reappear relatively quickly once the process begins, as in the case of a mussel community. Tube-worm communities may be the most sensitive of all communities because of the combined requirements of hard substrate and active hydrocarbon seepage. Mature tube-worm bushes have been found to be several hundred years old. There is evidence that substantial impacts on these communities would permanently prevent reestablishment.

A proposed action in the WPA is expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience minor impacts from drilling discharges or resuspended sediments located at more than 1,500 ft away as required by NTL 2000-G20.

4.3.1.2.3. Nonchemosynthetic Deepwater Benthic Communities

Physical

Benthic communities other than chemosynthetic organisms could be impacted by OCS-related, bottom-disturbing activities associated with pipelaying (Chapter 4.1.1.3.8.1), anchoring (Chapter 4.1.1.3.3.1), and structure emplacement (Chapter 4.1.1.3.2), as well as from a seafloor blowout (Chapter 4.4.1.4). Potential impacts from blowouts are discussed in Chapter 4.4.3.2.2. These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area. Considerable mechanical damage can be inflicted upon the bottom by routine OCS drilling activities. The physical disturbance by structures related to a drilling operation itself affects a small area of the sea bottom. These impacts are the same as those encountered in shallower continental shelf waters.

Anchors from support boats and ships (or, as assumed in these water depths, from any buoys set out to moor these vessels), floating drilling units, and pipelaying vessels also cause severe disturbances to small areas of the seafloor with the areal extent related to the size of the mooring anchor and length of chain that would rest on the bottom. Excessive scope (length) and movement of the mooring chain could disturb a much larger area of the bottom than would an anchor alone, depending on the prevailing wind and current directions. A 50-m radius of chain movement on the bottom around a mooring anchor could destroy communities in an area of nearly 8,000 m^2. A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the central drilling structure. Larger anchors and additional scope of anchor chain are expected for operations in deep water as compared to operations on the shelf. Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, are expected to be greater for operations that employ anchoring in deep water. The area affected by anchoring operations will depend on the water depth, length of the chain, size of the anchor, and current. (Many OCS-support operations and activities will not result in anchor impacts to deepwater benthic communities because vessels will tie-up directly to rigs, platforms, or mooring buoys or will use dynamic positioning.) Anchoring will not necessarily directly destroy small infaunal organisms living within the sediment; the bottom disturbance would most likely change the environment to such an extent that the majority of the directly impacted infauna community would not survive (e.g., burial or relocation to sediment layers without sufficient oxygen). In cases of carbonate outcrops or reefs with attached epifauna, the impacted area of disturbance may be small in absolute terms, but it could be large in relation to the area inhabited by hard corals or other organisms that rely on exposed rock substrate.

As described in the previous section for chemosynthetic communities, normal pipelaying activities in deepwater areas could destroy large areas of benthic communities (it is assumed that 0.32 ha of bottom is disturbed per kilometer of pipeline installed.); although, without consideration of chemosynthetic organisms, there are no differences between this activity in deep water as compared to shallow-water operations.

In addition to direct physical impacts, structure removals and other bottom-disturbing activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cuttings discussed below.

Discharges

In deep water, discharges of drilling muds and cuttings at the surface are spread across broader areas of the seafloor and are, in general, distributed in thinner accumulations than in shallower areas on the continental shelf. Recent information about the effects of surface discharge of muds and cuttings at a well in 565 m is reported by Gallaway and Beaubien (1997) and is described in the previous section on chemosynthetic communities. In this instance and in another deepwater survey reported by Nunez (personal communication, 1994), muds and cuttings were documented in accumulations ranging up to 30 cm thick at distances up to 610 m from the well site.

Impact from muds and cuttings are also expected from two additional sources: (1) initial well drilling prior to the use of a riser to circulate returns to the surface; and (2) the potential use of various riserless drilling techniques in the deep sea. Jetted or drilled cuttings discharged at the bottom from the initial wellbore would total as much as 226 m^3 (Halliburton Company, 1995). In the case of some riserless drilling practices, all muds and cuttings from well spudding through total depth would be discharged at the seafloor. Although the full areal extent and depth of burial from these activities is not known, the potential impacts are expected to be localized and short term. Since these areas would occupy only a minuscule portion of the available seafloor in the deepwater Gulf of Mexico, these impacts are not considered significant provided that sensitive communities (e.g., chemosynthetic communities) are avoided.

Burial by sediments or rock fragments originating from drilling muds and cuttings discharges could smother and kill almost all community components of benthic organisms, with the exception of highly motile fish and possibly some crustaceans such as shrimp capable of moving away from the impacted area. Depending on the organism type, just a few centimeters of burial could cause death. The damage would be both mechanical and toxicological. Some types of macrofauna could burrow through gradual accumulations of overlying sediments depending on the toxicological effects of those added materials. Information on the potential toxic effects on various benthic organisms is limited and essentially nonexistent for deepwater taxa.

It can be expected that detrimental effects due to burial would decrease exponentially with distance from the origin. The physical properties of the naturally occurring surface sediment (grain size, porosity, and pore water) could also be changed as a result of discharges such that recolonizing benthic organisms would be comprised of different species than inhabited the area previous to the impact. Although the impacts could be considered severe to the nonmotile benthos in the immediate area affected, they would be considered very temporary. Due to the proximity of undisturbed bottom with similar populations of benthic organisms from microbenthos to megafauna, these impacts would be very localized and reversible at the population level and are not considered significant.

Carbonate outcrops not associated with chemosynthetic communities, such as the deepwater coral "reef" or habitat reported by Moore and Bullis (1960), are considered to be most at risk from oil and gas operations. Due to the fact that deepwater corals require hard substrate, existing communities completely buried by some amount of sediment would likely never recover.

Effluents other than muds or cuttings from routine OCS operations in deep water would be subject to rapid dilution and dispersion and are not projected to reach the seafloor at depths greater than 100 m.

Proposed Action Analysis

For a proposed action in the WPA, 4-5 oil and gas structures ranging from small subsea developments to large developments involving floating, fixed, or subsea structures are estimated to be installed between 2001 and 2040 in Subareas W200-800, W800-1600, W1600-2400, and W>2400 (Table 4-3). These deepwater production structures are expected to be installed 5-10 years after a proposed lease sale, with a peak annual rate of 1-2. Physical disturbance or destruction of a limited area of benthos or to a limited number of megafauna organisms, such as brittle stars, sea pens, or crabs, would not result in a major impact to the deepwater benthos ecosystem as a whole. Surface discharge of muds and cuttings, as opposed to seafloor discharge, would reduce or eliminate the impact of smothering the benthic communities on the bottom.

Under the current review procedures for chemosynthetic communities, carbonate outcrops are targeted as one possible indication (surface anomaly on 3D seismic survey data) that chemosynthetic seep communities are nearby. Unique communities that may be associated with any carbonate outcrops or other topographical features could be identified via this review along with the chemosynthetic communities. Typically, all areas suspected of being hard bottom are avoided as a geological hazard for any well sites. Any proposed activity in water depth greater than 400 m would automatically trigger the NTL 2000-G20 evaluation described above.

Summary and Conclusion

Some impact to benthic communities from drilling and production activities would occur as a result of physical impact from structure placement (including templates or subsea completions), anchoring, and installation of pipelines regardless of their locations. Megafauna and infauna communities at or below the sediment/water interface would be impacted from the muds and cuttings normally discharged at the seafloor at the start of every new well prior to riser installation. The impact from muds and cuttings discharged at the surface are expected to be low in deep water. Drilling muds would not be expected to reach the bottom beyond a few hundred meters from the surface-discharge location, and cuttings would be dispersed. Even in situations where substantial burial of typical benthic communities occurred, recolonization from populations from neighboring substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of days for bacteria and probably less than one year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be very rare. These unique communities are distinctive and similar in nature to protected pinnacles and topographic features on the continental shelf. Any hard substrate communities located in deep water would be particularly sensitive to impacts from OCS activities. Impacts to these sensitive habitats could permanently prevent recolonization with similar organisms requiring hard substrate.

A proposed action in the WPA is expected to cause little damage to the ecological function or biological productivity of the widespread, typical deep-sea benthic communities.

4.3.1.3. Impacts on Water Quality

Activities that are projected to result from a single lease sale in the WPA are given in Table 4-3. The routine activities that will impact water quality include

- discharges during drilling of exploration and development wells;
- workover of a well;
- structure installation and removal;
- discharges during production;
- installation of pipelines;
- service vessel discharges; and
- discharges from support facilities.

The current NPDES General Permit for OCS discharges in USEPA Region 6 (WPA and western CPA) will expire in April 2004.

4.3.1.3.1. Coastal Waters

In coastal waters, the water quality will be impacted by the discharges from the service vessels in port. The types of discharges and regulations were discussed in Chapters 4.1.1.3.4.8 and 4.1.2.1.10.2. Most discharges are treated prior to release, with the exception of ballast water. In coastal waters, bilge water may be discharged with an oil content of 15 ppm or less. The discharges will affect the water quality locally. Estimates of the volume of bilge water that may be discharged are not available.

Supporting infrastructure also discharge into local waterways as a part of their business. The types of onshore facilities were discussed in Chapter 4.1.2.1.10.1. All point-source discharges are regulated by the USEPA, which is the agency responsible for coastal water quality. Run-off is not regulated and may add hydrocarbon and trace-metal pollutants. Data are not available to make estimates of the impact from this type of discharge.

The dredging of navigation channels and the installation of pipelines will result in a temporary increase in the suspended sediment load.

Summary and Conclusion

The primary impacting sources to water quality in coastal waters are point-source and nonpoint-source discharges from support facilities and vessel discharges. The impacts to coastal water quality from a proposed action in the WPA should be minimal as long as all regulatory requirements are met.

4.3.1.3.2. Marine Waters

Drilling Muds and Cuttings

The primary effects on water quality during the drilling of exploratory and development wells result from the discharges of drilling fluids, called "muds," and cuttings. Table 4-9 gives estimated volumes of muds and cuttings that may be discharged from drilling of an "average" well. The MMS estimates that each lease sale in the WPA will result in 37-115 exploratory and delineation wells and 97-166 development wells being drilled over 35 years. Using the data in Table 4-9, discharges of 500,000-1,000,000 bbl of water-based drilling fluids (WBF) and 70,000-150,000 bbl of associated cuttings are estimated from drilling these wells. The direct discharge of synthetic-based drilling fluids (SBF) is prohibited, however some fluid adheres to the cuttings and an estimated 30,000-70,000 of SBF may be discharged with the estimated 30,000-60,000 bbls of SBF-associated cuttings.

Drill cuttings deposited on the seafloor are representative of the geological formations below the seafloor. The cuttings will include clastic (e.g., sand, silt, and clay), carbonate (e.g., limestone), and evaporite (e.g., salt) rock fragments. They may contain a variety of naturally occurring metals. Silicon, aluminum, iron, and calcium are typically abundant in cuttings, while elements such as cadmium, vanadium, and mercury are found in trace quantities. These elements are unlikely to leach from cuttings into water in any appreciable amounts because they are chemically bound within the rock minerals and therefore not available for biological assimilation. Of environmental concern is the physical impact of the cuttings deposition to the benthic habitat and the potential toxicity of drilling fluid adhered to the cuttings.

The fate and effects of WBF have been extensively studied throughout the world (Engelhardt et al., 1989). The primary concerns for WBF are the increased turbidity in the water column, alteration of sediment characteristics because of coarse material in cuttings, and trace metals. Occasionally, formation fluids may be discharged with the cuttings adding hydrocarbon contamination. Water based drilling fluids are rapidly dispersed in the water column immediately after discharge and descend to the seafloor (Neff, 1987). The greatest effects to the benthos are within 100-200 m, primarily due to the increased coarsening of the sediment by cuttings. Most of the components of drilling fluid have low toxicity with the exception of some trace metals. Barium is the major element in the mud because of the high barite level, but trace amounts of chromium, copper, cadmium, mercury, lead, and zinc are also present. Significant elevations of all these metals except chromium were observed within 500 m of six Gulf of Mexico drilling sites on the continental shelf (Boothe and Presley, 1989). The USEPA guidelines limit the levels of cadmium and mercury in stock barite to 3.0 milligrams/kilogram (mg/kg) and 1.0 mg/kg (dry weight), respectively. A study of chronic impacts from oil and gas activities (Kennicutt, 1995) determined that metals from discharges, including mercury and cadmium, were localized to within 150 m of the structure. Highest levels of metal contaminants were attributed to a platform where discharges are shunted to within 10 m of the bottom.

A recent literature review (Neff et al., 2000) discusses the current knowledge about the fate and effects of SBF on the seabed. Like oil-based drilling fluids (OBF), the SBF do not disperse in the water column and therefore are not expected to adversely affect water quality. They do, however, settle very close to the discharge point, thus affecting the local sediments. Unlike OBF, SBF do not typically contain toxic aromatic compounds. The primary affects are smothering, alteration of grain size, and addition of organic matter, which can result in localized anoxia while the SBF degrade. Different formulations of SBF use different base fluids that degrade at different rates, thus affecting the impact. The SBF cuttings can pass the current discharge criterion for WBF because of their low toxicity. Bioaccumulation tests also indicate that SBF and their degradation products should not significantly bioaccumulate. It is expected that discharged cuttings should degrade within 2-3 years after cessation of discharge. The MMS is currently jointly funding a study of the spatial and temporal effects of discharged cuttings to evaluate the effects. In deep water (>400 m), the use of dual density drilling techniques may result in the discharge of cuttings at the seafloor. The cuttings will not have undergone any cleaning process to remove the drilling fluids, and the impacts of these discharges are not known.

Produced Water

During production, produced water is the primary discharge and will impact water quality by adding hydrocarbons and trace metals to the environment. As discussed in Chapter 4.1.1.3.4.2, the volume of produced water from a facility ranges from 2 to 150,000 bbl/day. With a monthly average of 29 milligrams/liter (mg/l), the volume of added hydrocarbons would be 5.8 x 10^{-5} bbl/day. As a result of a single lease sale in the WPA, MMS estimates that 11-15 production structures will be installed (Table 4-3). Examination of historical data for produced water extracted from blocks in the Gulf of Mexico (Table 4-10) demonstrates that, on average for the past five years, 7,580 bbl of produced water are generated per block per year. As can be seen in Figure 4-3, most of the produced water is extracted in the CPA, with very little in the WPA. Most fields in the WPA produce gas and very little water as opposed to those in the CPA. Assuming that each production structure produces an average of 7,580 bbl/yr of water and the discharge averages 29 mg/l, then approximately 0.2-0.3 bbl/yr of hydrocarbons are added to the environment from each structure. This amount is negligible relative to natural sources of hydrocarbons. Discharges from workovers and other activities are generally mixed with the produced water and therefore must meet the same criteria.

Several studies have been conducted to evaluate the effects of produced-water discharges from platforms on the surrounding water column, sediments, and biota (e.g. Rabalais et al., 1991; Kennicutt, 1995; CSA, 1997b). The GOOMEX study (Kennicutt, 1995) examined the effects of discharges at three natural gas platforms. Effects, including increased hydrocarbons, trace metals, and coarser grain size sediments, were observed within 150 m of the platform. Localized hypoxia was observed during the summer months and attributed to stratification of the water column and increased organic material near the platform. The distribution of contaminants was patchy and there were several variables that could contribute to the observations, specifically sand from cuttings, hydrocarbons, and trace metals in the porewater. It was not possible to make a definitive judgment as to the precise source of observed toxic effects in the benthic community.

A bioaccumulation study (CSA, 1997b) examined trace metals and hydrocarbons in several fish and invertebrate species near platforms on the continental shelf. The produced-water discharge and ambient seawater were also analyzed for the same compounds. Of the 60 target chemicals, only 2 (arsenic and cadmium) were measured in the edible tissues of mollusks at levels above the USEPA risk-based concentrations. The target organic compounds were not present in most tissue samples above the target level. However, radium isotopes were measured in 55 percent of the samples, but at low concentrations.

Measurements of radium in formation water range from 40 to 1,000 picocuries/liter (pCi/l). These values are greater than marine waters, but when formation waters are discharged offshore, the radium is rapidly diluted to ambient concentrations and the higher levels are not seen as a problem (Reid, 1980).

Other Impacting Activities

Platform installation and removal results in localized sediment suspension. Also, the installation of pipelines can increase the local total suspended solids. These activities result in only a temporary adverse effect on water quality.

Supply-vessel traffic affects water quality through discharges of bilge water, ballast water, and domestic and sanitary wastes. Bilge water and sanitary wastes are treated before discharge. Ballast water is uncontaminated water but may come from a source with properties, such as lower or higher salinity, different from those of the receiving waters. Estimates of the volumes of these discharges are not available.

Summary and Conclusion

During exploration and development drilling activities, the primary impacting sources to marine water quality are discharges of drilling fluids and cuttings. Impacting discharges during production activities are produced water and supply-vessel discharges. Impacts to marine waters from a proposed action in the WPA should be minimal as long as all regulatory requirements are followed.

4.3.1.4. Impacts on Air Quality

The following activities will potentially degrade air quality: platform construction and emplacement; platform operations; drilling activities; flaring; seismic-survey and support-vessel operations; pipeline laying and burial operations; evaporation of volatile petroleum hydrocarbons during transfers and from surface oil slicks; and fugitive emissions. Supporting materials and discussions are presented in Chapters 3.1.1 (description of the coastal air quality status of the Gulf coastal area), 4.1.1.3.6 (air emissions), 4.1.1.3.9 (hydrogen sulfide), and 9.1.3 (description of the meteorology of the northern Gulf of Mexico). The parameters of this analysis are emission rates, surface winds, atmospheric stability, and the mixing height.

Emissions of certain air pollutants are known to be detrimental to public health and welfare. Some of these pollutants are directly emitted into the air, while others are formed in the atmosphere through chemical reactions. Nitric oxide and nitrogen dioxide constitute nitrogen oxide (NO_x) emissions. Nitrogen dioxide, a by-product of all combustion processes, is emitted from sources such as internal combustion engines, natural gas burners, and flares. Nitrogen dioxide is a precursor pollutant involved in photochemical reactions that yield ozone. Nitrogen dioxide is an irritating gas that may increase susceptibility to infection and may constrict the airways of people with respiratory problems. Further, nitrogen dioxide can react with water to form nitric acid, which is harmful to vegetation and materials, as a result of increased acidity in precipitation (i.e., the acid rain).

Carbon monoxide (CO) is a by-product of incomplete combustion, primarily contained in engine exhaust. Carbon monoxide is readily absorbed into the body through the lungs, where it reacts with hemoglobin in the blood, reducing the transfer of oxygen within the body. CO particularly affects people with cardiovascular and chronic lung diseases.

Sulfur dioxide (SO_2) may cause constriction of the airways and particularly affects individuals with respiratory diseases. Sulfur dioxide reacts in the atmosphere, principally with water vapor and oxygen, producing sulfuric acid, which along with nitric acid are the major constituents of acid rain. Acid rain can be harmful to animals, vegetation, and materials. The flaring of natural gas containing hydrogen sulfide (H_2S) and the burning of liquid hydrocarbons containing sulfur (Chapter 4.1.1.3.9) result in the formation of SO_2. The amount of SO_2 produced is directly proportional to the sulfur content of the hydrocarbons being flared or burned.

The concentration of the H_2S varies substantially from formation to formation and even varies to some degree within the same reservoir. In the deepwater projects, the natural gas has been mainly sweet (i.e., low in sulfur content), but the oil is averaging between 1 and 4 percent sulfur content by weight.

Flaring of sour gas is of concern because it could significantly impact onshore areas, particularly when considering the short-duration averaging periods (3 and 24 hr) for SO_2. The combustion of liquid hydrocarbon fuel is the primary source of sulfur oxides (SO_x), when considering the annual averaging period; however, impacts from high-rate well cleanup operations can generate significant SO_2 emissions. To prevent inadvertently exceeding established criteria for SO_2 for the 3-hr and 24-hr averaging periods, all incinerating events involving H_2S or liquid hydrocarbons are evaluated individually during the postlease process.

Volatile organic compounds (VOC's) are precursor pollutants involved in a complex photochemical reaction with NO_x in the atmosphere to produce ozone. The primary sources of VOC's result from venting and evaporative losses that occur during the processing and transporting of natural gas and petroleum products. A more concentrated source of VOC's is from vents on glycol dehydrator stills.

Particulate matter is comprised of finely divided solids or liquids such as dust, soot, fumes, and aerosols. The PM_{10} particles are small enough to bypass the human body's natural filtration system and can be deeply inhaled into the lungs, affecting respiratory functions. The PM_{10} can also affect visibility, primarily due to scattering of light by the particles and, to a lesser extent, light absorption by the particles.

Ozone is a nearly colorless gas with a faint but distinctive odor, somewhat similar to chlorine. It is formed in the troposphere (i.e., lower level of the atmosphere) from complex chemical reactions involving VOC's and NO_x in the presence of sunlight. At ground level, ozone can cause or aggravate respiratory problems, interfere with photosynthesis, and can damage vegetation and crack rubber. Children, the elderly, and healthy people who work or exercise strenuously outdoors are particularly sensitive to elevated ozone concentrations. In the upper atmosphere (i.e., above the troposphere), ozone is essential to life as we know it. The upper ozone layer shields the Earth's surface from harmful ultraviolet radiation. Depletion of the upper ozone layer is one of the most complex environmental issues facing the world today. This analysis will not include impacts on upper atmospheric ozone.

Emissions of air pollutants will occur during exploration, development, and production activities. The profile of typical emissions for exploratory and development drilling activities (Chapter 4.1.1.3.6) shows that emissions of NO_x are the most prevalent pollutant of concern. These emission estimates are based on a drilling scenario of a 4,115-m (13,500-ft) hole during exploration activities and a 3,050-m (10,000-ft) hole during development activities. Emissions during exploration are higher than emissions during development due to power requirements for drilling a deeper hole.

Platform emission rates for the Gulf of Mexico region (Chapter 4.1.1.3.6) are provided from the 1992 emission inventory of OCS sources compiled by MMS (Steiner et al., 1994). This compilation was based on information from a survey of 1,857 platforms, which represented an 85 percent response rate. Since these responses included all the major oil and gas production facilities, they were deemed representative of the type of emissions to be associated with a platform. The NO_x and VOC's are the primary pollutants of concern, since both are considered to be precursors to ozone. Emission factors for other activities such as support vessels, helicopters, tankers, and loading and transit operations were obtained from Jacobs Engineering Group, Inc. (1989) and USEPA AP-42 (1985).

Flaring is the venting and/or burning of natural gas from a specially designed boom. Flaring systems are also used to vent gas during well testing or during repair/installation of production equipment. The MMS operating regulations provide for some limited volume, short duration flaring or venting of some natural gas volumes upon approval by MMS. These operations may occur for short periods (typically 2-14 days) as part of unloading/testing operations that are necessary to remove potentially damaging completion fluids from the well bore, to provide sufficient reservoir data for the operator to evaluate a reservoir and development options, and in emergency situations. Emissions from flaring were included in the emissions tables and in the modeling analysis (since platform emissions included flaring along with all other sources).

Accidents, such as oil spills, blowouts and pipeline ruptures, are another source of emissions related to OCS operations. The potential impacts from these accidental events are discussed in Chapter 4.4.3.4.

Once pollutants are released into the atmosphere, atmospheric transport and dispersion processes begin circulating the emissions. Transport is carried out by the prevailing net wind circulation. During summer, the wind regime in the WPA is predominantly onshore at mean speeds of 3-4 m/sec (6.7-9.0 mph). Average winter winds are complex. The predominant winds blow from the north and south, averaging 4-8 m/sec (8.9-17.9 mph); the east and west winds are weaker and less frequent, although the easterly component is more common than the westerly component. Since the north and south winds nearly balance each other out, the resulting mean wind vector is from the northeast at about 2 m/sec (4.4 mph).

Dispersion depends on emission height, atmospheric stability, mixing height, exhaust gas temperature and velocity, and wind speed. For emissions inside the atmospheric boundary layer, the vertical heat flux, which includes effects from wind speed and atmospheric stability (via air-sea temperature differences), is a better indicator of turbulence available for dispersion (Lyons and Scott, 1990). Heat flux calculations in the WPA (USDOI, MMS, 1988) indicate an upward flux year-round, being highest during winter and lowest in summer.

The mixing height is very important because it determines the space available for spreading the pollutants. The mixing height is the height, above the surface, of the top of the layer through which vigorous vertical mixing occurs. Vertical mixing is most vigorous during unstable conditions. Vertical motion is suppressed during stable conditions; these stagnant conditions generally result in the worst periods of air quality. Although mixing height information throughout the Gulf of Mexico is scarce, measurements near Panama City (Hsu, 1979) show that the mixing height can vary between 400 and 1,300 m, with a mean of 900 m. The mixing height tends to be higher in the afternoon, more so over land than over water. Further, the mixing height tends to be lower in winter, with daily changes smaller than in summer.

Proposed Action Analysis

The emissions in tons of the criteria pollutants over the 40-year life of a proposed action are indicated in Table 4-33. The major pollutant emitted is NO_x, while PM_{10} is the least emitted pollutant. Combustion-intensive operations such as platform operations, well drilling, and service-vessel activities contribute mostly NO_x; platform operations are also the major contributors of VOC emissions. Platform construction emissions contribute appreciable amounts of all pollutants over the life of a proposed action. These emissions are temporary in nature and generally occur for a period of 3-4 months. Typical construction emissions result from the derrick barge placing the jacket and various modular components and from various service vessels supporting this operation. Drilling operations contribute considerable amounts of all pollutants. These emissions are temporary in nature and typically occur over a 40-day drilling period. Support activities for OCS activities include crew and supply boats, helicopters, and pipeline vessels; emissions from these sources consist mainly of NO_x and CO. These emissions are directly proportional to the number and type of OCS operations requiring support activities. Most emissions from these support activities occur during transit between the port and the offshore facilities; a smaller percentage of the emissions occur during idling at the platform. Platform and well emissions were calculated using the integration of projected well and platform activities over time.

Total emissions for each offshore subarea in the WPA due to a proposed action are presented in Table 4-34. Activities projected for Subarea W0-60 would generate the greatest amounts of emissions, while the other five subareas are estimated to generate lower amounts of pollutants. Pollutants are distributed to subareas proportional to the projected number of production structure installations slated for those areas.

The total pollutant emissions per year are not uniform. During the early years of a proposed action, emissions would be small. Emissions increase over time with platform emplacements and increasing production. After reaching a maximum, emissions would decrease as wells are depleted and abandoned, platforms are removed, and service-vessel trips and other related activities are no longer needed.

The peak-year emissions in tons per year for the criteria pollutants are indicated in Table 4-35. The peak-year emissions for a proposed action in the WPA are projected to occur in the 2015-2018 timeframe. The peak emissions are calculated by combining peak-year activity total emissions for exploratory wells, development wells, and platforms over the life of a proposed action, and superimposing projected peak activity for support vessels and other emissions into that peak year. Peak well-drilling activities and platform emissions are not necessarily simultaneous. It is assumed for this analysis that total well and platform peak-year emissions combined with vessels and other emissions occur simultaneously. Use of the peak emissions provides the most conservative estimates of potential impacts to onshore air quality. The main pollutant emitted is NO_x, with platforms and service vessels being the primary source.

Projected peak-year activities would generate the greatest amounts of emissions in offshore Subarea W0-60 (Table 4-36). Pollutants are distributed to offshore subareas proportional to the projected number of production structure installations slated for each subarea.

The MMS regulations (30 CFR 250.44) do not establish annual significance levels for CO and VOC. For CO, a comparison of the projected emission rate to the MMS exemption level will be used to assess impacts. The formula to compute the emission rate in tons/yr for CO are $3,400 \bullet D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility. Offshore Texas, the CO exempt emission level is 14,819 tons/yr at the State boundary line of 3 leagues, which is greater than CO peak emissions from the whole WPA.

The VOC emissions are best addressed as their corresponding ozone impacts, which were studied in the Gulf of Mexico Air Quality Study (GMAQS). The GMAQS indicated that OCS activities have little impact on ozone exceedance episodes in coastal nonattainment areas including the Houston/Galveston, Port Arthur/Lake Charles and Baton Rouge areas. Total OCS contributions to the exceedance (greater than 120 ppb) episodes studied were less than 2 ppb. In the GMAQS, the model was also run using double emissions from OCS petroleum development activities and the resulting attributable ozone concentrations, during modeling exceedance episodes, were still small, ranging 2-4 ppb. The activities under this proposed action will not result in a doubling of the emissions, and because the proposed activities are substantially smaller than this worst-case scenario, it is logical to conclude that their impact would be substantially smaller as well (Systems Applications International et al., 1995). Additionally, 30 CFR 250.303(f)(2) requires that if a facility would significantly impact (defined as exceeding the MMS significance levels) an onshore nonattainment area, then it would have to reduce its impact fully through the application of the best available control technology (BACT) and possibly through offsets as well.

The implementation of the new 8-hour ozone standard, a Federal standard that is still pending court action, may affect the ozone level in coastal areas from OCS emissions. The new 8-hour ozone standard (0.08 ppm) is more stringent than the existing 1-hour standard. Thus, if the new 8-hour standard is implemented, it could result in more areas being classified as nonattainment for ozone. This may include a number of parishes in Louisiana as well as counties in Mississippi and the Florida Panhandle.

A new modeling analysis will be conducted using OCS emissions data of the year 2000. The results will be used to investigate the potential effects of OCS emissions on 8-hour average ozone levels in the near future. However, it is expected that the impact on ozone level due to contribution from OCS emissions sources would be minor, because the emission from all sources would remain about the same level or less (sea also Draft EIS on the proposed OCS Oil and Gas Leasing Program: 2002-2007; USDOI, MMS, 2001c).

It is estimated that over 99 percent of the gas and oil will be piped to shore terminals. Thus, fugitive emissions associated with tanker and barge loadings and transfer will be small, as will the associated exhaust emissions. Safeguards to ensure minimum emissions from any offloading and loading operations of OCS crude oil production from surface vessels at ports have been adopted by the State of Texas. Current industry practice is to transport OCS-produced oil and gas via pipeline whenever feasible.

The MMS studied the impacts of offshore emissions using the Offshore and Coastal Dispersion (OCD) Model. Three large areas in the WPA were modeled. The limiting factor on the size of each area was the run time needed to process the number of sources. The areas modeled were offshore Corpus Christi Bay, Matagorda Bay, and Galveston Bay. The receptors were set along the coastline and also a short distance inland in order to capture coastal fumigation. Circular areas were chosen to reduce edge effect. The areas were selected to best capture most of the offshore sources and to focus on the highly concentrated areas of development. Emissions for a proposed action were projected and compared to the emission inventory for the GMAQS. Ratios between these two sets of total emission rates were developed and applied to the GMAQS inventory; this modified inventory was then used as the database for the sources for the OCD modeling. Only the onshore maximum concentrations reported for all of the runs are discussed. The results of the runs are reported in Table 4-37. The results are also compared with the federally allowable increases in ambient concentrations as regulated by 30 CFR 250.45(g) and 40 CFR 51.166(c).

Table 4-37 lists the highest predicted contributions to onshore pollutant concentrations from OCS activities, as well as the maximum allowable increases over a baseline concentration established under the air quality regulations. While the table shows that OCS activities would result in concentration increases that are well within the maximum allowable limits for a Class II area, a direct comparison between the two sets of figures is not possible. This is because the actual maximum allowable increase depends on the net change in emissions from all other sources in the area, both offshore and onshore, since the date the baseline level was established. Sources that were already in place at the applicable baseline date are included in the establishment of the baseline and corresponding concentration and do not count in the determination of the maximum allowable increment. The PM_{10} are emitted at a substantially smaller rate than NO_2 and SO_2; hence, impacts from PM_{10} would be expected to be even smaller since chemical decay was not employed in this dispersion modeling. As a proposed action in the WPA would represent approximately 1 percent of OCS activities in the WPA, emissions from activities resulting from a proposed action would be substantially below the maximum allowable limits for a Class II area.

Gaseous and fine particulate matter in the atmosphere can potentially degrade the atmospheric visibility. The visibility degradation is primarily due to the presence of particulates with the size in the range of 1 to 2 microns. The sources of these particulates may come from fuel burning and the chemical transformation of the atmospheric constituents. The chemical transformation of NO_2, SO_2, and VOC may produce nitrates, sulfates, and carbonaceous particles. High humidity also may contribute tot he visibility impairment in the Gulf coastal areas. Visibility is considered an important resource in the Breton National Wilderness Area, a Federal Class I area. Because future air emission from all sources in the area are expected to be about the same level or less, it is expected that the impact on visibility due to the presence of fine particulates would be minor.

Suspended particulate matter is important because of its potential in degrading visibility and because of its potential health effects at high concentrations. The impact depends on emission rates and particle size. Particle size represents the equivalent diameter (diameter of a sphere) that will have the same settling velocity as the particle. Particle distribution in the atmosphere has been characterized as being largely trimodal (Godish, 1991), with two peaks located at diameters smaller than 2 μm and a third peak with diameters larger than 2 μm. Particles with diameters of 2 μm or larger settle very close to the source (residence time of approximately ½ day, Lyons and Scott, 1990). For particles smaller than 2 μm, which do not settle fast, wind transport determines their impacts. Projected PM_{10} concentrations are expected to have a low impact.

Summary and Conclusion

Emissions of pollutants into the atmosphere from the activities associated with a proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. Emissions from proposed-action activities are not expected to have concentrations that would change onshore air-quality classifications. The OCD modeling results show that increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than the maximum increases allowed in the PSD Class II areas.

4.3.1.5. Impacts on Marine Mammals

The major impact-producing factors affecting marine mammals as a result of routine OCS activities include the degradation of water quality from operational discharges; noise generated by helicopters, vessels, operating platforms, and drillships; vessel traffic; explosive structure removals; seismic surveys; and jetsam and flotsam from service vessels and OCS structures. These major factors may affect marine mammals in the Gulf at several temporal and spatial scales that result in acute or chronic impacts.

Discharges

Produced waters, drill muds, and drill cuttings are routinely discharged into offshore marine waters and are regulated by the USEPA's NPDES permits. Most operational discharges are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API, 1989; NRC, 1983; Kennicutt, 1995). Any potential impacts from drilling fluids would be indirect, either as a result of impacts to prey species or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of marine mammals or species lower in the marine food web. Marine mammals generally are inefficient assimilators of petroleum compounds in prey (Neff, 1990). Analyses of samples from stranded Gulf of Mexico bottlenose dolphins showed high levels of organochlorides and heavy metals (e.g., Salata et al., 1995; Kuehl and Haebler, 1995). Many heavy metals presumably are acquired from food, but the ultimate sources are poorly known (API, 1989). Adequate baseline data is not available to determine the significant sources of contaminants that accumulate in Gulf cetaceans or their prey, due in no small part to the fact that contaminants are introduced into the Gulf of Mexico from a suite of national and international watersheds. Many cetaceans are wide-ranging animals, which also compounds the problem. It is known that neritic cetacean species tend to have higher levels of metals than those frequenting oceanic waters (Johnston et al., 1996). Oceanic cetaceans feeding on cephalopods have higher levels of cadmium in their tissues than comparable fish-eating species (Johnston et al., 1996). There also is, in many cases, a striking difference between the relatively high mercury levels in the toothed whales and the lower levels found in baleen whales, which is probably attributable to the different prey species consumed by baleen whales, as well as differences in the habitat (Johnston et al., 1996).

Aircraft

Aircraft overflights in proximity to cetaceans can elicit a startle response. Whales often react to aircraft overflights by hasty dives, turns, or other abrupt changes in behavior. Responsiveness varies widely depending on factors such as the activity the animals are engaged in and water depth (Richardson et al., 1995). Whales engaged in feeding or social behavior are often insensitive to overflights. Whales in confined waters, or those with calves, sometimes seem more responsive. This behavioral response could be a result of noise and/or visual disturbance. The effects appear to be transient, and there is no indication that long-term displacement of whales occur. Absence of conspicuous responses to an aircraft does not show that the animals are unaffected; it is not known whether these subtle effects are biologically significant (Richardson and Würsig, 1997).

Vessel Traffic

Of 11 species known to have been hit by vessels, fin whales are struck most frequently, sperm whales are hit commonly, and records of collisions with Bryde's whales are rare (Laist et al., 2001). Fin whales are rare, sperm whales are common, and Bryde's whales are uncommon in the Gulf of Mexico.) Data compiled of 58 collisions indicate that all sizes and types of vessels can collide with whales; the majority of collisions appear to occur over or near the continental shelf; most lethal or severe injuries are caused by ships 80 m or longer; whales usually are not seen beforehand or are seen too late to be avoided; and most lethal or severe injuries involve shops traveling 14 kn or faster. Vessel collisions can significantly affect small populations of whales, such as northern right whales in the western North Atlantic (Laist et al., 2001).

Increased traffic from support vessels involved in survey, service, or shuttle functions will increase the probability of collisions between vessels and marine mammals occurring in the area. These collisions can cause major wounds on cetaceans and/or be fatal (e.g., northern right whale, Kraus, 1990, and Knowlton et al., 1997; bottlenose dolphin, Fertl, 1994; sperm whale, Waring et al., 1997). Debilitating injuries may have negative effects on a population through impairment of reproductive output. Slow-moving cetaceans (e.g., northern right whale) or those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., sperm whale) might be expected to be the most vulnerable. Smaller delphinids often approach vessels that are in transit to bow-ride. It would seem that delphinids are agile enough to easily avoid being struck by vessels. However, there are occasions that dolphins are either not attentive (due to behaviors they are engaged in or perhaps because of their age/health) or there is too much vessel traffic around them, and they are struck by screws. Nowacek and Wells (2001) found that bottlenose dolphins had longer interbreath intervals during boat approaches compared to control periods (no boats present within 100 m) in a study conducted in Sarasota Bay, Florida. They also found that dolphins decreased interanimal distance, changed heading, and increased swimming speed significantly more often in response to an approaching vessel than during control periods.

Toothed whales (and baleen whales, to a lesser extent) show some tolerance of vessels, but may react at distances of several kilometers or more when confined by environmental features or when they learn to associate the vessel with harassment. Evidence suggests that certain whales have reduced their use of certain areas heavily utilized by ships (Richardson et al., 1995), possibly avoiding or abandoning important feeding areas, breeding areas, resting areas, or migratory routes. The continued presence of various cetacean species in areas with heavy boat traffic indicates a considerable degree of tolerance to ship noise and disturbance. An experiment involving playback of low-frequency sound in the Canary Islands suggests that sperm whales from an area that has heavy vessel traffic have a high tolerance for noise (Andre et al., 1997). There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or growth, unless they occur frequently.

Long-term displacement of animals, in particular baleen whales, from an area is also a possibility. It is not known whether toothed whales exposed to recurring vessel disturbance are stressed or otherwise affected in a negative, but inconspicuous way (Richardson et al., 1995). Stress or "alert" responses could occur quite early during an encounter. For example, Myrick and Perkins (1995) found stress responses occurring as early as the chase stage in purse-seine netting on dolphins.

It is possible that manatees could occur in coastal areas where vessels traveling to and from the leased sites could affect them. If a manatee should be present where there is vessel traffic, they could be injured or killed by a boat striking them (Wright et al., 1995). Inadequate hearing sensitivity at low frequencies may be a contributing factor to the manatees' inability to effectively detect boat noise and avoid collisions with boats (Gerstein et al., 1999).

Drilling and Production Noise

Exploration, delineation, and production structures, as well as drillships, produce an acoustically wide range of sounds at frequencies and intensities that can be detected by cetaceans. Some of these sounds could mask cetaceans' reception of sounds produced for echolocation and communication. Odontocetes use sounds at frequencies that are generally higher than the dominant sounds generated by offshore drilling and production activities. Low-frequency hearing has not been studied in many species, but bottlenose dolphins can hear sounds at frequencies as low as 40-125 Hz. Below 1 kHz, where most OCS-industry noise energy is concentrated, sensitivity seems poor (Richardson et al., 1995). Pilot whales and sperm whales changed their behavior (in particular, ceased vocalizations) during low-frequency transmissions from the Heard Island Feasibility Test in the southern Indian Ocean (Bowles et al., 1994); this throws doubt on the assumed insensitivity of odontocete hearing at low frequencies. Baleen whales mainly utter low-frequency sounds that overlap broadly with the dominant frequencies of many industrial sounds. There are indirect indications that baleen whales are sensitive to low- and moderate-frequency sounds (Richardson et al., 1995). Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies, averaging 5 Hz and 10-500 Hz, respectively (Richardson et al., 1995). There is particular concern for baleen whales that are apparently more dependent on low-frequency sounds than are other marine mammals; many OCS-industry sounds are concentrated at low frequencies. Drillships produce higher levels of underwater noise than other types of platforms. There are few published data on underwater noise levels near production platforms and on the marine mammals near those facilities (Richardson et al., 1995). However, underwater strong noise levels may often be low, steady, and not very disturbing (Richardson et al., 1995). Stronger reactions would be expected when sound levels are elevated by support vessels or other noisy activities (Richardson et al., 1995).

Human-made sounds may affect the ability of marine mammals to communicate and to receive information about their environment (Richardson et al., 1995). Such noise may interfere with or mask the sounds used and produced by these animals and thereby interfere with their natural behavior. These sounds may frighten, annoy, or distract marine mammals and lead to physiological and behavioral disturbances. The response threshold may depend on whether habituation (gradual waning of behavioral responsiveness) or sensitization (increased behavioral responsiveness) occurs (Richardson et al., 1995). Sounds can cause reactions that might include disruption of marine mammals' normal activities (behavioral and/or social disruption) and, in some cases, short- or long-term displacement from areas important for feeding and reproduction (Richardson et al., 1995). The energetic consequences of one or more disturbance-induced periods of interrupted feeding or rapid swimming, or both, have not been evaluated quantitatively. Energetic consequences would depend on whether suitable food is readily available. Of the animals responding to noise, females in late pregnancy or lactating would probably be most affected. Human-made noise may cause temporary or permanent hearing impairment in marine mammals if the noise is strong enough. Such impairment would have the potential to diminish the individual's chance for survival. Tolerance of noise is often demonstrated, but this does not prove that the animals are unaffected by noise; for example, they may become stressed, making the animal(s) more vulnerable to parasites, disease, environmental contaminants, and/or predation. Noise-induced stress is possible, but little studied in marine mammals. Aversive levels of noise might cause animals to become irritable, affecting feed intake, social interactions, or parenting; all of these effects might eventually result in population declines (Bowles, 1995).

Structure Removals

A limited amount of information is available on the effects of explosions on marine mammals (O'Keeffe and Young, 1984; Ketten, 1998). The shock wave produced by explosions can cause physical damage to nearby animals. The potential for injury is associated with gas-containing internal organs, such as the lungs and intestines (Yelverton et al., 1973). Data are limited regarding blast-induced auditory damage. Explosions and shock waves and their intense transient sound field have the ability to produce blast injury and acoustic trauma in marine mammals (Ketten, 1995 and 1998). Consequences of hearing damage may range from subtle modification of certain behaviors that require a modicum of hearing ability to acute, where concussive effects may lead to death (Ketten, 1995).

For example, two humpback whales were found with damage to their ear bones following an explosion in Newfoundland (Ketten et al., 1993). Yet other humpback whales in Newfoundland, foraging in an area of explosive activity, showed little behavioral reaction to the detonations in terms of decreased residency, overall movements, or general behavior, though orientation ability appeared to be affected (Todd et al., 1996). Todd et al. (1996) suggested caution in interpretation of the lack of visible reactions as indication that whales are not affected or harmed by an intense acoustic stimulus; both long- and short-term behavior as well as anatomical evidence should be examined. The researchers interpreted increased entrapment rate of humpback whales in nets as the whales being influenced by the long-term effects of exposure to deleterious levels of sound.

Odontocetes cannot hear well in the frequencies emitted by explosive detonations (Richardson et al., 1995). The animals may not be able to hear the pulse generated from open-water detonations of explosive charges because it is very brief (*Federal Register*, 1995a). Sublethal effects would include a startle response. Even if dolphins are not capable of hearing the acoustic signature of the explosion, physiological, pathological, or behavioral responses to detonations may still result. The NMFS (USDOC, NMFS, 1995) cites such examples as detection of low-frequency sound by some mechanism other than conventional hearing and harassment due to tactile stings from the shock wave accompanying detonations. Impacts resulting from resuspension of bottom sediments due to explosive detonation include increased water turbidity and mobilization of sediments containing hydrocarbon extraction waste (*Federal Register*, 1995a). Because of its temporary effect, no impacts to higher life forms are expected, and, because of its temporary and localized nature, biomagnification is unlikely.

The extent of potential injury is dependent upon the amount of explosive used, distance from the charge, and body mass of the cetacean. As explained in detail in the USDOC, NMFS (1995), it may be assumed that marine mammals more than 3,000 ft (910 m) from structures to be removed would avoid injury caused by explosions. There is no evidence linking dolphin injuries or deaths in the Gulf to explosive removal of structures (Klima et al., 1988; Gitschlag et al., 1997). In October 1995, NMFS issued regulations authorizing and governing the taking of bottlenose and spotted dolphins incidental to the removal of gas drilling and production structures in State waters and on the Gulf of Mexico OCS for a period of five years (*Federal Register*, 1995a). Those regulations are currently being reviewed and revised by MMS and NOAA Fisheries.

In order to minimize the likelihood of removals occurring when cetaceans may be nearby, MMS has issued guidelines (NTL 2001-G08) for removing offshore structures with explosives to offshore operators. These guidelines specify explosive removals only during daylight hours, staggered detonation of explosive charges, placement of charges 5 m below the seafloor, and pre- and post-detonation aerial surveys within one hour before and after detonation. Trained observers watch for sea turtles and marine mammals in the vicinity of the structures to be removed.

Seismic Surveys

The MMS has almost completed a programmatic EA on G&G permit activities in the Gulf of Mexico (USDOI, MMS, in preparation). The EA includes a detailed description of the seismic surveying technologies, energy output, and operations; these descriptions are incorporated here by reference. Seismic surveys use a high-energy noise source. During Irish Sea seismic surveys, pulses were audible on hydrophone recordings above the highly elevated background ship noise at least up to the 20-km range (Goold and Fish, 1998). Although the output of airgun arrays is usually tuned to concentrate low-frequency energy, a broad frequency spectrum is produced, with significant energy at higher frequencies (e.g., Goold and Fish, 1998). These energies encompass the entire audio frequency range of 20 Hz to 20 kHz (Goold and Fish, 1998) and extend well into the ultrasonic range up to 50 kHz.

Baleen whales seem quite tolerant of low- and moderate-level sound pulses from distant seismic surveys but exhibit behavioral changes in the presence of nearby seismic activity (Richardson et al., 1995). Subtle effects on surfacing, respiration, and dive cycles have been noted (Richardson et al., 1995; Richardson, 1997). Response appears to diminish gradually with increasing distance and decreasing sound level (Richardson, 1997). Bowhead and gray whales often show strong avoidance within 6-8 km of an airgun array. Humpback whales off western Australia were found to change course at 3-6 km from an operating seismic survey vessel, with most animals keeping a standoff range of 3-4 km (McCauley et al., 1998a and b). Humpback whale groups containing females involved in resting behavior in key habitat types were more sensitive than migrating animals and showed an avoidance response estimated at 7-12 km from a large seismic source (McCauley et al., 2000). Whales exposed to sound from distant seismic survey ships may be affected even though they remain in the area and continue their normal activities (Richardson et al., 1995). For baleen whales, in particular, it is not known (1) whether the same individuals return to areas of previous seismic exposure, (2) whether seismic work has caused local changes in distribution or migration routes, or (3) whether whales that tolerate strong seismic pulses are stressed (Richardson et al., 1995). Individually identified gray whales remained in Puget Sound long after the seismic survey (as is normal), despite being exposed to noise (Calambokidis and Osmek, 1998; Bain et al., 1999).

Goold (1996) found that acoustic contacts with common dolphins in the Irish Sea dropped sharply as soon as seismic activity began, suggesting a localized disturbance of dolphins. It was also estimated that seismic energy from the 2,120-in^3 airgun array in a shelf sea environment was safe to common dolphins at a radius from the gun array of 1 km (Goold and Fish, 1998). Given the high, broadband seismic-pulse power levels across the entire recorded bandwidth and the known auditory thresholds for several dolphin species, Goold and Fish (1998) considered such seismic emissions to be clearly audible to dolphins across a bandwidth of tens of kilohertz and at least out to the 8-km range.

Sperm whales during the Heard Island Feasibility Test were found to cease calling during some (but not all) times when seismic pulses were received from an airgun array >300 km away (Bowles et al., 1994) (whether sperm whales were responding directly to the seismic pulses is not known). In contrast, there are observations of sperm whales in the Gulf continuing to vocalize while seismic pulses are ongoing (Evans, personal communication, 1999). One report of Gulf of Mexico sperm whales suggested that the animals may have moved 50+ km away in response to seismic pulses (Mate et al., 1994), but further work suggests that the animals may not have moved in response to the sound, but perhaps relative to oceanographic features and prey distribution. It is unclear whether the well-documented, continued occurrence of sperm whales in the area off the mouth of the Mississippi River is a consequence of low sensitivity to seismic sound or a high motivation to remain in the area. Sperm whales have historically occupied this area; their continued presence might suggest habituation to the seismic signals. During the MMS-sponsored GulfCet II study on marine mammals, results showed that the cetacean sighting rate did not change significantly due to seismic exploration signals (Davis et al., 2000). The analysis of the results was unable to detect small-scale (<100 km) changes in cetacean distribution. Results of passive acoustic surveys to monitor sperm whale vocal behavior and distribution in relation to seismic surveys in the northeast Atlantic revealed few, if any, effects of airgun noise (Swift et al., 1999). The authors suggested that sperm whales in that area may be habituated to seismic surveys and/or responses may occur at scales to which the research was not sensitive.

No obvious behavior modifications relative to the seismic activity were recorded during the majority of the small odontocete observations made during marine mammal monitoring carried out during a 3D seismic survey offshore California in late 1995 (Arnold, 1996). There was also no observable behavior modification or harassment of large whales attributable to the sound effects of the survey (Arnold, 1996).

There are no data on auditory damage in marine mammals relative to received levels of underwater sound pulses (Richardson et al., 1995). Indirect "evidence" suggests that extended or repeated exposure to seismic pulses is unlikely to cause permanent hearing damage in marine mammals given a study of damage risk criteria; the transitory nature of seismic exploration; the presumed ability of marine mammals to tolerate exposure to strong calls from themselves or other nearby mammals; and the avoidance responses that occur in at least some baleen whales, when exposed to certain levels of seismic pulses (Richardson et al., 1995).

Flotsam and Jetsam

In recent years, there has been increasing concern about manmade debris (discarded from offshore and coastal sources) and its impact on the marine environment (e.g., Shomura and Godfrey, 1990; Laist, 1997). Both entanglement in and ingestion of debris has caused the death or serious injury of marine mammals (Heneman and the Center for Environmental Education, 1988; MMC, 1998). The debris items most often found entangling animals are net fragments and monofilament line from commercial and recreational fishing boats, as well as strapping bands and ropes probably from all types of vessels. Plastic bags and small plastic fragments are the most commonly reported debris items in the digestive tracts of cetaceans and manatees (e.g., Barros and Odell, 1990; Tarpley and Marwitz, 1993; Laist, 1997; MMC, 1998). Many types of plastic materials are used during drilling and production activities; the offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore (Miller et al., 1995). The MMS prohibits the disposal of equipment, containers, and other materials into coastal and offshore waters by lessees (30 CFR 250.40). Prohibition of the discharge and disposal of vessel- and offshore structure-generated garbage and solid waste items into both offshore and coastal waters was established January 1, 1989, via the enactment of MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which the USCG enforces. Accidental release of debris from OCS activities is known to occur offshore, and such flotsam may injure or kill cetaceans.

Proposed Action Analysis

The major impact-producing factors affecting marine mammals as a result of routine OCS activities include the degradation of water quality from operational discharges; noise generated by helicopters, vessels, operating platforms, and drillships; vessel traffic; explosive structure removals; seismic surveys; and jetsam and flotsam from service vessels and OCS structures.

Information on drilling fluids, drill cuttings, and produced waters that would be discharged offshore as a result of a proposed action is provided in Chapter 4.1.1.3.4. Some effluents are routinely discharged into offshore marine waters. It is expected that cetaceans may have some interaction with these discharges. Direct effects to cetaceans are expected to be sublethal. It should be noted, however, that any pollution in the effluent could poison and kill or debilitate marine mammals and adversely affect the food chains and other key elements of the Gulf ecosystem (Tucker & Associates, Inc., 1990). Because OCS discharges are diluted and dispersed in the offshore environment, impacts to cetaceans are expected to be negligible.

Helicopter activity projections are 110,000-410,000 trips over the life of a proposed action (Table 4-3) or 2,820-10,513 trips annually. The FAA Advisory Circular 91-36C encourages pilots to maintain higher than minimum altitudes (noted below) over noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. In addition, guidelines and regulations promulgated by NOAA Fisheries under the authority of the Marine Mammal Protection Act do include provisions specifying helicopter pilots to maintain an altitude of 1,000 ft within 100 yd (91 m) of marine mammals. It is unlikely that cetaceans would be affected by routine OCS helicopter traffic operating at these altitudes, provided pilots do not alter their flight patterns to more closely observe or photograph marine mammals that they see. It is expected that about 10 percent of helicopter trips would occur at altitudes below the specified minimums listed above as a result of inclement weather. Routine overflights may elicit a startle response from, and interrupt cetaceans nearby (depending on the activity of the animals) (Richardson et al., 1995). Occasional overflights probably have no long-term consequences on cetaceans; however, frequent overflights could have long-term consequences if they repeatedly disrupt vital functions, such as feeding and breeding. Frequent overflights are expected in coastal and Federal neritic waters. Generally, overflights are less frequent the further from shore the OCS facilities being serviced are located; however, many offshore fields are supported by resident helicopters that results in increased localized overflights. The area supported by a resident helicopter is dependent in part on the size of the field that it supports. Temporary disturbance to cetaceans may occur on occasion as helicopters approach or depart OCS facilities if animals are near the facility. Such disturbance is believed negligible.

An estimated 25,000-36,000 OCS-related, service-vessel trips are expected to occur over the life of a proposed action (Table 4-3). The rate of trips would be about 641-923 trips/yr. Noise from service-vessel traffic may elicit a startle and/or avoidance reaction from cetaceans or mask their sound reception. There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity. Long-term displacement of animals from an area is also a consideration. It is not known whether toothed whales exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased ship traffic could increase the probability of collisions between ships and marine mammals, resulting in injury or death to some animals. Smaller delphinids may approach vessels that are in transit to bow-ride. Limited observations on an NMFS cruise off the mouth of the Mississippi River in the summer of 2000 indicated that sperm whales appeared to avoid passing service vessels. However, marine mammalogists conducting surveys in the CPA during the summer of 2001 documented an adult killer whale that bore conspicuous and aged scarring across its back that were indubitably the result of a collision with a motor vessel. A manatee was unintentionally hit and killed by a boat off Louisiana (Schiro et al., 1998). Another manatee was killed by vessel traffic (type of vessel unknown) in Corpus Christi Bay in October 2001 (Beaver, personal communication, 2001). It appears there is limited threat posed to smaller, coastal delphinids where the majority of OCS vessel traffic occurs. As exploration and development of petroleum resources in oceanic waters of the northern Gulf increases, OCS vessel activity will increase in these waters, thereby increasing the risk of vessel strike to sperm whales and other deep-diving cetaceans (e.g., *Kogia* and beaked whales). Deep-diving whales are more vulnerable to vessel strikes because of the extended surface period required to recover from extended deep dives. Manatees are rare in the western and central Gulf, consequently, there is little risk posed by OCS vessel traffic.

A total of 37-115 exploration wells and 97-166 development wells are projected to be drilled as a result of a proposed action (Table 4-3). A total of 11-15 production structures are projected to be installed as a result of a proposed action (Table 4-3). These wells and platforms could produce sounds at intensities and frequencies that could be heard by cetaceans. It is expected that noise from drilling activities would be relatively constant and last no longer than four months per well. Odontocetes echolocate and communicate at higher frequencies than the dominant sounds generated by drilling platforms. Sound levels in this range are not expected to be generated by drilling operations (Gales, 1982). Bottlenose dolphins, one of the few species in which low-frequency sound detection has been studied, have been found to have poor sensitivity levels at the level where most OCS-industry noise energy is concentrated. There is some concern for baleen whales since they are apparently more dependent on low-frequency sounds than other marine mammals; however, except for the Bryde's whale, baleen whales are extralimital or accidental in occurrence in the Gulf. During GulfCet surveys, Bryde's whale was sighted only in the EPA; these sightings were in waters deeper than 100 m (Davis et al., 2000). Therefore, Bryde's whale would not likely be subjected to OCS drilling and production noise. Potential effects on Gulf of Mexico marine mammals include disturbance (subtle changes in behavior, interruption of previous activities, or short- or long-term displacement); masking of calls from conspecifics, reverberations from own calls, and other natural sounds (e.g., surf, predators); stress (physiological); and hearing impairment (permanent or temporary) by explosions and strong nonexplosive sounds.

Potential impacts to marine mammals from the detonation of explosives include lethal and injurious incidental take, as well as physical or acoustic harassment. Injury to the lungs and intestines and/or auditory system could occur. Harassment of marine mammals as a result of a noninjurous physiological response to the explosion-generated shock wave as well as to the acoustic signature of the detonation is also possible. It is estimated that 5-7 production structures resulting from a proposed action would be removed using explosives (Table 4-3). It is expected that structure removals would cause only minor behavioral changes and noninjurious physiological effects on cetaceans as a result of the implementation of MMS guidelines and NOAA Fisheries Observer Program for explosive removals (Chapter 4.1.1.3.3). To date, there are no documented "takes" of marine mammals resulting from explosive removals of offshore structures.

Many types of materials, including plastics, are used during drilling and production operations. Some of this material is accidentally lost overboard where cetaceans can consume it. The result of ingesting some materials lost overboard could be lethal. The relationship between the occurrence of these waste products and the quantities ingested that produce a lethal effect are unknown.

Summary and Conclusion

Small numbers of marine mammals could be killed or injured by chance collision with service vessels and by eating indigestible debris, particularly plastic items, lost from service vessels, drilling rigs, and fixed and floating platforms. Deaths due to structure removals are not expected due to existing mitigation measures or those being developed for structures placed in oceanic waters. There is no conclusive evidence whether anthropogenic noise has or has not caused long-term displacements of, or reductions in, marine mammal populations. Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification, although the scope of effects and their magnitude are not known.

The routine activities of a proposed action is not expected to have long-term adverse effects on the size and productivity of any marine mammal species or population stock endemic to the northern Gulf of Mexico.

4.3.1.6. Impacts on Sea Turtles

The major impact-producing factors resulting from the routine activities associated with a proposed action that may affect loggerhead, Kemp's ridley, hawksbill, green, and leatherback turtles include water-quality degradation from operational discharges; noise from helicopter and vessel traffic, operating platforms, and drillships; vessel collisions; brightly-lit platforms; explosive platform removals; and OCS-related trash and debris.

Discharges

Produced waters, drill muds, and drill cuttings are routinely discharged into offshore marine waters and are regulated by USEPA NPDES permits. Most operational discharges, as regulated, are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API, 1989; Kennicutt, 1995). Any potential that might exist for impact from drilling fluids would seem to be indirect, either by impact on prey items or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of sea turtles or species lower in the marine food web (for further information on bioaccumulation, see Chapter 4.1.1.3.4). Sea turtles may bioaccumulate chemicals such as heavy metals that occur in drilling mud. This might ultimately reduce reproductive fitness in the turtles, an impact that the already diminished population(s) cannot tolerate. Samples from stranded turtles in the Gulf of Mexico carry high levels of organochlorides and heavy metals (Sis et al., 1993).

Noise

There are no systematic studies published of the reactions of sea turtles to aircraft overflights, and anecdotal reports are scarce. However, it is assumed that aircraft noise could be heard by a sea turtle at or near the surface and cause the animal to alter its normal behavior pattern (Advanced Research Projects Agency, 1995). Noise from service-vessel traffic may elicit a startle reaction from sea turtles and produce a temporary sublethal stress (NRC, 1990). Startle reactions may result in increased surfacings, possibly causing an increase in risk of vessel collision. Reactions to aircraft or vessels, such as avoidance behavior, may disrupt normal activities, including feeding. Important habitat areas (e.g., feeding, mating, and nesting) may be avoided due to noise generated in the vicinity. There is no information regarding the consequences that these disturbances may have on sea turtles in the long term. If sound affects any prey species, impacts to sea turtles would depend on the extent that prey availability might be altered.

Drilling and production facilities produce an acoustically wide range of sounds at frequencies and intensities that could possibly be detected by turtles. Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies (Richardson et al., 1995). Sea turtle hearing sensitivity is not well studied. A few preliminary investigations using adult green, loggerhead, and Kemp's ridley turtles suggest that they are most sensitive to low-frequency sounds (Ridgway et al., 1969; Lenhardt et al., 1983; Moein Bartol et al., 1999). It has been suggested that sea turtles use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Lenhardt et al., 1983). Bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving structures (Lenhardt et al., 1983).

Noise-induced stress has not been studied in sea turtles. Captive loggerhead and Kemp's ridley turtles exposed to brief, audio-frequency vibrations initially showed startle responses of slight head retraction and limb extension (Lenhardt et al., 1983). Sound-induced swimming has been observed for captive loggerheads and greens (O'Hara and Wilcox, 1990; Moein Bartol et al., 1993; Lenhardt, 1994). Some loggerheads exposed to low-frequency sounds responded by swimming towards the surface at the onset of the sound, presumably to lessen the effects of the transmissions (Lenhardt, 1994). Sea turtles have been seen to begin to noticeably increase their swimming in response to an operating seismic source at 166 dB re-1µPa-m (measurement of sound level in water) (McCauley et al., 2000). The MMS has almost completed a programmatic EA on G&G permit activities in the Gulf of Mexico (USDOI, MMS, in preparation). The EA includes a detailed description of the seismic surveying technologies, energy output, and operations; these descriptions are incorporated here by reference. An anecdotal observation of a free-ranging leatherback's response to the sound of a boat motor suggests that leatherbacks may be sensitive to low-frequency sounds, but the response could have been to mid- or high-frequency components of the sound (Advanced Research Projects Agency, 1995). The potential direct and indirect impacts of sound on sea turtles include physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on the food chain. Low-frequency sound transmissions could potentially cause increased surfacing and avoidance from the area near the sound source (Lenhardt et al., 1983; O'Hara and Wilcox, 1990; McCauley et al., 2000). The potential for increased surfacing could place turtles at greater risk of vessel collisions and potentially greater vulnerability to natural predators.

Vessel Collisions

Data show that vessel traffic is one cause of sea turtle mortality in the Gulf (Lutcavage et al., 1997). Stranding data for the U.S. Gulf of Mexico and Atlantic coasts, Puerto Rico, and the U.S. Virgin Islands show that between 1986 and 1993 about 9 percent of living and dead stranded sea turtles had boat strike injuries (n=16, 102) (Lutcavage et al., 1997); however,vessel-related injuries were noted in 13 percent of stranded turtles examined from strandings in the Gulf of Mexico and on the Atlantic Coast during 1993 (Teas, 1994), but this figure includes those that may have been struck by boats post-mortem. In Florida, where coastal boating is popular, 18 percent of strandings documented between 1991 and 1993 were attributed to vessel collisions (Lutcavage et al., 1997). Large numbers of loggerheads and 5 to 50 Kemp's ridley turtles are estimated to be killed by vessel traffic per year in the U.S. (NRC, 1990; Lutcavage et al., 1997). Numbers of OCS-related vessel collisions with sea turtles offshore are unknown, but it is expected that some sea turtles will be impacted.

Brightly-lit Platforms

Brightly-lit, offshore drilling facilities present a potential danger to hatchlings (Owens, 1983). Hatchlings are known to be attracted to light (Raymond, 1984; Witherington and Martin, 1996; Witherington, 1997) and may orient toward lighted offshore structures (Chan and Liew, 1988). If this occurs, hatchling predation might increase dramatically since large birds and predatory fishes also congregate around structures (Owens, 1983; Witherington and Martin, 1996).

Structure Removals

Offshore structures serve as artificial reefs and are sometimes used by sea turtles (Gitschlag and Herczeg, 1994). The dominant species of turtle observed at explosive structure removals is the loggerhead, but leatherback, green, Kemp's ridley, and hawksbill have also been observed (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997). Loggerheads may reside at specific offshore structures for extended periods of time (Rosman et al., 1987b; Gitschlag and Renaud, 1989). The probability of occupation by sea turtles increases with the age of the structures (Rosman et al., 1987b). Sea turtles probably use platforms as places to feed and rest. Offshore structures afford refuge from predators and stability in water currents, and loggerheads have been observed sleeping under platforms or beside support structures (Hastings et al., 1976; Rosman et al., 1987b; Gitschlag and Renaud, 1989). Only near the Chandeleur and Breton Islands were sea turtles positively associated with platforms (Lohoefener et al., 1989 and 1990).

Information about the effects of underwater explosions on sea turtles is limited. O'Keeffe and Young (1984) assumed that shock waves would injure the lungs and other organs containing gas, expected that ear drums of turtles would be sensitive, and suggested that smaller turtles would suffer greater injuries from the shock wave than larger turtles. The NMFS conducted several studies before and after an explosive platform removal to determine its effects on sea turtles in the immediate vicinity (Duronslet et al., 1986; Klima et al., 1988). Immediately after the explosion, turtles within 3,000 ft of the platform were rendered unconscious (Klima et al., 1988), although they resumed apparently normal activity 5-15 minutes post-explosion (Duronslet et al., 1986). One of these turtles also sustained damage to the cloacal lining (it was everted) (Klima et al., 1988). Dilation of epidermal capillaries was a condition that continued for three weeks, after which time all turtles appeared normal. Effects on their hearing were not determined. Impacts of explosive removals on sea turtles are not easily assessed, primarily because turtle behavior makes observations difficult. Sea turtles in temperate latitudes generally spend less than 10 percent of their time at the surface, and dive durations can exceed one hour. Injured turtles that are capable of swimming may return to the surface, while moribund turtles may sink to the seafloor or drift away from the work site. Unconsciousness renders a turtle more susceptible to predation; effects of submergence on stunned turtles is unknown (Klima et al., 1988). The number of documented sea turtles impacted by explosives is two loggerheads during 1986-1994 (Gitschlag and Herczeg, 1994; NRC, 1996), one loggerhead in 1997 (Gitschlag, personal communication, 1999), one loggerhead in 1998 (Shah, personal communication, 1998), and one loggerhead in 2001 (Gitschlag, personal communication, 2001). A total of six additional sea turtles have been captured prior to detonation of explosives and saved from possible injury or death (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997). The low number of turtles affected by explosive removal of structures may be due to the few turtles that occur in harm's way at the time explosives are detonated, the effectiveness of the monitoring program established to protect sea turtles, and/or the inability to adequately assess and detect impacted animals.

In 1987, in response to 51 dead sea turtles that washed ashore on Texas beaches (explosions were identified as the primary cause by Klima et al., 1988), NMFS initiated an observer program at explosive removals of structures in State and Federal waters of the Gulf of Mexico. For at least 48 hours prior to detonation, NMFS observers watch for sea turtles at the surface. Helicopter surveys within a 1-mi radius of the removal site are conducted a minimum of 30 minutes prior to and after detonation (Gitschlag and Herczeg, 1994). If sea turtles are observed, detonations are delayed until the turtles have been safely removed or have left the area. Monitoring the water's surface for sea turtles is not 100 percent effective. Once observed, there is currently no practical and efficient means of removing a sea turtle from the area that will be impacted by explosives (Gitschlag and Herczeg, 1994). Although divers have had some success in capturing sea turtles, this procedure is limited to animals resting or sleeping beneath structures.

Even if turtles are not capable of hearing the acoustic properties of an explosion, physiological or behavioral responses (startle) to detonations may still result (USDOC, NMFS, 1995). Impacts resulting from resuspension of bottom sediments due to explosive detonation include increased water turbidity and mobilization of sediments containing hydrocarbon extraction waste (*Federal Register*, 1995a). Because of its temporary effect and localized nature, biomagnification is unlikely.

Jetsam and Flotsam

A wide variety of trash and debris is commonly observed in the Gulf. Marine trash and debris comes from a variety of land-based and ocean sources (Cottingham, 1988). Some material is accidentally lost during drilling and production operations. From March 1, 1994, to February 28, 1995, 40,580 debris items were collected in a 16-mi transect made along the Padre Island National Seashore (Miller et al., 1995). The offshore oil and gas industry was shown to contribute 13 percent of the trash and debris found in the transect. Turtles may become entangled in drifting debris and ingest fragments of synthetic materials (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988). Entanglement usually involves fishing line or netting (Balazs, 1985). Once entangled, turtles may drown, incur impairment to forage or avoid predators, sustain wounds and infections from the abrasive or cutting action of attached debris, or exhibit altered behavior that threaten their survival (Laist, 1987). Both entanglement and ingestion have caused the death or serious injury of individual sea turtles (Balazs, 1985). Balazs (1985) compiled dozens of records of sea turtle entanglement, ingestion, and impaction of the alimentary canal by ingested plastics, although tar was the most common item ingested. The marked tendency of leatherbacks to ingest plastic has been attributed to misidentification of the translucent films as jellyfish. Lutz (1990) concluded that turtles will actively seek out and consume plastic sheeting. Ingested debris may block the digestive tract or remain in the stomach for extended periods, thereby lessening the feeding drive, causing ulcerations and injury to the stomach lining, or perhaps even providing a source of toxic chemicals (Laist, 1987). Weakened animals are then more susceptible to predators and disease; they are also less fit to migrate, breed, or nest successfully.

The initial life history of sea turtles involves the hatching of eggs, evacuation of nests, and commencement of an open ocean voyage. Some hatchlings spend their "lost years" in sargassum rafts; ocean currents concentrate or trap floating debris in sargassum (Carr, 1987). Witherington (1994) studied post-hatchling loggerheads in drift lines 8-35 nmi east of Cape Canaveral and Sebastian Inlet, Florida. Out of 103 turtles captured, 17 percent of the animals contained plastic or other synthetic fibers in their stomachs or mouths. The Gulf of Mexico had the second highest number of turtle strandings affected by debris (35.9%) (Witzell and Teas, 1994). Although the Kemp's ridley is the second most commonly stranded turtle, they are apparently less susceptible to the adverse impacts of debris than the other turtle species for some unknown reason (Witzell and Teas, 1994). The MMS prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458) prohibits the disposal of any plastics at sea or in coastal waters.

Proposed Action Analysis

Information on drilling fluids, drill cuttings, and produced waters that would be discharged offshore as a result of a proposed action is provided in Chapter 4.1.1.3.4. These effluents are routinely discharged into offshore marine waters and are regulated by the USEPA's NPDES permits. Turtles may be affected by these discharges. Very little information exists on the impact of drilling muds on Gulf sea turtles (Tucker and Associates, Inc., 1990).

Structure installation, pipeline placement, dredging, blowouts, and water quality degradation can impact seagrass bed and live-bottom sea turtle habitats. These impacts are analyzed in detail in Chapter 4.2.1.1. A discussion of the causes and magnitude of wetland loss as a result of a proposed action can be found in Chapter 4.2.1.1.2. The seagrass and high-salinity marsh components of wetland loss would be indirectly important for sea turtles by reducing the availability of forage species that rely on these sensitive habitats. Little or no damage is expected to the physical integrity, species diversity, or biological productivity of live-bottom marine turtle habitat as a result of a proposed action because these sensitive resources are protected by several mitigation measures established by MMS.

An estimated 25,000-36,000 OCS-related, service-vessel trips are expected to occur over the life of a proposed action (Table 4-3). The rate of trips would be about 641-923 trips/yr. Transportation corridors would be through areas where sea turtles have been sighted. Helicopter activity projections are 110,000-410,000 trips over the life of a proposed action (Table 4-3) or 2,820-10,513 trips annually. Noise from service-vessel traffic and helicopter overflights may elicit a startle reaction from sea turtles; there is the possibility of short-term disruption of activity patterns. Sounds from approaching aircraft are detected in the air far longer than in water. For example, an approaching Bell 214ST helicopter became audible in the air over four minutes before passing overhead, while it was detected underwater for only 38 seconds at 3-m depth and for 11 seconds at 18-m depth (Greene, 1985 *in* Richardson et al., 1995). There are no systematic studies published concerning the reactions of sea turtles to aircraft overflights, and anecdotal reports are scarce. It is assumed that aircraft noise could be heard by a sea turtle at or near the surface and cause it to alter its activity (Advanced Research Projects Agency, 1995). In the wild, most sea turtles spend at least 3-6 percent of their time at the surface. Despite the brevity of their respiratory phases, sea turtles sometimes spend as much as 19-26 percent of their time at the surface, engaged in surface basking, feeding, orientation, and mating (Lutcavage et al., 1997). Sea turtles located in shallower waters have shorter surface intervals, whereas turtles occurring in deeper waters have longer surface intervals. It is not known whether turtles exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased vessel traffic will increase the probability of collisions between vessels and turtles, potentially resulting in injury or death to some animals.

A total of 37-115 exploratory wells and 97-166 development wells are projected to be drilled as a result of a proposed action (Table 4-3). A total of 11-15 production structures are projected as a result of a proposed action (Table 4-3). These structures could generate sounds at intensities and frequencies that could be heard by turtles. There is some evidence suggesting that turtles may be receptive to low-frequency sounds, which is at the level where most industrial noise energy is concentrated. Potential effects on turtles include disturbance (subtle changes in behavior, interruption of activity), masking of other sounds (e.g., surf, predators, vessels), and stress (physiological).

It is estimated that 5-7 production structures would be removed by explosives as a result of a proposed action (Table 4-3). Potential impacts to sea turtles from the detonation of explosives include death, injury, stress, and physical or acoustic harassment. Injury to the lungs and intestines, and/or auditory system could occur. It is expected that structure removals would cause chiefly sublethal effects on sea turtles as a result of MMS guidelines for explosive removals (Chapter 4.1.1.3.3). Since 1986 when explosive removals were identified as a potential source of "take" of sea turtles, there have been only five documented "takes" of loggerhead sea turtles attributed to explosive removals.

Sea turtles can become entangled in or ingest debris produced by exploration and production activities resulting from a proposed action. Leatherback turtles that mistake plastics for jellyfish may be more vulnerable to gastrointestinal blockage than other sea turtle species. The probability of plastic ingestion/entanglement is unknown.

Summary and Conclusion

Routine activities resulting from a proposed action have the potential to harm sea turtles. These animals could be impacted by the degradation of water quality resulting from operational discharges; noise generated by helicopter and vessel traffic, platforms, and drillships; brightly-lit platforms; explosive removals of offshore structures; vessel collisions; and jetsam and flotsam generated by service vessels and OCS facilities. Lethal effects are most likely to be from chance collisions with OCS service vessels and ingestion of plastic materials. "Takes" due to explosive removals are expected to be rare due to mitigation measures already established (e.g., NOAA Fisheries Observer Program) and in development. Most OCS activities are expected to have sublethal effects. Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification; there is uncertainty concerning the possible effects. Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas could cause declines in survival or fecundity, and result in either population declines; however, such declines are not expected. The routine activities of a proposed action are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or population in the Gulf of Mexico.

4.3.1.7. Impacts on Coastal and Marine Birds

This section discusses the possible effects of a proposed action in the WPA on coastal and marine birds of the Gulf of Mexico and its contiguous waters and wetlands. Major, potential impact-producing factors for marine birds in the offshore environment include OCS-related helicopter and service-vessel traffic and noise, air emissions, degradation of water quality, habitat degradation, and discarded trash and debris from service-vessels and OCS structures. Any effects are especially grave for intensively managed populations. For example, endangered and threatened species may be harmed by any impact on viable reproductive population size or disturbance of a few key habitat factors.

Proposed Action Analysis

Noise

The transportation or exchange of supplies, materials, and personnel between coastal infrastructure and offshore oil and gas structures is accomplished with helicopters, aircraft, and boats and a variety of service vessels. It is projected that 110,000-410,000 helicopter flights related to a proposed action in the WPA would occur over the life of a proposed action; this is a rate of 2,750-10,250 annual helicopter trips. Service vessels would use selected nearshore and coastal (inland) navigation waterways, or corridors, and adhere to protocol set forth by the USCG for reduced vessel speeds within these inland areas. It is projected that 25,000-36,000 service-vessel trips related to a proposed action in the WPA would occur in the life of a proposed action; this is a rate of 625-900 service-vessels trips annually.

Major concerns related to helicopter and service-vessel traffic are intense aversion, panic, and head injury following a bird's collision with helicopters or vessels. Disturbances from OCS-related helicopter or service-vessel traffic to coastal birds can result from the mechanical noise or physical presence (or wake) of the vehicle. The degree of disturbance exhibited by groups of coastal birds to the presence of air or vessel traffic is highly variable, depending upon the bird species in question, type of vehicle, altitude or distance of the vehicle, the frequency of occurrence of the disturbance, and the season. Helicopter and service-vessel traffic related to OCS activities could sporadically disturb feeding, resting, or nesting behavior. Disturbance can also lead to a permanent desertion of active nests or of critical or preferred habitat, which could contribute to the relocation of a species or group to less favorable areas or to a decline of species through reproductive failure resulting from nest abandonment. When birds are flushed prior to or during migration, the energy cost could be great enough that they might not reach their destination on schedule or they may be more susceptible to diseases (Anderson, 1995). Waterfowl are more overtly responsive to noise than other birds and seem particularly responsive to aircraft, possibly because aerial predators frequently harass them (Bowles, 1995). The FAA and corporate helicopter policy advise helicopters to maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas or across coastlines and 2,000 ft over populated areas and biologically sensitive areas such as wildlife refuges and national parks. Many undisturbed coastal areas and refuges provide preferred and/or critical habitat for feeding, resting (or staging), and nesting birds. The effect of low-flying aircraft within the vicinity of aggregations of birds on the ground or on the water typically results in mass disturbance and abandonment of the immediate area. However, pilots traditionally have taken great pride in not disturbing birds. Compliance to the specified minimum altitude requirements greatly reduces effects of aircraft disturbance on coastal and marine birds. Routine presence of aircraft at sufficiently high altitudes results in acclamation of birds to routine noise. As a result of inclement weather, about 10 percent of helicopter trips would occur at altitudes somewhat below the minimums listed above. Although these incidents are seconds in duration and sporadic in frequency, they can disrupt coastal bird behavior and, at worst, possibly result in habitat or nest abandonment. Birds in flight over water typically avoid helicopters. Low-flying aircraft may temporarily disrupt feeding or flight paths. Routine presence and low speeds of service vessels within inland and coastal waterways would diminish the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. Birds can lose eggs and young when predators attack nests after parents are flushed into flight by service-vessel noise.

Air Quality Degradation

Contamination of wildlife by air emissions can occur in three ways: inhalation, absorption, and ingestion. Inhalation is the most common mode of contamination for birds (Newman, 1980). The major effects of air pollution include direct mortality, debilitating injury, disease, physiological stress, anemia, hypocalcemic condition, bioaccumulation of air pollutants with associated decrease in resistance to debilitating factors, and population declines (Newman, 1979). Direct effects can be either acute, such as sudden mortality from hydrogen sulfide, or chronic, such as fluorosis from fluoride emissions. The magnitude of effect, acute or chronic, is a function of the pollutant, its ambient concentration, pathway of exposure, duration of exposure, and the age, sex, reproductive condition, nutritional status, and health of the animal at the time of exposure (Newman, 1980). For metals in air emissions, chemical composition as well as size of particulate compounds has been shown to influence the toxicity levels in animals. Particulate size affects retention time and clearance from and deposition in the respiratory tract (Newman, 1981).

Levels of sulfur oxide (mainly sulfur dioxide, SO_2) emissions from hydrocarbon combustion from OCS-related activities are of concern in relation to birds. Research specific to birds has elucidated both acute and chronic effects from SO_2 inhalation (Fedde and Kuhlmann, 1979; Okuyama et al., 1979). Due to their lack of tracheal submucosal glands, birds appear to have more tolerance for inhaled SO_2 than most mammals (Llacuna et al., 1993; Okuyama et al., 1979). This suggestion stems from laboratory investigations where the test subject was the domestic chicken and results from these studies are not necessarily applicable to wild bird species. Acute exposure of birds to 100 ppm SO_2 produced no alteration in heart rate, blood pressure, lung tidal volume, respiratory frequency, arterial blood gases, or blood pH.

Exposure to 100 ppm or less of SO_2 did not affect respiratory mucous secretion. Exposure to 1,000 ppm SO_2 caused mucus to increase and drip from the mouths of birds, but lungs appeared normal. Exposure to 5,000 ppm resulted in gross pathological changes in airways and lungs, and then death (Fedde and Kuhlmann, 1979). Chronic (two week) exposure of birds to three concentrations of SO_2 for 16 hr/day for various total periods showed a statistical change in 10 cellular characteristics and resulted in cellular changes characteristic of persistent bronchitis in 69 percent of the tests done (Okuyama et al., 1979).

The indirect effects of air emissions on wildlife include food web contamination and habitat degradation, as well as adverse synergistic effects of air emissions with natural and other manmade stresses. Air emissions can cause shifts in trophic structure that alter habitat structure and change local food supplies (Newman, 1980).

Air pollutants may cause a change in the distribution of certain bird species (e.g., Newman, 1977; Llacuna et al., 1993). Migratory bird species will avoid potentially suitable habitat in areas of heavy air pollution in favor of cleaner areas if available (Newman, 1979). The abundance and distribution of passerine birds, both active and sedentary, and migratory species, as well as nonpasserine and nonmigratory varieties, are also greatly affected by natural factors such as weather and food supply. Therefore, any reduction in the numbers of birds within a given locale does not have a diagnostic certainty pointing to air emissions (Newman, 1980).

Chapter 4.3.1.4 provides an analysis of the effects of a proposed action in the WPA on air quality. Emissions of pollutants into the atmosphere from the activities associated with a proposed action would have minimum effects on offshore and onshore air quality because of the prevailing atmospheric conditions, emission heights and rates, and pollutant concentrations. Estimated increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} would be less than 0.29, 0.03, and 0.01 micrograms/m^3, respectively, per modeled steady state concentrations. These concentrations are far below concentrations that could harm coastal and marine birds.

Water Quality Degradation

Chapter 4.3.1.3 provides an analysis of the effects of a proposed action in the WPA on water quality. Expected degradation of coastal and estuarine water quality resulting from of OCS-related discharges may affect coastal birds directly by means of acute or chronic toxic effects from ingestion or contact, or indirectly through the contamination of food sources. Operational discharges or runoff in the offshore environment could also affect seabirds (e.g., laughing gulls) that remain and feed in the vicinity of offshore OCS structures and platforms. These impacts could also be both direct and indirect.

Maintenance dredging operations remove several million cubic feet of material, resulting in localized impacts (primarily increased turbidity and resuspended contaminants) during the duration of the operations. Water clarity will decrease over time within navigation channels used for vessel operations and within pipeline canals due to continuous sediment influx from bank erosion, natural widening, and reintroduction of dredged material back into surrounding waters. A proposed action would result in very small incremental contribution to the need for channel maintenance. Coastal and marine birds that feed exclusively within these locations would likely experience chronic, sublethal physiological stress. Some coastal and marine birds would experience a decrease in viability and reproductive success that would be indistinguishable from natural population variations.

Habitat Degradation

The greatest negative impact to coastal and marine birds is loss or degradation of preferred or critical habitat. The extent of bird displacement resulting from habitat loss is highly variable between different species, based upon specific habitat requirements and availability of similar habitat in the area. Habitat requirements for most bird species are incompletely known. Generally, destruction of habitat from OCS pipeline landfalls and onshore construction displaces localized groups or populations of these species. As these birds move to undisturbed areas of similar habitat, their presence may augment habitat utilization pressure on these selected areas as a result of intra- and interspecific competition for space and food. Pipeline landfalls and terminals, and other onshore OCS-related construction, can destroy coastal bird feeding or nesting habitat and can displace coastal bird populations from affected areas. Onshore pipelines cross a wide variety of coastal environments, including freshwater marsh and canals, and can therefore affect certain species generally not associated with marine or estuarine systems. These include certain waders, marsh birds, shorebirds, and waterfowl.

The analysis of the potential impacts to coastal environments (Chapter 4.3.1.1) concludes that a proposed action in the WPA is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. Initial adverse impacts and more secondary impacts of pipeline and navigation canals are the most significant OCS-related and proposed-action-related impacts to wetlands. Initial impacts are locally significant and largely limited to where OCS-related canals and channels pass through wetlands. Secondary impacts may have substantial, progressive, and cumulative adverse impacts to the hydrologic basin or subbasin in which they are found.

Debris

Coastal and marine birds are susceptible to entanglement in floating, submerged, and beached marine debris; specifically in plastics discarded from both offshore sources and land-derived litter and waste disposal (Heneman and the Center for Environmental Education, 1988). Studies in Florida reported that 80 percent of brown pelicans showed signs of injury from entanglement with fishing gear (Clapp and Buckley, 1984). In addition, seabirds ingest plastic particles and other marine debris more frequently than do any other taxon (Ryan, 1990). Interaction with plastic materials may lead to permanent injuries and death. Ingested debris may have three basic effects on seabirds: irritation and blockage of the digestive tract, impairment of foraging efficiency, and release of toxic chemicals (Ryan, 1990; Sileo et al., 1990a). Effects of plastic ingestion may last a lifetime and may include physical deterioration due to malnutrition; plastics often cause a distention of the stomach, thus preventing its contraction and simulating a sense of satiation (Ryan, 1988). Some birds also feed plastic debris to their young, which could reduce survival rates. The chemical toxicity of some plastics can be high, posing a hazard in addition to obstruction and impaction of the gut (Fry et al., 1987). Sileo et al. (1990b) found that the prevalence of ingested plastic found within the gut of examined birds varied greatly among species. Species that seldom regurgitate indigestible stomach contents are most prone to the aforementioned adverse effects (Ryan, 1990). Within the Gulf of Mexico, these include the phalaropes, petrels, storm petrels, and shearwaters. It is expected that coastal and marine birds will seldom become entangled in or ingest OCS-related trash and debris as a result of MMS prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics, garbage, and other solid wastes at sea or in coastal waters, went into effect January 1, 1989, and is enforced by the USCG.

Summary and Conclusion

The majority of effects resulting from a proposed action in the WPA on endangered/threatened and nonendangered/nonthreatened coastal and marine birds are expected to be sublethal: behavioral effects, sublethal exposure to or intake of OCS-related contaminants or discarded debris, temporary disturbances, and displacement of localized groups from impacted habitats. Chronic sublethal stress, however, is often undetectable in birds. As a result of stress, individuals may weaken, facilitating infection and disease; then migratory species may not have the strength to reach their destination. No significant habitat impacts are expected to occur directly from routine activities resulting from a proposed action. Secondary impacts to coastal habitats will occur over the long-term and may ultimately displace species from traditional sites to alternative sites.

4.3.1.8. Impacts on Fish Resources and Essential Fish Habitat

Effects on fish resources and essential fish habitat (EFH) from activities associated with a proposed action could result from coastal environmental degradation, marine environmental degradation, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters. Potential effects from routine activities resulting from a proposed action in the WPA on fish resources and EFH are described below. Potential effects on the three habitats of particular concern for Gulf of Mexico fish resources (the Flower Garden Banks National Marine Sanctuary, Weeks Bay National Estuarine Research Reserve in Alabama, and Grand Bay in Mississippi and Alabama) are included under the analyses for topographic features (Chapter 4.3.1.2.1) and wetlands (Chapter 4.3.1.1.2). Potential effects from accidental events (blowouts and spills) are described in Chapter 4.4.3.1.8. Potential effects on commercial fishing from a proposed action are described in Chapter 4.3.1.9.

Healthy fish resources and fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Because of the wide variation of habitat requirements for all life history stages (as described in Chapter 3.2.9) for managed fish species in the WPA, the EFH for the Gulf of Mexico includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ). Collectively, the adverse impacts on coastal EFH and marine EFH are called, respectively, coastal and marine environmental degradation in this analysis.

Since the majority of fish species within the WPA are estuary dependent, coastal environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. The environmental deterioration and effects on EFH and fish resources result from the loss of Gulf wetlands and coastal estuaries as nursery habitat and from the functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992).

Wetlands and estuaries within Texas and Louisiana may be affected by activities resulting from a proposed action (Chapters 4.2.1.1.2, 4.3.1.1.2, and 4.4.3.1.2). These activities include construction of new onshore facilities in wetland areas, pipeline emplacement in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, inshore disposal of OCS-generated petroleum-field wastes, and spills from both coastal and offshore OCS-support activities.

Coastal water quality (Chapters 4.3.1.3.1 and 4.4.3.3.1) may be adversely affected by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions.

Since many of the fish species within the WPA are dependent on offshore water and live bottoms, marine environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. Offshore EFH includes both high- and low-relief live bottoms (pinnacles) and both natural (topographic features) and artificial reefs. Natural banks within the WPA are listed in Table 3-4. A detailed discussion of artificial reefs appears in Appendix 9.1.4. Three banks in the WPA are of particular importance; Stetson Bank and the East and West Flower Garden Banks now comprise the Flower Garden Banks National Marine Sanctuary and are considered EFH Habitat Areas of Particular Concern (HAPC). A proposed action could impact soft-bottom communities, hard-bottom communities (on high- and low-relief features), sand-bottom algal communities, and organisms colonizing scattered anthropogenic debris and artificial reefs. Impact-producing factors that could affect EFH include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, blowouts, and pipeline trenching. The impacts could include immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

The Topographic Features Stipulation (Chapter 4.1.3.1) would prevent most of the potential impacts from a proposed action on topographic feature communities (EFH) from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills.

Impact-producing factors from routine offshore activities that could result in marine water quality degradation include platform and pipeline installation, platform removal, and the discharge of operational wastes (Chapter 4.3.1.3.2). Offshore accidents including blowouts and spills from platforms, service vessels, and pipelines could also occur and potentially alter offshore water quality (Chapter 4.4.3.3.2). Coastal operations could indirectly affect marine water quality through the migration of contaminated coastal waters (Chapter 4.3.1.3.1).

Lessees are required to remove all structures and underwater obstructions from their leases in the Federal OCS within one year of the lease relinquishment or termination of production (Chapter 4.1.1.4). Seventy percent of the platforms in water depths less than 200 m are removed by severing their pilings with explosives placed 5 m below the seafloor. The concussive force is lethal to fish that have internal air chambers (swim bladders), are demersal, or are in close association with the platform being removed (Gitschlag et al., 2000; Scarborough-Bull and Kendall, 1992; Young, 1991). Within the past decade, stocks of reef fish have declined in the Gulf. There is concern over a possible connection between this decline and the explosive removal of platforms. To examine this issue of concern, MMS entered into a formal Interagency Agreement with NOAA Fisheries and has investigated fish death associated with structure removal. This study reported the evaluation of fish deaths from platform removals related to the status of reef fish stocks in the Gulf of Mexico. Results indicated that the number of red snapper and other commercial species killed during explosive platform removals is less than 1 percent of the annual harvest of those species from the Gulf of Mexico (Gitschlag et al., 2000). One significant result determined that for red snapper, even when mortality estimates were doubled, impacts were estimated to be small and would not alter current determinations of status or current management recovery strategies.

Chronic, low-level pollution is a persistent and recurring event resulting in frequent but sublethal physiological irritation to fish resources that lie within the range of impact and that are likely to be adversely affected by the pollution. The geographic range of the pollutant effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question (in this case hydrocarbons).

Drilling muds contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources; however, the discharge plume disperses rapidly, is very near background levels at a distance of 1,000 m, and is usually undetectable at distances greater than 3,000 m (Kennicutt, 1995) (Chapter 4.1.1.3.4.1). Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make drilling muds. There has recently been increased media focus on mercury uptake in fish and other marine species. An MMS-funded study titled *Gulf of Mexico Offshore Operations Monitoring Experiment* (Kennicutt, 1995) analyzed sediments at three sites in the GOM. Results of this study indicated that mercury levels were slightly elevated in sediments or organisms at one platform site (HI A-389). The average concentration of mercury at HI A-389 was twice as high as the other two platforms. The highest average concentration (0.41 ug/g) was found within 50 m of the platform but decreased to 0.12 ug/g at 100 m. Although these concentrations were the highest found, they were low relative to the probable effects level (0.7) believed to cause biological effects. This platform used the relatively rare practice of shunting drilling muds and cuttings to within 10 m of the seafloor to avoid dispersal and prevent impact to the nearby East Flower Garden Bank.

Metal concentrations were measured in tissues for 37 marine species. Fish tissue concentrations were generally low; for example, the average concentration was 0.45 ug/g for all flounder species, 0.39 ug/g all hake species, and 0.24 ug/g for all snapper species. Shrimp had statistically higher tissue concentrations (0.36 ug/g) near platforms than far (0.19 ug/g) from platforms. These values are well below the Federal guidelines set by FDA to protect human health, which is 1 ppm. Additional discussion of mercury in drilling muds can be found in Chapter 4.1.1.3.4.1.

In addition to toxic trace elements and hydrocarbons in produced waters, there are additional components and properties, such as hypersalinity and organic acids, that have a potential to adversely affect fishery resources. Produced waters that are discharged offshore are diluted and dispersed to very near background levels at a distance of 1,000 m and are undetectable at a distance of 3,000 m from the discharge point (Harper, 1986; Rabalais et al., 1991; Kennicutt, 1995).

Proposed Action Analysis

The effects of a proposed action on coastal wetlands and coastal water quality, with the exception of accidental events, are analyzed in detail in Chapters 4.3.1.1.2 and 4.3.1.3.1, respectively. Collectively, the adverse impacts from these effects are called coastal environmental degradation in this EIS. The effects of a proposed action on offshore live bottoms and marine water quality are analyzed in detail in Chapters 4.3.1.2.1 and 4.3.1.3.2, respectively. Collectively, the adverse impacts from these effects are called marine environmental degradation in this EIS. The direct and/or indirect effects from coastal and marine environmental degradation on fish resources and EFH are summarized and considered below.

Coastal Environmental Degradation

A proposed action is projected to increase traffic in navigation channels to and from service bases in Texas and Louisiana. This may result in some erosion of wetlands along the channels, particularly in Louisiana. Additional information regarding erosion along navigation channels is provided in the wetland analysis (Chapters 4.3.1.1.2).

One new landfall is projected fin support of a proposed action. Depending on the site of this projected pipeline landfall, the activities associated with the installation could result in localized impacts to the coastal environment including degradation of water quality and potential erosion and loss of wetlands habitat.

Localized, minor degradation of coastal water quality is expected in waterbodies in the immediate vicinity of coastal shore bases, commercial waste-disposal facilities, and oil refineries or gas processing plants as a result of routine effluent discharges and runoff. A proposed action in the WPA is projected to contribute about 1 percent of the OCS-Program-related use of these facilities.

Maintenance dredging of waterways and channels would result in decreased water clarity and some resuspension of contaminants. This could preclude, in rare instances, uses of those waters directly affected by the dredging operations for up to several months. The periods between projected dredging operations, ranging from 1-2 years, should generally allow for the recovery of affected areas. Only a small amount of the routine dredging done in coastal areas will be directly or indirectly due to a proposed action.

It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH. Wetlands that could be impacted for some period of time or converted to open water are discussed in the wetlands analysis (Chapter 4.3.1.1.2). Recovery of fish resources or EFH can occur from more than 99 percent, but not all, of the potential coastal environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation and most EFH can recuperate quickly, but the loss of wetlands as EFH could be permanent. At the expected level of effect, the resultant influence on fish resources or EFH from a proposed action would be negligible and indistinguishable from natural population variations.

Marine Environmental Degradation

The Topographic Features Stipulation would prevent most of the potential impacts from a proposed action on topographic-feature communities (EFH) from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills resulting from a proposed action. For any activities associated with a proposed action, USEPA's Region 6 will regulate discharge requirements for the WPA through their NPDES permits. Contaminant levels in the WPA are generally low, reflecting the lack of pollution sources and high-energy environment of much of the region. The primary water quality impact from any increased turbidity would be decreased water clarity. Bottom disturbance from emplacement operations associated with a proposed action would produce localized, temporary increases in suspended sediment loading, resulting in decreased water clarity and little reintroduction of pollutants.

The major sources of discharges associated with a proposed action to marine waters are the temporary discharge of drilling muds and cuttings and the long-term discharge of produced-water effluent. Both of these discharges contain various contaminants of concern (e.g., trace metals and petroleum-based organic) that may have environmental consequences on marine water quality and aquatic life. Drilling mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than concentrations found a few meters from the discharge point. Offshore discharges of drilling muds are expected to dilute to background levels within 1,000 m of the discharge point.

Produced-water discharges contain components and properties potentially detrimental to fish resources. Moderate petroleum and metal contamination of sediments and the water column are expected to occur out to several hundred meters downcurrent from the discharge point (CSA, 1997a). Offshore discharges of produced water are expected to disperse and dilute to background levels within 1,000 m of the discharge point and amount to less than 1 percent of the annual harvest of surveyed commercial species.

The projected total number of platform installations resulting from a proposed action in the WPA is 11-15 for all water depths. Ten years after a platform is installed, the structure would be acting as an artificial reef. About 99 percent of the species present would be residents and not new transients from nearby live bottoms. All structures associated with a proposed action are expected to be removed by 2037. Structure removal results in artificial habitat loss and causes fish kills when explosives are used. Most multi-leg platforms in water depths less than 156 m are removed by severing their pilings with explosives placed 5 m below the seafloor. It is projected that 5-7 structures in water depths <200 m in the WPA will be removed using explosives as a result of a proposed action. It is expected that structure removals would have a negligible effect on fish resources because these activities kill only those fish proximate to the removal site.

The projected length of pipeline installations for a proposed action if 320-640 km. Trenching for pipeline burial has the potential to adversely affect fish resources. It is assumed that 5.02 m^2 of sediments per kilometer of pipeline would be resuspended during the installation of 160-320 km of pipelines in water depths less than 60 m. Where pipeline burial is necessary, a jetting sled is generally used. Water jets are directed downward to dig a trench and the apparatus can lay pipe at an average of 1.6 km/day (see Chapters 4.1.1.3.8.1 and 4.1.2.1.7 for additional discussion of pipelaying activities). Sandy sediments would be quickly redeposited within 400 m of the trench or blowout site, and finer sediments would be widely dispersed and redeposited within a few thousand meters over a period of 30 days or longer. Any affected population is expected to recover to predisturbance condition in one generation. At the expected level of impact, the resultant influence on fish resources would be negligible and indistinguishable from other natural population variations.

It is expected that marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of marine environmental degradation is expected to cause an undetectable decrease in fish populations. Recovery of fish resources or EFH can occur from 100 percent of the potential marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation. Offshore live bottoms are not expected to be impacted. Offshore discharges and subsequent changes to marine water quality will be regulated by USEPA NPDES permits. At the expected level of effect, the resultant influence on fish resources or EFH would be negligible and indistinguishable from natural population variations.

Summary and Conclusion

It is expected that coastal and marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of coastal and marine environmental degradation is expected to cause an undetectable decrease in fish resources or in EFH. Fish resources and EFH are expected to recover from more than 99 percent, but not all, of the expected coastal and marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation, but any loss of wetlands as EFH would be permanent.

Offshore live bottoms will not be impacted. Offshore discharges and subsequent changes to marine water quality will be regulated by NPDES permits. At the expected level of impact, the resultant influence on fish resources and EFH would be negligible and indistinguishable from natural population variations.

Activities such as pipeline trenching and OCS discharge of drilling muds and produced water would cause negligible impacts and would not deleteriously affect fish resources or EFH. At the expected level of impact, the resultant influence on fish resources would cause less than a 1 percent change in fish populations or EFH. As a result, there would be little disturbance to fish resources or EFH.

A proposed action is expected to result in less than a 1 percent decrease in fish resources and/or standing stocks or in EFH. It would require one generation for fish resources to recover from 99 percent of the impacts. Recovery from the loss of wetlands habitat would probably not occur.

4.3.1.9. Impacts on Commercial Fisheries

Effects on commercial fishing from activities associated with a proposed action could result from installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, subsurface blowouts, pipeline trenching, and petroleum spills. The potential effects on fish resources and EFH from routine activities resulting from a proposed action in the WPA are described in Chapter 4.3.1.8. The potential effects from accidental events (blowouts and spills) are described in Chapter 4.4.3.10. The potential effects on commercial fishing from routine activities resulting from a proposed action are described below.

Healthy fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Due to the wide variation of habitat requirements for all life history stages (as described in Chapter 3.2.9) for species in the WPA, the EFH for the Gulf of Mexico includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ). Collectively, the adverse impacts on coastal EFH and marine EFH are called, respectively, coastal and marine environmental degradation in this analysis.

Since the majority of the commercial species harvested within the WPA are estuary dependent, coastal environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and commercial fisheries. Environmental deterioration and effects on EFH and commercial fisheries result from the loss of Gulf wetlands and coastal estuaries as nursery habitat and from the functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992).

Wetlands and estuaries in Texas and Louisiana may be affected by activities resulting from a proposed action (Chapters 4.3.1.1.2 and 4.4.3.1.2). These activities include construction of new onshore facilities in wetland areas, pipeline emplacement in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, inshore disposal of OCS-generated petroleum-field wastes, and spills from both coastal and offshore OCS-support activities.

Coastal water quality (Chapters 4.3.1.3.1 and 4.4.3.3.1) may be adversely affected by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions.

Since many of the fish species harvested within the WPA are dependent on offshore water and live bottoms, marine environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. Offshore EFH includes both high-relief and low-relief live bottoms (pinnacles) and both natural (topographic features) and artificial reefs. Natural banks within the WPA are listed in Table 3-4. A detailed description of artificial reefs appears in Appendix 9.1.4. Three banks in the WPA are of particular importance. Stetson Bank and the East and West Flower Garden Banks now comprise the Flower Garden Banks National Marine Sanctuary and are also considered EFH Habitat Areas of Particular Concern (HAPC). Activities resulting from a proposed action could impact soft-bottom communities, hard-bottom communities (on high- and low-relief features), sand-bottom algal communities, and organisms colonizing scattered anthropogenic debris and artificial reefs. Impact-producing factors that could affect EFH include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, blowouts, and pipeline trenching. The impacts could include immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

The Topographic Features Stipulation (Chapter 2.4.1.3) would prevent most of the potential impacts from a proposed action on topographic-feature communities/EFH from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills.

Impact-producing factors from routine offshore activities that could result in degradation of marine water quality include platform and pipeline installation, platform removal, and the discharge of operational wastes. Offshore accidents including blowouts and spills from platforms, service vessels, and pipelines could also occur and potentially alter offshore water quality (Chapter 4.4.3.3.2). Offshore water quality could also be impacted through migration of contaminated coastal waters (Chapter 4.4.3.3.1).

The area occupied by structures, anchor cables, and safety zones associated with a proposed action would be unavailable to commercial fishermen and could cause space-use conflicts. Exploratory drilling rigs would spend approximately 30-150 days onsite and would cause short-lived interference to commercial fishing. A bottom-founded, major production platform in shallow water, with a surrounding 100-m navigational safety zone, requires approximately 6 ha of space. A floating production system in deeper water requires as much as 5 ha of space. The use of FPSO's is not projected for a proposed action and the USCG has not yet determined what size of a navigational safety zone will be required for an FPSO during normal or offloading operations.

Underwater OCS obstructions, such as pipelines, can cause loss of trawls and catch, business downtime, and vessel damage. Pipelines in water depths less than 61 m (200 ft) are required to be buried, and their locations made public knowledge. Although Gulf fishermen are experiencing some economic loss from gear losses, the economic loss for a fiscal year has historically been less than 0.1 percent of the value of that same fiscal year's commercial fisheries landings. In addition, most financial losses from gear losses are covered by the Fishermen's Contingency Fund (FCF).

Lessees are required to remove all structures and underwater obstructions from their leases in the Federal OCS within one year of the lease relinquishment or termination of production (Chapter 4.1.1.4). Seventy percent of the platforms in water depths less than 200 m are removed by severing their pilings with explosives placed 5 m below the seafloor. The concussive force is lethal to fish that have internal air chambers (swim bladders), are demersal, or are in close association with the platform being removed (Gitschlag et al., 2000; Scarborough-Bull and Kendall, 1992; Young, 1991). Within the past decade, stocks of reef fish have declined in the Gulf. There is concern over a possible connection between this decline and the explosive removal of platforms. To examine this issue of concern, MMS entered into a formal Interagency Agreement with NOAA Fisheries and has investigated fish death associated with structure removal. This study reported the evaluation of fish deaths from platform removals related to the status of reef fish stocks in the Gulf of Mexico. Results indicated that the number of red snapper and other commercial species killed during explosive platform removals is less than 1 percent of the annual harvest of those species from the Gulf of Mexico (Gitschlag et al., 2000). One significant result determined that for red snapper, even when mortality estimates were doubled, impacts were estimated to be small, and would not alter current determinations of status or current management recovery strategies.

Chronic, low-level pollution is a persistent condition, resulting in frequent but sublethal physiological irritation to those resources that lie within the range of impact and that are likely to be adversely affected. The geographic range of the effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource.

Drilling muds contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources; however, the plume disperses rapidly, is very near background levels at a distance of 1,000 m, and is usually undetectable at distances greater than 3,000 m (Kennicutt, 1995) (Chapter 4.1.1.3.4.1). Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make drilling muds.

In addition to toxic trace elements and hydrocarbons in produced waters, there are additional components and properties, such as hypersalinity and organic acids, that have a potential to adversely affect commercial fishery resources. Produced waters that are discharged offshore are diluted and dispersed to very near background levels at a distance of 1,000 m and are undetectable at a distance of 3,000 m from the discharge point (Harper, 1986; Rabalais et al., 1991; Kennicutt, 1995).

Proposed Action Analysis

Installation of offshore structures may cause space-use conflicts with commercial fishing activities. The total projected number of production structure installation for a proposed action ranges from 11 to 15. Using the 100-m navigational safety zone figure (although to date very few operators have elected to apply to the USCG for a safety zone around their production platforms), the possible area excluded from commercial trawl fishing or longlining would range from 66 to 90 ha. The maximum excluded area represents only a very small fraction (0.0006%) of the total area of the WPA. All structures associated with a proposed action are projected to be removed by the year 2037.

In water depths less than 200 m, the area of concentrated bottom trawl fishing, 8-11 platforms would be installed under a proposed action, eliminating 48-66 ha from the area available for commercial fishing. There is no use of FPSO's projected for a proposed action. It is assumed that space-use conflicts will seldom occur. The effect of space loss to trawl fishing resulting from the construction of platforms in support of a proposed action in the WPA would be negligible; the maximum extent of the area lost to commercial trawling would be less than 0.01 percent of the available trawl fishing area in water depths less than 200 m. Nearly 845, 000 km^2 in two areas in the northeastern CPA and the northwestern EPA have been closed by NOAA Fisheries to longline fishing (Chapter 3.3.1 and Figure 3-9). The closure will displace commercial longlining and may increase activity in the WPA.

Underwater OCS obstructions such as pipelines may cause fishing gear loss and additional user conflicts. The area of concentrated bottom trawl fishing is in water depths less than 200 m. For a proposed action, it is projected that 157-314 km of pipeline associated with a proposed action will be installed in water depths less than 60 m; no projection of the length of installed pipelines has been made for water depths of 60-200 m. Gear loss and user conflicts are mitigated by the FCF. Direct payments for claims in FY 1997 totaled $238,404 and total payments for FY 1998 were $311,290. The amount available for Gulf of Mexico FCF claims in FY 1999 was $1,212,969. The majority of claims are resolved within six months of filing. The economic loss from gear loss and user conflicts has historically been less than 0.1 percent of the same year's value of Gulf commercial fisheries landings. It is assumed that installed pipelines will seldom conflict with bottom trawl or other fishing activities, and they are expected to have a negligible effect on commercial fishing.

Structure removals result in loss of artificial habitat and cause fish kills when explosives are used. It is projected that 5-7 structure removals using explosives will occur in water depths <200 m as a result of a proposed action. It is expected that structure removals will have a negligible effect on commercial fishing because of the inconsequential number of removals and the consideration that removals kill only those fish proximate to the removal site.

Seismic surveys will occur in both shallow and deepwater areas in the WPA. Usually, fishermen are precluded from a very small area for several days. This should not impact the annual landings or value of landings for commercial fisheries in the Gulf. Gulf of Mexico species can be found in many adjacent locations and Gulf commercial fishermen do not fish in one locale. Loss of fishing gear because of seismic surveys is also mitigated (see above) by the FCF. All seismic survey locations and schedules are published in the USCG *Local Notice to Mariners,* a free publication available to all fishermen. Seismic surveys will have a negligible effect on commercial fishing.

Summary and Conclusion

Activities such as seismic surveys, and pipeline trenching will cause negligible impacts and will not deleteriously affect commercial fishing activities. Operations such as production platform emplacement, underwater OCS impediments, and explosive platform removal, will cause slightly greater impacts on commercial fishing. At the expected level of impact, the resultant influence on commercial fishing will be indistinguishable from variations due to natural causes. As a result, there would be very little impact on commercial fishing. A proposed action is expected to result in less than a 1 percent change in activities, in pounds landed, or in the value of landings. It will require less than six months for fishing activity to recover from any impacts.

4.3.1.10. Impacts on Recreational Beaches

This section discusses the possible effects of a proposed action in the WPA on recreational beaches. Millions of annual visitors attracted to these resources are responsible for thousands of local jobs and billions of dollars in regional economic activity. Major recreational beaches are defined as those frequently visited sandy areas along the shoreline that are exposed to the Gulf of Mexico and that support a multiplicity of recreational activities, most of which is focused at the land and water interface. Included are Padre Island National Seashore, State parks and recreational areas, county and local parks, urban beaches, private resort areas, and State and private environmental preservation and conservation areas. The general locations of these beaches are indicated on MMS Visual 2 (Multiple Use; USDOI, MMS, 2001d).

The primary impact-producing factors to the enjoyment and use of recreational beaches are trash and debris, and oil spills. Additional factors such as the physical presence of platforms and drilling rigs can affect the aesthetics of beach appreciation, and noise from OCS-related aircraft can adversely affect a beach-related recreation experience. All these factors, either individually or collectively, may adversely affect the number and value of recreational beach visits. The potential impacts from oil spills and other accidental events are discussed in Chapter 4.4.3.12.

The physical presence of platforms and drilling rigs visible from shore, and noise associated with vessels and aircraft traveling between coastal shore bases and offshore operation sites can adversely affect the natural ambience of primitive coastal beaches. Drilling rigs and platforms placed 3-10 mi from shore are within sight range of shoreline recreational beaches. Federal and State oil and gas operations are already occurring on nearshore tracts off Texas and Louisiana.

Although these factors may affect the quality of recreational experiences, they are unlikely to reduce the number of recreational visits to coastal beaches in the Central and Western Gulf.

Proposed Action Analysis

A proposed action in the WPA is projected to result in the drilling of 47-70 exploration and production wells and the installation of 6-8 platforms in water depths <60 m. In water depths of 60-200 m, a proposed action is projected to result in 16-34 wells and 1-2 platforms. Marine debris will be lost from time to time from OCS operations associated with drilling activities and production facilities projected to result from a proposed action in the WPA. Waste management practices and training programs are expected to minimize the level of accidental loss of solid wastes from activities resulting from a proposed action. Recreational beaches in Louisiana and Texas are most likely to be impacted by any waterborne trash. Beached litter and debris from a proposed action is unlikely to be perceptible to beach users or administrators because a proposed action would constitute only a small percentage (about 1%) of the total OCS Program activity in the WPA.

A proposed action is expected to result in 25,000-36,000 service-vessel trips over the life of the leases or about 625-900 trips annually. A proposed action is also expected to result in 110,000-410,000 helicopter trips, which is about 2,750-10,250 trips annually. Service vessels are assumed to use established nearshore traffic lanes and helicopters are assumed to comply with areal clearance restrictions at least 90 percent of the time. This additional helicopter and vessel traffic will add very little noise pollution likely to affect beach users.

Summary and Conclusion

Marine debris will be lost from time to time from operations resulting from a proposed action. The impact on Gulf Coast recreational beaches is expected to be minimal. The incremental increase in helicopter and vessel traffic is expected to add very little additional noise that may affect beach users. A proposed action is expected to result in nearshore operations that may adversely affect the enjoyment of some Gulf Coast beach uses; however, these will have little effect on the number of beach users.

4.3.1.11. Impacts on Archaeological Resources

Blocks with a high probability for the occurrence of prehistoric, prehistoric and historic, or historic archaeological resources are found in the Western Gulf. Blocks with a high probability for prehistoric archaeological resources are found landward of a line that roughly follows the last geologic still-stand before inundation at approximately 13,000 B.P. (years before present). This13,000-B.P. still-stand also roughly follows the 45-m bathymetric contour. Because of inherent uncertainties in both the depth of historic sea-level stands and the entry date of prehistoric man into North America, MMS has adopted the 12,000 B.P. and 60-m water depth as the seaward extent of the high-probability area for prehistoric archaeological resources.

The areas of the northern Gulf of Mexico that are considered to have a high probability for historic period shipwrecks were redefined as a result of an MMS-funded study (Garrison et al., 1989; LTL's dated November 30, 1990, and September 5, 1995). The study expanded the shipwreck database in the Gulf of Mexico from 1,500 to more than 4,000 wrecks. Statistical analysis of shipwreck location data identified two specific types of high-probability areas—the first within 10 km of the shoreline and the second proximal to historic ports, barrier islands, and other loss traps. High-probability search polygons associated with individual shipwrecks were created to afford protection to wrecks located outside the two aforementioned high-probability areas (cf. Visual 3, Offshore Regulatory Features; USDOI, MMS, 2001e). The historic archaeological high-probability areas are under MMS review at the time of this writing. NTL 98-06, issued August 10, 1998, supersedes all other archaeological NTL's and makes minor technical amendments, updates cited regulatory authorities, and continues to mandates a 50-m remote-sensing, survey linespacing density for historic shipwreck surveys in water depth of 200 m or less. The NTL also requires submission of an increased amount of magnetometer data to facilitate MMS analysis. Survey and report requirements for prehistoric sites have not been changed.

An Archaeological Resources Stipulation was included in all Gulf of Mexico lease sales from 1974 through 1994. The stipulation was incorporated into operational regulations at 30 CFR 250.26 with few changes, and all protective measures offered in the stipulation have been adopted in the regulation.

Additional supportive material for the archaeological resources analysis is provided in Chapters 3.3.2 (Description of the Affected Environment), and Chapters 4.2.1.13, 4.3.1.1.11, 4.4.3.13, and 4.5.13 (Environmental Consequences).

Several OCS-related, impact-producing factors may cause adverse impacts to archaeological resources. Offshore development could result in a drilling rig, platform, pipeline, dredging activity or anchors having an impact on an historic shipwreck. Direct physical contact with a wreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the period from which the ship dates.

The placement of drilling rigs and production platforms has the potential to cause physical impact to prehistoric and/or historic archaeological resources. It is assumed that the standard rig in less than 750 m of water will directly disturb 1.5 ha of soft bottom; the average platform in less than 450 m of water, 2 ha. Pile driving associated with platform emplacement may also cause sediment liquefaction an unknown distance from the piling, disrupting stratigraphy in the area of liquefaction.

Pipeline placement has the potential to cause a physical impact to prehistoric and/or historic archaeological resources. Pipelines placed in water depths of less than 61 m must be buried. Burial depths of 1 m are required with the exception of shipping fairways and anchorage areas, where the requirements are 3.0 m and 4.6 m, respectively.

The dredging of new channels, as well as maintenance dredging of existing channels, has the potential to cause a physical impact to historic shipwrecks (Espey, Huston, & Associates, 1990a). There are many navigation channels that provide OCS access to onshore facilities; most are located in the Central Gulf.

Anchoring associated with platform and pipeline emplacement, as well as with service-vessel and shuttle-tanker activities, may also physically impact prehistoric and/or historic archaeological resources. It is assumed that during pipeline emplacement, an array of eight 20,000-lb anchors is continually repositioned around the pipe-laying barge.

Activities resulting from a proposed action will generate ferromagnetic structures and debris, which will tend to mask magnetic signatures of significant historic archaeological resources. The task of locating historic resources through an archaeological survey is, therefore, made more difficult as a result of leasing activity.

4.3.1.11.1. Historic Archaeological Resources

Proposed Action Analysis

The likely locations of archaeological sites cannot be delineated without first conducting a remote-sensing survey of the seabed and near-surface sediments. The MMS has issued regulations at 30 CFR 250.194, 250.203(b)(15), 250.203(o),. 250.204(b)(8)(v)(A), 250.204(s), and 250.1007(a)(5) that require OCS lessees and operators and applicants for pipeline rights-of-way to conduct an archaeological survey prior to proposed activities within areas determined to have a high probability for historic and/or prehistoric archaeological resources. Generally, in the western part of the WPA, where unconsolidated sediments are thick, it is likely that side-scan sonar will not detect shipwrecks buried beneath the mud. In this area, the effectiveness of the survey for detecting historic shipwrecks of composite and wooden construction would depend on the capability of a magnetometer to detect ferromagnetic masses of the size characteristically associated with shipwrecks. It is assumed that the required 50-m line spacing (as specified in NTL 2002-G01) is a highly effective survey methodology, allowing detection of approximately 90 percent of historic shipwrecks within the survey area. The survey would therefore reduce the potential for an impact to occur by an estimated 90 percent.

According to estimates presented in Table 4-5, 134-281 exploration, delineation, and development wells will be drilled and 11-15 production platforms will be installed in support of a proposed action. Of these, 63-104 exploration, delineation, and development wells will be drilled, and 7-9 platforms will be installed in water depths of 200 m or less, where the majority of blocks with a high probability for historic period shipwrecks are located. The location of any proposed activity within a lease that has a high probability for historic shipwrecks requires archaeological clearance prior to operations. Considering that the expanded database contains 615 historic period shipwrecks in the entire Western Gulf OCS, the probability of an OCS activity contacting and damaging a shipwreck is very low. If an oil and gas structure contacted a historic resource, however, there could be a loss of significant or unique archaeological information.

Because there is only a thin Holocene sediment veneer overlying an indurated Pleistocene surface in the eastern part of the WPA, shipwrecks are more likely to be detected by side-scan sonar; therefore, the 50-m survey linespacing is expected to be even more effective (95%) for reducing the potential for a direct physical contact between an impact-producing factor and a shipwreck in the eastern WPA. There is a very small possibility that a historic shipwreck could be impacted by OCS activities. Should such an impact occur, however, significant or unique archaeological information could be lost.

Onshore historic properties include sites, structures, and objects such as historic buildings, forts, lighthouses, homesteads, cemeteries, and battlefields. Sites already listed on the National Register of Historic Places and those considered eligible for the Register have already been evaluated as being able to make a unique or significant contribution to science. At present, unidentified historic sites may contain unique historic information and would have to be assessed after discovery to determine the importance of the data.

Onshore development could result in the direct physical contact between the construction of new onshore facilities or pipeline canals and previously unidentified historic sites. This direct physical contact with a historic site could cause physical damage to, or complete destruction of, information on the history of the region and the Nation. It is assumed that 1 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action. Table 4-5 shows the projected coastal infrastructure related to OCS Program activities. Each facility projected to be constructed must receive approval from the pertinent Federal, State, county/parish, and/or community involved. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes involved. There is, therefore, no expected impact to onshore historic sites in the WPA from onshore development.

Maintenance dredging in support of activities resulting from a proposed action has the potential to impact a historic shipwreck. For instance, maintenance dredging in the Port Mansfield Entrance Channel is believed to impact the *Santa Maria de Yciar*, which sank on April 29, 1554 (Espey, Huston & Associates, 1990a) and is expected to impact the *SS Mary*, which sank on November 30, 1876, in Aransas Pass (Espey, Huston & Associates, 1990b). Impacts from maintenance dredging can be attributed proportionally to the users of the navigation channels. The MMS assessment indicates that, under a proposed action, less than 1 percent of the ship traffic through the Port Mansfield Cut is related to OCS use. Therefore, the impact to the *Santa Maria de Yciar* and *SS Mary* directly attributable to traffic and maintenance dredging as a result of the OCS Program is negligible. While the specific example falls within onshore coastal Subarea TX-1, an area unlikely to be affected by activities resulting from a proposed action in the WPA, it serves to illustrate that the potential exists for historic shipwrecks to be impacted by dredging. As these shipwrecks are unique historic archaeological resources, maintenance dredging, in general, is responsible for impacts to historic shipwrecks. Proposed action activities represent < 1 percent of the usage of the major navigation channels for the Western.

The loss of ferromagnetic debris during exploration and production activities has the potential to mask the magnetic signatures of historic shipwrecks. Under a proposed action, it is expected that hundreds of tons of ferromagnetic debris will be lost overboard. It is expected that most ferromagnetic debris associated with OCS structures will be removed from the seafloor during site-clearance activities. Site clearance, however, takes place after the useful life of the structure is complete. It has been noted that such debris has the potential to be moved from the area of initial deposition as a result of trawling activities (Garrison et al., 1989). Also, no site-clearance activities are required for pipeline emplacement operations. Therefore, there remains the potential for masking the signatures of historic shipwrecks as a result of ferromagnetic debris from OCS oil and gas activities.

Since all platform locations within the high-probability areas for the occurrence of offshore historic and prehistoric archaeological resources are given archaeological clearance prior to setting the structure, removal of the structure should not result in any adverse impact to archaeological resources. This is consistent with the findings of the *Programmatic Environmental Assessment: Structure Removal Activities, Central and Western Gulf of Mexico Planning Areas* (USDOI, MMS, 1987).

Summary and Conclusion

The greatest potential impact to a historic archaeological resource as a result of a proposed action in the WPA would result from direct contact between an offshore activity (platform installation, drilling rig emplacement, and dredging or pipeline project) and a historic shipwreck. An MMS-funded study (Garrison et al., 1989) resulted in the redefinition of the high-probability areas for the location of historic period shipwrecks. An MMS review of the historic high-probability areas is occurring at the time of this writing. The NTL for archaeological resource surveys in the Gulf of Mexico Region, NTL 2002-G01, mandates a 50-m linespacing for remote-sensing surveys of leases within the high-probability areas for historic shipwreck.

Ferromagnetic debris has the potential to mask the magnetic signatures of historic shipwrecks.

Maintenance dredging of navigation channels may result in impacts to historic shipwrecks; however, the percentage of OCS use of these channels under a proposed action is less than 1 percent.

Most other routine activities associated with a proposed action in the WPA are not expected to impact historic archaeological resources. It is conservatively assumed that 1 percent of the OCS Program's use of projected onshore facilities will occur in support of a proposed action (Table 4-8). It is expected that archaeological resources will be protected through review and approval processes of various Federal, State, and local agencies involved in permitting onshore activities.

Offshore oil and gas activities resulting from a proposed action could contact a shipwreck because of incomplete knowledge on the location of shipwrecks in the Gulf. Although this occurrence is not probable, such an event would result in the disturbance or destruction of important historic archaeological information. Other factors associated with a proposed action in the WPA are not expected to affect historic archaeological resources.

4.3.1.11.2. Prehistoric Archaeological Resources

Offshore development as a result of a proposed action could result in an interaction between a drilling rig, a platform, a pipeline, dredging, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy fragile artifacts or site features and could disturb artifact provenance and site stratigraphy. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for North America, Central America, South America, and the Caribbean.

Proposed Action Analysis

According to projections presented in Table 4-3, under a proposed action, 63-104 exploration, delineation, and development wells will be drilled, and 11-15 production platforms will be installed as a result of a proposed action in the WPA. Analysis by MMS indicates there is no potential for the occurrence of prehistoric archaeological sites in water depths greater than 60 m. If only the area likely to contain prehistoric sites (shallower than 60 m) is considered, 47-70 exploration, delineation, and development wells and 6-8 production platforms are projected to be installed (Table 4-3). The limited amount of impact to the seafloor throughout the WPA, the required archaeological survey, and archaeological clearance are sufficient to assume a low potential for impacting a prehistoric archaeological site. Should such an impact occur, damage to or loss of significant or unique prehistoric archaeological information could occur.

Onshore prehistoric archaeological resources include sites, structures, and objects such as shell middens, earth middens, campsites, kill sites, tool manufacturing areas, ceremonial complexes, and earthworks. At present, unidentified onshore prehistoric sites would have to be assessed after discovery to determine the uniqueness or significance of the information that they contain. Sites already listed in the National Register of Historic Places and those considered eligible for the Register have already been evaluated as having the potential for making a unique or significant contribution to science. Of the unidentified coastal prehistoric sites that could be impacted by onshore development, some may contain unique information.

Onshore development as a result of a proposed action could result in direct physical contact between construction of new onshore facilities or a pipeline landfall and a previously unidentified prehistoric site. Direct physical contact with a prehistoric site could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast region. It is assumed that 1 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action. Table 4-8 shows the projected coastal infrastructure related to OCS Program activities. Each facility projected to be constructed must receive approval from the pertinent Federal, State, county/parish, and/or community involved. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes involved. There should, therefore, be no impact to onshore WPA prehistoric sites from onshore development related to a proposed action.

Each platform location within the high-probability areas for the occurrence of historic and prehistoric archaeological resources requires archaeological clearance prior to setting the structure; therefore, removal of the structure should not result in any adverse impact to archaeological resources. This is consistent with the findings of the *Programmatic Environmental Assessment: Structural Removal Activities, Central and Western Gulf of Mexico Planning Areas* (USDOI, MMS, 1987).

Summary and Conclusion

Several impact-producing factors may threaten the prehistoric archaeological resources of the Western Gulf. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric site located on the continental shelf. The archaeological survey and archaeological clearance of sites required prior to an operator beginning oil and gas activities on a block are expected to be highly effective (90%) at identifying possible prehistoric sites. Since the survey and clearance provide a significant reduction in the potential for a damaging interaction between an impact-producing factor and a prehistoric site, there is a very small possibility of an OCS activity contacting a prehistoric site. Should such contact occur, there would be damage to or loss of significant or unique archaeological information.

Onshore development as a result of a proposed action could result in the direct physical contact from new facility construction, pipeline trenching, and new navigation canal dredging. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes of the Federal, State, and local agencies involved.

A proposed action in the WPA is not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost.

4.3.1.12. Impacts on Human Resources and Land Use

This proposed action analysis considers the effects of OCS-related, impact producing activities from a proposed WPA lease sale in relation to the continuing baseline of non-OCS-related factors. Non-OCS factors include fluctuations in workforce, net migration, relative income, oil and gas activity from State waters, wetland loss, and tropical storms. Unexpected events that may influence oil and gas activity within the analysis area but that cannot be predicted are not considered in this analysis.

4.3.1.12.1. Land Use and Coastal Infrastructure

Chapters 3.3.3.3 and 3.3.3.8 discuss land use and OCS-related oil and gas infrastructure associated with the analysis area. The existing oil and gas infrastructure is expected to be sufficient to handle development associated with a proposed action. A proposed WPA lease sale would not alter the current land use of the area.

4.3.1.12.2. Demographics

In this section, MMS projects how and where future demographic changes will occur and whether they correlate with a proposed WPA lease sale. The addition of any new human activity, such as oil and gas development resulting from a proposed action, can affect local communities in a variety of ways. Typically, these effects are in the form of people and money, which can translate into changes in the local social and economic institutions and land use.

Proposed Action Analysis

Population

Population projections related to activities resulting from a proposed action are expressed as total population numbers and as a percentage of the population levels that would be expected if the proposed lease sale was not held (Tables 4-38 and 4-39). Chapter 3.3.3.4.1 discusses baseline population projections for the analysis area. Because the baseline projections assume the continuation of existing social, economic, and technological trends, they also include population changes associated with the continuation of current patterns in OCS Program activities. Population impacts from a proposed action in the WPA mirror the assumptions for employment impacts described in Chapter 4.3.1.12.3 below. Projected population changes reflect the number of people dependent on income from OCS related employment for their livelihood, which is based on the ratio of population to employment in the analysis area over the life of a proposed lease sale. Note that Subareas LA-1, LA-2, LA-3, and MA-1 correspond to the offshore CPA; TX-1 and TX-2 correspond to the WPA; and FL-1, FL-2, FL-3 and FL-4 correspond to the EPA.

Population associated with a proposed WPA lease sale is estimated at about 4,500-10,900 persons during the peak year of impact (year 10) for the low- and the high-case scenarios, respectively. While population associated with a typical WPA lease sale as proposed is projected to peak in year 10, years 7 and 11 also display close to peak levels of population. During the years of peak or near-peak population, a substantial amount of platform and pipeline installations are projected in association with a proposed WPA lease sale. Platform fabrication and installation, and pipeline installation activities are labor intensive and tend to occur concurrently, therefore leading to employment and population impacts.

Population impacts from a proposed action in the WPA are expected to be minimal, i.e., less than 1 percent of total population for any coastal subarea. The mix of males to females is expected to remain unchanged. The increase in employment is expected to be met primarily with the existing population and available labor force with the exception of some in-migration (some of whom may be foreign) projected to move into focal areas, such as Port Fourchon.

Age

If a proposed WPA lease sale is held, the age distribution of the analysis area is expected to remain virtually unchanged. Given both the low levels of population growth and industrial expansion associated with a proposed action, the age distribution pattern discussed in Chapter 3.3.3.4.2 is expected to continue through the year 2040. Activities relating to a proposed WPA Lease Sale are not expected to affect the analysis area's median age.

The population estimates in Table 4-38 reflects the diversity in the age of the residents in the urban region of the analysis area. Given both the projections of population growth and industrial expansion, this pattern is expected to continue into the year 2040 as well. Activities relating to a proposed WPA lease sale are not expected to affect the analysis area's median age.

Race and Ethnic Composition

The racial distribution of the analysis area is expected to remain virtually unchanged if a proposed WPA lease sale is held. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the racial distribution pattern described in Chapter 3.3.3.4.3 is expected to continue through the year 2040.

Education

Activities relating to a proposed WPA lease sale are not expected to significantly affect the analysis area's educational levels. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the analysis area's education status, described in Chapter 3.3.3.4.4, is expected to continue through the year 2040. Activities relating to a proposed WPA lease sale are not expected to affect the analysis area's educational attainment.

Summary and Conclusion

Activities relating to a proposed WPA lease sale are expected to minimally affect the analysis area's land use, infrastructure, and demography. These impacts are projected to mirror employment effects that are estimated to be negligible to any one subarea. Baseline patterns and distributions of these factors, as described in Chapter 3.3.3.3, are expected to maintain. Changes in land use throughout the analysis area are expected to be contained and minimal. The OCS-related infrastructure is in place and will not change as a result of a proposed action. Current baseline estimates of population growth for the analysis area show a continuation of growth, but at a slower rate.

4.3.1.12.3. Economic Factors

The importance of the oil and gas industry to the coastal communities of the Gulf of Mexico is significant, particularly in south Louisiana, eastern Texas, and coastal Alabama. Dramatic changes in the level of OCS oil and gas activity over recent years have resulted in parallel fluctuations in population, labor, and employment in the analysis area. The economic analysis for a proposed Lease Sale in the WPA focuses on the potential direct, indirect, and induced impacts of the OCS oil and gas industry on the population and employment of the counties and parishes in the analysis region defined in Chapter 3.3.3.1. To improve regional economic impact assessments and to make them more consistent with each other, MMS developed a new methodology for estimating changes to employment and other economic factors. The methodology developed to quantify these impacts on population and employment takes into account changes in OCS-related employment, along with population impacts resulting from these employment changes within each individual subarea.

The Gulf of Mexico region model has two steps.

(1) Because there are no publicly available models that estimate the expenditures resulting from offshore oil and gas activities, the model first estimates expenditures for 10 scenario activities projected to result from a proposed action in the WPA. These activities include exploratory drilling, development drilling, production operations and maintenance, platform fabrication and installation, pipeline construction, pipeline operations and maintenance, gas processing and storage construction, gas processing and storage operations and maintenance, workovers, and platform removal and abandonment. The model than assigns these expenditures to industrial sectors in the 10 subareas defined in Chapter 3.3.3.1.

(2) The second step in the model uses multipliers from the commercial input-output model IMPLAN (using 1999 data, the latest available data) to translate these expenditures into direct, indirect, and induced employment and other economic factors. Direct employment results from the first round of industry spending. It is the employment that results from the initial dollars spent by the oil and gas industry on the 10 scenario activities (listed above). Indirect employment results as the initial spending reverberates through the economy. First, the suppliers of the goods and services for the 10 activities spend the initial direct dollars from the industry. Then, these dollars are re-spent by other suppliers until the initial dollars have trickled throughout the economy. Households spending the resulting labor income creates induced employment.

Both the level (the amount spent) and the sectoral (the industry in which it is spent) allocation of expenditures can vary considerably by the phase of OCS activity and by the water depth of the OCS activities. For example, an exploratory well in 0-60 m of water is expected to be drilled using a jack-up rig and cost about $4 million, whereas an exploratory well in 800 m or greater water depth is expected to be drilled using a drillship and to cost in excess $10 million to complete. In addition, spending on materials such as steel will be much higher for platform fabrication and installation than for operations and maintenance once production begins. Therefore, the model estimates and allocates expenditures for ten scenario activities in four water-depth categories: 0-60 m, 61-200 m, 201-800 m, and >800 m). Because local economies vary, a separate set of IMPLAN multipliers is used for each coastal subarea to which expenditures are assigned. Each set of multipliers is based on the actual historical patterns of economic transactions in the area. Model results for employment are presented in the number of jobs per year, where one job is defined as a year of employment. This does not necessarily mean only one person occupies the position through out the year. One job may be equal to two part-time positions occupied over the year or one person occupying a position for 6 months, while another person occupies it for the other 6 months.

The projections in this section are not statements of what will happen but of what might happen, given the assumptions and methodologies used. The projections are business-as-usual trend forecasts, given known technology, technological and demographic trends, and current laws and regulations. Because energy markets are complex, models are simplified representations of energy production and consumption, regulations, and producer and consumer behavior. Projections are highly dependent on the data, methodologies, model structures, and assumptions used in their development. Energy projections are subject to much uncertainty. Many of the events that shape energy markets are random and cannot be anticipated, including severe weather, political disruptions, strikes, and technological breakthroughs. In addition, future developments in technologies, demographics, and resources cannot be foreseen with any degree of certainty. Given this, MMS has endeavored to make these projections as objective, reliable, and useful as possible (USDOE, EIA, 2001b).

Proposed Action Analysis

Total employment projections for activities resulting from a proposed action are expressed as absolute numbers and as a percentage of the employment levels expected if no development occurs (Tables 4-40 and 4-41). Note that coastal Subareas TX-1 and TX-2 correspond to the offshore WPA; Subareas LA-1, LA-2, LA-3, and MA-1 correspond to the CPA; and Subareas FL-1, FL-2, FL-3 and FL-4 correspond to the EPA. The baseline projections of population and employment used in this analysis are described in Chapters 3.3.3.4 and 3.3.3.5 (Tables 3-12 to 3-27). Because these baseline projections assume the continuation of existing social, economic, and technological trends, they also include employment resulting from the continuation of current patterns in OCS Program activities. Population impacts, described in Chapter 4.3.1.12.2 (Table 4-40), mirror those assumptions associated with employment. Projected population changes reflect the number of people dependent on income from oil- and gas-related employment for their livelihood. This figure is based on the ratio of population to employment in the impact region over the life of a proposed lease sale.

Based on model results, direct employment associated with a proposed WPA Lease Sale is estimated at about 1,500-3,600 jobs during peak impact activity year 10 for the low- and high-case scenarios, respectively. Indirect employment is projected at about 500-1,300 jobs, while induced employment is calculated to be about 600-1,500 jobs for the low- and high-case scenarios, respectively. Therefore, total employment resulting from a proposed WPA lease sale is not expected to exceed 2,700-6,400 jobs in any given year over a proposed action’s 40-year lifetime. While employment peaks in year 10 for the low- and high-case scenarios, years 7 and 11 also display close to peak levels of employment particularly for the low-case scenario. During these years, platform and pipeline installations are projected in association with a proposed WPA lease sale. Platform fabrication and installation, and pipeline installation activities are labor intensive and tend to occur concurrently.

Although most of the employment related to a proposed action is expected to occur in Subarea TX-2, employment is not expected to exceed 1 percent of the total employment in any given subarea of Texas, Louisiana, Mississippi, or Alabama (Table 4-41). On a percentage basis (percent of baseline employment), Subarea LA-1 depicts the greatest employment impact, with 0.2 percent of total employment from a proposed WPA lease sale. Considering Florida’s current opposition to oil and gas development in offshore waters and the scarcity, if not absence, of onshore supporting service bases, MMS anticipates that very few OCS-related activities will be staged from Florida. Model results concur there would be little to no economic stimulus to the Florida analysis region as a result of a proposed WPA lease sale.

Summary and Conclusion

Should a proposed WPA lease sale occur, there would be only minor economic changes in the Texas, Louisiana, Mississippi, and Alabama subareas. A proposed action is expected to generate less than a 1 percent increase in employment in any of these subareas. This demand will be met primarily with the existing population and available labor force. There would be very little to no economic stimulus in the Florida subareas.

While a proposed WPA lease sale will not significantly impact the analysis area, OCS activities from past and future OCS lease sales will continue to occur and impact the analysis area. In other words, even if a proposed action were not held, there would still be impacts from past and future OCS lease sales on the analysis area. The OCS-related impacts will continue even in the absence of a proposed action. In addition, the lack of a proposed action would lead to reduced employment in affected sectors.

4.3.1.12.4. Environmental Justice

The analysis of environmental justice concerns is divided into those related to routine operations (below) and those related to oil spills (Chapter 4.4.3.14.2). Concerns related to routine operations center on increases in onshore activity (such as employment, migration, commuter traffic, and truck traffic) and on additions to the infrastructure supporting this activity (such as fabrication yards, supply ports, and onshore disposal sites for offshore waste). Chapter 3.3.3.5 describes the widespread presence of an extensive OCS support system and associated labor force, as well as economic factors related to OCS activities. The MMS estimates that production from a proposed action will be 0.136-0.262 BBO and 0.810-1.440 tcf of gas.

Proposed Action Analysis

Environmental justice issues involve questions of disproportionate and negative effects on minority and low-income populations. A proposed action in the WPA is expected to increase slightly employment opportunities in a wide range of businesses along the Gulf Coast. These conditions preclude a prediction of where much of this employment will occur or who will be hired. Figures 3-15 and 3-16 provide distributions of census tracts of high concentrations of minority groups and low-income households. As stated in Chapter 3.3.3.10, pockets of concentrations of these populations are scattered throughout the Gulf of Mexico coastal counties and parishes. Many of these populations are in large urban areas where the complexity and dynamism of the economy and labor force preclude a measurable effect. Low-income populations are almost exclusively minority and urban. Because the distribution of low-income and minority populations does not parallel the distribution of industry activity, effects of a proposed action are not expected to be disproportionate.

The widespread economic effects of a proposed action on minority and low-income populations are not expected to be negative. Ongoing MMS research includes gathering information on race and employment. Offshore workers in the production sector are almost entirely male and white (Rosenberg, personal communication, 2001). Other sectors, such as the fabrication industry and support industries (e.g., trucking), employ minority workers and provide jobs across a wide range of pay levels and educational/skill requirements (Austin et al., 2002a and b; Donato et al., 1998). A study of oil industry trends between 1980 and 1990 found that downsizing was concentrated in the production sector; therefore, it affected white male employment more than that of women or minorities (Singelmann, in press). Evidence also suggests that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations. One MMS study in Louisiana found income inequality decreased during the oil boom and increased with the decline (Tolbert, 1995). Another MMS-funded study found that reemployment rates for poorly educated black and white women laid off in the closing of an OCS-related plant in one rural town were much higher than reemployment rates in similar closings elsewhere because Louisiana's oil industry had created a complex local economy (Tobin, 2001). While a proposed action will provide little additional employment, it will have the effect of maintaining current activity levels, which is expected to be beneficial to low-income and minority populations.

Environmental justice often concerns the possible siting of infrastructure in places that will have disproportionate and negative effects on minority and low-income populations. Since a proposed action will help to maintain ongoing levels of activity rather than expand them, no one proposed lease sale will generate significant new infrastructure demand. For this reason, this EIS considers infrastructure projections only for the cumulative analysis (Chapter 4.4.3.14.4). The cumulative analysis concludes that, as with the analysis of the employment effects of a proposed action, infrastructure effects are expected to be widely and thinly distributed. Since the siting of new infrastructure will reflect the distribution of the petroleum industry and not that of minority and low-income populations, the OCS activity in the WPA is not expected to disproportionately effect these populations. Again, Lafourche Parish is identified as a location of more concentrated effects. Each OCS-related facility constructed onshore must first receive approval by the relevant Federal, State, county or parish, and community involved, and MMS assumes that new construction will be approved only if consistent with appropriate land-use plans, zoning regulations, and other State/regional/local regulatory mechanisms.

Because of Louisiana's extensive oil-related support system (Chapter 3.3.3.5.1) and because the configuration of the WPA makes much of the deepwater area of the WPA closer to coastal Louisiana than to coastal Texas, Louisiana is likely to experience more employment effects related to a proposed action in the WPA than are the other coastal states. Lafourche Parish, Louisiana, is likely to experience the greatest concentration and is the only parish where the additional OCS-related activities and employment are sufficiently concentrated to increase stress to its infrastructure. Even so, the effects of a proposed action are not expected to be significant in the long term. The concentrated socioeconomic impacts in Lafourche Parish are not expected to have disproportionate effects on minority and low-income populations for several reasons. The Parish is not predominately minority or low income (Figures 3-15 and 3-16). Existing information indicates that the Houma, a Native American tribe recognized by the State of Louisiana, are not expected to be disproportionately affected because they are not residentially segregated but, rather, live interspersed among the non-minority population (Fischer, 1970).

Two local infrastructure issues described in Chapter 3.3.3.2 could possibly have related environmental justice concerns—traffic on LA Hwy. 1 and the Port Fourchon expansion. Human settlement patterns in the area (on high ground along LA Hwy. 1 and Bayou Lafourche) mean that rich and low-income alike would be affected by any increased traffic. Port Fourchon is relatively new and is surrounded by mostly uninhabited land. Existing residential areas close to the port are also new and not considered low-income areas. Any expansion of infrastructure at Port Fourchon is not expected to disproportionately affect minority or low-income populations. Lafourche Parish is an area of relatively low unemployment because of the concentration of petroleum-related industry in the area (Hughes et al., in preparation). While the minority and low-income populations of Lafourche Parish will share with the rest of the parish population any negative impacts related to a proposed action in the WPA, most effects related to a proposed action would be economic and positive.

Summary and Conclusion

Because of the presence of an existing extensive and widespread support system for the OCS-related industry and associated labor force, the effects of a proposed action in the WPA are expected to be widely distributed and little felt. In general, who will be hired and where new infrastructure might be located is impossible to predict. Impacts related to a proposed action are expected to be economic and have a limited but positive effect on low-income and minority populations. Given the existing distribution of the industry and the limited concentrations of minority and low-income peoples, a proposed action sale is not expected to have a disproportionate effect on these populations. A proposed action is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people.

4.3.2. Alternative B — Proposed Action Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features

Description of the Alternative

Alternative B differs from Alternative A (proposed action) by not offering the 61 unleased blocks of the 200 total blocks that are possibly affected by the proposed Topographic Features Stipulation (Chapter 2.4.1.3.1). All of the assumptions (including the two other potential mitigating measures) and estimates are the same as for a proposed action (Alternative A). A description of Alternative A is presented in Chapter 2.4.1.

The Federal offshore area is divided into subareas based on water depths in meters (W0-60, W60-200, W200-800, W800-1600, W1600-2400, and W>2400), and the adjacent coastal region is divided into two coastal subareas (TX-1 and TX-1). These subareas are delineated on Figure 4-1.

Effects of the Alternatives

The following analyses are based on the scenario for a proposed action in the WPA (Alternative A). The scenario provides assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major, related impact-producing factors is included in Chapter 4.1.1.

The analyses of impacts to the various resources under Alternative B are very similar to those for Alternative A. The reader should refer to the appropriate discussions under Alternative A for additional and more detailed information regarding impact-producing factors and their expected effects on the various resources. Impacts under Alternative B are expected to be the same as those under a typical proposed action in the WPA (Chapter 4.3.1) for the following resources:

–Sensitive Coastal Environments
–Sensitive Offshore Resources
  Deepwater Benthic Communities
–Water Quality
–Air Quality
–Marine Mammals
–Coastal and Marine Birds
–Commercial Fisheries
–Recreational Beaches
–Socioeconomic Conditions

The impacts to some Gulf of Mexico resources under Alternative B would be different from the impacts expected under a proposed action. These impacts are described below.

Impacts on Sensitive Offshore Resources

Topographic Features

The sources and severity of impacts associated with this alternative are those sale-related activities discussed for a proposed action. As noted in Chapter 4.3.1.2.1, the potential impact-producing factors to the topographic features of the Western Gulf are anchoring and structure emplacement, effluent discharge, blowouts, oil spills, and structure removal. A more detailed discussion of these potential impact-producing factors is presented in that Chapter 4.3.1.2.1.

All of the 23 topographic features of the Western Gulf are located within water depths less than 200 m. These features occupy a very small portion of the entire area. Of the potential impact-producing factors to the topographic features, anchoring, structure emplacement, and structure removal will be eliminated by the adoption of this alternative. Effluent discharge and blowouts will not be a threat to the topographic features because blocks near enough to the banks for these events to have an impact on the biota of the banks will have been excluded from leasing under this alternative. Thus, the only impact-producing factor remaining from operations in blocks included in this alternative (i.e., those blocks not excluded by this alternative) is an oil spill. The potential impacts from oil spills are summarized below and are discussed further in Chapter 4.4.3.2.2.

A subsurface spill would have to come into contact with a biologically sensitive feature to have an impact. The chances of one or more subsurface pipeline spills ≥1,000 bbl in the Western Gulf is 17-30 percent. The chance of any amount of oil being released during a blowout is less than 10 percent. All evidence to date indicates that accidental oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column. The fact that the topographic features are widely dispersed in the Western Gulf, combined with the random nature of spills, would serve to limit the likelihood of a spill occurring proximate to a topographic feature. Chapter 4.4.1.1.8 discusses the risk of spills interacting with topographic features, especially the Flower Garden Banks, in more detail. The currents that move around the banks are expected to steer any oil around the banks rather than directly upon them, lessening impact severity. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for most of the adult sessile biota. Lethal effects would probably be limited to a few coral colonies (as in the case of the Flower Garden Banks National Marine Sanctuary) (CSA, 1992b and 1994). It is anticipated that recovery from a mostly sublethal exposure would occur within a period of 2 years. In the unlikely event that oil from a subsurface spill could reach a coral-covered area (in the case of the Flower Garden Banks), the areal extent of coral mortality would be limited, but long-lasting sublethal effects may be incurred by organisms surviving the initial effects of a spill (Jackson et al., 1989). Indeed, the stress resulting from the oiling of reef coral colonies could affect their resilience to natural disturbances (e.g., elevated water temperature, diseases) and may hamper their ability to reproduce. A complete recovery of such an affected area could take in excess of 10 years.

Conclusion

Alternative B is expected to cause little or no damage to the physical integrity, species diversity, or biological productivity of the habitats of the topographic features. In the unlikely event that oil from a subsurface spill contacts the biota of a topographic feature, the effects would be localized and primarily sublethal for most of the adult sessile biota. Some lethal effects would probably occur upon oil contact to coral colonies (as in the case of the Flower Garden Banks National Marine Sanctuary); recovery from such an event is anticipated to occur within a period of 2 years.

Impacts on Sea Turtles

The level of activity associated with Alternative B is the same the infrastructure and activity described for a proposed action (Chapter 4.1 and Table 4-3). The sources and severity of impacts for sea turtles under Alternative B are the same as those under a proposed action (Chapter 4.3.1.6). The major impact-producing factors related to Alternative B that may affect Gulf sea turtles, including structure installation, dredging, operational discharges, and explosive platform removals, would not occur within the area excluded under Alternative B. The effects of these activities would occur in the remainder of the WPA and are expected to be primarily nonlethal, with few lethal impacts; the probability of an interaction is low.

Conclusion

Alternative B is expected to temporarily disturb some sea turtles and their habitats; however, it is unlikely to have significant long-term adverse effects on the size and productivity of any turtle species or population stock in the northern Gulf of Mexico.

4.3.3. Alternative C — No Action

Description of the Alternative

Alternative C is equivalent to cancellation of a sale scheduled for a specific period in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007*. The OCS lease sales in the Western Gulf are scheduled on an annual basis. By canceling a proposed Western Gulf sale, the opportunity is postponed or foregone for development of the estimated 0.136-0.262 billion barrels of oil (BBO) and 0.810-1.440 trillion cubic feet (tcf) of gas.

Effects of the Alternative

Under Alternative C, the U.S. Dept. of the Interior cancels a planned Western Gulf of Mexico sale. Therefore, the oil expected from a sale will remain undiscovered and undeveloped. The environmental effects of Alternative A (proposed action) also would not occur. Energy from alternative sources for the lost production. Canceling a sale would eliminate the effects described for Alternative A (the proposed action). Other sources of energy would need to substitute for the lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have significant environmental impacts of their own.

This section briefly discusses the most likely alternative sources, the quantities expected to be needed, and the environmental impacts associated with the alternatives. The discussion is based on material from the following MMS publications: *Proposed Final Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002, Decision Document* (USDOI, MMS, 1996a); *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002, Final Environmental Impact Statement* (USDOI, MMS, 1996b); and *Energy Alternatives and the Environment* (USDOI, MMS, 2001f). These sources are incorporated into this document by reference.

Most Important Substitutes for Production Lost Through No Lease Sale

Energy Alternatives and the Environment discusses a long list of potential alternatives to natural gas and oil. However, most substitutes for the natural gas and oil from a proposed action will come from four sources:

- additional imports;
- conservation;
- additional domestic production; and
- fuel switching.

Additional domestic production and imports will augment supply, while conservation and switching to alternative fuels shift demand downward. The table below shows the percentage and range of quantities expected to be needed to substitute for the lost natural gas and oil production. The quantities for conservation and fuel switching are in equivalent energy units.

Substitutes for Natural Gas and Oil Lost Because of No Lease Sale

Source	Percent of Lost Oil Production	Range of Oil Quantity (MMbbl)	Percent of Lost Gas Production	Range of Gas Quantity (Bcf)
Additional Imports	88%	134-385	12%	184-527
Conservation	5%	8-22	14%	214-615
Additional Domestic Production	4%	6-18	41%	627-1,800
Fuel Switching	3%	5-13	33%	505-1,449
Total Production Lost through No Sale	100%	153-438	100%	1,530-4,391

Environmental Impacts from the Most Important Substitutes

Additional Imports: Significant environmental impacts from an increase in oil imports include the following:

- generation of greenhouse gases and air pollutants from both transport and dockside activities (emissions of NO_x, SO_x, and VOC's have an impact on acid rain, tropospheric ozone formation, and stratospheric ozone depletion);

- degradation of water quality from oil spills related to accidental discharges or tanker casualties;
- oil-spill contact with flora, fauna, or recreational and scenic land and water areas; and
- increasing public concern about increasing imports of foreign oil and the potential for unauthorized interdiction or terrorist attacks on oil tankers.

Imported oil may also impose negative environmental impacts in producing countries and in countries along trade routes. Additional imports of natural gas would require construction of new pipelines from the most likely sources, which are Canada and Mexico. Pipeline construction can disrupt wildlife habitat, lead to increased erosion, and add to the siltation of streams and rivers.

Conservation: Conservation is composed of two major components:

- substituting energy-saving technology, often embodied in new capital equipment, for energy resources (e.g., adding to home insulation)
- consuming less of an energy-using service (e.g., turning down the thermostat in an office during the winter).

Consuming less of an energy service is positive from an environmental perspective. Substituting energy-saving technology will tend to result in positive net gains to the environment. The amount of gain will depend on the extent of negative impacts from capital equipment fabrication.

Additional Domestic Production: Onshore oil and gas production has notable negative impacts on surface water, groundwater, and wildlife. It can also cause negative impacts on soils, air pollution, vegetation, noise, and odor. Offshore oil and gas production imposes the risk of oil spills affecting water quality, localized degradation of air quality, potential impacts on coastal wetlands dependent wildlife, and shoreline erosion from additional supply boat traffic. Offshore activities may also have negative impacts on social, cultural, and economic measures such as recreation.

Fuel Switching: The most likely substitutes for natural gas are oil, which will further increase imports, and coal for use in electricity generation. Coal mining causes severe damage to land and wildlife habitat. It also is a major contributor to water quality deterioration through acid drainage and siltation. Alternative transportation fuels may constitute part of the oil substitution mix. The mix depends on future technical and economic advances. No single alternative fuel appears to have an advantage at this time. Every fuel alternative imposes its own environmental effects.

Other Substitutes

Government could also impose other substitutes for natural gas and oil. The most likely sectors to target would be transportation, electricity generation, or various chemical processes. *Energy Alternatives and the Environment* discusses many of the alternatives at a level of detail impossible here.

Summary and Conclusion

Canceling a sale would eliminate the effects described for Alternative A (Chapter 4.3.1). Other sources of energy would substitute for the lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have significant environmental impacts of their own.

4.4. ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTIONS—ACCIDENTAL EVENTS

4.4.1. Accidental Events

The National Environmental Policy Act (NEPA) requires Federal agencies to consider potential environmental impacts of proposed actions as part of agency planning and decisionmaking. The NEPA analyzes actions that could result in impacts, including actions that have a very low probability of occurrence, but that the public considers important, are controversial, or may have severe consequences. Accidental events that fall into this category and are addressed in this section are oil spills, blowouts, vessel collisions, and spills of chemicals or drilling fluids.

4.4.1.1. Oil Spills

Large oil spills associated with OCS activities are low-probability events. Public input through scoping meetings and Federal and State agencies' input through consultation and coordination indicate that oil spills continue to be a major issue. This section analyzes the risk of spills that could occur as a result of typical proposed actions in the CPA and WPA. Chapter 4.1.3.4 provides information on accidental spills that could result from all operations conducted under the OCS Program, as well as information on the number and sizes of spills from non-OCS sources.

4.4.1.1.1. Spill Prevention

Beginning in the 1980's, MMS has comprehensive pollution prevention requirements that include redundant safety systems, as well as inspection and testing requirements to confirm that these devices are working properly (Chapter 1.5). There was an 89 percent decline in the volume of oil spilled per billion barrels produced from OCS operations during 1980 through the present (8,211 bbl/Bbbl from facilities and 1,493 bbl/Bbbl from pipelines) compared to the total volume spilled per billion barrels prior to 1980 (45,897 bbl/Bbbl from facilities and 44,779 bbl/Bbbl from pipelines). This reduction in spill volume has occurred during a period when oil production has been increasing. The MMS attributes this improvement to MMS operational requirements, ongoing efforts by the oil and gas industry to enhance safety and pollution prevention, and the evolution and improvement of offshore technology.

4.4.1.1.2. Overview of Spill Risk Analysis

There are many factors that MMS evaluates to determine the risk of impact occurring from an oil spill. Information that can be quantitatively estimated include likely spill sources, likely spill sizes, the likelihood and frequency of occurrence for different size spills, timeframes for the persistence of spilled oil, volumes of oil lost due to weathering and cleanup, and the likelihood of transport by wind and waves resulting in contact to specified environmental features. Some factors cannot be quantified or projected. For example, the location and source of the spill; the characteristics of the spilled oil; the season and weather at the time of the spill; and the life stage, activities, biological abundance and locations of the species of concern. This section of the EIS addresses the likelihood of spill occurrence, transpiration of oil slicks by winds and waves, and the probability of an oil spill contacting sensitive environmental resources. Sensitivity of the environmental resources and potential effects are addressed in the analyses for the specific resources of concern (Chapter 4.4.3).

The MMS uses data on past OCS production and spills, along with estimates of future production, to evaluate the risk of future spills. Data on the numbers, types, sizes, and other information on past spills were reviewed to develop the spill scenario for analysis in this EIS. The spill scenario provides the set of assumptions and estimates on future spills; the type, frequency, quantity, and fate of the spilled oil for specific scenarios; and the rationale for the scenario assumptions or estimates. The spill scenario accounts for spill response and cleanup activities and the estimated time that the spill remains floating on the water.

The MMS uses two numerical models to calculate the likely trajectory and weathering of spills and analyzes the historical database to make other oil-spill projections. A description of the trajectory model, called the OSRA (oil spill risk analysis) model, and its results are summarized in this EIS and are published in a separate report (Ji et al., in preparation). The OSRA model simulates thousands of spills launched throughout the Gulf of Mexico OCS and calculates the probability of these spills being transported and contacting specified environmental resources. The OSRA modeling results in a numerical expression of risk based on spill rates, projected oil production, and trajectory modeling. The oil-weathering model used by MMS is considered to be state-of-the-art (Reed et al., 2000).

The following discussion provides separate risk information for offshore spills ≥1,000 bbl, offshore spills <1,000 bbl, and coastal spills that may result from the proposed actions.

4.4.1.1.3. Past OCS Spills

4.4.1.1.3.1. Offshore Spills

The MMS spill-event database includes records of past spills from activities that MMS regulates. These data include oil spills >1 bbl that occurred in Federal waters from OCS facilities and pipeline operations. Spills from facilities include spills from drilling rigs, drillships, and storage, processing, or production platforms that occurred during OCS drilling, development, and production operations. Spills from pipeline operations are those that have occurred on the OCS and are directly attributable to the transportation of OCS oil.

The MMS recently updated an analysis of trends in OCS spills (Anderson and LaBelle, 2000). Spill records for the most recent period analyzed, 1985-1999, were used to project future spill risk for this EIS. Data for this period reflect recent spill prevention and occurrence conditions. The 15-year record was chosen because it reflects how the spill rates have changed while still maintaining a significant portion of the record.

Table 4-20 presents oil spills for seven different spill-size groupings for the period 1985-1999. Data are provided on the total number of spills, number of spills by operation, total volume of oil spilled, and the spill rate calculated from data on historical spills and production. The average spill size and median spill size during this period are given for each spill-size category.

Tables 4-42 and 4-43 provide information on OCS oil spills ≥1,000 bbl that have occurred offshore in the Gulf of Mexico for the entire period that records have been kept (1964-2000). These data are divided into two groups based on whether the spills were from accidents associated with facility operations or pipeline transportation. The data show that there were no facility spills ≥1,000 bbl and eight pipeline spills ≥1,000 bbl during the period 1985-1999. The pipeline spills have been the result of damage caused by anchors, fishing trawls, and hurricanes.

The MMS data records do not include spills ≤1 bbl, but data on these small spills are available from the USCG Marine Safety Information System. Also not included in the MMS database are spills that have occurred in Federal waters from OCS barging operations and from other service vessels that support the OCS oil and gas industry. These data are included in the USCG record of all spills; however, the USCG database does not include the source of oil (OCS versus non-OCS) or in the case of spills from vessels, the type of vessel operations; such information is needed to determine if a particular spill occurred as a result of OCS operations.

4.4.1.1.3.2. Coastal Spills

Spills have occurred in coastal waters at shoreline storage, processing, or transport facilities supporting the OCS oil and gas industry. Coastal spills have occurred in State offshore waters and in navigation channels, rivers, and bays from barges and pipelines carrying OCS-produced oil. Records of spills in coastal waters and State offshore waters are maintained by the USCG (USDOT, Coast Guard, 2001a), but the database does not identify the source of the oil (OCS versus non-OCS). A pipeline carrying oil from a shore base to a refinery may be carrying oil stored from both State and OCS production; imported oil might also be commingled in the pipeline. The MMS does not maintain records on coastal spill events. Therefore, there is no database available that contains all past spills that have occurred in State offshore or coastal waters directly as a result of OCS oil and gas development. Information on past coastal spills that have occurred in the Gulf of Mexico area is found in Chapter 4.1.3.4.

4.4.1.1.4. Characteristics of OCS Oil

The physical and chemical properties of oil greatly affect how it will behave on the water surface (surface spills) or in the water column (subsea spills), the persistence of the slick on the water, the type and speed of weathering process, the degree and mechanisms of toxicity, the effectiveness of containment and recovery equipment, and the ultimate fate of the spill residues. Crude oils are a mixture of hundreds of different compounds. Hydrocarbons account for up to 98 percent of the total composition. The chemical composition of crude oil can vary significantly from different producing areas; thus, the exact composition of oil being produced in OCS waters varies throughout the Gulf.

The API gravity is a measurement of the density of the oil. The API gravity is calculated from the specific gravity; the lower the specific gravity, the higher the API gravity and the lighter the oil will be. Density is one of the most important physical characteristics of crude oil. The density of oil determines whether it will sink or float, whether it will collect sediment (heavier oils tend to collect sediment) and sink. The density of oil is one of the keys factors in predicting whether spilled oil will entrain water and form emulsions.

The API gravities of 91 plays are identified in the MMS 1995 National Assessment (Lore et al., 1999). The MMS data atlas presents an average of the many reservoirs contained in each play. Of the 91 plays represented, 67 plays had cumulative oil production greater than 100 Mbbl. A recently completed MMS study analyzed the API gravities (Trudel et al., 2001) of these 67 plays. The range of the average API gravities for these 67 plays was 22.8° -58.6°. Weighting the gravities by the relative oil production, all of the oils displayed API gravities in the 32 ° to 36 ° range, with an average of 33.9°. This represents a fairly light crude oil. Sorting the data by water depth indicates that oils become slightly heavier as water depths increase.

Water Depth	API Gravity
0-60 m	35°
61-200 m	34°
201-900 m	32°
>900 m	30°

It is expected that a typical oil spilled as a result of an accident associated with a proposed action would be within the range of 30° to 35° API. The oil at the light end of the range would have little asphaltenes, would not emulsify, and would not form tarballs. The oil at the heavier end of the range would more likely occur in deeper water; some emulsification and tarballs may occur with a spill of this heavier oil.

4.4.1.1.5. Risk Analysis for Offshore Spills ≥1,000 bbl

This section addresses the risk of spills ≥1,000 bbl that could occur from accidents associated with activities resulting from a proposed action.

4.4.1.1.5.1. Estimated Number of Offshore Spills ≥1,000 bbl and Probability of Occurrence

The number of spills ≥1,000 bbl estimated to occur as a result of a proposed action are provided in Table 4-44. The mean number of spills estimated for a proposed action in the WPA is less than one spill (mean equal to 0.21-0.40). The mean number of spills estimated for a proposed action in the CPA is one spill or less (mean equal to 0.42-0.99). The range of the mean number of spills reflects the range of oil production volume estimated as a result of a proposed action. The mean number of future spills ≥1,000 bbl is calculated by multiplying the spill rate for spills ≥1,000 bbl (1.51) by the volume of oil estimated to be produced as a result of a proposed action.

Figures 4-10 and 4-11 provide the probability of a particular number of offshore spills ≥1,000 bbl resulting from a proposed action during the 40-year analysis period.

For a proposed action in the CPA, there is a 27-37 percent chance of one spill ≥1,000 bbl occurring, a 6-18 percent chance of two spills ≥1,000 bbl occurring, a 1-6 percent chance of three spills ≥1,000 bbl occurring, and a <0.5-1 percent chance of four spills ≥1,000 bbl occurring. Overall, there is a 34-63 percent chance of one or more spills ≥1,000 bbl occurring.

For a proposed action in the WPA, there is a 17-27 percent chance of one spill ≥1,000 bbl occurring, a 2-5 percent chance of two spills ≥1,000 bbl occurring, and a <0.5-1 percent chance of three spills ≥1,000 bbl occurring. Overall, there is a 19-33 percent chance of one or more spills ≥1,000 bbl occurring.

Spill rates for all of the spill-size categories are provided in Table 4-20. Spill rates were calculated based on the assumption that spills occur in direct proportion to the volume of oil handled and are expressed as number of spills per billion barrels of oil handled.

A recently published paper by MMS authors provides more information on OCS spill-rate methodologies and trends (Anderson and LaBelle, 2000). A discussion of how the range of resource estimates was developed is provided in Chapter 4.1.1.1.

4.4.1.1.5.2. Most Likely Source of Offshore Spills ≥1,000 bbl

Figures 4-10 and 4-11 indicate the probabilities of one or more spills ≥1,000 bbl occurring from an OCS facility or pipeline in each OCS planning area. The data show that the most likely cause of a spill ≥1,000 bbl is a pipeline break at the seafloor.

Blowout events are often equated with catastrophic spills; however, in actuality very few blowout events have resulted in spilled oil, and the volumes spilled are often very small. Since 1998, three blowouts have resulted in oil spills with the amount of oil spilled ranging from <1 bbl to 200 bbl. Table 4-20 shows that there have been no spills ≥1,000 bbl from blowouts in the last 30 years.

4.4.1.1.5.3. Most Likely Size of an Offshore Spill ≥1,000 bbl

The median size of spills ≥1,000 bbl that occurred during 1985-1999 is 4,551 bbl and the median size for spills ≥10,000 bbl is 15,000 bbl (Table 4-20). Based on these median sizes, MMS estimates that the most likely size of a spill ≥1,000 bbl from a proposed action would be 4,600 bbl.

4.4.1.1.5.4. Fate of Offshore Spills ≥1,000 bbl

Persistence

The persistence of an offshore oil slick is strongly influenced by how rapidly it spreads and weathers and by the effectiveness of oil-spill response in removing the oil from the water surface.

As part of the risk analysis of an offshore spill ≥1,000 bbl, MMS estimated the expected persistence time of the spill, specifically, how long it might last as a cohesive mass on the surface of the water, capable of being tracked and moved by winds and currents. Tables 4-45 and 4-46 provide a mass balance over time for a likely spill related to a proposed action in each planning area. The MMS estimates that a spill ≥1,000 bbl with the characteristics and parameters specified in the table below would dissipate from the water surface in 2-10 days.

Spreading

Gulf of Mexico oils having API gravities between 30^o and 35^o will float, except under turbulent mixing conditions such as during a large storm offshore. Once spilled, it is expected that all Gulf of Mexico oils would rise and reach the surface of the open Gulf. On the sea surface, the oil would rapidly spread out on the water surface, forming a slick that is initially a few millimeters (mm) in thickness in the center and much thinner around the edges. The rate of spreading depends upon the viscosity of the spilled oil, whether or not the oil is released at the water surface or subsurface, and whether the spill is instantaneous or continuous for some period. The spilled oil would continue to spread until its thickest part is about 0.1 mm. Once it spreads thinner than 0.1 mm, the slick would begin to break up into small patches, forming a number of elongated slicks, with an even thinner sheen trailing behind each patch of oil.

Table 4-45 and 4-46 provides an estimate of the thickness and areal extent of a typical oil slick for different times after a spill event. If an offshore spill ≥1,000 bbl of oil having the properties and characteristics specified in the table below were to occur as a result of a proposed action and typical cleanup response was to take place, the slick would attain its greatest surface area by 12 hours after the spill event. The maximum water surface area covered by such a slick would be between 200 and 350 ac.

Weathering

Immediately upon being spilled, oil begins reacting with the environment. This process is called weathering. A number of processes alter the chemical and physical characteristics of the original hydrocarbon mixture, which reduces the oil mass over time. Weathering processes include evaporation of volatile hydrocarbons into the atmosphere, dissolution of soluble components, dispersion of oil droplets into the water column, emulsification and spreading of the slick on the surface of the water, chemo- or photo-oxidation of specific compounds creating new components that are often more soluble, and biodegradation. Weathering and the existing meteorological and oceanographic conditions determine the time that the oil remains on the surface of the water, and the characteristics of the oil at the time of contact with a particular resource also influence the persistence time of an oil slick. Oil-spill cleanup timing and effectiveness would also be determining factors.

Chemical, physical, and biological processes operate on spilled oil to change its hydrocarbon compounds, reducing many of the components until the slick can no longer continue as a cohesive mass floating on the surface of the water. By spreading out, the oil's more volatile components are exposed to the atmosphere and up to about two-thirds of the oil evaporates rapidly.

Over time, if the slick is not completely dissipated, a tar-like residue may be left; this residue breaks up into smaller tar lumps or tarballs that usually sink below the sea surface but not necessarily to the seafloor. Not all oils form tarballs; many Gulf of Mexico oils do not (Jefferies, 1979).

The MMS uses the SINTEF model to numerically model weathering processes to (1) estimate the likely amount of oil remaining on the ocean surface as a function time and (2) predict the composition of any remaining oil. Table 4-45 and 4-46 summarizes the model's results for a typical oil and the environmental scenarios in the WPA and CPA. Four scenarios were modeled. Information on the SINTEF model can be found in Daling et al. (1997) and Reed et al. (2000). The table below provides the scenario parameters used for the weathering model runs.

Input Parameters Used to Run Four Scenarios for Weathering Model

Parameter	Input
Spill Size	4,600 bbl
Duration of Spill	24 hours
API Gravity of Spilled 0il	Two oils: (1) 30^{o} API (Garden Banks 387) (2) 35^{o} API (Grand Isle)
Surface Water Temperature	Summer WPA & CPA 29 ^{o}C Winter WPA & CPA 20.2 ^{o}C
Mean Wind Speed	Summer WPA 5.3 m/s
	Winter WPA 7.2 m/s
	Summer CPA 4.0 m/s
	Winter CPA 7.2 m/s
Distance of Spill Source from Shore	200 m
Emulsification Formation	Yes for 30 ^{o} API oil No for 35 ^{o} API oil

The results of the weathering analyses are summarized in Tables 4-45 and 4-46. By 10 days after a spill event of $\geq$1,000 bbl, approximately 32-74 percent of the slick would have dissipated by natural weathering, between 30 and 32 percent would have been lost to the atmosphere via evaporation, and about 2-42 percent would have been lost into the water column via natural dispersion. The volume of the slick would be further reduced by spill-response efforts (Chapter 4.4.2.).

Seafloor Release

All evidence to date indicates that accidental oil discharges that occur at the seafloor (for example, from a blowout or a pipeline break) would rise in the water column, surfacing almost directly over the source location. All known reserves in the Gulf to date have specific gravities and chemical characteristics that would preclude oil slicks from sinking. Evidence from direct observation and remote imagery from space indicates oil slicks originating from natural seeps in the Gulf of Mexico occur on the sea surface almost directly above the known seep locations. Shipboard observations during submersible operations noted the surface expression of rising oil at a horizontal distance of 100 m from the origin of the seep on the bottom (MacDonald et al., 1995). A recent study in Norway, which intentionally released oil with chemical characteristics similar to Gulf of Mexico OCS oils at depth (844 m) and simulated blowout conditions, provided direct evidence that such an oil spill quickly rises to the surface. Within an hour after release, the oil appeared on the surface within a few hundred meters (horizontally) of the release site (Johansen et al., 2001).

4.4.1.1.5.5. Transport of Spills ≥1,000 bbl by Winds and Currents

Using the OSRA model, MMS estimates the likely trajectories of hypothetical offshore spills ≥1,000 bbl. The trajectories combined with estimated spill occurrence are used to estimate the risk of future spills occurring and contacting environmental features.

The OSRA model simulates the trajectory of a point launched from locations mapped onto a gridded area. The gridded area represents an area of the Gulf of Mexico, and the point's trajectory simulates a spill's movement on the surface of water using modeled ocean current and wind fields. The model uses temporally and spatially varying, numerically computed ocean currents and winds.

The OSRA model can simulate a large number of hypothetical trajectories from each launch point. Spill trajectories are launched once per day from each origin point and are time stepped every hour until a statistically valid number of simulations have been run to characterize the risk of contact. The simulated oil spills for this EIS were "launched" from approximately 4,000 points uniformly distributed 6-7 mi apart within the Gulf OCS. This spacing between launch points is sufficient to provide a resolution that created a statistically valid characterization of the entire area (Price et al., 2001).

The model tabulates the number of times that each trajectory moves across or touches a location (contact) occupied by polygons mapped on the gridded area. These polygons represent locations of various environmental features. The OSRA model compiles the number of contacts to each environmental feature that result from all of the modeled trajectory simulations from all of the launch points for a specific area. Contact occurs for offshore features if the trajectory simulation passes through the polygon. Contact occurs for land-based features if the trajectory simulation touches the border of the feature. The simulation stops when the trajectory contacts the lines representing the land/water boundary or the borders of the domain. The probability of contact to an environmental feature is calculated by dividing the number of contacts by the number of trajectories started at various launch locations in the gridded area.

The output from this component of the OSRA model provides information on the likely trajectory of a spill by wind and current transport, should one occur and persist for the time modeled in the simulations; the calculations for this EIS were modeled for 30 days. Because the analysis of the fate of a likely OCS spill (Chapter 4.4.1.1.5.4) showed that a slick would not persist on the water surface beyond 10 days, the OSRA model simulations were analyzed up to 10 days. All contacts that occurred during this period were tabulated.

A detailed description of the OSRA model used in this analysis is provided separately in a published report (Ji et al., in preparation). This report, including its figures and tables, will be available from the MMS Internet site (http://www.temporarygomr.com).

4.4.1.1.5.6. Length of Coastline Affected by Offshore Spills ≥1,000 bbl

Table 4-45 and 4-46 provides MMS's estimates of the length of shoreline that could be contacted if a typical spill ≥1,000 bbl occurred as a result of an accident associated with a proposed action. The length of shoreline contacted is dependent upon the original spill size and the volume of oil removed by natural weathering and offshore cleanup operations prior to the slick making shoreline contact. The shoreline length contacted is a simple arithmetic calculation based on the area of the remaining slick. The calculation assumes that the slick will be carried 30 m inshore of the shoreline, either onto the beachfront up from the water's edge or into the bays and estuaries, and will be spread out at uniform thickness of 1 mm; this assumes that no oil-spill boom is used. The maximum length of shoreline affected by a typical spill ≥1,000 bbl is estimated to be 30-50 km of shoreline, assuming such a spill were to reach land within 12 hours. Some redistribution of the oil due to longshore currents and further smearing of the slick from its original landfall could also occur.

4.4.1.1.5.7. Likelihood of an Offshore Spill ≥1,000 bbl Occurring and Contacting Modeled Locations of Environmental Resources

A more complete measure of spill risk was calculated by multiplying the probability of contact generated by the OSRA model by the probability of occurrence of one or more spills ≥1,000 bbl as a result of a proposed action. This provides a risk factor that represents the probability of a spill occurring as a result of a proposed action and contacting the resource of concern. These numbers are often referred to as "combined probabilities" because they combine the risk of occurrence of a spill from OCS sources and the risk of such a spill contacting sensitive environmental resources.

The combined probabilities are provided for each resource of concern in Figures 4-13 through 4-31. A discussion of spill risk to the resources is provided in Chapter 4.4.1.1.8.

To better reflect the geologic distribution of oil and gas resources and natural variances of meteorological and oceanographic conditions in the computation of combined probabilities, the MMS also generated combined probabilities for smaller areas within the WPA and CPA. The MMS used a cluster analysis to analyze the contact probabilities generated for each of the 4,000 launch points. For this analysis, similar trajectories and contact to 10-mi shoreline segments were used to identify offshore cluster areas. The estimated oil production from a proposed action was proportionally distributed to the cluster areas and the likelihood of spill occurrence was calculated for each cluster area. The probability of spill occurrence was combined with probabilities of contact from the trajectory modeling to estimate the combined risk of spills occurring and contacting various resources from spills in each cluster area. To account for the risk of spills occurring from the transportation of oil to shore, generalized pipeline corridors originating within each of the offshore cluster areas and terminating at major oil pipeline landfall areas were developed. The oil volume estimated to be produced as a result of a proposed action within each cluster area was proportioned among the pipeline corridors. The mean number of spills and the probability of contact of spills from each pipeline corridor were then calculated and combined with the risk of spills occurring and contacting resources from OCS facility development and production operations to complete the analysis.

4.4.1.1.5.8. Risk Analysis for Offshore Spills <1,000 bbl

The following section addresses the risk of spills <1,000 bbl resulting from a proposed action. To discuss spills <1,000 bbl, information is broken into size groups shown in Table 4-20.

Analysis of historical data show that most offshore OCS oil spills have been ≤1 bbl (Figure 4-12). Although spills of ≤1 bbl have made up 94 percent of all OCS-related spill occurrences; spills of this size have contributed very little (5%) to the total volume of OCS oil that has been spilled. Most of the total volume of OCS oil spilled (95%) has been from spills ≥10 bbl. For the period 1980-1999, OCS operators produced about 7.4 Bbbl of oil and the amount of OCS oil spilled offshore totaled about 71,500 bbl (less than 0.001%) or 1 bbl spilled for every 104,000 bbl oil and condensate produced.

For all spills ≥50 bbl, pipeline spills occurred the most frequently (60%). For all sizes of spills, facility spills have occurred more frequently than pipeline spills. For all spills >1 bbl since 1980, there have been 18 pipeline spills resulting in 60,718 bbl spilled and 55 facility spills resulting in 10,769 bbl spilled.

4.4.1.1.5.9. Estimated Number of Offshore Spills <1,000 bbl and Total Volume of Oil Spilled.

The number of spills <1,000 bbl estimated to occur over the next 40 years as a result of a proposed action is provided in Table 4-44. The number of spills is estimated by multiplying the oil-spill occurrence rate for each of the different size groups by the range of oil volumes estimated to be produced as a result of a proposed action. As spill size increases, the occurrence rate decreases and so the number of spills estimated to occur decreases.

The number of spills ≥500 bbl estimated to occur is less than one (mean number of spills equal to 0.07-0.14 for a WPA proposed action and 0.14-0.34 for a CPA proposed action).

The chance of one spill between 500 bbl and 1,000 bbl occurring is 6-12 percent for a WPA proposed action and 12-24 percent for a CPA proposed action.

Over the 40-year analysis period, 1-2 spills >50 bbl and <500 bbl are estimated to occur in the WPA from activities related to a proposed action, and 2-4 spills in this size category are estimated to occur in the CPA from activities related to a proposed action.

Multiplying the estimated number of spills by the median or average spill sizes for each size group yields the volume of oil estimated to be spilled by all spills <1,000 bbl as a result of a proposed action over the 40-year analysis period. A total of 500-1,600 bbl of oil is estimated from spills <1,000 bbl as a result of a proposed action in the WPA. A total of 1,000-2,900 bbl of oil is estimated from spills <1,000 bbl as a result of a proposed action in the CPA.

4.4.1.1.5.10. Most Likely Source and Type of Offshore Spills <1,000 bbl

Most spills <1,000 bbl would likely occur from a mishap on a production facility, most likely related to a failure related to storage of oil. Analysis of the 24 offshore oil spills >50 bbl and <1,000 bbl that occurred between 1985 and 1999 showed that 42 percent were diesel spills, 25 percent were condensate spills, and 21 percent were crude oil spills. The remaining spills were hydraulic fluids (2 spills) and diesel fuel or mineral oil-based drilling muds (2 spills). The most likely type of spill <1,000 bbl as a result of a proposed action is a diesel spill.

4.4.1.1.5.11. Most Likely Size of Offshore Spills <1,000 bbl

Table 4-44 provides the most likely volume of oil estimated to be spilled for each of the spill-size groups. These volumes represent the median spill size calculated for each category from MMS historical records (Table 4-20). During the 40-year analysis period, 97 percent of spills <1,000 bbl estimated to occur as a result of a proposed action would be ≤1 bbl.

4.4.1.1.5.12. Persistence, Spreading, and Weathering of Offshore Oil Spills <1,000 bbl

It is expected that slicks from spills <1,000 bbl will persist a few minutes (<1 bbl), a few hours (<10 bbl), or a few days (10-1,000 bbl) on the open ocean. Spilled oil would rapidly spread out, evaporate, and weather, quickly becoming dispersed into the water column. Most spills <1,000 bbl are expected to be diesel, which dissipates very rapidly. Diesel is a distillate of crude oil and does not contain the heavier components that contribute to crude oil's longer persistence in the environment.

4.4.1.1.5.13. Transport of Spills <1,000 bbl by Winds and Currents

To be transported by winds and currents, an oil slick must remain a drifting cohesive mass. Only spills >50 bbl have a chance of remaining a cohesive mass long enough to be transported any distance.

4.4.1.1.5.14. Likelihood of an Offshore Spill <1,000 bbl Occurring and Contacting Modeled Locations of Environmental Resources

Because spills <1,000 bbl are not expected to persist as a slick on the surface of the water beyond a few days and because spills on the OCS would occur at least 3 mi from shore, it is unlikely that any spills would make landfall prior to breaking up. For an offshore spill <1,000 bbl to make landfall, the spill would have to occur proximate to State waters (defined as 3-12 mi from shore). If a spill were to occur proximate to State waters, only a spill >50 bbl would be expected to have a chance of persisting long enough to reach land. Spills >50 bbl and <1,000 bbl size are very infrequent. Should such a spill occur, the volume that would make landfall would be expected to be extremely small (a few barrels). These assumptions are supported by a previous analysis of 3-day trajectory model runs, previous weathering analyses, and historical records of spill incidents.

4.4.1.1.6. Risk Analysis for Coastal Spills

Spills in coastal waters could occur at storage or processing facilities supporting the OCS oil and gas industry or from the transportation of OCS-produced oil through State offshore waters and along navigation channels, rivers, and through coastal bays. The MMS projects that almost all (>99%) oil produced as a result of a proposed action will be brought ashore via pipelines to oil pipeline shore bases, stored at these facilities, and eventually transferred via pipeline or barge to Gulf coastal refineries. Because oil is commingled at shore bases and cannot be directly attributed to a particular lease sale, this analysis of coastal spills addresses spills that could occur prior to the oil arriving at the initial shoreline facility. It is also possible that non-OCS oil may be commingled with OCS oil at these facilities or during subsequent secondary transport.

4.4.1.1.6.1. Estimated Number and Most Likely Sizes of Coastal Spills

The USCG Marine Safety Information System database of offshore and inland spills does not differentiate between spills associated with OCS and non-OCS activities. The MMS uses this database to estimate the number of coastal oil spills attributable to a proposed action by proportioning all spills occurring in the Gulf of Mexico coastal area by the volumes of oil handled by all oil-handling operations in the coastal area including OCS support operations, State oil and gas production, intra-Gulf transport, and coastal import/export oil activities. Chapter 4.1.3.4 provides more information on oil spills from these other operations.

From MMS's analysis of the USCG database for all spills in U.S. water and using assumptions to partition these spills to Gulf of Mexico OCS operations, Table 4-47 provides the number of spills by size group estimated to occur in coastal waters (both offshore State waters and coastal waters) during the 40-year analysis period as a result of each proposed action. The table provides an assumed spill size, derived from the USCG statistics, for each of the size groups. The MMS estimates that 25-50 spills in coastal waters are likely as a result of a typical sale in the WPA. Most of these spills would be ≤1 bbl (20-40 spills). One spill >50 bbl and <1,000 bbl could occur (assumed size 150 bbl)

For a typical sale in the CPA, the MMS estimates 55-125 spills during the 40-year analysis period, with 40-95 of these spills being ≤1 bbl. The MMS estimates that one spill ≥1,000 bbl (assumed size 3,000 bbl) and 1-2 spills >50 bbl and <1,000 bbl could occur (assumed size 150 bbl).

4.4.1.1.6.2. Likelihood of Coastal Spill Contact with Various Resources

The coastal spill rate is based on historical spills and the projected amount of oil production. For the purpose of this analysis, coastal spills are assumed to occur where oil production is brought to shore. Figure 4-32 shows major oil pipeline landfall areas and the projected percentages of oil production for a CPA proposed action and a WPA proposed action that will be brought to shore in these areas. Because the majority (70%) of oil production from a WPA proposed action is projected to be brought to shore in the Galveston/Houston/Texas City Area, it is assumed the majority of coastal spills from a WPA proposed action will also occur in this area. It is projected that the majority (95%) of oil production for a CPA proposed action will be brought to shore in eastern Louisiana, from Atchafalaya Bay to east of the Mississippi River. Based on this assumption the majority of coastal spills are projected to occur in this area, including one spill ≥1,000 bbl (assumed size 3,000 bbl) estimated to occur as the result of a CPA proposed action.

4.4.1.1.7. Risk Analysis by Resource

This section summarizes MMS's information on the risk to resources analyzed in this EIS from oil spills and oil slicks that could occur as a result of a proposed action in the WPA or CPA. The risk results are based on MMS's estimates of likely spill locations, sources, sizes, frequency of occurrence, physical fates of different types of oil slicks, and probable transport that are described in more detail in the preceding spill scenarios. This analysis presents combined probabilities, which include both the likelihood of a spill from a proposed action occurring and the likelihood of the oil slick reaching areas where known environmental resources occur. The analysis of the likelihood of direct exposure and interaction of a resource with an oil slick and the sensitivity of a resource to the oil is provided under each resource category in Chapter 4.4.3.

The term "oil spill" is a term that has several meanings. It may be used to describe the actual action of spilling oil. It is often used interchangeably with "oil slick." In this EIS, "oil spill" is used to describe an event that has a life history – it has a "birth" (the action of spilling) and is subjected to physical processes such as "aging" (weathering). Therefore, the oil spill can be described as undergoing life history stages, which include the following: slick formation, spreading, photolysis and evaporation, dissolution of water-soluble components, oil-in-water dispersion, adsorption to particles, microbiological degradation, vertical and horizontal diffusion, sedimentation, and resurfacing of larger oil droplets. Some of these stages are processes, while others describe the physical status of the spilled hydrocarbons.

Risk to sensitive environmental resources does not disappear when the "slick" disappears. After a slick disperses, hydrocarbons continue to persist in the sea for decades or longer. Marine organisms are exposed to these hydrocarbons in the waters where they reside, as well as through the prey that they consume. For example, FWS biologists from Texas recently commented to MMS that they are still finding tarballs, probably from the *Ixtoc* oil spill in Mexico that occurred decades ago, washing up on Padre Island National Seashore (PINS), a nesting beach for endangered Kemp's ridley sea turtles. Not far away is the Aransas National Wildlife Refuge, which is critical habitat to the endangered whooping crane. Sea turtle hatchlings that evacuate nests on PINS are at risk of ingesting or becoming fouled with these tarballs. Whooping cranes are also at risk of contact as they forage in estuarine and bay waters along the Coastal Bend region of Texas. During foraging forays, they may ingest or become fouled with tarballs. If parent birds become fouled by tarballs, they may subsequently foul the nest or their offspring. They may even feed their offspring prey contacted by tarballs.

Prior to washing up on beaches, tarballs persist in the sea. They may remain neutrally buoyant and suspended in the water column, or they may settle on the seafloor. Numerous marine organisms (including endangered and threatened cetaceans, manatees, and sea turtles) feed and ingest materials found in the water column or on the seafloor. These animals are at risk of ingesting oil or consuming prey contaminated or fouled by residual hydrocarbons introduced from an oil spill. The risk of exposure to marine protected species and their prey may last decades. The risk of exposure to tarballs or persistent hydrocarbons from an oil spill in the sea is less than the risk associated with exposure to an oil slick.

Analysis of Spill Risk to Sensitive Coastal Environments

Sensitive coastal environments located in the Gulf of Mexico consist primarily of coastal barrier beaches, wetlands, and seagrass communities (Chapter 3.2.1).

Risk from Offshore Spills ≥1,000 bbl

Because of the widespread distribution of sensitive coastal environments along the Gulf Coast, specific resource locations were not analyzed by the OSRA model trajectory simulations. The probabilities of an offshore spill ≥1,000 bbl occurring and contacting coastal counties and parishes was used as an indicator of the risk of a slick from such a spill reaching sensitive coastal environments. Figure 4-13 shows the Gulf of Mexico coastal counties and parishes having a risk >0.5 percent of being contacted within 10 days by an offshore spill ≥1,000 bbl occurring as a result of a proposed action in the CPA or WPA. Most counties and parishes have a <0.5 percent probability of a spill ≥1,000 bbl occurring and contacting (combined probability) their shorelines within 10 days; five counties in Texas and six parishes in Louisiana have a 1-8 percent chance of an OCS offshore spill ≥1,000 bbl occurring and reaching their shoreline within 10 days. Plaquemines Parish, Louisiana, has the greatest risk (4-8%) of a spill occurring and contacting its shoreline within 10 days as a result of a CPA proposed action. In Texas, Matagorda County has the greatest risk (1-2%) of being contacted within 10 days by a spill occurring offshore as a result of a WPA proposed action.

Tables 4-45 and 4-46 provide MMS estimates of the likely size and remaining volumes of oil slicks of a "typical" CPA oil and a "typical" WPA oil for several time increments after spills of assumed size 4,600 bbl occur. In the CPA, it is estimated that 50 bbl would remain in the slick 10 days after the spill; about 1 km of shoreline would be contacted if the 10-day-old, 50-bbl slick reached shore. In the WPA, it is estimated that the slick would dissipate within 4 days. It is estimated that 10-50 km of land would be contacted if a slick from a WPA proposed action reached shore within 24 hours after the spill incident.

Risk from Offshore Spills <1,000 bbl

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach land. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters and to reach shore. Should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probability of occurrence.

Based on the assumption that spill occurrence is proportional to the volume of oil handled, sensitive coastal environments located near the coastal waters of the Galveston/Houston/Texas City area have the greatest risk of being contacted by coastal spills related to a proposed action in the WPA. A total of 70 percent of all oil estimated to be produced as a result of a proposed action in the WPA is projected to be to be brought into this area.

Sensitive coastal environments in eastern Louisiana, from Atchafalaya Bay to east of the Mississippi River, including Barataria Bay, have the greatest risk of being contacted by spills from operations related to a CPA proposed action. The greatest risk of contact would be from the assumed 3,000-bbl spill should it occur within or near wetlands.

Analysis of Spill Risk to Live Bottoms

The live bottoms (topographic features and pinnacle trend) sustaining sensitive benthic communities are listed and described in Chapters 4.2.1.2 and 4.3.1.2.

Risk from Offshore Spills

All evidence to date indicates that oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column, surfacing almost directly over the source location (Chapter 4.4.1.1.5.4). Therefore, a subsurface oil spill would have to occur very close to a topographic or pinnacle trend feature for the rising oil to contact the feature. There is a 16-25 percent chance that one pipeline spill ≥1,000 bbl would occur and a 1-5 percent chance that a second pipeline spill ≥1,000 bbl would occur as a result of a WPA proposed action. There is a 26-37 percent chance that one pipeline spill ≥1,000 bbl would occur, a 5-17 percent chance that a second pipeline spill ≥1,000 bbl would occur, and a 1-5 percent chance that a third pipeline spill ≥1,000 bbl would occur as a result of a CPA proposed action. For a proposed action in the WPA, 1-2 blowouts are estimated to occur during the 40-year analysis period; 2-4 blowouts are estimated to occur from a proposed action in the CPA. No pipeline spill or blowout would occur within 1,000 m of a topographic or pinnacle trend feature because lease stipulations prohibit drilling or pipeline emplacement within 1,000 m of identified live-bottom features.

Once the oil from a subsea spill reaches the sea surface, the slick behaves similarly to a slick from a surface spill. Oil from a surface slick can be driven into the water column. Measurable amounts have been documented down to a 10-m depth, and modeling exercises have indicated such oil may reach a depth of 20 m. As the crests of topographic and pinnacle trend features in the northern Gulf are primarily deeper than 20 m, with the exception of the features within the Flower Gardens Banks National Marine Sanctuary, oil from a surface spill is unlikely to reach the sessile biota of these live-bottom features.

The tops of the shallowest features in the Flower Gardens Banks National Marine Sanctuary are at approximately 15 m below sea level. If oil in a slick passing over the sanctuary were driven into the water column as deep as 15 m or more, biota in the sanctuary could be contacted. The likelihood of a surface slick from a spill associated with proposed action operations passing over the Sanctuary was calculated by the MMS's trajectory model. For proposed actions in the CPA and WPA, there is up to a 4 percent risk of an oil spill occurring and the surface slick passing over the Flower Garden Banks; there is up to 2 percent chance of a spill occurring and the surface slick passing over Stetson Bank.

Analysis of Spill Risk to Deepwater Benthic Communities

Deepwater benthic communities include both chemosynthetic and nonchemosynthetic communities (Chapter 3.2.3). Chemosynthetic communities occur in water depths of >400 m.

Risk from Offshore Spills

All evidence to date indicates that oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column, surfacing almost directly over the source location (Chapter 4.4.1.1.5.4). Therefore, a subsurface oil spill would have to occur very close to a benthic community for rising oil to contact the benthic organisms. There is a 16-25 percent chance that one pipeline spill ≥1,000 bbl would occur and a 1-5 percent chance that a second pipeline spill ≥1,000 bbl would occur as a result of a WPA proposed action. There is a 26-37 percent chance that one pipeline spill ≥1,000 bbl would occur, a 5-17 percent chance that a second pipeline spill ≥1,000 bbl would occur, and a 1-5 percent chance that a third pipeline spill ≥1,000 bbl would occur as a result of a CPA proposed action. For a proposed action in the WPA, 1-2 blowouts are estimated to occur during the 40-year analysis period; 2-4 blowouts are estimated to occur from a proposed action in the CPA. The likelihood that a pipeline spill or blowout would occur near a chemosynthetic community is extremely low, especially with consideration that NTL 2000-G20 prohibits drilling or pipeline emplacement within 1,500 ft of potential chemosynthetic communities.

The likelihood of weathered oil components from a surface slick reaching a deepwater chemosynthetic community in any measurable concentrations is very small.

Analysis of Spill Risk to Water Quality

The potential for spills to affect the quality of Gulf of Mexico coastal and marine waters is dependent on the frequency and volume of spills.

Risk from Offshore Spills

The MMS estimates that about 500-22,000 bbl of oil would be spilled in offshore waters over the 40-year life of a proposed action in the WPA and about 1,000-23,000 bbl of oil would be spilled in offshore waters over the 40-year life of a proposed action in the CPA. These volumes include volumes from spill incidents in all size groups.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. The MMS estimates coastal spills related to the proposed actions could introduce 200-3,200 bbl of oil into coastal waters of Texas and 200-3,500 bbl of oil into coastal waters of Louisiana. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probability of occurrence.

For offshore spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach coastal waters. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters. Should a slick from such a spill reach coastal waters, the volume of oil remaining in the slick is expected to be small.

Analysis of Spill Risk to Air Quality

Oil exposed to the atmosphere has the potential to contribute to air pollutants through evaporation of the volatile components of the oil. The number of spills estimated to occur as a result of typical proposed actions in the WPA and CPA are presented in Chapter 4.4.1.1. Estimates of the contribution of spills to the total volume of volatile hydrocarbons are provided in Chapters 4.2.1.4 and 4.3.1.4.

Analysis of Spill Risk to Marine Mammals

Risk from Offshore Spills ≥1,000 bbl

Spills occurring in or being transported through coastal waters as a result of a proposed action may contact groups of bottlenose dolphin, Atlantic spotted dolphin, or the West Indian manatee. Figure 4-16 depicts the locations of marine mammal habitats in coastal waters that were analyzed by the OSRA model. Figure 4-16 also provides the probabilities of a spill ≥1,000 bbl occurring from a proposed action in either the WPA or the CPA and the slick reaching identified marine mammal coastal habitats within 10 days. The OSRA modeling results indicate that there is a 5-8 percent probability of a spill ≥1,000 bbl occurring as a result of a proposed action in the WPA and the slick reaching the Texas State waters used by marine mammals within 10 days. The probability of an oil spill ≥1,000 bbl occurring as a result of a proposed action in the CPA and the slick reaching Texas coastal waters within 10 days is 1 percent. Coastal waters of Louisiana west of the Mississippi River have a 9-19 percent and 1-2 percent risk of being contacted within 10 days by a slick resulting from an offshore spill ≥1,000 bbl related to a proposed action in the CPA and WPA, respectively. There is a 2-4 percent risk of a spill occurring from a proposed action in the CPA and the slick contacting Louisiana coastal waters east of the Mississippi River mouth within 10 days. The OSRA model projected a <0.5 percent chance of a slick from a spill ≥1,000 bbl reaching the coastal waters east of Louisiana within 10 days as a result of either proposed actions (Figure 4-16).

Figure 4-17 shows the geographic locations analyzed by the OSRA model to estimate the risk of oil-spill occurrence and contact to areas predictably used by manatees. The probability of a spill ≥1,000 bbl occurring from a proposed action and the slick reaching manatee areas within 10 days was <0.5 percent, except for the manatee habitat located off the shoreline from eastern Louisiana to Alabama. Under the high-case resource development scenario, there is a 1 percent likelihood of a spill ≥1,000 bbl occurring from a proposed action in the CPA and reaching this manatee area.

Risk from All Offshore Spills

About 500-22,000 bbl of oil are estimated to be spilled in offshore waters over a 40-year period from the estimated 473-910 spill events as a result of a proposed action in the WPA, and about 1,000-23,000 bbl of oil is estimated to be spilled in offshore waters from the estimated 956-2,227 spills as a result of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from one spill incident in the size group ≥1,000 bbl and one spill incident in the size group ≥10,000 bbl.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. The MMS estimates coastal spills related to the proposed actions could introduce 200-3,200 bbl of oil into coastal waters of Texas and 200-3,500 bbl of oil into coastal waters of Louisiana. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have low probability of occurrence.

Analysis of Spill Risk to Sea Turtles

Risk from Offshore Spills ≥1,000 bbl

Spills occurring as a result of a proposed action and oil slicks migrating through coastal waters could reach coastal sea turtle habitats. Figure 4-19 maps the locations analyzed by the OSRA model in calculating the risk of an oil slick contacting the general, mating, and nesting habitats of sea turtles. The table below provides the geographic areas and months used for the OSRA model. Working with FWS, the MMS determined the months (listed in the table below) when sea turtles used the identified coastal habitats. The model results present the likelihood of slicks reaching the identified locations only during these months.

State	Geographic Area Type	Habitat Use	Seasonality
Tamaulipas	Coastal beaches	Nesting	April-September
Tamaulipas	State coastal waters	Mating	March-July
Tamaulipas	State coastal waters	General	year round
TX	Coastal beaches	Nesting	April-September
TX	State coastal waters	Mating	March-July
TX	State coastal waters	General	year round
LA	Chandeleur Islands	Nesting	April-November
LA	State coastal waters	General	year round
LA	Chandeleur Islands	Mating	March-July
MS-AL	Coastal beaches	Nesting	April-November
MS-AL	State coastal waters	Mating	March-July
MS-AL	State coastal waters	General	year round
FL Panhandle	Coastal beaches	Nesting	April-November
FL Panhandle	State coastal waters	Mating	March-July
FL Panhandle	State coastal waters	General	year round
FL peninsula	Coastal beaches	Nesting	April-November
FL Peninsula	State coastal waters	Mating	March-July
FL Peninsula	State coastal waters	General	year round
Tortugas	Coastal beaches	Nesting	April-November
Tortugas	State coastal waters	Mating	March-July
Tortugas	State coastal waters	General	year round

Figure 4-19 provides the likelihood of an offshore spill ≥1,000 bbl occurring from a proposed action in either the WPA or the CPA and reaching the identified coastal sea turtle habitats within 10 days during the identified months of use.

The OSRA modeling results indicate that there is a 5-8 percent probability that a spill ≥1,000 bbl occurring as a result of a WPA proposed action and the slick reaching Texas waters used by sea turtles as general coastal habitat within 10 days after a spill event. There is a 3-5 percent chance that one or more spills would occur and the slick reaching Texas waters within 10 days after the spill occurrence during mating season. There is a <0.5-2 percent chance that a spill ≥1,000 bbl would occur from a WPA proposed action and the slick reaching shore within 10 days during Texas's sea turtle nesting season.

The probability of an offshore oil spill ≥1,000 bbl occurring as a result of a proposed action in the CPA and the slick reaching Louisiana coastal waters used by turtles as general coastal habitat within 10 days ranges from 2 to 19 percent. The Chandeleur Islands is the only area in Louisiana considered sea turtle habitat for mating and nesting; there is up to a 1 percent chance that this habitat would be contacted by slick from an offshore spill ≥1,000 bbl occurring as a result of a proposed action.

The OSRA model results show that there is a <0.5 percent chance that coastal areas in Mexico, Mississippi, Alabama, or Florida, when serving as sea turtle habitat, would be contacted by an oil slick resulting from an offshore spill ≥1,000 related to a proposed action in the CPA or WPA.

Tables 4-45 and 4-46 provide MMS estimates of the likely size and remaining volumes of oil slicks of a "typical" CPA oil and a "typical" WPA oil for several time increments after spills of assumed size 4,600 bbl occur. In the CPA, it is estimated that 50 bbl would remain in the slick 10 days after the spill; about 1 km of shoreline would be contacted if the 10-day-old, 50-bbl slick reached shore. In the WPA, it is estimated that the slick would dissipate within 4 days. It is estimated that 10-50 km of land would be contacted if a slick from a WPA proposed action reached shore within 24 hours after the spill incident.

Risk from All Offshore Spills

The MMS estimates that about 500-22,000 bbl of oil would be spilled in offshore waters from an estimated 473-910 spills over the 40-year life of a proposed action in the WPA and about 1,000-23,000 bbl of oil would be spilled in offshore waters from an estimated 956-2,227 spills over the 40-year life of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from one spill incident in the size class of ≥1,000 bbl and one in the size class of ≥10,000 bbl.

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach land. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters and to reach shore. Should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. The MMS estimates coastal spills related to the proposed actions could introduce 200-3,200 bbl of oil into coastal waters of Texas and 200-3,500 bbl of oil into coastal waters of Louisiana. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probably of occurrence.

Analysis of Spill Risk to Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

Risk from Offshore Spills ≥1,000 bbl

Figure 4-20 provides the results of MMS's analysis of the risk of a spill ≥1,000 bbl occurring offshore and reaching endangered beach mice habitat within 10 days as a result of a proposed action in either the CPA or WPA. There is a <0.5 percent chance that one or more offshore spills ≥1,000 bbl would occur and contact the shoreline inhabited by the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice during the life of a proposed action (2003-2042).

Risk from Offshore Spills <1,000 bbl

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach land. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters and to reach shore. Should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small.

Risk from Coastal Spills

No coastal spills are estimated to occur in Mississippi, Alabama, or Florida coastal waters as a result of a proposed action in the CPA.

Analysis of Spill Risk to Marine Birds

Risk from All Offshore Spills

About 500-22,000 bbl of oil are estimated to be spilled in offshore waters over a 40-year period from the estimated 473-910 spill events as a result of a proposed action in the WPA, and about 1,000-23,000 bbl of oil are estimated to be spilled in offshore waters from the estimated 956-2,227 spills as a result of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from one spill incident in the size group ≥1,000 bbl and one spill incident in the size group ≥10,000 bbl.

There is a 6-18 percent chance of two spills ≥1,000 bbl occurring in the CPA over the next 40 years as a result of a proposed action. There is a 2-5 percent chance of two spills ≥1,000 occurring in the WPA over the 40-year life of a proposed action.

Analysis of Spill Risk to Coastal Birds

The risk of contact to coastal birds from spills related to proposed action operations is dependent upon the likelihood that a spill occurs and the likelihood that the spilled oil reaches the shore areas inhabited or used by these birds.

Risk from Offshore Spills ≥1,000 bbl

The risk of contact to coastal birds from offshore spills ≥1,000 bbl is dependent upon (1) the likelihood that oil spills occurring from proposed action operations could be transported to the shoreline identified as coastal bird habitats and (2) oil-spill contact occurs during the period that specific coastal birds are present in the area. Figures 4-21 through 4-31 identify the shoreline areas representing identified coastal bird type habitat that were analyzed for spill risk. The following table lists the coastal birds types and the periods when the birds are expected to occupy identified habitats that were used for this OSRA model run.

Coastal Bird Type	When Birds Occupy Identified Habitat Areas
Diving birds	year round
Gulls, terns, charadriid allies	year round
Raptor birds	year round
Charadriid shorebirds	year round
Wading birds	year round
Waterfowl	year round
Snowy plover	February-August
Brown pelican	year round
Whooping crane	November-April
Bald eagle	year round
Piping plover	July-May

Figures 4-21 through 4-31 also provide the results of MMS's model trajectory simulation. Probabilities shown represent the likelihood that a spill ≥1,000 bbl would occur offshore as a result of a proposed action in either the CPA or the WPA and the slick would reach various coastal bird habitats during the periods when the birds are known to use the area and within 10 days after the spill incident. The probabilities of occurrence and contact within 10 days for all species and habitats modeled range between <0.5 and 18 percent.

In addition to accounting for wind and current transport and risk of spill occurrence, the combined probabilities incorporate the length of time each coastal bird type occupies the identified habitat. For example, the whooping crane occupies the identified habitat for 6 months out of the year. The chance of a spill occurring offshore and the slick reaching within 10 days this habitat during those 6 months is calculated to be <0.5 percent. In contrast, waterfowl are found everywhere along the Gulf's shoreline year round; thus, the risk of spill occurrence and contact is higher (9-18% from a proposed action in the CPA and 5-8% from a proposed action in the WPA). Given the widespread distribution of waterfowl throughout the Gulf Coast, if an oil spill from a proposed action were to occur and reach land, waterfowl habitat would likely be contacted.

Tables 4-45 and 4-46 provide MMS estimates of the likely size and remaining volumes of oil slicks of a "typical" CPA oil and a "typical" WPA oil for several time increments after spills of assumed size 4,600 bbl occur. In the CPA, it is estimated that 50 bbl would remain in the slick 10 days after the spill; about 1 km of shoreline would be contacted if the 10-day-old, 50-bbl slick reached shore. In the WPA, it is estimated that the slick would dissipate within 4 days. It is estimated that 10-50 km of land would be contacted if a slick from a WPA proposed action reached shore within 24 hours after the spill incident.

Risk from Offshore Spills <1,000 bbl

About 500-22,000 bbl of oil is estimated to be spilled in offshore waters over a 40-year period from the estimated 473-910 spill events as a result of a proposed action in the WPA, and about 1,000-23,000 bbl of oil is estimated to be spilled in offshore waters from the estimated 956-2,227 spills as a result of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from one spill incident in the size group ≥1,000 bbl and one spill incident in the size group ≥10,000 bbl.

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach land. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters and to reach shore. Should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. The MMS estimates coastal spills related to the proposed actions could introduce 200-3,200 bbl of oil into coastal waters of Texas and 200-3,500 bbl of oil into coastal waters of Louisiana. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probability of occurrence.

Based on the assumption that spill occurrence is proportional to the volume of oil handled, bird populations located near the coastal waters of the Galveston/Houston/Texas City area have the greatest risk of being contacted by coastal spills related to a proposed action in the WPA. A total of 70 percent of all oil estimated to be produced as a result of a proposed action in the WPA is projected to be brought into this area. Bird populations in eastern Louisiana, from Atchafalaya Bay to east of the Mississippi River, including Barataria Bay, have the greatest risk of being contacted by spills from operations related to a CPA proposed action. The greatest risk of contact would be from the assumed 3,000-bbl spill should it occur within or near the identified habitat areas when the birds are occupying those habitats.

Analysis of Spill Risk to Gulf Sturgeon

In 1996, Gulf sturgeon occurred from the Mississippi River to Charlotte Harbor in western Florida (Patrick, personal communication, 1996). Figure 4-17 shows this habitat.

Risk from All Offshore Spills

Figure 4-17 provides the results of the analysis of the risk of a spill ≥1,000 bbl occurring offshore as a result of a proposed action in either the CPA or the WPA and reaching the known locations of the Gulf sturgeon within 10 days after the spill event. The likelihood of a spill ≥1,000 bbl occurring within the WPA area and reaching locations used by the Gulf sturgeon within 10 days after the spill incident is <0.5 percent. There is a 2-5 percent chance that a spill ≥1,000 bbl would occur within the CPA as a result of a proposed action and would reach coastal waters where the Gulf sturgeon has been found within 10 days. The risk of exposure of Gulf sturgeon to such a spill would be dependent upon the species abundance and density as well as the size and persistence of the slick.

About 500-22,000 bbl of oil are estimated to be spilled in offshore waters over a 40-year period from the estimated 473-910 spill events as a result of a proposed action in the WPA, and about 1,000-23,000 bbl of oil are estimated to be spilled in offshore waters from the estimated 956-2,227 spills as a result of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from one spill incident in the size group ≥1,000 bbl and one spill incident in the size group ≥10,000 bbl.

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach coastal waters. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters. Should a slick from such a spill reach coastal waters, the volume of oil remaining in the slick is expected to be small.

Risk from Coastal Spills

The coastal waters inhabited by the Gulf sturgeon are not expected to be at risk from coastal spills resulting from a proposed action in the CPA. Considering the projected use of shore bases in support of activities resulting from a proposed action in the CPA (Chapter 4.1.2.1), very few of the estimated 55-125 coastal spills resulting from a proposed action in the CPA are likely to occur east of the Mississippi River. No coastal spills are projected to occur in Mississippi, Alabama, or Florida coastal waters as a result of a proposed action in the CPA.

Analysis of Spill Risk to Fish Resources, Essential Fish Habitats, and Commerical Fisheries

The essential fish habitat (EFH) for the Gulf of Mexico includes all estuarine and marine waters and substrates from the shoreline to the seaward limit of the U.S. Exclusive Economic Zone (EEZ). Coastal areas that are considered EFH include wetlands and areas of submerged vegetation. Live-bottom features and their biotic assemblages are also considered EFH. Any spill that occurs as a result of a proposed action in the WPA or CPA will contact EFH.

Risk of All Offshore Spills

Figure 4-8 shows that there is a 6-18 percent chance of two spills ≥1,000 bbl occurring from a proposed action in the CPA over the next 40 years, and Figure 4-9 shows a 2-5 percent chance of two spills ≥1,000 occurring from a proposed action in the WPA.

The MMS estimates that about 500-22,000 bbl of oil would be spilled in offshore waters from an estimated 473-910 spills over the 40-year life of a proposed action in the WPA and about 1,000-23,000 bbl of oil would be spilled in offshore waters from an estimated 956-2,227 spills over the 40-year life of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from one spill incident in the size class of ≥1,000 bbl and one in the size class of ≥10,000 bbl.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. The MMS estimates coastal spills related to the proposed actions could introduce 200-3,200 bbl of oil into coastal waters of Texas and 200-3,500 bbl of oil into coastal waters of Louisiana. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probability of occurrence.

Based on the assumption that spill occurrence is proportional to the volume of oil handled, the most likely locations of the 17-40 coastal spills >1 bbl estimated to occur from operations related to both proposed actions are the coastal locations proximate to the major oil pipeline shore facilities. Sensitive coastal resources located within the coastal waters of the Galveston/Houston/Texas City area have the greatest risk of being contacted by coastal spills related to a proposed action in the WPA. A total of 70 percent of all oil estimated to be produced as a result of a proposed action in the WPA is projected to be brought into this area. Sensitive coastal resources located in eastern Louisiana, from Atchafalaya Bay to east of the Mississippi River, including Barataria Bay, have the greatest risk of being contacted by spills related to CPA proposed action support operations. The greatest risk of contact would be from the assumed 3,000-bbl spill should it occur when and where fish species are most vulnerable.

Analysis of Spill Risk to Recreational Beaches

The following table lists the major recreational beach areas and the timeframes analyzed for spill risk.

Recreational Beaches	Major Seasonal Use
Texas	
Coastal Bend Area Beaches	April-September
Matagorda Area Beaches	April-September
Galveston Area Beaches	April-September
Sea Rim State Park	April-September
Louisiana	
Beaches	April-November
Alabama/Mississippi	
Gulf Islands	April-November
Gulf Shores	April-November
Florida	
Panhandle Beaches	April-November
Big Bend Beaches	April-November
Southwest Beaches	April-November
Ten Thousand Islands	April-November

Risk of All Offshore Spills

Figure 4-14 provides the results of the analysis of the risk of a spill ≥1,000 bbl occurring offshore as a result of a proposed action in either the CPA or WPA and reaching major recreational beach areas. The likelihood of a spill ≥1,000 bbl occurring from a proposed action in the WPA and reaching Texas recreational beaches within 10 days is <0.5-2 percent. Western Louisiana beaches have a 1 percent chance that oil spill ≥1,000 bbl would occur from a WPA proposed action and contact the area within 10 days.

The likelihood of a spill ≥1,000 bbl occurring from a proposed action in the CPA and reaching recreational beaches in Louisiana within 10 days is 2-4 percent. The likelihood of a spill occurring from a CPA proposed action and contacting beaches in Texas is <0.5 percent.

Tables 4-45 and 4-46 provide MMS estimates of the likely size and remaining volumes of oil slicks of a "typical" CPA oil and a "typical" WPA oil for several time increments after spills of assumed size 4,600 bbl occur. In the CPA, it is estimated that 50 bbl would remain in the slick 10 days after the spill; about 1 km of shoreline would be contacted if the 10-day-old, 50-bbl slick reached shore. In the WPA, it is estimated that the slick would dissipate within 4 days. It is estimated that 10-50 km of land would be contacted if a slick from a WPA proposed action reached shore within 24 hours after the spill incident.

There is a <0.5 percent chance of a spill ≥1,000 bbl occurring from a proposed action in either the CPA or WPA and reaching recreational beaches in Mississippi, Alabama, or Florida within 10 days.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. The MMS estimates coastal spills related to the proposed actions could introduce 200-3,200 bbl of oil into coastal waters of Texas and 200-3,500 bbl of oil into coastal waters of Louisiana. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probably of occurrence.

Analysis of Spill Risk to Archaeological Resources

Since possible locations of historic and prehistoric resources are widespread along the Gulf Coast, specific resource locations were not analyzed by the OSRA model trajectory simulations.

Risk from All Offshore Spills

The probabilities of an offshore spill ≥1,000 bbl occurring and contacting coastal counties and parishes was used as an indicator of the risk of an offshore spill reaching archaeological resources. Figure 4-13 shows the Gulf of Mexico coastal counties and parishes having a risk >0.5 percent of being contacted within 10 days by an offshore spill ≥1,000 bbl occurring as a result of a proposed action in the CPA or WPA. Most counties and parishes have a <0.5 percent probability of a spill ≥1,000 bbl occurring and contacting (combined probability) their shorelines within 10 days; five counties in Texas and six parishes in Louisiana have probabilities of 1-8 percent of an OCS offshore spill ≥1,000 bbl occurring and reaching their shorelines within 10 days. Plaquemines Parish, Louisiana, has the greatest risk (4-8%) of a spill occurring and contacting its shoreline within 10 days as a result of a CPA proposed action. In Texas, Matagorda County has the greatest risk (1-2%) of being contacted within 10 days by a slick occurring offshore as a result of a WPA proposed action.

Tables 4-45 and 4-46 provide MMS estimates of the likely size and remaining volumes of oil slicks of a "typical" CPA oil and a "typical" WPA oil for several time increments after spills of assumed size 4,600 bbl occur. In the CPA, it is estimated that 50 bbl would remain in the slick 10 days after the spill; about 1 km of shoreline would be contacted if the 10-day-old, 50-bbl slick reached shore. In the WPA, it is estimated that the slick would dissipate within 4 days. It is estimated that 10-50 km of land would be contacted if a slick from a WPA proposed action reached shore within 24 hours after the spill incident.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. The MMS estimates coastal spills related to the proposed actions could introduce 200-3,200 bbl of oil into coastal waters of Texas and 200-3,500 bbl of oil into coastal waters of Louisiana. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probably of occurrence.

4.4.1.2. Blowouts

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellbore or wellhead are called blowouts. Historically, most blowouts have occurred during development drilling operations, but blowouts can happen during exploratory drilling, production, well completions, or workover operations. One-third of blowouts were associated with shallow gas flows. Most blowouts last for a short duration, with half lasting less than a day.

From 1992 to 2000, a total of 35 blowouts have occurred in the OCS with an average of 4 blowouts per 1,000 well starts. From 1995 to 2000, the blowout rate rose from 1 per 1,000 well starts to 6 per 1,000 well starts. For this EIS, blowout rates of 7 per 1,000 well starts and 2 per 1,000 existing wells were used. Since 1999, there has been one blowout per year in deepwater (> 1,000 ft), which is five blowouts per well start.

Blowouts may result in the release of synthetic drilling fluid or loss of oil. From 1992 to 2000, less than 10 percent of the blowouts have resulted in spilled oil. Of the 35 blowouts that have occurred during this period, the following three resulted in oil release:

Year	Amount Spilled	Water Depth
2000	0.5 bbl of oil	309 ft
2000	150-200 bbl of crude oil	2,223 ft
1998	1.5 bbl of condensate	51 ft

In 1997, an MMS-funded study on the fate and behavior of oil well blowouts (S.L. Ross Environmental Research Ltd., 1997). Oil well blowouts generally involve two fluids—crude oil (or condensate) and natural gas. A highly turbulent zone occurs within a few meters of the discharge point, then rapidly loses momentum with distance. In water depths <300 m, the flow of natural gas determines the initial dimensions of oil slicks from subsea blowouts. As the gas rises, it entrains oil and water in the vicinity and carries them to the surface. In these water depths, currents have little effect compared to the plume's velocity. In deeper water (>300 m) with lower temperatures and higher pressures, gas may form hydrates and the volume of gas may be depleted through dissolution into the water. Larger droplets will reach the surface faster and closer to the source, while smaller droplets will be carried farther by the currents before reaching the surface.

Severe subsurface blowouts could resuspend and disperse abundant sediments within a 300-m radius from the blowout site. The fine sediment fraction could be resuspended for more than 30 days. The coarse sediment fraction (sands) would settle at a rapid rate within 400 m from the blowout site, particularly in a 30-m water depth and a 35-cm/sec blowout scenario.

Prior to the 1980's, blowouts were the leading cause of fatalities on the OCS. One blowout-related fatality has occurred since 1986.

The MMS requires the use of blowout preventors (BOP) and that BOP systems are tested at specific times: (1) when installed, (2) before 14 days have elapsed since the last BOP pressure test, and (3) before “drilling out” each string of casing or a liner (30 CFR 250.407). A 1996 MMS-funded study looked at the reliability of BOP’s (Tetrahedron, Inc., 1996). This study found that subsea BOP’s had a lower failure rate (28%) than surface BOP’s (44%). A test was considered to have failed if any piece of equipment had to be physically repaired or sent for repairs after the test.

An estimated 2-4 blowouts could occur from activities resulting from a proposed action in the CPA. An estimated 1-2 blowouts could occur from activities resulting from a proposed action in the WPA.

For OCS Program activities in the Gulf of Mexico for the years 2003-2042, the estimated total number of blowouts is 215-259.

4.4.1.3. Vessel Collisions

The MMS data show that, from 1995 to 2001, there were 56 OCS-related collisions. Most collision mishaps are the result of service vessels colliding with platforms or vessel collisions with pipeline risers. Approximately 10 percent of vessel collisions with platforms in the OCS caused diesel spills. To date, the largest diesel spill associated with a collision occurred in 1979 when an anchor-handling boat collided with a drilling platform in the Main Pass Area, spilling 1,500 bbl.

Safety fairways, traffic separation schemes, and anchorages are the most effective means of preventing vessel collisions with OCS structures. In general, fixed structures such as platforms and drilling rigs are prohibited in fairways. Temporary underwater obstacles, such as anchors and attendant cables or chains attached to floating or semisubmersible drilling rigs, may be placed in a fairway under certain conditions. A limited number of fixed structures may be placed at designated anchorages. The USCG’s requirements for indicating the location of fixed structures on nautical charts and for lights, sound-producing devices, and radar reflectors to mark fixed structures and moored objects also help minimize the risk of collisions. In addition, the USCG 8th District’s Local Notice to Mariners (monthly editions and weekly supplements) informs Gulf of Mexico users about the addition or removal of drilling rigs and platforms, locations of aids to navigation, and defense operations involving temporary moorings. Marked platforms often become aids to navigation for vessels (particularly fishing boats and vessels supporting offshore oil and gas operations) that operate in areas with high densities of fixed structures.

The National Offshore Safety Advisory Committee (NOSAC, 1999) examined collision avoidance measures between a generic deepwater structure and marine vessels in the Gulf of Mexico. The NOSAC offered three sets of recommendations: (1) voluntary initiatives for offshore operators; (2) joint government/industry cooperation or study; and (3) new or continued USCG action. The NOSAC (1999) proposes that oil and gas facilities be used as aids-to-navigation because of their proximity to fairways, fixed nature, well-lighted decks, and inclusion on navigational charts. Mariners intentionally set and maintain course toward these facilities, essentially maintaining a collision course. Unfortunately, most deepwater facilities do not install collision avoidance radar systems to alert offshore facility personnel of a potentially dangerous situation. The NOSAC estimates that 7,300 large vessels (tankships, freight ships, passenger ships, and military vessels) pass within 35 mi of a typical deepwater facility each year. This estimate resulted in approximately 20 transits per day for the 13 deepwater production structures existing in 1999. The NOSAC found the total collision frequency to be approximately one collision per 250 facility-years (3.6×10^{-3} per year). The NOSAC estimated that if the number of deepwater facilities increases to 25, the estimated total collision frequency would increase to one collision in 10 years. A cost-benefit analysis within the report did not support the use of a dedicated standby vessel for the generic facility; however, the analysis did support the use of a radar system on deepwater facilities if the annual costs of the system were less than or equal to $124,500.

The OCS-related vessels could collide with marine mammals, turtles, and other marine animals during transit. To limit or prevent such collisions, NOAA Fisheries provides all boat operators with "Whalewatching Guidelines," which is derived from the Marine Mammal Protection Act. These guidelines suggest safe navigational practices based on speed and distance limitations when encountering marine mammals. The frequency of vessel collisions with marine mammals, turtles, or other marine animals probably varies as a function of spatial and temporal distribution patterns of the living resources, the pathways of maritime traffic (coastal traffic is more predictable than offshore traffic), and as a function of vessel speed, the number of vessel trips, and the navigational visibility.

4.4.1.4. Chemical and Drilling-Fluid Spills

A recent study of chemical spills from OCS activities determined that only two chemicals could potentially impact the marine environment—zinc bromide and ammonium chloride (Boehm et al., 2001). Both of these chemicals are used for well treatment or completion and therefore are not in continuous use; thus, the risk of a spill for these chemicals is very small. Most other chemicals are either nontoxic or used in small quantities.

Zinc bromide is of particular concern because of the toxic nature of zinc. The study modeled a spill of 45,000 gallons of a 54-percent aqueous solution, which would result in an increase in zinc concentrations to potentially toxic levels. Direct information on the toxicity of zinc to marine organisms is not available; however, the toxicity of zinc to a freshwater crustacean (*Ceriodaphnia dubia*) indicated that exposure to 500 ppb zinc results in measurable effects. One factor not considered in the model is the rapid precipitation of zinc in marine waters, which would minimize the potential for impact.

Ammonium chloride was modeled using potassium chloride as a surrogate. The model looked at a spill of 4,717 kg of potassium chloride powder. The distribution of potassium would overestimate the distribution of ammonia released during a spill. The model indicated that close to the release point, ammonia concentrations could exceed toxic levels for time scales of hours to days. Additional information on the degradation of ammonia in seawater would be needed for a more complete evaluation.

Accidental riser disconnects could result in the release of large quantities of drilling fluids and are of particular concern when synthetic-based drilling fluids (SBF) are in use. The use of SBF occurs primarily in deepwater where large volumes can be released. Three recent (2000-2001) riser disconnects occurred in the Gulf of Mexico OCS. Each release occurred as a result of unplanned riser disconnect near the seafloor. The contents of the riser was discharged within an hour of the disconnect. In all cases, approximately 600-800 bbl of SBF were discharged at the seafloor. The fate and effects of such a large release of SBF have never been studied.

4.4.2. Spill Response

Offshore Response and Cleanup

A number of cleanup techniques are available for response to an oil spill. Open-water response options include mechanical recovery, chemical dispersion, in-situ burning, or natural dispersion. Although bioremediation was at one time considered for use in open water, studies have shown that this technique is not an effective spill-response option in open water because of the high degree of dilution of the product and the rapid movement of oil in open water. Effective use of bioremediation requires that the products remain in contact with the oil for extended periods of time.

Single or multiple spill-response cleanup techniques may be used in abating a spill. The cleanup technique chosen for a spill response will vary depending upon the unique aspects of each situation. The selected mix of countermeasures will depend upon the shoreline and natural resources that may be impacted; the size, location, and type of oil spilled; weather; and other variables. The overall objective of on-water recovery is to minimize the risk of impact by preventing the spread of free-floating oil. The physical and chemical properties of crude oil can greatly affect the effectiveness of containment and recovery equipment, dispersant application, and *in-situ* burning. It is expected that oil found in the proposed action areas (CPA and WPA) could range from a medium-weight oil to light condensates.

Mechanical Cleanup

Generally, mechanical containment and recovery is the primary oil-spill-response method used (33 CFR 153.305(a)). Mechanical recovery is the process of using booms and skimmers to pick up oil from the water surface. In a typical offshore oil-spill scenario, a boom is deployed in a V, J, or U configuration to gather and concentrate oil on the surface of the water. The oil is gathered in the wide end of the boom (front) and travels backward toward the narrow apex of the boom (back). The skimmer is positioned at the apex of the boom, where the oil is the thickest. The skimmer recovers the oil by sucking in the top layer via a weir skimmer, or the oil adheres to and is removed from a moving surface (i.e., an oleophylic skimmer). The oil is then pumped from the skimmer to temporary storage on an attendant vessel or barge, the latter of which serves as the skimming platform. When this on-board storage is full, the oil must be pumped into a larger storage vessel.

Mechanical oil-spill-response equipment that is contractually available to the operators through Oil Spill Removal Organization (OSRO) membership or contracts would be called out to respond to an offshore spill in the CPA or WPA. Each individual operator's response to a spill would differ according to the location of the spill, the volume and source of the spill, the OSRO under contract, etc. At this time, in the Gulf of Mexico, there are three major OSRO's that can respond to spills in the open ocean: (1) Clean Gulf Associates, (2) Marine Spill Response Corporation (MSRC), and (3) National Response Corporation. The equipment owned by these OSRO's is strategically located near the busier port areas throughout the Gulf to service the oil and gas exploration and production operators and, in some cases, the marine transportation industry. Numerous smaller OSRO's that stockpile additional shoreline and nearshore response equipment are also located throughout the Gulf coastal area.

In consideration of the present location of the major OSRO equipment stockpiles, it is expected that the oil-spill-response equipment needed to respond to an offshore spill in the CPA or WPA can be called out from one or more of the following major oil-spill equipment base locations: Corpus Christi, Ingleside, Port Arthur, and Galveston, Texas; Lake Charles, New Iberia, Houma, Fourchon, Fort Jackson, and Venice, Louisiana; Pascagoula, Mississippi; Mobile, Alabama; or Tampa, Florida. Response times for this equipment would vary, dependent on the location of the equipment, the staging area, and the spill site; and on the transport requirements for the type of equipment procured.

It is assumed that 10-30 percent of a spill ≥1,000 bbl of a light- to medium-weight oil can be mechanically removed from the water prior to the spill making landfall (U.S. Congress, Office of Technology Assessment, 1990). Even when response efforts occur quickly, smaller spills (<50 bbl) in an offshore environment may not be recoverable by mechanical skimming equipment because such small spills spread quickly to a minimal thickness**.** Often, these smaller spills dissipate prior to equipment reaching the spill site.

Should an oil spill occur during a storm, spill response from shore would occur following the storm. Spill response would not be possible while storm conditions continued, given the sea state limitations for skimming vessels and containment boom deployment. However, oil released onto the ocean surface during a storm event would be subject to accelerated rates of weathering and dissolution (i.e., oil and water would be agitated, forcing oil into smaller droplets and facilitating dissolution of the high end aromatic compounds present).

Dispersants

When dispersants are applied to spilled crude oil, the surface tension of the oil is reduced. This allows normal wind and wave action to break the oil into tiny droplets, which are dispersed into the upper portion of the water column. Natural processes then break down these droplets much quicker than they would if the oil were allowed to remain on the water surface.

Dispersants are required to be used in accordance with the Regional Response Teams' Preapproved Dispersant Use Manual. Dispersant use would be in accordance with the restrictions for specific water depths or distances from shore. For a deepwater >1,000 ft water depth) spill ≥1,000 bbl, dispersant application may be a preferred response in the open-water environment to prevent oil from reaching a coastal area, in addition to mechanical response.

Based on the present location of dispersant stockpiles and dispersant application equipment in the Gulf of Mexico, it is expected that the dispersants and dispersant application aircraft initially called out for an oil-spill response to an offshore spill in the CPA or WPA will come from Houma, Louisiana. Response times for this equipment would vary, depending on the spill site and on the transport time for additional supplies of dispersants to arrive at a staging location**.** Based on historic information, this EIS assumes that dispersant application will be effective on 20-50 percent (S.L. Ross Environmental Research Ltd., 2000) of the treated oil.

In-situ Burning

In-situ burning is an oil-spill cleanup technique that involves the controlled burning of the oil at or near a spill site. The use of this spill-response technique can provide the potential for the removal of large amounts of oil over an extensive area in less time than other techniques. *In-situ* burning involves the same oil collection process used in mechanical recovery, except instead of going into a skimmer, the oil is funneled into a fire-boom, a specialized boom that has been constructed to withstand the high temperatures from burning oil. Fire resistant booms are used to isolate the oil from the source of the slick. The oil in the fire-boom is then ignited and allowed to burn. While *in-situ* burning is another method for disposing of oil that has been collected in a boom, this method is typically more effective than skimmers when the oil is highly concentrated.

For oil to ignite on water, it must be at least 2-3 mm thick. Most oils must be contained with fireproof boom to maintain this thickness. Oils burn at a rate of 3-4 mm per minute. Most oils will burn, although emulsions may require treatment before they will burn. Water in the oil will affect the burn rate; however, recent research has indicated that this effect will be marginal. One approximately 200–m length of fire resistant boom can contain up to 11,000 gallons of oil, which takes about 45 minutes to burn. In total, it would take about three hours to collect this amount of oil, tow it away from a slick, and burn it (Fingas, 2001). Response times for bringing a fire-resistant boom onsite would vary, dependent on the location of the equipment, the staging area, and the spill site.

Natural Dispersion

In some instances, the best response to a spill may be to allow the natural dispersion of a slick to occur. Natural dispersion may be a preferred option for smaller spills of lighter nonpersistent oils and condensates that form slicks that are too thin to be removed by conventional methods and are expected to dissipate rapidly, particularly if there are no identified potential impacts to offshore resources and a potential for shoreline impact is not indicated. In addition, natural dispersion may also be a preferred option in some nearshore environments when the potential damage caused by a cleanup effort could cause more damage than the spill itself.

Oil-Spill Response Assumptions Used in the Analysis of a Most Likely Spill $\geq$1,000 bbl Incident Related to a Proposed Action

Refer to Tables 4-45 and 4-46 for the estimated amounts of oil that will either be removed by the application of dispersants or mechanically recovered for the 4,600-bbl pipeline spill scenarios analyzed in this EIS. These tables reflect recovery and removal estimates for two different scenarios:

- a 4,600-bbl spill of 35^{o} API oil lost over 12 hours as result of a potential pipeline break during winter conditions at High Island Area; and
- a 4,600-bbl spill of 30^{o} API oil lost over 12 hours as result of a potential pipeline break during summer conditions at Ship Shoal Area.

The assumptions used in calculating the amounts removed as a result of dispersant use and mechanical recovery efforts for the two 4,600-bbl spill scenarios are listed below.

- The spills occurred and were reported at 6 a.m.
- The 35^{o} API oil did not emulsify; the 30^{o} API oil did emulsify.

- Spill-response efforts were conducted during daylight hours only.
- Mechanical response equipment (i.e., fast-response units having a USCG de-rated skimming capacity of 3,400 bbl/day) owned by the oil-spill-response cooperative, Clean Gulf Associates, was procured from Galveston, Texas, and Lake Charles, Louisiana, for response to the High Island Area Block A-425 scenario.
- Mechanical response equipment (i.e., fast-response units having a USCG de-rated skimming capacity of 3,400 bbl/day) owned by the oil-spill-response cooperative, Clean Gulf Associates, was procured from Houma and Venice, Louisiana, for response to the Ship Shoal Area Block 281 scenario.
- Dispersant application aircraft was deployed for both scenarios from Houma, Louisiana. This location also served as the staging location for loading dispersants. Three aircraft from this location were deployed for dispersant application in the first few days of the scenario—two DC3's and one DC4.
- Sea-state conditions: during the summer—2-ft waves; during the winter — 4-ft waves.
- A dispersant effectiveness rate of 30 percent for the treated oil was assumed (S.L. Ross Environmental Research Ltd., 2000).
- Because of the projected stable emulsion formation of the 30^{o} API oil during the summer scenario, it was assumed that dispersant application would no longer be effective after 48 hours in this scenario.

Onshore Response and Cleanup

Offshore response and cleanup is preferable to shoreline cleanup; however, if an oil slick reaches the coastline it is expected that the specific shoreline cleanup countermeasures identified and prioritized in the appropriate Area Contingency Plans (ACP's) for various habitat types would be used. The sensitivity of the contaminated shoreline is the most important factor in the development of cleanup recommendations. Shorelines of low productivity and biomass can withstand more intrusive cleanup methods such as pressure washing. Shorelines of high productivity and biomass are very sensitive to intrusive cleanup methods, and in many cases, the cleanup is more damaging than allowing natural recovery.

Oil-spill response planning in the United States is accomplished through a mandated set of interrelated plans. The ACP represents the third tier of the National Response Planning System and was mandated by OPA 90. The ACP's cover subregional geographic areas. The ACP's are a focal point of response planning, providing detailed information on response procedures, priorities, and appropriate countermeasures. The Gulf coastal area is covered by seven ACP's. The ACP's are written and maintained by Area Committees assembled from Federal, State, and local governmental agencies that have pollution response authority; nongovernmental participants may attend meetings and provide input. The coastal Area Committees are chaired by respective Federal On-Scene Coordinators from the appropriate USCG Marine Safety Office and are comprised of members from local or area-specific jurisdictions. Response procedures identified within an ACP reflect the priorities and procedures agreed to by members of the Area Committees.

The single most frequently recommended spill-response strategy for the areas identified for protection in all of the applicable ACP's is the use of a shoreline boom to deflect oil away from coastal resources such as seagrass beds, marinas, resting areas for migratory birds, bird and turtle nesting areas, etc. If a shoreline is oiled, the selection of the type of shoreline remediation to be used will depend on the following: (1) the type and amount of oil on the shore; (2) the nature of the affected coastline; (3) the depth of oil penetration into the sediments; (4) the accessibility and the ability of vehicles to travel along the shoreline; (5) the possible ecological damage of the treatment to the shoreline environment; (6) weather conditions; (7) the current state of the oil; and (8) political considerations.

Shoreline Cleanup Countermeasures

The following descriptions regarding the shoreline cleanup of spills reflect a generalization of the site-specific guidance provided in the ACP's applicable to the Gulf of Mexico. The ACP's applicable to the Gulf coastal area cover a vast geographical area. The differences in the response priorities and procedures among the ACP's reflect the differences in the identified resources needing spill protection in the area covered by each ACP.

- *Barrier Island/Fine Sand Beaches Cleanup*: After the oiling of a barrier island/fine sand beach with a light- to medium-weight oil, applicable cleanup options include manual removal, trenching (recovery wells), sediment removal, cold-water deluge flooding, shore removal/replacement, and warm-water washing. Other possible shoreline countermeasures include low-pressure, cold-water washing; burning; and nutrient enhancement. Responders are requested to avoid the following countermeasures: no action; high-pressure, cold-water washing; hot-water washing; slurry sand blasting; vacuum; and vegetation cutting. Passive collection (sorbents) is not recommended for medium-weight oils.
- *Fresh or Salt Marsh Cleanup*: In all cases, cleanup options that avoid causing additional damage to the marshes will be selected. After the oiling of a fresh or salt marsh with a light- to medium-weight oil, the preferred cleanup option would be to take no action. Another applicable alternative would be trenching (recovery wells). Shore removal/replacement, vegetation cutting, or nutrient enhancement could be used. The option of using vegetation cutting as a shoreline countermeasure will depend upon the time of the year and will be considered generally only if re-oiling of birds is possible. Chemical treatment, burning, and bacterial addition are also countermeasures that would also be considered. Responders are advised to avoid manual removal, debris removal/heavy equipment, sediment removal, cold-water flooding, high- or low-pressure cold-water washing, warm-water washing, hot-water washing, slurry sand blasting, and shore removal/replacement. Passive collection (sorbents) is not recommended for medium-weight oils.
- *Coarse Sand/Gravel Beaches Cleanup:* After the oiling of a coarse sand/gravel beach with a light- to medium-weight oil, applicable cleanup options are manual removal, trenching (recovery wells), sediment removal, cold-water deluge flooding, and shore removal/replacement. Other possible shoreline countermeasures include low-pressure, cold-water washing; burning; warm-water washing; and nutrient enhancement. Responders are requested to avoid the following countermeasures: no action; high-pressure, cold-water washing; hot-water washing; slurry sand blasting; vacuum; and vegetation cutting. Passive collection (sorbents) is not recommended for medium-weight oils.
- *Seawall/Pier Cleanup:* After the oiling of a seawall or pier with a light- to medium-weight oil, the applicable cleanup options include manual removal; cold-water flooding; low- and high-pressure, cold-water washing; warm-water washing; hot-water washing; slurry sand blasting; vacuum; and shore removal replacement. Other possible shoreline countermeasures listed include burning and nutrient enhancement. Responders are requested to avoid no action, trenching, sediment removal, and vegetation cutting. Passive collection (sorbents) is not recommended for medium-weight oils.

4.4.3. Environmental Impacts of Accidental Events

4.4.3.1. Impacts on Sensitive Coastal Environments

Impacts to the general vegetation and physical aspects of coastal environments by spills and cleanup response activities resulting from the proposed actions are considered in Chapters 4.4.3.1.1, 4.4.3.1.2, and

4.4.3.1.3. Potential impacts to barrier islands seaward of the barrier-dune system are considered in the coastal barrier beaches and associated dunes analysis. Potential impacts to barrier islands landward of the barrier-dune system are considered in the wetlands analysis. Impacts to animals that use these environments, the recreational value of beaches, and archaeological resources found there are described in impact analysis sections for those specific resources.

The types and sources of spills that may occur, their dissipation prior to contacting coastal resources, spill-response activities, and mitigation are described in Chapters 4.4.1 and 4.4.2.

4.4.3.1.1. Coastal Barrier Beaches and Associated Dunes

The fate of accidental oil spills in the Gulf of Mexico depends upon where each spill originates; the chemical composition and nature of the spilled oil; and the seasonal, meteorological, and oceanographic circumstances. Chapter 4.4.1.1 provides estimates of the number of oil spills that might result from a proposed action, as well as oil slick dispersal and weathering characteristics. Figure 4-13 provides the probability of an offshore spill ≥1,000 bbl occurring and contacting counties and parishes around the Gulf.

In coastal Louisiana, dune-line heights range from 0.5 to 1.3 m above mean high-tide level. In Mississippi and Alabama (coastal Subarea MA-1), dune elevations exceed those in Louisiana. For tides to carry oil from a spill across and over the dunes, strong southerly winds would have to persist for an extended time prior to or immediately after the spill. Strong winds required to produce such high tides would also accelerate dispersal and spreading of the oil slick, thereby reducing impact severity at the landfall site. Significant dune contact by a spill associated with a proposed action is very unlikely. A study in Texas showed that oil disposal on sand and vegetated sand dunes had no deleterious effects on the existing vegetation or on the recolonization of the oiled sand by plants (Webb, 1988).

Oil-spill cleanup operations can affect barrier beach stability. If large quantities of sand were to be removed during spill-cleanup operations, a new beach profile and sand configuration would be established in response to the reduced sand supply and volume. The net result of these changes could be accelerated rates of shoreline erosion, especially in a sand-starved, eroding-barrier setting such as found along the Louisiana Gulf Coast. To address these possible impacts, the Gulf Coast States have established policies to limit sand removal by cleanup operations.

Based on MMS analysis of the USCG data on all U.S. coastal spills (Chapter 4.4.1.1.7), MMS assumes that 32 percent of coastal spills that will occur as a result of a proposed action will occur in State offshore waters 0-3 mi from shore, 4 percent will occur in offshore waters 3-12 mi from shore, and 64 percent will occur in inland waters. It is assumed all offshore coastal spills will contact land and proximate resources. Most inshore spills resulting from a proposed action will occur from barge, pipeline, and storage tank accidents involving transfer operations, leaks, and pipeline breaks, which are remote from barrier beaches. When transporting cargoes to terminals, oil barges make extensive use of interior waterways, which are remote from barrier beaches. Most inland spills are assumed to have no contact with barrier beaches or dunes. For a barge or pipeline accident to affect a barrier beach, the accident would need to occur in offshore waters, on a barrier beach or dune, or inshore in the vicinity of a tidal inlet.

The September 1989 spill from a barge in the Mississippi Sound oiled the landward side of Horn Island, but not the Gulf side. Similarly, the October 1992 Greenhill Petroleum Corporation oil spill (blowout during production in State waters) just inland of East Timbalier Island, Louisiana, oiled inland shorelines but did not impact barrier beaches or dunes. Other smaller inland oil spills have impacted coastal islands similarly. Inshore pipelines or barge accidents are assumed to result in spilled oil contacting the inland shores of a barrier island, with unlikely adverse impacts to barrier beaches or dunes.

Proposed Action Analysis

The probabilities of proposed-action-related spills occurring in OCS waters and contacting various parishes and counties are provided in Chapter 4.4.1. The risk of offshore spills ≥1,000 bbl occurring and contacting barrier beaches is discussed in Chapter 4.4.1.1.8. Generally, the coastal, deltaic parishes of Louisiana have the highest risk of being contacted by an offshore spill resulting from a proposed action in the CPA; Plaquemines Parish has the highest probability. The probabilities of an offshore spill occurring and contacting coastal counties or parishes as a result of a proposed action in the WPA are generally higher for the region between Matagorda County, Texas, and Cameron Parish, Louisiana.

Coastal spills in offshore coastal waters or in the vicinity of Gulf tidal inlets present a greater potential risk to barrier beaches because of their close proximity. Inland spills that occur away from Gulf tidal inlets are generally not expected to significantly impact barrier beaches and dunes.

Oil that makes it to the beach may be either liquid weathered oil, an oil and water mousse, or tarballs. Oil is generally deposited on beaches in lines defined by wave action at the time of landfall. Initially, components of oil on the beach will evaporate more quickly under warmer conditions. Under high tide and storm conditions, oil may return to the Gulf and be carried higher onto the beach. Oil that remains on the beach will thicken as its volatile components are lost. Thickened oil may form tarballs or aggregations that incorporate sand, shell, and other materials into its mass. Tar may be buried to varying depths under the sand. On warm days, both exposed and buried tarballs may liquefy and ooze. Oozing may also serve to expand the size of a mass as it incorporates beach materials.

Oil on the beach may be cleaned up manually, mechanically, or by using both methods. Removal of sand during cleanup is expected to be minimized to avoid significantly reducing sand volumes. Some oil will likely remain on the beach at varying depths and may persist for several years as it slowly biodegrades and volatilizes.

Summary and Conclusion

Should a spill contact a barrier beach, oiling is expected to be light and sand removal during cleanup activities minimized. No significant impacts to the physical shape and structure of barrier beaches and associated dunes are expected to occur as a result of a proposed action.

4.4.3.1.2. Wetlands

The Texas Gulf Coast is comprised of a broad range of saline, brackish, intermediate and fresh marsh wetlands, including wet prairies, forested wetlands, barrier islands, mud flats, estuarine bays, bayous, and riparian wooded areas. Saline and brackish marshes are most widely distributed south of the Galveston Bay area, while the intermediate marshes are the most extensive marsh type east of Galveston Bay. The most extensive wetlands along the Texas coast are located in the Strandplain-Chenier Plain System that runs from eastern Chambers County, Texas, through Vermilion Parish, Louisiana. Coastal Louisiana is made up of two wetland-dominated ecosystems, the Deltaic Plain of the Mississippi River and the Chenier Plain extending from eastern Texas through Vermilion Parish, Louisiana; both are influenced by the Mississippi River. Like Texas, the Louisiana wetlands are comprised of a broad range of wetland habitat including saline, brackish, intermediate, and fresh marsh wetlands; barrier islands; cheniers (ancient beach deposits left stranded in a marsh by the seaward advancement of the marsh); mud flats; estuarine bays; and bayous.

Offshore oil spills associated with a proposed action can result from platform accidents, pipeline breaks, or navigation accidents. Offshore spills are much less likely to have a deleterious effect on vegetated coastal wetlands or seagrasses than inshore spills, which are located inland in the WPA or CPA. Information on oil spills related to a proposed action is provided in Chapter 4.4.1. Information on the risk of spills occurring from a proposed action is provided in Chapter 4.4.1.1.8.

Coastal oil spills can result from storage, barge, or pipeline accidents. Most of these occur as a result of transfer operations. This data indicates that approximately 64 percent of coastal spills occur inland. Coastal spills projected are discussed in Chapter 4.4.1.1.7.

The most likely locations of coastal spills are at pipeline terminals and other shore bases. Spills from support vessels could occur from navigation accidents and will be largely confined in navigation channels and canals. Slicks may quickly spread through the channel by tidal, wind, and traffic (vessel) currents. Spills that damage wetland vegetation fringing and protecting canal banks will accelerate erosion of those once protected wetlands and spoil banks (Alexander and Webb, 1987).

Primary Impacts of Oil Spills

Shoreline types have been rated (via Environmental Sensitivity Indices, (ESI's); Hayes et al., 1980; Irvine, 2000) according to their expected retention of oil and, to some extent, biological effects are believed to be aligned with oil persistence. This is evident in various low-energy environments like salt marshes. Oil has been found or estimated to persist for at least 17-20 years in such environments (Teal et al., 1992; Baker et al., 1993; Burns et al., 1993; Irvine, 2000). In some instances, where there has been further damage due to cleanup activities, recovery has been estimated to take from 8 to 100 years (Baca et al., 1987). Effects on marsh vegetation can be severe (Baca et al., 1987; Baker et al., 1993). The side effects of the depletion of marsh vegetation, which are of special concern to coastal Louisiana and parts of coastal Texas, is the increased erosion. Again, cleanup activities in marshes may accelerate rates of erosion and retard recovery rates, which have been reported to occur from years to decades following a spill.

The critical concentration of oil is that concentration above which impacts to wetlands will be long term and recovery will take longer than two growing seasons, and which causes plant mortality and some permanent wetland loss. Critical concentrations of various oils are currently unknown and are expected to vary broadly for wetland types and wetland plant species. Louisiana wetlands are assumed to be more sensitive to oil contact than elsewhere in the Gulf because of high cumulative stress.

Because OCS-related pipelines traverse wetland areas, pipeline accidents could result in high concentrations of oil directly contacting limited areas of wetland habitats (Fischel et al., 1989). Based on data from Mendelssohn et al. (1990), recovered vegetation is expected to be the ecologically functional equivalent of unaffected vegetation. A reduction in plant density was therefore studied as the principle impact from spills. Mendelsohn and his associates demonstrated that oil could persist in the soil for greater than 5 years if a pipeline spill occurs within the interior of a wetland where wave-induced or tidal flushing is not regular or vigorous.

Numerous investigators have studied the immediate impacts of oil spills on wetland habitats in the Gulf and other wetland habitats similar to those affected by OCS activities, resulting in a range of conclusions. Some of these inconsistencies can be explained by differences in oil concentrations contacting vegetation, kinds of oil spilled, types of vegetation affected, season of year, preexisting stress level of the vegetation, soil types, and numerous other factors. In overview, the data suggest that light-oiling impacts will cause plant dieback with recovery within two growing seasons without artificial replanting. Most impacts to vegetation are considered short term and reversible (Webb et al., 1985; Alexander and Webb, 1987; Lytle, 1975; Delaune et al., 1979; Fischel et al., 1989). Because OCS-related pipelines traverse wetland areas, pipeline accidents could result in high concentrations of oil directly contacting areas of wetland habitats (Fischel et al., 1989) or open waters. The fluid nature of the oil, water levels, weather, and the density of the vegetation would limit the area of interior wetlands contacted by any given spill.

In coastal Louisiana, the critical concentration of oil resulting in long-term impacts to wetlands is assumed to be 0.1 liter per square meter (l/m^2). Concentrations less than this will cause dieback of the aboveground vegetation for one growing season, but limited mortality. Higher concentrations will cause mortality of contacted vegetation, but 35 percent of the affected area will recover within 4 years. Oil will persist in the wetland soil for at least 5 years. After 10 years, permanent loss of 10 percent of the affected wetland area will be expected as a result of accelerated landloss indirectly caused by the spill. If a spill contacts wetlands exposed to wave attack, additional and accelerated erosion will occur, as documented by Alexander and Webb (1987).

Wetlands in Texas occur on a more stable substrate and receive more inorganic sediment per unit of wetland area than wetlands in Louisiana. Texas wetlands have not experienced the extensive alterations caused by rapid submergence rates and extensive canal dredging that affect Louisiana wetlands. The examinations of Webb and colleagues (Webb et al., 1981 and 1985; Alexander and Webb, 1983 and 1985) are used to evaluate impacts of spills in these settings. For wetlands along more stable coasts, such as in Texas, the critical oil concentration is assumed to be 1.0 l/m^2 (Alexander and Webb, 1983). Concentrations below the expected 1.0 l/m^2 will result in short-term, above-ground dieback for one growing season. Concentrations above this will result in longer-term impacts to wetland vegetation, including plant mortality extensive enough to require recolonization.

Using these studies, the following model was developed. For every 50 bbl of oil spilled and contacting wetlands, approximately 2.7 ha of wetland vegetation will experience dieback. Thirty percent of these damaged wetlands are assumed to recover within 4 years; 85 percent within 10 years. About 15 percent of the contacted wetlands are expected to be converted permanently to open-water habitat.

Secondary Impacts of Oil Spills

The cleanup of oil spills in coastal marshes remains a problematic issue because wetlands can be extremely sensitive to the disturbances associated with cleanup activities. Once a marsh is impacted by an oil spill, a decision must be made concerning the best method of cleanup and restoration. Often the best course of action is to let the impacted area(s) recover naturally in order to avoid secondary impacts associated with the cleanup process (McCauley and Harrel, 1981; Long and Vandermeulen, 1983: Getter et al., 1984; Baker et al., 1993; Mendelssohn et al., 1993). Foot traffic and equipment traffic on the marsh surface during cleanup operations are considered secondary impacts that can have significant adverse effects on the recovery of the marsh by trampling vegetation, accelerating erosion, and burying oil into anaerobic soils where it may persist for years (Getter et al., 1984).

Proposed Action Analysis

Figure 4-13 provides the results of the OSRA model that calculated the probability of a spill ≥ 1, 000 bbl occurring offshore as a result of a proposed action in the WPA or CPA and reaching a Gulf Coast county or parish. The probabilities are very small. Most of the counties and parishes are at minimum risk of being contacted; the most frequently calculated probability of a spill contacting their shorelines is less than 0.5 percent. Five counties in Texas and six parishes in Louisiana have a chance of spill contact that is greater than 0.5 percent. For these counties and parishes, the chance of an OCS offshore spill ≥ 1,000 bbl occurring and reaching their shoreline ranges from 1 percent to 8 percent. Plaquemines Parish, Louisiana, has the greatest risk of a spill occurring and contacting its shoreline. In Texas, Matagorda County has the greatest risk of being contacted by a spill occurring offshore as a result of a WPA proposed action. Should such a contact occur, oiling will be very light and spotty with short-term impacts to vegetation. Coastal spills are the greater spill threat to interior wetlands.

Summary and Conclusion

Offshore oil spills resulting from a proposed action are not expected to significantly damage inland wetlands, however, if an inland oil spill related to a proposed action occurs, some impact to wetland habitat would be expected. Although the impact may occur generally over coastal regions, the impact has the highest probability of occurring in the coastal regions, by and large northeast of Galveston County, in the vicinities where WPA oil is handled, and in and around Plaquemines and St. Bernard Parishes in the CPA.

Although the probability of occurrence is low, the greatest threat to wetland habitat is from an inland spill resulting from a vessel accident or pipeline rupture. While a resulting slick may cause minor impacts to wetland habitat and surrounding seagrass communities, the equipment and personnel used to clean up a slick over the impacted area may generate the greatest impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

4.4.3.1.3. Seagrass Communities

Seagrass communities in the WPA are widely scattered beds in shallow, high-salinity coastal lagoons and bays. The most extensive seagrass beds are found in both the Upper and Lower Laguna Madre along the Texas coast, as well as Baffin Bay. In the Texas Laguna Madre, seagrass meadows are the most common submerged habitat type. Seagrass beds in the CPA are restricted to small shallow areas behind barrier islands in Mississippi and Chandeleur Sounds and to smaller, more scattered populations elsewhere. Lower-salinity, seagrass beds are found inland and discontinuously throughout the coastal zone of Louisiana and Mississippi.

Accidental impacts associated with a proposed action that could adversely affect seagrass beds include oil spills associated with the transport and storage of oil (Chapter 4.4.1.1). The degree of impact from oil spills depends on the location of the spill, oil slick characteristics, water depth, currents, and weather. Offshore oil spills that occur in the proposed action areas are much less likely to contact seagrass communities than are inshore spills because the seagrass beds are generally protected by barrier islands, peninsulas, sand spits, and currents.

Some oils can emulsify; suspended particles in the water column will adsorb oil in a slick, decreasing the oil's suspendability and causing some of the oil to be dispersed downward into the water column. Typically, seagrass communities reduce water velocity among the vegetation as well as for a short distance above it. Minute oil droplets, whether or not they are bound to suspended particulate, may adhere to the vegetation or other marine life, be ingested by animals, or settle onto bottom sediments. In all of these situations, oil has a limited life because it will be degraded chemically and biologically. Microbes, which are found in all marine environments, are considered the greatest degraders of oil (Zieman et al., 1984). Because estuaries have a greater suspended particulate load and greater microbial population, oil degrades more rapidly there (Lee, 1977). Oil that penetrates deeply into the sediments is less available for dissolution, oxidation, or microbial degradation. If buried, oil may be detectable in the sediments for 5 years or more, depending upon the circumstances.

The cleanup of slicks in shallow or protected waters (less than 5 ft deep) may be performed using johnboats or booms, anchors, and skimmers mounted on boats or shore vehicles. Personnel assisting in oil-spill cleanup in water shallower than 3-4 ft may readily wade through the water to complete their tasks (Chapter 4.4.1.1).

Proposed Action Analysis

The probability of one or more oil spills ≥1,000 bbl occurring due to a proposed action ranges from 34 to 63 percent in the CPA and from 19 to 33 percent in the WPA, for the range of resources estimated to be developed) (Chapter 2.3.1 for the CPA and Chapter 2.4.1 for the WPA). The probabilities of a spill ≥1,000 bbl occurring and contacting environmental features are described in Chapter 4.4.1.1. The total estimated number of spill events over the 40-year life of a proposed action is 956-2,277 offshore spills for a typical proposed action in the CPA and 473-910 offshore spills for a typical proposed action in the WPA (Chapter 4.4.1.1). Spills that could occur in coastal waters from proposed action support operations are estimated at 51-123 spills for a proposed action in the CPA and 26-52 for a proposed action in the WPA.

The risk of an offshore spill ≥1,000 bbl occurring and contacting coastal counties and parishes was calculated by MMS's oil-spill trajectory model. Counties and parishes are used as an indicator of the risk of an offshore spill reaching sensitive coastal environments. Figure 4-13 provides the results of the OSRA model that calculated the probability of a spill ≥1, 000 bbl occurring offshore as a result of a proposed action in the CPA or WPA and reaching a Gulf Coast county or parish. The probabilities are very small. Most of the counties and parishes are at minimum risk of being contacted; the most frequently calculated probability of a spill contacting their shorelines is less than 0.5 percent. Five counties in Texas and six parishes in Louisiana have a chance of spill contact that is greater than 0.5 percent. For these counties and parishes, the chance of an OCS offshore spill ≥1,000 bbl occurring and reaching their shoreline ranges from 1 percent to 8 percent. Plaquemines Parish, Louisiana, has the greatest risk of a spill occurring and contacting its shoreline. In Texas, Matagorda County has the greatest risk of being contacted by a spill occurring offshore as a result of a WPA proposed action.

The more inland seagrass beds are generally protected from offshore spills by barrier islands, shoals, shorelines, and currents. These beds are generally more susceptible to contact by inshore spills, which have a low probability of occurrence. Inshore vessel collisions may release fuel and lubricant oils and pipeline ruptures may release crude and condensate oil. In either case, seagrass beds grow below the water surface. In this region of the Gulf, they remain submerged due to the micro-tides that occur there. Their regenerative roots and rhizomes are buried in the water bottom, where they are further protected (Chapter 3.2.1.3). Should an oil slick pass over these seagrass communities, damage would occur if an unusually low tide were to occur, causing contact between the two. A more damaging scenario would be that a slick might pass over and remain over a submerged bed of vegetation in a protected embayment during typical fair-weather conditions. This would reduce light levels in the bed. If light reduction continues for several days, chlorophyll content in the leaves will be reduced (Wolfe et al., 1988), causing the grasses to yellow and reducing their productivity. Shading by an oil slick of the sizes described should not last long enough to cause mortality, depending upon the slick thickness, currents, weather, and the nature of the embayment. In addition, a slick that remains over seagrass beds in an embayment also will reduce or eliminate oxygen exchange between the air and the water of the embayment. Oxygen depletion is a serious problem for seagrasses (Wolfe et al., 1988). If currents flush little oxygenated water between the embayment and the larger waterbody and if the biochemical oxygen demand (BOD) is high, as it would be in a shallow water bed of vegetation, and then enhanced by an additional burden of oil, the grasses and related epifauna will be stressed and perhaps suffocated. In this situation, the degree of suffocation will depend upon the reduced oxygen concentration and duration of those conditions. Oxygen concentrations and their duration depend upon currents, tides, weather, temperature, percentage of slick coverage, and BOD.

The Galveston/Houston/Texas City area has the greatest risk of experiencing coastal spills related to a proposed action in the WPA and the Deltaic Plain area of Louisiana has the highest risk in the CPA (Chapter 4.4.1.1).

Should weather conditions or currents increase water turbulence sufficiently, a substantial amount of oil from the surface slick will be dispersed downward into the water column. Suspended particles in the water column will adsorb to the dispersed oil droplets as well as to some of the oil in the sheen. Typically, submerged vegetation reduces water velocity among the vegetation and enhances sedimentation. Typically, this will not cause long-term or permanent damage to the seagrass communities. Some dieback of leaves would be expected for one growing season. No permanent loss of seagrass habitat is projected to result from the spill unless an unusually low tidal event allows direct contact between the slick and the vegetation. The most probable danger under these more likely circumstances is a reduction, for up to 2 years, of the diversity or population of epifauna and benthic fauna found in seagrass beds.

No significant burial of the oil is expected to occur from any one spill. Oil measured at some depth usually means the area is impacted by chronic oil contamination, new sediments are spread over the area, or heavy foot or other traffic works the oil into the bottom sediment. The cleanup of slicks that settle over seagrass communities in shallow waters may damage the areas where props, anchors, boat bottoms, treads, wheels, trampling, and dragging booms crush or dig up plants.

Summary and Conclusion

Should a spill ≥1,000 bbl occur offshore from activities resulting from a proposed action, the seagrass communities with the highest probabilities of contact within 10 days would be those located within Matagorda County, Texas, for a proposed action in the WPA and Plaquemines Parish, Louisiana, for a proposed action in the CPA.

Because of the location of most submerged aquatic vegetation, inshore spills pose the greatest threat to them. Such spills may result from either vessel collisions that release fuel and lubricants or from pipelines that rupture. If an oil slick settles into a protective embayment where seagrass beds are found, shading may cause reduced chlorophyll production; shading for more than about 2 weeks could cause thinning of leaf density. Under certain conditions, a slick could reduce dissolved oxygen in an embayment and cause stress to the bed and associated organisms due to reduced oxygen conditions. These light and oxygen problems can correct themselves once the slick largely vacates the embayment and light and oxygen levels are returned to pre-slick conditions.

Increased water turbulence due to storms or vessel traffic will break apart the surface sheen and disperse some oil into the water column, as well as increase suspended particle concentration, which will adsorb to the dispersed oil. Typically, these situations will not cause long-term or permanent damage to the seagrass beds, although some dieback of leaves is projected for one growing season. No permanent loss of seagrass is projected to result from oil contact, unless an unusually low tidal event allows direct contact between the slick and vegetation. The greatest danger under the more probable circumstances is a reduction, for up to 2 years, of the diversity or population of epifauna and benthic fauna found in seagrass beds.

Although the probability of their occurrence is low, the greatest threat to inland, seagrass communities would be from an inland spill resulting from a vessel accident or pipeline rupture. Although a resulting slick may cause minor impacts to the bed, equipment and personnel used to clean up a slick over shallow seagrass beds may generate the greatest direct impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Scarring may occur if an oil slick is cleaned up over a shallow submerged aquatic vegetation bed where vessels, booms, anchors, and personnel on foot would be used and scar the bed. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

4.4.3.2. Impacts on Sensitive Offshore Resources

4.4.3.2.1. Live Bottoms (Pinnacle Trend)

A number of OCS-related factors may cause adverse impacts on the pinnacle trend communities and features. Damage caused by oil spills, blowouts, anchoring, structure emplacement and removal, pipeline emplacement, drilling discharges, produced-water discharges, and the disposal of domestic and sanitary wastes can cause the immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

Oil spills have the potential to foul benthic communities and cause lethal or sublethal effects on live-bottom organisms. Oil from a surface spill can be driven into the water column, with measurable amounts to a 20-m depth. Yet, at this depth, the spilled oil would be at concentrations several orders of magnitude lower than the amount shown to have an effect on marine organisms. Subsurface oil spills from pipeline ruptures would have a greater potential to bring high concentrations of oil in contact with the biota of the pinnacles. The actual concentrations of subsurface-released oil reaching this biota would depend on the severity and the proximity of the spill and on the speed and direction of prevailing subsurface currents.

Blowouts have the potential of resuspending considerable amounts of sediment and releasing hydrocarbons into the water column. This would pose a threat to the biota of pinnacles, particularly when the disturbance is immediately adjacent to the resource. Oil or condensate may be present in the reservoir and may also be injected into the water column. The bulk of the sediments would be redeposited within a few thousand meters of the blowout site. The sedimentation caused by a severe subsurface blowout occurring within 400 m of a pinnacle community could result in the smothering of biota. Blowout incidents do not necessarily result in sediment releases or resuspension.

Proposed Action Analysis

The pinnacles in the Central Gulf of Mexico are located in the Main Pass and Viosca Knoll lease areas off Mississippi and Alabama within offshore Subareas C0-60 and C60-200; there are no known pinnacle features found in the Western Gulf. Table 4-2 provides information regarding the level of OCS-related activities in the vicinity of the pinnacles including the number of projected wells, production structures, pipeline lengths, and blowouts. The majority of the exploratory/delineation wells and production structures will not be located in the pinnacle trend area, based on an MMS analysis.

Any surface oil spill resulting from a proposed action would likely have no impact on the biota of the pinnacle trend because the crests of these features are much deeper than 20 m.

All evidence to date indicates that accidental oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column, surfacing almost directly over the source location (Chapter 4.4.1.1.5.4), and thus not impact pinnacles. The risk for weathering components from a surface slick reaching pinnalces in any measurable concentrations would be very small. Such natural containment and dispersion of oil, as well as the widespread nature of the biota, would limit the severity and the extent of the area impacted by subsurface spills. A subsurface pipeline oil spill ($\geq$1,000 bbl) could result in the most deleterious impacts on the biota of pinnacles, particularly if the oil impinges directly on the pinnacles. Yet, the biota of the pinnacles would probably recover once the oil is cleared. There are no data to date that reveal the effects or recovery time associated with oil spills on pinnacle trend features.

There are 1-2 projected blowouts associated with a proposed action in the CPA (Table 4-2); however, any activity of a debilitating nature would be well away from the pinnacles based on the implementation of the proposed Live Bottom Stipulation, which restricts the distance wells can be from a pinnacle feature.

Summary and Conclusion

With implementation of the Live Bottom Stipulation, there would be few operations in the vicinity of the pinnacles as a result of a proposed action. Because of this and the small size and dispersed nature of many of the features, impacts from accidental events as a result of a proposed action are expected to be infrequent. No community-wide impacts are expected. Potential impacts from blowouts would be minimized because of the proposed Live Bottom Stipulation and the low levels of oil and gas activities anticipated in the area. Oil spills would not be followed by adverse impacts (e.g., high elevated decrease in live cover) because of the depth of the features and dilution of spills (by currents and the quickly rising oil). The frequency of impacts on the pinnacles would be rare, and the severity should be slight because of the widespread nature of the features.

Effects of the Proposed Action without the Proposed Stipulation

Activities resulting from a proposed action without the protection of the proposed biological stipulation could have an extremely deleterious impact on portions of the pinnacle trend. Potential impacts on the pinnacle trend, live-bottom areas from a proposed action, and blowouts would be infrequent because of the low projected levels of OCS activities. In addition, the widespread occurrence of these pinnacles would further restrain these impacts.

4.4.3.2.2. Live Bottoms (Topographic Features)

The topographic features of the Western and Central Gulf sustaining sensitive offshore habitats are listed and described in Chapters 4.2.1.2.1 and 4.3.1.2.1, respectively. Please refer to Chapters 2.3.1.3.1 and 2.4.1.3.1 for a complete description and discussion of the proposed Topographic Features Stipulations.

Disturbances resulting from the proposed actions, including oil spills and blowouts, have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of topographic features of both the CPA and WPA.

Oil spills potentially affecting topographic features and their biological communities could result from surface and seafloor spills. Surface oil spills may occur as a result of platform or tanker spills. A tanker accident, pipeline rupture, or well blowout could cause spills at the seafloor. Both surface and subsurface spills could result in a steady discharge of oil over a long period of time. The depth to which topographic features rise in the northern Gulf of Mexico (to within 15 m [49 ft] of the sea surface) and their distance from shore (more than 103 km (64 mi)) should protect any of the tropical reef plant and animal species they harbor from surface oil slicks. Oil from a surface spill can be driven into the water column; measurable amounts have been documented down to a 10-m depth, although modeling exercises have indicated such oil may reach a depth of 20 m. At this depth, the oil is found at concentrations several orders of magnitude lower than the amount shown to have an effect on corals (Lange, 1985; McAuliffe et al., 1975 and 1981; Knap et al., 1985). Because the crests of topographic features in the northern Gulf are found below 10 m, no concentrated oil from a surface spill could reach their sessile biota.

A subsurface oil spill could reach a topographic feature and would have the potential of considerably impacting the local biota contacted by the oil. Such impacts on the biota may have severe and long-lasting consequences, including loss of habitat, biodiversity, and live coverage; destruction of hard substrate; change in sediment characteristics; and reduction or loss of one or more commercial and recreational fishery habitats.

Subsurface spills could result in the formation and settling of oil-saturated material, and oil-sediment particles could come into contact with living coral tissue; however, a subsurface spill should rise to the surface, and any oil remaining at depth would probably be swept clear of the banks by currents moving around the banks (Rezak et al., 1983). Should any of the oil come in contact with adult sessile biota, effects would be primarily sublethal, with few incidences of actual coral mortality. The sublethal effects could be long lasting and affect the resilience of coral colonies to natural disturbances (e.g., elevated water temperature and diseases) (Jackson et al., 1989).

Continental Shelf Associates (CSA) (1992b) modeled the potential impacts of a pipeline larger than the one estimated to occur from a proposed action (10,000 bbl spilled over 2-7 days) to maximize the estimates of dispersed oil concentrations reaching four topographic features (East Flower Garden, West Flower Garden, MacNeil, and Rankin Banks). Referencing their model, CSA estimated that the worst-case concentrations of crude oil reaching the four banks would be sublethal to the corals and much of the other biota present.

CSA (1994) also investigated the potential effects of oil spilled from a platform-pipeline complex proposed for installation near the Flower Garden Banks using a range of spill scenarios that included the most likely one estimated for this EIS. Twenty-four different spill scenarios from two platforms and three pipelines were modeled. The modeling resulted in the maximum concentration of oil reaching the East Flower Garden Bank. The most damaging scenarios resulting from this modeling effort included a 2,617-bbl/day and a 1,000-bbl/day spill, both lasting 30 days and both occurring at the same platform location. Although the model estimated no acute toxicity to reef coral colonies, the values were within the range of acute toxicity to embryos and larvae of fish, corals, and other invertebrates.

In 1996, the Regional Response Team for Region VI, which includes the coastal states of Texas and Louisiana, approved the use of chemical dispersants on surface oil spills in exclusion zones of the northern Gulf such as the Flower Garden Bank National Marine Sanctuary (revised Federal On-Scene Coordinator Preapproved Dispersant Use Manual-Region VI Oil and Hazardous Substances Pollution Contingency Plan). Depending on the toxicity of the dispersant used; tradeoffs to responding to surface oil spills using dispersants include impacts on pelagic organisms and on the adult as well as the larval stages of benthic organisms on topographic features. Gulf of Mexico oil, however, is usually dispersed with Corexit 9527. Considering the depth of the crests of topographic features (greater than 15 m), the dilution by seawater, and the added dispersion by currents, any dispersed oil that reaches the benthic dwellers would be expected to be at very low concentrations (less than 1 ppm). Such low oil concentrations would not be life threatening to larval or adult stages at depth (Fucik et al., 1994). Dispersants would probably not be approved during coral spawning periods (e.g., August-September for major reef-building species) (Gittings et al., 1992 and 1994) in order to limit the impacts of oil pollution on the near-surface portion of the water column.

Dodge et al. (1995) observed that, compared to a control site and to a site exposed to oil alone, a 2-m deep reef environment off the Caribbean coast of Panama was negatively impacted by dispersed oil (probably at a concentration greater than 10 ppm) as it reduced the cover of all reef organisms as much as 40 percent, particularly that of live substrate-binding sponges. Ten years later, the same impacted site regained or even exceeded the pre-impact live cover. Guzman et al. (1991), however, found that a prolonged exposure to oil alone, as well as chronic exposure to oil, greatly depressed both the coverage and growth rates of reef corals within a 6-m-deep reef area along the Caribbean coast of Panama. Also, Bak (1987) showed that reef corals on the shallow (4-6 m) southwestern shore of Aruba (Netherlands Antilles) had incurred mortality, decreases in live coral cover by as much as 70 percent, reductions of species diversity (as many as 10 out of 24 species missing), and reef structural changes over a 10- to 15-km downstream shore length as a result of the exposure to long-term (1929-1985) chronic oil spills, dispersed oil, and refinery discharges. *Diploria strigosa* appeared to be more resilient to oil pollution than other reef coral species because its cover did not seem to be affected by the pollutants. Therefore, it has been shown that oil, as well as dispersed oil, has the potential to greatly impact reef coral communities, particularly when the exposure is chronic and long term. The time needed for the recovery of such impacted reefs could be as long as 30 years and would depend on the frequency and severity of any future human-made and natural disturbances.

The proposed Topographic Features Stipulations would preclude drilling in a No Activity Zone to prevent adverse effects from nearby drilling on topographic features. Oil spills originating outside the No Activity Zones would be dispersed to diluted concentrations in the water column prior to reaching topographic features (CSA, 1992b and 1994).

Oil or gas well blowouts are possible occurrences in the OCS. Benthic communities exposed to large amounts of resuspended sediments following a subsurface blowout could be subject to sediment suffocation, exposure to resuspended toxic contaminants, and reduced light attenuation. Should oil or condensate be present in the blowout flow, liquid hydrocarbons could be an added source of negative impact on the benthic community (low-molecular-weight gases would dissolve in the water column until saturation is reached). The amounts of oil or sediments that settle vary as a function of the specific gravity of the oil or the sediments, and their dilution, dispersion, and response to currents (Brooks and Bernard, 1977). In most cases, currents should sweep the impact-producing materials around a topographic feature rather than deposit them on top of it (Rezak et al., 1983). The bulk of the blowout materials would be redeposited within a few thousand meters of their source; sand would be redeposited within 400 m of the blowout site. The extent of the damage incurred by the benthic community would depend on the amount and duration of exposure to sediments or oil. The consequences of a blowout directly on or near a topographic feature could last more than 10 years. Since the proposed stipulations would preclude drilling in the No Activity Zone, most adverse effects on topographic features from blowouts would likely be prevented.

Proposed Action Analysis

All of the 42 topographic features (shelf edge banks, low-relief banks, and south Texas banks) in the CPA and WPA are found in waters less than 200 m deep. They represent a small fraction of the continental shelf area in the CPA and WPA. The fact that the topographic features are widely dispersed, combined with the probable random nature of oil-spill locations, serves to limit the extent of damage from any given oil spill to any one of the sensitive areas.

The proposed Topographic Features Stipulations (discussed in Chapters 2.3.1.3.1 and 2.4.1.3.1) will assist in preventing most of the potential impacts from oil and gas operations, including accidental oil spills and blowouts, on the biota of topographic features. However, operations outside the No Activity Zones (including blowouts and oil spills) may still affect topographic features. The projected oil-spill scenarios related to the proposed actions for the CPA and WPA (projections are based on a 40-year life for any one lease sale) are found in Table 4.4.3.1.2.

Approximately 1-2 blowouts are projected to occur in waters less than 200 m deep in the CPA and zero blowouts are projected in the WPA during activities resulting from the proposed actions. With the application of the proposed stipulations, none of these blowouts should occur within the No Activity Zones. Furthermore, blowouts outside the No Activity Zones are unlikely to impact the biota of topographic features.

Some offshore resources are at a minimal risk of being contacted should a spill originate in the CPA and WPA as a result of a proposed action. There is a 2.0-5.0 percent and 0.5-1.0 percent likelihood that a spill would reach the area of the Flower Garden Banks National Marine Sanctuary from the WPA or CPA, respectively. The East Flower Garden Bank rises to within 16 m of the sea surface, and the West Flower Garden Bank to within 18 m. Any oil that might be driven to 16 m or deeper would probably be at concentrations low enough to avoid or substantially reduce any impact; therefore, a surface oil spill would probably not impact the biota of the Flower Garden Banks or the other topographic features. In addition to the Flower Garden Banks, there are several other feature locations with a minimal percent probability of an accidental oil spill occurring as a result of a proposed action reaching their locations:

Resource Location	WPA Range (Low/High)* % Probability	CPA Range (Low/High)* % Probability
Texas State Offshore Waters	5-8	1-1
Flower Garden Banks	2-4	<0.5-1
Stetson Bank	1-2	<0.5
Louisiana (E) State Offshore Waters	<0.5	2-4
Louisiana (W) State Offshore Waters	1-2	9-19
Sonnier Bank	1-1	1-2

* Low = low oil-volume estimate.
High = high oil-volume estimate.

A subsurface spill originating from a pipeline rupture or a blowout may cause sessile biota of topographic features to be impacted by oil, potentially causing sublethal and lethal effects. Projections of persistence for a pipeline spill occurring during the summer months 50 mi off Louisiana in 200 ft of water and for a winter spill occurring 65 mi off Texas in 130 ft of water are listed in Tables 4.SpillCPAWeathering and 4.SpillWPAWeathering. The Topographic Features Stipulations would limit the potential impact of such occurrences by keeping the sources of such adverse events geographically removed from the sensitive biological resources of topographic features.

Summary and Conclusion

The proposed Topographic Features Stipulations will assist in preventing most of the potential impacts on live-bottom communities from blowouts and surface and subsurface oil spills. Recovery from incidences of impacts from blowouts would take place within 10 years.

Contact with spilled oil would cause lethal and sublethal effects in benthic organisms. The oiling of benthic organisms is not likely because the proposed Topographic Features Stipulations would keep subsurface sources of spills away from the immediate vicinity of topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for adult sessile biota, including coral colonies in the case of the Flower Garden Banks, and there would be limited incidences of mortality. The recovery of harmed benthic communities could take more than 10 years.

Effects of the Proposed Actions without the Proposed Stipulations

The topographic features and associated coral reef biota of the Central and Western Gulf could be adversely impacted by oil and gas activities resulting from the proposed actions should they be unrestricted by the absence of the proposed Topographic Features Stipulations. This would be particularly true should operations occur directly on top of or in the immediate vicinity of otherwise protected topographic features.

The area within the No Activity Zones would probably be the areas of the topographic features most susceptible to adverse impacts if oil and gas activities are unrestricted by the Topographic Features Stipulations or project-specific mitigating measures. These impacting factors would include blowouts, surface oil spills, and subsea oil spills. Potential impacts from routine activities resulting from the proposed actions are discussed in Chapters 4.2.1.2.1 and 4.3.1.2.1. Oil spills as well as routine activities have the potential to considerably alter the diversity, cover, and long-term viability of the reef biota found within the No Activity Zone. In most cases, recovery from disturbances would take 10 years or more. Indeed, disturbances, including oil spills and blowouts, would alter benthic substrates and their associated biota over areas possibly ranging from tens to thousands of square meters per event. In the unlikely event of a blowout, sediment resuspension potentially associated with oil could cause adverse turbidity and sedimentation conditions. In addition to affecting the live cover of a topographic feature, a blowout could alter the local benthic morphology, thus irreversibly altering the reef community. Oil spills (surface and subsea) could be harmful to the local biota should the oil have a prolonged or recurrent contact with the organisms.

Therefore, in the absence of the Topographic Features Stipulations, the proposed actions could cause long-term (10 years or more) adverse impacts to the biota of the topographic features, located in most cases on those portions of the topographic features that are in 85 m and less water depth.

4.4.3.2.3. Chemosynthetic Deepwater Benthic Communities

Accidental events that could impact chemosynthetic communities are limited primarily to blowouts. A blowout at the seafloor could create a crater and could resuspend and disburse large quantities of bottom sediments within a 300-m radius from the blowout site, thus organisms located within that distance. The application of avoidance criteria for chemosynthetic communities required by NTL 2000-G20 should preclude the impact of a blowout to a distance of 457 m (1,500 ft).

Impacts to chemosynthetic communities from any oil released would be a remote possibility. Release of hydrocarbons associated with a blowout should not present an possibility for impact to chemosynthetic communities located a minimum of 457 m (1,500 ft) from well sites. All known reserves in the Gulf to date have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. The potential for weathered components from a surface slick reaching a chemosynthetic community in any measurable volume would be very small.

Oil and chemical spills are not considered to be a potential source of measurable impacts on chemosynthetic communities because of the water depths at which these communities are located. Oil spills at the surface would tend not to sink. All evidence to date indicates that accidental oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column, surfacing almost directly over the source location (Chapter 4.4.1.1.5.4), and thus not impact the benthos. The risk for weathering components from a surface slick reaching the benthos in any measurable concentrations would be very small.

There is some reason to believe the presence of oil may not have an impact in the first place because these communities live among oil and gas seeps; however, natural seepage is very constant and at very low rates as compared to the potential volume of oil released from a blowout or pipeline rupture. All seep organisms also require unrestricted access to oxygenated water at the same time as exposure to hydrocarbon energy sources.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type), although it may reappear relatively quickly once the process begins, as in the case of a mussel community. Tube-worm communities may be the most sensitive of all communities because of the combined requirements of hard substrate and active hydrocarbon seepage. Mature tube-worm bushes have been found to be several hundred years old. There is evidence that substantial impacts on these communities would permanently prevent reestablishment, particularly if hard substrate required for recolonization was buried.

Proposed Action Analysis

For water depths greater than 200 m, 0-3 blowouts are estimated in the CPA and 0-1 blowouts are estimated in the WPA. The application of avoidance criteria for chemosynthetic communities required by NTL 2000-G20 should preclude the impact of a blowout to a distance of 457 m (1,500 ft), which is beyond the distance of expected benthic disturbance. Resuspended bottom sediments transported by near-bottom currents could reach chemosynthetic comminutes located beyond 457 m and potentially impact them by burial or smothering.

The risk of various sizes of oil spills occurring in the CPA or WPA are presented in Table 4-44. The probability of oil in any measurable concentration reaching depths of 400 m or greater is very small.

Summary and Conclusion

Chemosynthetic communities could be susceptible to physical impacts from a blowout depending on bottom-current conditions. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type). There is evidence that substantial impacts on these communities would permanently prevent reestablishment, particularly if hard substrate required for recolonization was buried.

Potential accidental impacts from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities located at more than 1,500 ft away from a blowout could experience minor impacts from resuspended sediments.

4.4.3.2.4. Nonchemosynthetic Deepwater Benthic Communities

A blowout at the seafloor could create a crater and could resuspend and disburse large quantities of bottom sediments within a 300-m radius from the blowout site, thus destroying any organisms located within that distance. Physical disturbance or destruction of a limited area of benthos or to a limited number of megafauna organisms, such as brittle stars, sea pens, or crabs, would not result in a major impact to the deepwater benthos ecosystem as a whole.

Oil and chemical spills are not considered to be a potential source of measurable impacts to nonchemosynthetic deepwater benthic communities because of the water depths at which these communities are located. Oil spills at the surface would tend not to sink. All evidence to date indicates that accidental oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column, surfacing almost directly over the source location (Chapter 4.4.1.1.5.4), and thus not impact the benthos. The risk for weathering components from a surface slick reaching the benthos in any measurable concentrations would be very small.

Under the current review procedures for chemosynthetic communities, carbonate outcrops (surface anomaly on 3-D seismic survey data) are targeted as one possible indication that chemosynthetic seep communities are nearby. Any unique nonchemosynthetic communities that may be associated with carbonate outcrops or other topographical features would be avoided via this review along with the chemosynthetic communities. Typically, all areas suspected of being hard bottom are avoided as a potential geological hazard for any well sites. Any proposed activity in water depth greater than 400 m would automatically trigger the NTL 2000-G20 evaluation described above.

Proposed Action Analysis

For water depths greater than 200 m, 0-3 blowouts are estimated in the CPA and 0-1 blowouts are estimated in the WPA.

The risk of various sizes of oil spills occurring in the CPA or WPA are presented in Table 4-44. The probability of oil in any measurable concentration reaching depths of 400 m or greater is very small.

Summary and Conclusion

Accidental events resulting from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, typical, deep-sea benthic communities. Some impact to benthic communities would occur as a result of impact from an accidental blowout. Megafauna and infauna communities at or below the sediment/water interface would be impacted by the physical disturbance of a blowout or by burial from resuspended sediments. Even in situations where substantial burial of typical benthic communities occurred, recolonization from populations from neighboring substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of hours to days for bacteria and probably less than one year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be very rare. These unique communities are distinctive and similar in nature to protected pinnacles and topographic features on the continental shelf. Any hard substrate communities located in deep water would be particularly sensitive to impacts. Impacts to these sensitive habitats could permanently prevent recolonization with similar organisms requiring hard substrate, but adherence to the provisions of NTL 2000-G-20 should prevent all but minor impacts to hard-bottom communities beyond 454 m (1,500 ft).

The proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, typical, deep-sea benthic communities.

4.4.3.3. Impacts to Water Quality

Accidental events that could impact water quality include spills of oil, refined hydrocarbons, or chemicals. An accidental spill of oil could occur from leakage, a pipeline break, or a blowout. Water quality is altered and degraded by oil spills through the increase of petroleum hydrocarbons (alkanes, cycloalkanes, and aromatic compounds) and their various transformation/degradation products. The extent of impact from a spill depends on the behavior and fate of oil in the water column (e.g., movement of oil and rate and nature of weathering), which, in turn, depends on oceanographic and meteorological conditions at the time.

The National Academy of Sciences (NRC, 1985) and Boesch and Rabalais (1987) have reviewed the fate and effects of spilled oil. In general, the impacts to water quality are greatest when a spill occurs in a confined area where it persists for a long period of time. In an environment where the oil can be dispersed or diluted, the impacts are reduced. Very little information is available about the effects of an oil spill on water quality because most studies have focused on the spilled oil and its dissipation and not on the surrounding water and its alteration. Also, spills of opportunity are few and difficult to sample on short notice. The evaluation of impacts from a large spill on water quality are based on qualitative and speculative information.

There are very few oil spills from blowouts.

Accidental riser disconnects could result in the release of large quantities of drilling fluids and are of particular concern when synthetic-based drilling fluids (SBF) are in use. The use of SBF occurs primarily in deep water where large volumes can be released. Three recent riser disconnects have resulted in the discharge of 600-800 bbl of SBF per incident.

4.4.3.3.1. Coastal Waters

The ability of coastal waters to assimilate spilled oil is affected by the shallowness of the environment. Large volumes of water are not available to dilute suspended oil droplets and dissolved constituents. Since oil does not mix with water and is usually less dense, most of the oil forms a slick at the surface. Small droplets in the water may adhere to suspended sediment and be removed from the water column. Oil contains toxic aromatic compounds such as benzene, toluene, xylenes, naphthalenes, and polynuclear aromatic hydrocarbons, which are soluble to some extent in water. The effect of these compounds on water quality depends on the circulation in the coastal environment, the composition of the spilled oil, and the length of time the oil is in contact with the water. Oil may also penetrate sand on the beach or be trapped in wetlands, where it can be re-released into the water some time after the initial spill.

4.4.3.3.2. Marine Waters

The Gulf of Mexico has numerous natural hydrocarbon seeps as discussed in Chapters 3.1.2.2 and 4.1.3.4. The marine environment can be considered adapted to handling small amounts of oil released over time. Most of the oil spills that may occur as a result of a proposed action are expected to be ≤1 bbl (Table 4-44).

An oil spill ≥1,000 bbl at the water surface may result from a platform accident. Subsurface spills would occur from pipeline failure or a wellhead blowout. Most of the oil from a subsurface spill would likely rise to the surface and would weather and behave similarly to a surface spill, dependent upon a number of factors, particularly the characteristics of the released oil and oceanographic conditions. However, some of the subsurface oil may also get dispersed within the water column, as in the case of the *Ixtoc I* seafloor blowout. Evidence from a recent experiment in the North Sea indicates that oil released during a deepwater blowout would quickly rise to the surface and form a slick (Johansen et al., 2001). Impacts from a deepwater oil spill would occur at the surface where the oil would be mixed into the water and dispersed by wind waves.

Once the oil enters the ocean, a variety of physical, chemical, and biological processes act to disperse the oil slick, such as spreading, evaporation of the more volatile constituents, dissolution into the water column, emulsification of small droplets, agglomeration sinking, microbial modification, photochemical modification, and biological ingestion and excretion. The water quality of marine waters would be temporarily affected by the dissolved components and small oil droplets that do not rise to the surface or are mixed down by surface turbulence. Dispersion by currents and microbial degradation remove the oil from the water column or dilute the constituents to background levels.

The most likely oil-spill scenario for spills ≥1,000 bbl is a 4,600-bbl spill from a pipeline break that leaks for 12 hr. For a likely spill in the CPA, after three days, approximately 1 percent of the oil is expected to naturally disperse and about 45 percent is expected to be chemically dispersed. For the WPA, by two days, approximately 42 percent would be dispersed and 1,040 bbl chemically dispersed. The volume of oil is small relative to the amount of oil that enters the Gulf of Mexico through natural seeps; however, this represents a large quantity over a short period of time. Because the Gulf is a large body of water, the toxic constituents, such as benzene, toluene, xylene, and naphthalene, are expected to rapidly disperse to sublethal concentrations.

Chemical Spills

A recent study of chemical spills from OCS activities determined that accidental releases of zinc bromide and ammonium chloride could potentially impact the marine environment (Boehm et al., 2001). Both of these chemicals are used for well treatment or completion and are not in continuous use; thus, the risk of a spill is small. Most other chemicals are either nontoxic or used in such small quantities that a spill would not result in measurable impacts. Zinc bromide is of particular concern because of the toxic nature of zinc. Close to the release point of an ammonium chloride spill, the ammonia concentrations could exceed toxic levels for time scales of hours to days. Additional information on the degradation of ammonia in seawater is needed for a better evaluation of the impacts.

Accidental Releases of Drilling Fluids

The effects of the accidental release of a large volume of SBF (e.g., from an accidental riser disconnect) have not been studied. Because of the specific gravity of SBF, such drilling fluids would be expected to sink to the seafloor in the area immediately at and adjacent to the release site. Localized anoxic conditions at the seafloor would be expected to occur. This would be short term, lasting until the SBF decomposed.

Blowouts

For a proposed action in the WPA, 1-2 blowouts are expected to occur during the life of the leases; 2-4 blowouts are expected to be associated with activities resulting from a proposed action in the CPA. Blowouts may result in localized suspension of sediments, thus affecting water quality temporarily. Results from a recent simulated experiment of a deepwater blowout indicated that the oil rose from 850 m to the surface in approximately one hour.

Since blowouts are rare events and of short duration, potential impacts to marine water quality are not expected to be significant.

Summary and Conclusion

Smaller spills (<1,000 bbl) are not expected to significantly impact water quality in marine and coastal waters. Larger spills, however, could impact water quality especially in coastal waters. Chemical spills, the accidental release of SBF, and blowouts are expected to have temporary localized impacts on water quality.

4.4.3.4. Impacts on Air Quality

The accidental release of hydrocarbons or chemicals from OCS-related activities will cause the emission of air pollutants. Some of these pollutants are precursors to ozone, which is formed by complex photochemical reactions in the atmosphere. Accidents, such as oil spills and blowouts, are a source of emissions related to OCS operations. Typical emissions from OCS accidents consist of hydrocarbons; only fires produce a broad array of pollutants, including all NAAQS-regulated primary pollutants. The criteria pollutants considered here are nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur oxides (SO_x), volatile organic chemicals (VOC), and particulate matter less than 10 microns in size (PM_{10}).

An oil spill (assumed size of 4,600 bbl) from a pipeline break during the summer at a location 50 mi off Louisiana was modeled for a period of 10 days (Table 4-45). An oil spill (assumed size of 4,600 bbl) from a pipeline break during the winter at a location 65 mi off Texas was modeled for a period of 10 days (Table 4-46). At the end of 10 days 30% of the CPA slick and 31% of the WPA slick were lost due to evaporation. The contribution of oil-spill emissions to the total VOC emission is small, about 0.5 percent.

Blowouts are accidents related to OCS oil and gas activities and are defined as an uncontrolled flow of fluids from a wellhead or wellbore. The air pollutant emissions from blowouts depend on the amount of oil and gas released, the duration of the accident, and the occurrence or not of fire during the blowout. The duration of most blowouts is short duration, and half of blowouts lasted less than half a day. Blowouts may result in the release of synthetic drilling fluid or loss of oil. From 1992 to 2000, less than 10 percent of blowouts have resulted in spilled oil, which ranged from 1.5 to 200 bbl. An estimated 2-4 blowouts could occur from activities resulting from a proposed action in the CPA and 1-2 blowouts from a proposed action in the WPA.

The presence of hydrogen sulfide (H_2S) within formation fluids occurs sporadically throughout the Gulf of Mexico OCS, which may be released during an accident. There has been some evidence that petroleum from deepwater plays contain significant amounts of sulfur. Encounters with H_2S in oil and gas operations have caused injury and death throughout the United States, but none, to date, in the Gulf of Mexico region. H_2S concentrations in OCS vary from as low as a fraction ppm to as high as 650,000 ppm. The concentrations of H_2S found to date are generally greatest in the eastern portion of the CPA. The Occupational Safety and Health Administration's permissible exposure limit for H_2S is 10 ppm, which is 30 times lower than the "immediately dangerous to life and health" of 200 ppm set by the National Institute for Occupational Safety and Health. At about 500-700 ppm loss of consciousness and possible death can occur in 30-50 minutes. H_2S is a toxic gas; at lower concentrations, it is readily recognized by the “rotten egg” smell. Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage.

Summary and Conclusion

Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. Other emissions of pollutants into the atmosphere from accidental events as a result of a proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emissions height, emission rates, and the distance of these emissions from the coastline. These emissions are not expected to have concentrations that would change onshore air quality classifications. Increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than maximum increases allowed under the PSD Class I and II program.

4.4.3.5. Impacts on Marine Mammals

Blowouts

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellhead or wellbore are called blowouts. Blowouts can occur during any phase of development: exploratory drilling, development drilling, production, completion, or workover operations. In the event of a blowout, the eruption of gases and fluids may generate significant pressure waves and noise that may harass, injure, or kill marine mammals, depending on their proximity to the accident. The effects of explosions and noise on marine mammals are discussed at length in Chapters 4.2.1.5 and 4.3.1.5.

Oil Spills

Each major grouping of marine mammals (e.g., manatees and dugongs, and baleen and toothed whales) confronts spilled hydrocarbons in different ways. Oil spills could affect marine mammals through various pathways: surface contact, inhalation, ingestion, and baleen fouling (Geraci, 1990). Much of the information on the effects of oil on marine mammals comes from studies of fur-bearing marine mammals (e.g., seals and sea lions, and sea otters). Sea otters exposed to the *Exxon Valdez* spill experienced high incidences of emphysema, petroleum hydrocarbon toxicosis, abortion, and stillbirths (Williams and Davis, 1995). Direct contact with oil and/or tar for cetaceans can lead to irritation and damage of skin and soft tissues (such as mucous membranes of the eyes), fouling of baleen plates so as to hinder the flow of water and interfere with feeding, and incidental ingestion of oil and/or tar. Studies by Geraci and St. Aubin (1982 and 1985) have shown that the cetacean epidermis functions as an effective barrier to noxious substances found in petroleum. Unlike other mammals, penetration of such substances in cetacean skin is impeded by tight intercellular bridges, the vitality of the superficial cells, the thickness of the epidermis, and the lack of sweat glands and hair follicles (Geraci and St. Aubin, 1985). The cetacean epidermis is nearly impenetrable, even to the highly volatile compounds in oil, and when skin is breached, exposure to these compounds does not impede the progress of healing (Geraci and St. Aubin, 1985). Cetacean skin is free from hair or fur, which in other marine mammals, such as pinnipeds and otters, tends to collect oil and/or tar, which subsequently reduces the insulating properties of the fur (Geraci, 1990). Dolphins maintained at a captive site in Sevastopol, Ukraine, that were exposed to petroleum products initially exhibited a sharp depression of food intake along with an excitement in behavior, eye inflammation, and changes in hemoglobin as well as erythrocyte content (Lukina et al., 1996). Prolonged exposure to oil led to a depression of those blood parameters, as well as changes in breathing patterns and gas metabolism, while nervous functions became depressed and skin injuries and burns appeared (Lukina et al., 1996). Experiments with harbor porpoise in similar conditions possibly resulted in aspiration pneumonia (Lukina et al., 1996). Dolphins exposed to oil at a Japanese aquarium that draws seawater from the ocean began developing cloudy eyes (Reuters, 1997).

Fresh crude oil or volatile distillates release toxic vapors that, when inhaled, can lead to irritation of respiratory membranes, lung congestion, and pneumonia. Subsequent absorption of volatile hydrocarbons into the bloodstream may accumulate into such tissues as the brain and liver, causing neurological disorders and liver damage (Geraci and St. Aubin, 1982; Hansen, 1985; Geraci, 1990).

Toxic vapor concentrations just above the water's surface (where cetaceans draw breath) may reach critical levels for the first few hours after a spill, prior to evaporation and dispersion of volatile aromatic hydrocarbons and other light fractions (Geraci and St. Aubin, 1982).

Trained, captive bottlenose dolphins exposed to oil could not detect light oil sheen but could detect thick dark oil based on visual, tactile, and presumably echolocation cues (Geraci et al., 1983; Smith et al., 1983). Studies of captive dolphins also showed that they completely avoided surfacing in slick oil after a few brief, initial tactile encounters. Reactions of free-ranging cetaceans to spilled oil appears varied, ranging from avoidance to apparent indifference (reviewed by Geraci, 1990; Smultea and Würsig, 1991). In contrast to captive dolphins, bottlenose dolphins during the *Mega Borg* spill did not consistently avoid entering slick oil, which could increase their vulnerability to potentially harmful exposure to oil chemicals (Smultea and Würsig, 1991 and 1995). It is possible that some overriding behavioral motivation (such as feeding) induced dolphins to swim through the oil; that slick areas were too large for dolphins to feasibly avoid, or that bottlenose dolphins have become accustomed to oil due to the extent of oil-related activity in the Gulf (Smultea and Würsig, 1995). The latter could result in temporary displacement from migratory routes. After the *Exxon Valdez* spill, killer whales did not appear to avoid oil; however, none were observed in heavier slicks of oil (Matkin et al., 1994). It is unknown whether animals in some cases are simply not affected by the presence of oil, or perhaps are even drawn to the area in search of prey organisms attracted to the oil's protective surface shadow (Geraci, 1990). The probable effects on cetaceans swimming through an area of oil would depend on a number of factors, including ease of escape from the vicinity, the health of the individual animal, and its immediate response to stress (Geraci and St. Aubin, 1985).

Spilled oil can lead to the localized reduction, extirpation, or contamination of prey species. Prey species, such as zooplankton, crustaceans, mollusks, and fishes, may become contaminated by direct contact and/or by ingesting oil droplets and tainted food. Marine fishes are known to take up petroleum hydrocarbons from both water and food, though apparently do not accumulate high concentrations of hydrocarbons in tissues, and may transfer them to predators (Neff, 1990). Cetaceans may consume oil-contaminated prey (Geraci, 1990) or incidentally ingest floating or submerged oil or tar. Hydrocarbons may also foul the feeding apparatus of baleen whales (though laboratory studies suggest that such fouling has only transient effects) (Geraci and St. Aubin, 1985). In general, the potential for ingesting oil-contaminated prey organisms with petroleum-hydrocarbon, body-burden content is highest for benthic feeding whales and pinnipeds. The potential is reduced for plankton-feeding whales and is lowest for fish-eating whales and pinnipeds (Würsig, 1990). Baleen whales occurring in the Gulf of Mexico feed on small pelagic fishes (such as herring, mackerel, and pilchard) and cephalopods (Cummings, 1985). An analysis of stomach contents from captured and stranded odontocetes suggest that they are deep-diving animals, feeding predominantly on mesopelagic fish and squid or deepwater benthic invertebrates (Heyning, 1989; Mead, 1989). Delphinids feed on fish and/or squid, depending upon the species (Mullin et al., 1991).

As noted by St. Aubin and Lounsbury (1990), there have been no experimental studies and only a handful of observations suggesting that oil has harmed any sirenian. Dugongs (relatives of the manatees) have been found dead on beaches after the Gulf War oil spill and the 1983 *Nowruz* oil spill caused by the Iran-Iraq War (Preen, 1991; Sadiq and McCain, 1993). Some dugongs were sighted in the oil sheen after the Gulf War (Pellew, 1991). Four types of impacts to dugongs from contact with oil include asphyxiation due to inhalation of hydrocarbons, acute poisoning due to contact with fresh oil, lowering of tolerance to other stress due to the incorporation of sublethal amounts of petroleum fractions into body tissues, and nutritional stress through damage to food sources (Preen, 1989, in Sadiq and McCain 1993). Manatees concentrate their activities in coastal waters, often resting at or just below the surface, which may bring them in contact with spilled oil (St. Aubin and Lounsbury, 1990). Manatees are nonselective, generalized feeders that might consume tarballs along with their normal food; such occurrences have been rarely reported (review in St. Aubin and Lounsbury, 1990). A manatee might also ingest fresh petroleum, which some researchers have suggested might interfere with the manatee's secretory activity of their unique gastric glands or harm intestinal flora vital to digestion (Geraci and St. Aubin, 1980; Reynolds, 1980). Oil spills within the confines of preferred river systems and canals, particularly during winter (when the animals are most vulnerable physiologically), could endanger local populations. Manatees able to escape such areas might be forced into colder waters, where thermal stress could complicate the effects of even brief exposure to oil (St. Aubin and Lounsbury, 1990). Such a scenario will expose them to increased vessel traffic, the primary cause of unnatural manatee deaths. This scenario is not one likely to be associated with offshore production or transportation of petroleum. The greater risk is from coastal accidents. For a population whose environment is already under great pressure, even a localized incident could be significant (St. Aubin and Lounsbury, 1990). Spilled oil might affect the quality or availability of aquatic vegetation, including seagrasses, upon which manatees feed.

Indirect consequences of oil pollution on marine mammals include those effects that may be associated with changes in the availability or suitability of prey resources (Hansen, 1992). Depending on the spatial scale and magnitude of an oil spill, diminished prey abundance and availability may cause marine mammal predators to move to less suitable areas and/or consume less suitable prey. In either case, the impact can be significant to a marine mammal population or stock. No long-term bioaccumulation of hydrocarbons have been demonstrated; however, an oil spill may physiologically stress an animal (Geraci and St. Aubin, 1980), making them more vulnerable to disease, parasitism, environmental contaminants, and/or predation.

Spill-Response Activities

Spill-response activities include the application of dispersant chemicals to the affected area (Chapter 4.4.2). Dispersant chemicals are designed to break oil on the water's surface into minute droplets, which then break down in seawater. Essentially nothing is known about the effects of oil dispersants on cetaceans, except that removing oil from the surface would reduce the risk of contact and render it less likely to adhere to skin, baleen plates, or other body surfaces (Neff, 1990). The acute toxicity of most oil dispersant chemicals is considered to be low relative to the constituents and fractions of crude oil and refined products, and studies have shown that the rate of biodegradation of dispersed oil is equal to or greater than that of undispersed oil (Wells, 1989). A variety of aquatic organisms readily accumulate and metabolize surfactants from oil dispersants. Enzymatic hydrolysis of the surfactant yields hydrophilic and hydrophobic components. The former probably are excreted via the gills and kidneys, whereas the latter accumulate in the gallbladders of fish and are excreted very slowly (Neff, 1990). Metabolism of surfactants is thought to be rapid enough that there is little likelihood of food chain transfer from marine invertebrates and fish to predators, including marine mammals (Neff, 1990).

Biodegradation is another process used for removing petroleum hydrocarbons from the marine environment, utilizing chemical fertilizers to augment the growth of naturally occurring hydrocarbon-degrading microorganisms. Toxic effects of these fertilizers on cetaceans are presently unknown.

Proposed Action Analysis

The potential causes, sizes, and probabilities of oil spills that could occur during drilling, production, and transportation operations associated with a proposed action are presented in Chapters 4.4.1 and 4.4.2. Table 4-47 lists estimates for spill magnitude and abundance for Gulf coastal waters as a result of a proposed action. Analogous estimates of spill magnitude and abundance for Federal OCS waters as a result of a proposed action are given in Table 4-44. However, estimates of where these accidents occur relative to water depth are not presented. Qualitative inspection of spill data indicates that the following will likely be in each planning area: many, frequent, small spills; few, infrequent, moderate-sized spills; and a single, unlikely, large spill. Such spills are attributed to the proposed actions. The assessment of spill frequency (i.e., frequent, infrequent, unlikely) is based relative to the 40-year life span of a proposed action.

Oil spills introduced specifically into coastal waters (as opposed to spills immigrating to coastal waters from offshore) as a result of a proposed action are assumed to encroach upon adjacent coastal lands. Spill estimates (Table 4-47) indicate that spills of ≤1 bbl will introduce 20-40 bbl of oil into coastal waters of the WPA over the 40-year life span. Spills of between >1 and <1,000 bbl of oil are expected to introduce about 200 bbl of oil in coastal waters of the WPA. A single spill of ≥1,000 bbl of oil may occur in coastal waters of the WPA. The total volume of spilled oil introduced into coastal waters of the WPA ranges from 200 to 3,200 bbl.

Spill estimates indicate that between 40 and 95 spills of ≤1 bbl of oil will be introduced into coastal waters of the CPA over a 40-year period. A total of 200-3,500 bbl of spilled oil is estimated for coastal waters of the CPA. Analysis of spill data also indicate that approximately 64 percent of coastal spills will occur in inland waters, 32 percent of coastal spills will occur in State offshore waters 0-3 mi from the coast, and 4 percent of coastal spills will occur in State offshore waters 3-12 mi from the coast (applicable to Texas).

The OSRA modeling results indicate that a large spill (≥1,000 bbl) occurring in Federal offshore waters stands a 5-8 percent probability of impacting Texas State waters, based on a proposed action for the WPA (Figure 4-16). Should a large oil spill occur as a result of a proposed action in the CPA, Texas coastal waters run a 1 percent risk of impact (Figure 4-16). Coastal waters of western and central Louisiana stand a 9-19 percent and 1-2 percent risk of impact from an OCS spill occurrence resulting from the proposed actions in the CPA and WPA, respectively. There is a 2-4 percent spill risk to Louisiana coastal waters east of the mouth of the Mississippi River (CPA proposed action only). The OSRA model projected no large spills reaching coastal waters eastward of Louisiana as a result of either proposed action (Figures 4-16 and 4-17).

In general terms, coastal waters of the CPA and WPA are expected to be impacted by many, frequent, small spills; few, infrequent, moderately-sized spills; and a single, large (≥1,000 bbl) spill. Pipelines pose the greatest risk of a large spill occurring in coastal waters. Matagorda County, Texas, and Plaquemines Parish, Louisiana, are the most likely landfall locations in the two planning areas, where such a large spill might occur.

Spills originating in or migrating through coastal waters may impact groups of the bottlenose dolphin, Atlantic spotted dolphin, or the West Indian manatee. Bottlenose dolphins are abundant in coastal waters of the Western Gulf. Manatees are rarely encountered in the Western Gulf north of Mexico.

Estimates from spill data show that Federal offshore waters will be subjected to many frequent small spills (≤1 bbl); few, infrequent, moderately-sized spills (>1 bbl and <1,000 bbl); and/or rare large spills (≥1,000 bbl) (Table 4-44) as a result of OCS activities. Spill estimates for the WPA indicate that 300-600 bbl of oil will be introduced in offshore waters from small spills (≤1 bbl). An additional 200-1,000 bbl of oil will be spilled in >1 to <1,000 bbl spill events. A single, large spill (≥1,000 bbl) is estimated to introduce approximately 4,600 bbl of oil. A single, but unlikely spill may occur that introduces as much as 15,000 bbl of oil. The total volume of oil spilled in Federal offshore waters as a result of a proposed action in the WPA is estimated at 500-22,000 bbl of oil spread over the 40-year life span of the proposed actions.

Oil-spill data derived from historical trends estimate that a total volume of 1,000-23,000 bbl of oil will be introduced into Federal offshore waters over 40 years as a result of the a proposed lease sale in the CPA. Small spills (≤1 bbl) are projected to introduce 700-1,500 bbl of oil. Moderate-sized spills (>1 to <1,000 bbl), though occurring less frequently than smaller spills, will introduce an estimated 300-1,400 bbl of oil. A large spill (≥1,000 bbl) is assumed to introduce approximately 4,600 bbl of oil as a result of a proposed action in the CPA. There is a 34-63 percent chance that a single spill exceeding 1,000 bbl will occur. In the rare event that a spill exceeding 10,000 bbl should occur, it is estimated that approximately 15,000 bbl of oil will be spilled. Additionally, there are 2-4 blowouts projected to occur as a result of a proposed lease sale in the CPA (Table 4-2).

In neritic waters (<200 m), platforms pose the most likely source of small spills, whereas pipelines pose the most likely source of a large spill. The most likely sources of spills in oceanic and outer shelf waters are subsea blowouts or pipeline ruptures.

The greatest diversity and abundance of cetaceans inhabiting the Gulf of Mexico is found in its oceanic and OCS waters. Individual cetaceans are not necessarily randomly distributed in the offshore environment, but are instead prone to forming groups of varying sizes. In some cases, several species may be found aggregating in the same area. Large spills, particularly those continuing to flow fresh hydrocarbons into oceanic and/or outer shelf waters for extended periods (days, weeks, months), pose an increased likelihood of impacting cetacean populations inhabiting these waters. Based on abundance estimates and a hypothetical spill surface area, spills occurring in these waters could impact more species and more individuals than coastal spills potentially impacting coastal marine mammals. It is noteworthy that the endangered sperm whales use oceanic waters as their principle habitat, and the northern Gulf is known to support approximately 300-500 of these animals.

There is an extremely small probability that a single cetacean will encounter an oil slick resulting from a single, small spill. Increasing the size of a slick or factoring in the number of estimated spills over 40 years, increases the likelihood that an animal will encounter a single slick during the lifetime of an animal; many cetacean species are long-live and may traverse throughout waters of the northern Gulf. The likelihood that a cetacean population may encounter an oil slick resulting from a single spill during a

40-year period is greater than that of a single individual encountering a slick during its lifetime. It is impossible to predict precisely which cetacean species, population or stock members, or individuals will be impacted, to what magnitude, or in what numbers, since each species has unique distribution patterns in the Gulf and because of difficulties attributed to predicting when and where oil spills will occur over a 40-year period.

Given the distribution of available leases and pipelines associated with the proposed actions and the distribution of marine mammals in the northern Gulf of Mexico, the fate of an oil spill must be considered relative to the region and period of exposure. Spill estimates derived from data documenting historical trends of oil spills in coastal and offshore waters indicate that the proposed actions in the WPA and CPA may introduce 2,000-50,000 bbl of oil into Gulf marine and estuarine environments over 40 years. Spills of any size degrade water quality, and residuals become available for bioaccumulation within the food chain. Slicks may spread at the sea surface or may migrate underwater from the seafloor through the water column and never broach the sea surface. Regardless, a slick is an expanding, but aggregated mass of oil that, with time, will disperse into smaller units as it evaporates (if at the sea surface) and weathers. Chapter 4.4.1.1.5.4 details the persistence, spreading, and weathering process for offshore spills. As the slick breaks up into smaller units (e.g., slickets) and soluble components dissolve into the seawater, tarballs may remain within the water column. Tarballs may subsequently settle to the seafloor or attach to other particles or bodies in the sea. As residues of an oil spill disperse and commit to the physical environment (water, sediments, and particulates), populations or stocks of oceanic cetaceans may be exposed via the waters that they drink and swim, as well as via the prey they consume. For example, tarballs may be consumed by marine mammals and by other marine organisms, and eventually bioaccumulate within marine mammalian predators. Although marine mammals may (or may not) avoid oil spills or slicks, it is highly unlikely that they are capable of avoiding spill residuals in their environment. Consequently, the probability that a marine mammal is exposed to hydrocarbons resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of marine mammals in the northern Gulf will be exposed to residuals of oils spilled as a result of the proposed actions during their lifetimes.

In the event of a blowout, the eruption of gases and fluids may generate significant pressure waves and noise that may harass, injure, or kill marine mammals, depending on their proximity to the accident. There are 1-2 blowouts projected to occur as a result of a proposed action in the WPA (Table 4-3). There are 2-4 blowouts projected to occur as a result of a proposed action in the CPA (Table 4-2).

Blowouts, oil spills, and spill-response activities have the potential to adversely affect cetaceans, causing physical injury and irritation, fouling of baleen plates, respiratory stress from inhalation of toxic fumes, food reduction or contamination, direct ingestion of oil and/or tar, and temporary displacement from preferred habitats or migration routes. If these accidental events occur within marine mammal habitat, some potential effects follow, given that animals are exposed to pollutants. Some short-term (0-1 month) effects of oil on cetacean assemblages may be (1) changes in species or social group distributions associated with avoidance of aromatic hydrocarbons and surface oil, changes in prey distribution, and human disturbance; (2) increased mortality rates from ingestion or inhalation of oil; (3) increased petroleum compounds in tissues; and (4) impaired health (e.g., immunosuppression) (Harvey and Dahlheim, 1994). Several mechanisms for long-term injury can be postulated: (1) initial sublethal exposure to oil causing pathological damage; (2) continued exposure to hydrocarbons persisting in the environment, either directly or through ingestion of contaminated prey; and (3) altered availability of prey as a result of the spill (Ballachey et al., 1994). While no conclusive evidence of an impact on cetaceans by the *Exxon Valdez* spill was uncovered (Dahlheim and Matkin, 1994; Harvey and Dahlheim, 1994; Loughlin, 1994), investigations on the effects on sea otters and harbor seals revealed pathological effects on the liver, kidney, brain (also evidenced by abnormal behavior), and lungs, as well as gastric erosions (Ballachey et al., 1994; Lipscomb et al., 1994; Lowry et al., 1994; Spraker et al., 1994). In addition, harbor seal pup production and survival appeared to be affected (Frost et al., 1994). A delayed effect of oil spills on river otters was strongly suggested in Bowyer et al. (1994). Studies of sea otters in western Prince William Sound in 1996-1998 indicate continued exposure to residual *Exxon Valdez* oil (Ballachey et al., 1999; Monson et al., 2000). Oil spills have the potential to cause greater chronic (longer-term lethal or sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on mammals than originally thought. A few long-term effects include (1) decreases in prey availability and abundance because of increased mortality rates; (2) change in age structure because certain year-classes were impacted more by oil; (3) decreased reproductive rate; and (4) increased rate of disease or neurological problems from exposure to oil (Harvey and Dahlheim, 1994). It has been speculated that new mortalities of killer whales may be linked to the *Exxon Valdez* spill (Matkin and Sheel, 1996). There was no evidence to directly link the Gulf War oil spill to marine mammal deaths that occurred during that time (Preen, 1991; Robineau and Fiquet, 1994). Effects of cleanup activities are unknown, but increased human presence (e.g., vessels) could add to changes in cetacean behavior and/or distribution, thereby additionally stressing animals, and perhaps making them more vulnerable to various physiologic and toxic effects.

Evidence gathered from the studies of the *Exxon Valdez* spill indicates that oil spills have the potential to cause chronic (sublethal oil-related injuries) and acute (spill-related deaths) effects on marine mammals. The effects were particularly pronounced on fur-bearing mammals (pinnipeds and sea otters) and less clear for cetaceans. Also, cetaceans do not always avoid contact with oil (e.g., Smultea and Würsig, 1995). Although an interaction with a spill could occur, primarily sublethal effects are expected due to avoidance and natural dispersion/weathering of the spill in the offshore environment.

Summary and Conclusion

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact marine mammals in the Gulf of Mexico. Characteristics of impacts (i.e., acute vs. chronic impacts) depend on the magnitude, frequency, location, and date of accidents, characteristics of spilled oil, spill-response capabilities and timing, and various meteorological and hydrological factors. Populations of marine mammals in the northern Gulf will be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes. Chronic or acute exposure may result in the harassment, harm, or mortality to marine mammals occurring in the northern Gulf. In most foreseeable cases, exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick will result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) to marine mammals.

4.4.3.6. Impacts on Sea Turtles

Blowouts

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellhead or wellbore are called blowouts. Blowouts can occur during any phase of development: exploratory drilling, development drilling, production, completion, or workover operations. In the event of a blowout, the eruption of gases and fluids may generate significant pressure waves and noise that may harass, injure, or kill sea turtles, depending on their proximity to the accident. The effects of explosions and noise on sea turtles is discussed at length in Chapters 4.2.1.5 and 4.3.1.5.

Oil Spills

When an oil spill occurs, the severity of effects and the extent of damage to sea turtles are affected by geographic location; hydrocarbon type, dosage, and weathering; impact area; oceanographic and meteorological conditions; season; and life history stages of animals exposed to the hydrocarbons (NRC, 1985). All sea turtle species and life stages are vulnerable to the harmful effects of oil through direct contact or by fouling of their habitats and prey. Van Vleet and Pauly (1987) suggested that discharges of crude oil from tankers were having a significant effect on sea turtles in the Eastern Gulf of Mexico. Experiments on the physiologic and clinicopathologic effects of hydrocarbons have shown that major body systems of sea turtles are adversely affected by short exposure to weathered oil. Sea turtles accidentally exposed to oil or tarballs may suffer inflammatory dermatitis, ventilatory disturbance, salt gland dysfunction or failure, red blood cell disturbances, immune responses, and digestive disorders or blockages (Vargo et al., 1986; Lutz and Lutcavage, 1989; Lutcavage et al., 1995). Although disturbances may be temporary, long-term effects remain unknown, and chronically ingested oil may accumulate in organs. Direct contact with oil may harm developing turtle embryos. Exposure to hydrocarbons may be fatal, particularly to juvenile and hatchling sea turtles.

Oil can adhere to the body surface of marine turtles. Oil has been observed to cling to the nares, eyes, and upper esophagus, and to even seal the mouth (Witham, 1978; Overton et al., 1983; Van Vleet and Pauly, 1987; Gramentz, 1988; Lutcavage et al., 1995). Turtles may become entrapped by tar and oil slicks and rendered immobile (Witham, 1978; Plotkin and Amos, 1988; Gramentz, 1988). Periocular tissues and other mucous membranes would presumably be most sensitive to contact with hydrocarbons. Skin damage in turtles is in marked contrast to that observed in dolphins, where all structural and biochemical changes in the epidermis were minor and reversible. Changes in the skin are consistent with an acute, primary contact or irritant dermatitis. A break in the skin barrier could act as a portal of entry for pathogenic organisms, leading to infection, neoplastic conditions, and debilitation (Vargo et al., 1986).

Turtles surfacing in an oil spill will inhale oil vapors. Any interference with operation of the lungs would probably reduce a sea turtle's capacity for sustained activity (aerobic scope) and its dive time, both effects decreasing the turtle's chance of survival.

Lutcavage et al. (1995) found that operation of the salt gland in sea turtles was disrupted with exposure to hydrocarbons, but the disturbance did not appear until several days after exposure. The salt glands did recover function when tested after two weeks of recovery. Prolonged interference with salt gland functioning could have serious consequences since it would interfere with both water balance and ion regulation.

Studies on the effect of oil on digestive efficiency are underway, but Lutcavage et al. (1995) report finding oil in the feces of turtles that swallowed oil in experiments. Van Vleet and Pauly (1987) reported that oil ingested by turtles did not pass rapidly through the digestive tract but was retained within the system for a period of several days, thus increasing the likelihood that toxic components of oil could be assimilated by other internal organs and tissues of the turtle.

Significant changes in blood chemistry following contact with hydrocarbons have been reported (Lutcavage et al., 1995). Hematocrit and hemoglobin concentration decreased slightly during contact; these parameters are critical components of the blood's oxygen transport system. The most striking hematologic finding was an elevation of white blood cell count, which may indicate a "stress" reaction related to oil exposure and/or toxicity.

Eggs, hatchlings, and small juveniles are particularly vulnerable if contacted (Fritts and McGehee, 1982; Lutz and Lutcavage, 1989). Female sea turtles crawling through tar to lay eggs can transfer the tar to the nest; this was noted on St. Vincent NWR in 1994 (USDOI, FWS and USDOC NMFS, 1997). Potential toxic impacts to embryos will depend on the type of oil and degree of weathering, type of beach substrate, and especially upon the developmental stage of the embryo. Embryonic development in an egg may be altered or arrested by contact with oil (Fritts and McGehee, 1982). Fresh oil was found to be highly toxic, especially during the last quarter of the incubation period, whereas aged oil produced no detectable effects. Fritts and McGehee (1982) concluded that oil contamination of nesting beaches would have its greatest impact on nests that were already constructed; nests made on fouled beaches are less likely to be affected, if at all. However, residual oil and tarballs may be integrated into nests by nesting females. Residues may agglutinate sand grains where eggs are deposited, later impeding hatchlings from successfully evacuating nests and ultimately leading to their death. Hatchling and small juvenile turtles are particularly vulnerable to contacting or ingesting hydrocarbons because the currents that concentrate oil spills also form the debris mats in which young turtles are sometimes found (Carr, 1980; Collard and Ogren, 1990; Witherington, 1994). This would also be true for juvenile sea turtles that are sometimes found in floating mats of sargassum. Oil slicks, slicketts, or tarballs moving through offshore waters may foul sargassum mats that hatchling and juvenile sea turtles inhabit, which would conceivably result in the loss of sea turtle habitat or the "take" of sea turtles. The result of adult sea turtles feeding selectively in surface convergence lines could be prolonged contact with viscous weathered oil (Witham, 1978; Hall et al., 1983). High rates of oil contact in very young turtles suggest that bioaccumulation may occur over their potentially long lifespan. Exposure to hydrocarbons may begin as early as eggs are deposited in contaminated beach sand. A female coming ashore to nest might be fouled with oil or transport existing residues at the driftline to the nest. During nesting, she might push oil mixed with sand into the nest and contaminate the eggs (Chan and Liew, 1988). Assuming olfaction is critical to the process, oil fouling of a nesting area might disturb imprinting of hatchling turtles or confuse the turtles on their return migration after a 6- to 8-year absence (Geraci and St. Aubin, 1985; Chan and Liew, 1988).

Some captive turtles exposed to oil either reduced the amount of time spent at the surface, possibly avoiding the oil, or became agitated and had short submergence levels (Lutcavage et al., 1995). Sea turtles pursue and swallow tarballs, and there is no firm evidence that free-ranging turtles can detect and avoid oil (Odell and MacMurray, 1986). A loggerhead turtle sighted during an aerial survey in the Gulf of Mexico surfaced repeatedly within a surface oil slick for over an hour (Lohoefener et al., 1989). Oil might have a more indirect effect on the behavior of marine turtles. The effect on reproductive success could therefore be significant.

Contact with hydrocarbons may not cause direct or immediate death but cumulative sublethal effects, such as salt gland disruption or liver impairment, could impair the marine turtle's ability to function effectively in the marine environment (Vargo et al., 1986; Lutz and Lutcavage, 1989). Although many observed physiological insults are resolved in a 21-day recovery period, the impact of tissue oil intake on the long-term health and survival of sea turtles remains unknown (Lutcavage et al., 1995). There is evidence of bioacummulation in sea turtles exposed for longer periods of time. After the Gulf of Iraq war, a stranded green turtle did not appear to have contacted hydrocarbons, but upon necropsy, was found to have large amounts of oil in its liver and stomach tissues (Greenpeace, 1992).

A study of turtles collected during the *Ixtoc* spill determined that the three animals found dead had oil hydrocarbons in all tissues examined and that there was selective elimination of portions of this oil, indicating that exposure to the oil was chronic. The turtles evidently did not encounter the oil shortly before death but had been exposed to it for some time (Hall et al., 1983). The low metabolic rate of turtles may cause a limited capacity to metabolize hydrocarbons. Prolonged exposure to oil may have caused the poor body condition observed in the turtles, perhaps disrupting feeding activity. In such weakened condition, the turtles may have succumbed to some toxic component in the oil or some undiscovered agent.

The primary feeding grounds for adult Kemp's ridley turtles in the northern and southern Gulf of Mexico are near major areas of coastal and offshore oil exploration and production (USDOC, NMFS, 1992a). The nesting beach at Rancho Nuevo, Mexico, is also vulnerable and was indeed affected by the *Ixtoc* spill. The spill reached the nesting beach after the nesting season when adults had returned or were returning to their feeding grounds. It is unknown how adult turtles using the Bay of Campeche fared. It is possible that a high hatchling mortality occurred that year in the oceanic waters of the Gulf as a result of the floating oil.

Spill-Response Activities

In addition to the impacts from contact with hydrocarbons, spill-response activities could adversely affect sea turtle habitat and cause displacement from suitable habitat to inadequate areas. Impacting factors might include artificial lighting from night operations, booms, machine and human activity, equipment on beaches and in intertidal areas, sand removal and cleaning, and changed beach landscape and composition. Some of the resulting impacts from cleanup could include interrupted or deterred nesting behavior, crushed nests, entanglement in booms, and increased mortality of hatchlings due to predation during the increased time required to reach the water (Newell, 1995; Lutcavage et al., 1997). The damage assessment and restoration plan/environmental assessment for the August 1993 Tampa Bay oil spill also noted that hatchlings that were restrained during the spill response were released on beaches other than their natal beaches, thus potentially losing them from the local nesting population (FDEP et al., 1997). Additionally, turtle hatchlings and adults may become disoriented and normal behavior disrupted by human presence as well as industrial activity. Individual turtles covered with oil have been cleaned, rehabilitated, and released (e.g., FDEP et al., 1997). The strategy for cleanup operations should vary, depending on the season, recognizing that disturbance to the nest may be more detrimental than the oil (Fritts and McGehee, 1982). As mandated by OPA 90, seagrass beds and live-bottom communities are expected to receive individual consideration during spill cleanup. Required spill contingency plans include special notices to minimize adverse effects from vehicular traffic during cleanup activities and to maximize protection efforts to prevent contact of these areas with spilled oil. Loggerhead turtle nesting areas in the Chandeleur Islands, Cape Breton National Seashore, and central Gulf States would also be expected to receive special cleanup considerations under these regulations. Studies are completely lacking regarding the effects of dispersants and coagulants on sea turtles (Tucker and Associates, Inc., 1990).

Proposed Action Analysis

Since sea turtle habitat in the Gulf includes inshore, neritic, and oceanic waters, as well as numerous beaches in the region, sea turtles could be impacted by accidental spills resulting from operations associated with the proposed actions in the CPA and WPA. The potential causes, sizes, and probabilities of oil spills that could occur during drilling, production, and transportation operations associated with a proposed action are presented in Chapters 4.4.1 and 4.4.2. Table 4-47 lists the estimates for spill magnitude and abundance for Gulf coastal waters as a result of a proposed action. Analogous estimates of spill magnitude and abundance for Federal OCS waters as a result of a proposed action are given in Table 4-44. However, estimates of where these accidents occur relative to water depth are not presented. Qualitative inspection of spill data indicates that the following will likely be in each planning area: many, frequent, small spills; few, infrequent, moderate-sized spills; and a single, unlikely, large spill. Such spills are attributed to a proposed action. The assessment of spill frequency (i.e., frequent, infrequent, unlikely) is based relative to the 40-year life span of a proposed action.

Oil spills introduced specifically into coastal waters (as opposed to spills immigrating to coastal waters from offshore) as a result of a proposed action are assumed to encroach upon adjacent coastal lands. Spill estimates (Table 4-47) indicate that spills ≤1 bbl will introduce 20-40 bbl of oil into coastal waters of the WPA over the 40-year life span. Spills of >1 and <1,000 bbl of oil are expected to introduce about 200 bbl of oil in coastal waters of the WPA. A single spill ≥1,000 bbl of oil may occur in coastal waters of the WPA. The total volume of spilled oil introduced into coastal waters of the WPA ranges from 200 to 3,200 bbl.

Spill estimates indicate that between 40 and 95 spills of ≤1 bbl of oil will be introduced into coastal waters of the CPA (Table 4-47) over a 40-year period. An additional 300-1,400 bbl of oil are estimated to be spilled into coastal waters of the CPA from spills of >1 to <1,000 bbl. A total of 200-3,500 bbl of spilled oil is estimated for coastal waters of the CPA. Analysis of spill data also indicate that approximately 64 percent of coastal spills will occur in inland waters, 32 percent of coastal spills will occur in State offshore waters 0-3 mi from the coast, and 4 percent of coastal spills will occur in State offshore waters 3-12 mi from the coast (applicable to Texas).

The OSRA modeling results indicate that a large spill (≥1,000 bbl) occurring in Federal offshore waters stands a 5-8 percent probability of impacting Texas State waters, based on a proposed action for the WPA (Figure 4-19). Should a large oil spill occur as a result of a proposed action in the CPA, Texas coastal waters run a 1 percent risk of impact (Figure 4-19). Coastal waters of western and central Louisiana stand a 9-18 percent and 1-2 percent risk of impact from an OCS spill occurrence resulting from proposed actions in the CPA and WPA, respectively. There is a 2-4 percent spill risk to Louisiana coastal waters east of the mouth of the Mississippi River (CPA proposed action only). The OSRA model projected no large spills reaching coastal waters eastward of Louisiana as a result of either proposed actions (Figure 4-19).

In general terms, coastal waters of the planning areas are expected to be impacted by many, frequent, small spills (≤1 bbl); few, infrequent, moderately-sized spills (>1 bbl and <1,000 bbl); and a single, large (≥1,000 bbl) spill. Pipelines pose the greatest risk of a large spill occurring in coastal waters. Matagorda County, Texas, and Plaquemines Parish, Louisiana, are the most likely landfall locations in the two planning areas, where such a large spill might occur.

Because oil spills introduced specifically in coastal waters of Texas and Louisiana are assumed to impact adjacent lands, there is a likelihood that spilled oil will impact nesting beaches in these states. Nesting beaches along south Texas, such as the Padre Island National Seashore, are susceptible to such spills, thereby potentially impacting the recovery of Kemp's ridley, hawksbill, green, and loggerhead sea turtle populations in the Western Gulf. In Louisiana, loggerhead nesting beaches on the Chandeleur Islands are vulnerable to an oil spill originating in adjacent waters; however, these islands do not appear to have been used in the last several years because they suffered significant hurricane damage.

Depending on the timing of the spill's occurrence in coastal waters, its impact and resulting cleanup may interrupt sea turtle migration, feeding, mating, and/or nesting activity for extended periods (days, weeks, months). Spills originating in or migrating through coastal waters of Texas or Louisiana may impact any of the five sea turtle species inhabiting the Gulf. Kemp's ridley is the most endangered sea turtle species and is strongly associated with coastal waters of Texas and Louisiana. Also, green, hawksbill, loggerhead, and leatherback sea turtles use coastal waters of the Western Gulf and whose densities may be considerably greater during warmer months than those occurring offshore during the same period. Aside from the acute effects noted if sea turtles encounter an oil slick, the displacement of sea turtles to less suitable habitats from habitual feeding areas impacted by oil spills may increase vulnerability to predators, disease, or anthropogenic mortality. A high incidence of juvenile sea turtle foraging occurs along certain coastal regions of the Gulf Coast. Prime examples of known foraging areas for juvenile sea turtles in the Gulf are the Texas Laguna Madre, extending from the Texas-Mexico border to Mansfield Pass, Texas, for green turtles; and Sea Rim State Park, Texas, to Mermentau Pass, Louisiana, for Kemp's ridleys (Renaud, 2001). The interruption of mating and nesting activities for extended periods may influence the recovery of sea turtle populations. For example, a large oil spill could inhibit the mating or nesting activity of the Kemp's ridley sea turtle at Texas beaches by limiting the number of eggs being fertilized or the number of nests being constructed for one or more years.

Estimates from spill data show that Federal offshore waters will be subjected to many frequent small spills (≤1 bbl); few, infrequent, moderately-sized spills (>1 bbl and <1,000 bbl); and/or rare large spills (Table 4-44) as a result of the proposed actions. Spill estimates for the WPA indicate 300-600 bbl of oil will be introduced in offshore waters from small spills (≤1 bbl). An additional 796-952 bbl of oil will be spilled in quantities of a >1 to <1,000 bbl spill event. A single, large spill (≥1,000 bbl) is estimated to introduce approximately 4,600 bbl of oil. A single, but unlikely, spill may occur that introduces as much as 15,000 bbl of oil. The total volume of oil spilled in Federal offshore waters as a result of the four proposed actions in the WPA is estimated at 500-22,000 bbl of oil spread over the 40-year life span of the proposed actions.

Oil-spill data derived from historical trends estimate that a total volume of 1,000-23,000 bbl of oil will be introduced into Federal offshore waters over 40 years as a result of the proposed five lease sales in the CPA. Small spills (≤1 bbl) are projected to introduce 300-600 bbl of oil. Moderate-sized spills (>1 and <1,000 bbl), though occurring less frequently than smaller spills, will introduce an estimated 300-1,400 bbl of oil. A large spill (≥1,000 bbl) is assumed to introduce approximately 4,600 bbl of oil as a result of proposed actions in the CPA. There is a 34-63 percent chance that a single spill exceeding 1,000 bbl will occur. In the rare event that a spill exceeding 10,000 bbl should occur, it is estimated that approximately 15,000 bbl of oil will be spilled.

In neritic waters (<200 m), platforms pose the most likely source of small spills, whereas pipelines pose the most likely source of a large spill. The most likely sources of spills in oceanic and outer shelf waters are subsea blowouts or pipeline ruptures.

All neonate sea turtles undertake a passive voyage via oceanic waters following nest evacuation. Depending on the species and population, their voyage in oceanic waters may last 10 or more years. Beaches of the Caribbean Sea and Gulf of Mexico are used as nesting habitat, and hatchlings evacuating these nesting beaches emigrate to oceanic waters seaward of their nesting sites. Surface drifter card data (Lugo-Fernandez et al., 2001) indicate that circulation patterns in the Caribbean Sea and southern Gulf of Mexico may transport neonate and young juvenile sea turtles from these areas to oceanic waters off the coasts of Texas and Louisiana. Moreover, these journeys begin as pulsed events, with many hatchlings emerging and emigrating offshore at the same times. Oceanic OCS waters of the Gulf of Mexico are also inhabited by subadult and adult leatherback and loggerhead sea turtles; however, adults of any endemic sea turtle species may be found offshore. Consequently, intermediate to large spills occurring in these waters may impact multiple turtles, particularly neonate or young juvenile sea turtles associating with oceanic fronts or refuging in sargassum mats where oil slicks, decomposing residues, and tarballs are likely to accumulate. Large spills, particularly those flowing fresh hydrocarbons into oceanic and/or outer shelf waters for extended periods (days, weeks, months), pose an increased risk of impacting sea turtles inhabiting these waters. It is noteworthy that such an event may impact entire cohorts originating from nesting beaches in the Caribbean or southern Gulf, as well as those originating from Texas and Louisiana nesting beaches.

There is an extremely small probability that a single sea turtle will encounter an oil slick resulting from a single, small spill. Increasing the size of a slick or factoring in the number of estimated spills over 40 years increases the likelihood that an animal will encounter a single slick during the lifetime of an animal; many sea turtle species are long-live and may traverse throughout waters of the northern Gulf. The web of reasoning is incomplete without considering the abundance (stock or population) of each species inhabiting the Gulf. The likelihood that members of a sea turtle population (e.g., Kemp's ridley) may encounter an oil slick resulting from a single spill during a 40-year period is greater than that of a single individual encountering a slick during its lifetime. It is impossible to estimate precisely what sea turtle species, populations, or individuals will be impacted, to what magnitude, or in what numbers, since each species has unique distribution patterns in the Gulf and because of difficulties attributed to estimating when and where oil spills will occur over a 40-year period.

Given the distribution of available leases and pipelines associated with the proposed actions and the distribution of sea turtles in the northern Gulf of Mexico, the fate of an oil spill must be considered relative to the region and period of exposure. Spill estimates derived from data documenting historical trends of oil spills in coastal and offshore waters indicate that the proposed actions in the WPA and CPA may introduce 2,000-50,000 bbl of oil into Gulf offshore and coastal environments over 40 years. Spills of any size degrade water quality, and residuals become available for bioaccumulation within the food chain. Slicks may spread at the sea surface or may migrate underwater from the seafloor through the water column and never broach the sea surface. Regardless, a slick is an expanding, but aggregated mass of oil that, with time, will disperse into smaller units as it evaporates (if at the sea surface) and weathers. Chapter 4.4.1.1.5.4 details the persistence, spreading, and weathering process for offshore spills. As the slick breaks up into smaller units (e.g., slickets) and soluble components dissolve into the seawater, tarballs may remain within the water column. Tarballs may subsequently settle to the seafloor or attach to other particles or bodies in the sea. As residues of an oil spill disperse and commit to the physical environment (water, sediments, and particulates), sea turtles of any life history stage may be exposed via the waters that they drink and swim, as well as via the prey they consume. For example, tarballs may be consumed by sea turtles and by other marine organisms, and eventually bioaccumulate within sea turtles. Although sea turtles may (or may not) avoid oil spills or slicks, it is highly unlikely that they are capable of avoiding spill residuals in their environment. Consequently, the probability that a sea turtle is exposed to oil resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of sea turtles in the northern Gulf will be exposed to residuals of oils spilled as a result of the proposed actions during their lifetimes.

In general, on a yearly basis, about 1 percent of strandings identified by the U.S. Sea Turtle Stranding Network are associated with oil (e.g., Teas and Martinez, 1992). Turtles do not always avoid contact with oil (e.g., Lohoefener et al., 1989). Contact with petroleum and consumption of oil and oil-contaminated prey may seriously impact turtles; there is direct evidence that turtles have been seriously harmed by petroleum spills. Oil spills and residues have the potential to cause chronic (longer-term lethal or sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on turtles. Several mechanisms for long-term injury can be postulated: sublethal initial exposure to oil-causing pathological damage; continued exposure to hydrocarbons persisting in the environment, either directly or through ingestion of contaminated prey; and altered prey availability as a result of the spill.

Due to spill response and cleanup efforts, much of an oil spill may be recovered before it reaches the coast. However, cleanup efforts in offshore waters may result in additional harm or mortality of sea turtles, particularly to neonates and juveniles. Oil spills and spill-response activities at nesting beaches, such as beach sand removal and compaction, can negatively affect sea turtles. Although spill-response activities such as vehicular and vessel traffic during nesting season are assumed to affect sea turtle habitats, further harm may be limited because of efforts designed to prevent spilled oil from contacting these areas, as mandated by OPA 90. Increased human presence could influence turtle behavior and/or distribution, thereby stressing animals and making them more vulnerable to predators, the toxicological effects of oil, or other anthropogenic sources of mortality.

In the event of a blowout, the eruption of gases and fluids may generate significant pressure waves and noise that may harass, injure, or kill sea turtles, depending on their proximity to the accident. There are 1-2 blowouts projected to occur as a result of a proposed action in the WPA (Table 4-3). There are 2-4 blowouts projected to occur as a result of a proposed action in the CPA (Table 4-2).

Summary and Conclusion

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact small to large numbers of sea turtles in the Gulf of Mexico, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and date of accidents, and various meteorological and hydrological factors. Populations of sea turtles in the northern Gulf will be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes. Chronic or acute exposure may result in the harassment, harm, or mortality to sea turtles occurring in the northern Gulf. In most foreseeable cases, exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick will result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) to sea turtles. Sea turtles hatchlings exposed to and becoming fouled by or consuming tarballs persisting in the sea following the dispersal of an oil slick would likely result in their death.

4.4.3.7. Impacts on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

Direct contact with spilled oil can cause skin and eye irritation to endangered beach mice. Other direct toxic effects include asphyxiation from inhalation of fumes, oil ingestion, and food contamination. Indirect impacts from oil spills would include reduction of food supply, destruction of habitat, and fouling of nests. Impacts can also occur from spill-response activities. Vehicular traffic and other activities associated with oil-spill cleanup can degrade preferred habitat and cause displacement of mice from these areas.

The ranges of the four endangered subspecies of beach mice are shown in Figure 4-20. For a proposed action in the CPA or WPA, the probabilities were low (<0.5%) that one or more offshore spills ≥1,000 bbl would occur and contact the shoreline inhabited by the Alabama, Choctawhatchee, St. Andrews, and Perdido Key beach mice during the life of a proposed action (2003-2042).

There is no definitive information on the persistence of oil, in the event a spill were to contact beach mouse habitat. In Prince William Sound, Alaska, after the *Exxon Valdez* spill in 1989, buried oil is being measured in the intertidal zone of beaches, but no effort has been made to search for residual buried oil above high tide. Similarly, NRC (1985) makes no mention of studies of oil left above high tide after a spill. Regardless of the potential persistence of oil in beach mouse habitat, a slick cannot wash above high tide, over the foredunes, and into the preferred habitat of the endangered beach mice unless the oil is carried by a heavy storm swell.

Summary and Conclusion

Given the low probability of a major (≥1,000 bbl) spill occurring and the necessity of coincident storm surge for oil to reach beach mouse habitat and contact the beach mice, no direct impacts of oil spills on beach mice from a proposed action are anticipated. Protective measures required under the Endangered Species Act should prevent any oil-spill response and clean-up activities from having significant impact to the beach mice and their habitat.

4.4.3.8. Impacts on Coastal and Marine Birds

Oil Spills

Oil spills pose the greatest potential impact to coastal and marine birds. Pneumonia is not uncommon in oiled birds and can occur when birds, attempting to clean their feathers through preening, inhale droplets of oil. Exposure to oil can cause severe and fatal kidney damage (reviewed by Frink, 1994). Ingestion of oils might reduce the function of the immune system and, thus, reduce resistance to infectious diseases (Leighton, 1990). Ingested oil may cause toxic destruction of red blood cells and varying degrees of anemia (Leighton, 1990). Stress and shock enhance the effects of exposure and poisoning. The pathological conditions noted in autopsies may be directly caused by petroleum hydrocarbons or may be a final effect in a chain of events with oil as the initial cause and generalized stress as an intermediate cause (Clark, 1984). Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration.

If physical oiling of individuals or local groups of birds occurs, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected. Small coastal spills, pipeline spills, and spills resulting from accidents in navigation waterways can contact and affect many of the different groups of coastal and marine birds, most commonly marsh birds, waders, waterfowl, and certain shorebirds. Some deaths from these groups are to be expected. Raptors, such as the bald eagle and peregrine falcon, feed upon weakened or dead birds (and fish, in the case of the eagle) and as a result may become physically oiled or affected by the ingestion of the oiled prey. Pelicans are active swimmers and plunge dive for prey. They are therefore susceptible to both physical oiling and secondary effects via ingestion of oiled prey (i.e., fish). Plovers congregate and feed along tidally exposed banks and shorelines, following the tide out and foraging at the water's edge. They have short stout bills and chase mobile prey rather than probing into the sediment with long slender bills like many birds of the sandpiper family. Plovers can physically oil themselves while foraging on oiled shores or secondarily contaminate themselves through ingestion of oiled intertidal sediments and prey. Oil will reach the intertidal beach feeding areas before it will contact nests on the fore dunes. The least tern captures fish by means of shallow splash diving and surface dipping techniques. Some physical oiling could occur during these dives, as well as secondary toxic effects through the uptake of prey. It is possible that some death of endangered/threatened (as well as nonendangered and nonthreatened) species could occur, especially if spills occur during winter months when raptors and plovers are most common along the coastal Gulf or if spills contact preferred or critical habitat. Recruitment through successful reproduction is expected to take several years, depending upon the species and existing conditions.

Direct oiling of wading birds, including some long-legged shorebirds, is usually minor because they will only be contaminated by a slick on the sea surface, which may contact the birds' legs, necks, bills, and heads, but little else, when they are feeding through the slick. Many of these birds are merely stained as a result of their foraging behaviors (Vermeer and Vermeer, 1975). Redwing blackbirds depend on stiff cattails to support their nests, so injury to such plants could result in reproductive failure. Birds can ingest oil when feeding on contaminated food items or drinking contaminated water. Oil contamination will affect prey upon which birds depend. Prey populations after the *Arthur Kill* spill (January 1990, south coast of New York) had not returned to normal a year after the spill.

Geese and herbivorous ducks feed at a lower trophic level than the other species of waterbirds and may not suffer damaging effects when oil is biomagnified, or at least not to the same degree (Maccarone and Brzorad, 1994). They still may encounter lower food availability, owing to the localized destruction of aquatic vegetation. Birds, such as ibises, that sift through mud and other sediments for small invertebrates may be exposed to high toxin levels in the invertebrates (Maccarone and Brzorad, 1994). Chapman (1981) noted that oil on the beach from the 1979 *Ixtoc* spill caused habitat shifts by the birds. Many birds had to feed in less productive feeding habitats. Similar observations were made for wading birds after the *Arthur Kill* spill (Maccarone and Brzorad, 1995). Composition of prey populations changed after the spill. Shoreline vegetation may die after prolonged exposure to water contaminated with oil. Lush vegetation helps to conceal sparsely placed nests and their contents from potential predators. With destruction of vegetation, aerial predators may have easier access to eggs and chicks (Maccarone and Brzorad, 1994). Many species have inherently low reproductive potential, slowing recovery from impacts.

A population that endures oil-spill impacts may have the disadvantage of a long-flying distance to habitat of neighboring colonies. Otherwise, neighboring colonies' habitat could provide refuge for a bird population fleeing impacts and be a source of recruitment to a population recovering from impacts (Cairns and Elliot, 1987; Trivelpiece et al., 1986; Samuels and Ladino, 1983/1984). In that case, population recovery following destruction of a local breeding colony or a large group of wintering migrants would likely occur within 1-2 yearly breeding cycles. For many coastal and marine species, spills may delay the maturation and reproduction process in juveniles, and this could cause a decrease in reproductive success for at least one season (Butler et al., 1988). Disruption of pair bonds and altered cycles of reproductive hormones might also affect reproductive success for one breeding season (Leighton, 1990).

Oil-Spill Response and Cleanup Activities

Oil-spill cleanup methods often require heavy trafficking of beaches and wetland areas, application of oil dispersants and bioremediation chemicals, and the distribution and collection of oil containment booms and absorbent material. The presence of humans, along with boats, aircraft, and other technological creations, will also disturb coastal birds after a spill. Investigations have shown that oil-dispersant mixtures pose a threat like that of oil to successful reproduction in birds (Albers, 1979; Albers and Gay, 1982). The external exposure of adult birds to oil/dispersant emulsions may reduce chick survival more than exposure to oil alone would; however, successful dispersal of a spill will generally reduce the probability of exposure of coastal and marine birds to oil (Butler et al., 1988). It is possible that changes in size of an established breeding population may also be a result of disturbance in the form of personnel for shoreline cleanup, monitoring efforts, or the intensified research activity after oil spills (Maccarone and Brzorad, 1994). Studies are indicating that rescue and cleaning of oiled birds makes no effective contribution to conservation, except conceivably for species with a small world population (Clark, 1978 and 1984). A growing number of studies indicate that current rehabilitation techniques are not effective in returning healthy birds to the wild (Anderson et al., 1996; Boersma, 1995; Sharp, 1995 and 1996). Preventative methods, such as scaring birds from the path of an approaching oil slick or the use of booms to protect sensitive colonies in an emergency, are also not effective (Clark, 1984).

Summary and Conclusion

Oil spills from a proposed action pose the greatest potential direct and indirect impacts to coastal and marine birds. Birds that are heavily oiled are usually killed. If physical oiling of individuals or local groups of birds occurs, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected. Small coastal spills, pipeline spills, and spills from accidents in navigated waterways can contact and affect the different groups of coastal and marine birds, most commonly marsh birds, waders, waterfowl, and certain shorebirds. Lightly oiled birds can sustain tissue and organ damage from oil ingested during feeding and grooming or from oil that is inhaled. Stress and shock enhance the effects of exposure and poisoning. Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration. Reproductive success can be affected by the toxins in oil. Indirect effects occur by fouling of nesting habitat, and displacement of individuals, breeding pairs, or populations to less favorable habitats.

Dispersants used in spill cleanup activity can have toxic effects similar to oil on the reproductive success of coastal and marine birds. The, air, vehicle, and foot traffic that takes place during shoreline clean up activity can disturb nesting populations and degrade or destroy habitat.

4.4.3.9. Impacts on the Gulf Sturgeon

Existing occurrences of Gulf sturgeon in 1996 extended from the Mississippi River to Charlotte Harbor in western Florida (Patrick, personal communication, 1996). Oil spills are the OCS-related factor most likely to impact the Gulf sturgeon. Oil can affect Gulf sturgeon by direct ingestion or ingestion of oiled prey or by the absorption of dissolved petroleum products through the gills. Upon any exposure to spilled oil, liver enzymes of adult fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies et al., 1982). Contact with or ingestion/absorption of spilled oil by adult Gulf sturgeon could result in mortality or sublethal physiological impact, especially irritation of gill epithelium and disturbance of liver function. Behavior studies of other fish species suggest that adult sturgeon are likely to actively avoid an oil spill, thereby limiting the effects and lessening the extent of damage (Baker et al., 1991; Malins et al., 1982). Linden et al. (1979) note that early life stages of fish are very sensitive to the toxic effects of hydrocarbons. Fish eggs and larvae, with their limited physiology and mobility, are killed when contacted by oil (Longwell, 1977). As Gulf sturgeon deposit their eggs at the bottom of deep holes, the eggs and larvae are unlikely to come into contact with surface oil.

Chapter 4.4.1 discusses the risk of oil spills that could occur as a result of a proposed action in the CPA and WPA. Chapter 4.4.1.1.1.8 discusses the probability of occurrence and contact between a proposed-action-related spill and the coastal area known to be inhabited by the Gulf sturgeon. This analysis concluded that there is a very low risk of interaction between coastal waters inhabited by Gulf sturgeon and spills from proposed action accidents, few if any adult Gulf sturgeon are expected to be impacted by these spills.

Summary and Conclusion

The Gulf sturgeon could be impacted by oil spills resulting from a proposed action. Contact with spilled oil could cause irritation of gill epithelium and disturbance of liver function in Gulf sturgeon. The likelihood of spill occurrence and contact to the Gulf sturgeon as a result of a proposed action is very low.

4.4.3.10. Impacts on Fish Resources, Essential Fish Habitat, and Commercial Fisheries

Accidental events that could impact fish resources, essential fish habitat (EFH), and commercial fisheries include blowouts and oil or chemical spills. Due to the close association between discussions and proposed action analyses, the previously separate treatment of commercial fisheries has been combined in this single section. Impacts from other than accidental sources are discussed in Chapters 4.2.1.10 for the CPA and 4.3.1.8 for the WPA.

Blowouts

Subsurface blowouts have the potential to adversely affect fish resources and commercial fishing. A blowout at the seafloor could create a crater, and resuspend and disburse large quantities of bottom sediments within a 300-m radius from the blowout site, potentially affecting a limited number of fish in the immediate area. A blowout event, though highly unlikely, could cause damage to the nearby bottom and render the affected area closed to bottom fisheries, such as bottom longlining for tilefish or grouper, for some period of time. The majority of mobile fish taxa would be expected to leave the area (and not reenter) of a blowout before being impacted by the localized area of resuspended sediments. Blowouts may possibly result in the spillage of liquid hydrocarbons, but there have been no blowouts involving more than 500 bbl of spilled hydrocarbons since 1971 and they are not projected to occur during the period of a proposed action.

Resuspended sediments may clog gill epithelia of both finfish and shellfish with resultant smothering. Settlement of resuspended sediments may directly smother invertebrates or cover burrows of commercially important shellfish. However, sandy sediments are quickly redeposited within 400 m (1,312 ft) of the blowout site. Finer sediments are widely dispersed and redeposited over a period of hours to days within a few thousand meters depending on the particle size. Only gas-well blowouts are analyzed in this EIS. They are less of an environmental risk, resulting in resuspended sediments and increased levels of natural gas for a few days very near the source of the blowout. Loss of gas-well control does not release liquid hydrocarbons into the water. Natural gas consists mainly of methane, which rapidly disperses upward into the air (Van Buuren, 1984).

Spills

The risk of oil spills from a proposed action is discussed in Chapter 4.4.1.1; their characteristics, sizes, frequency, and fate are summarized in this chapter. Chapter 4.4.1.1.8 provides an analysis of the risk of fish being exposed to oil spills that could result from proposed action accidents. Spills that may occur as a result of a proposed action have the potential to affect fish resources, EFH, and commercial fishing in the Gulf. The toxicity of an oil spill depends on the concentration of the hydrocarbon components exposed to the organisms (in this case fish or “shellfish”) and the variation of the sensitivity of the species considered. The geographic range of the pollutant effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question. In this case, hydrocarbons are the primary pollutants of concern. The effects on and the extent of damage to fisheries resources and Gulf commercial fisheries from a petroleum spill are restricted by time and location. The impacts discussed in this EIS can be estimated from examinations of recent spills such as the *North Cape* (Rhode Island, 1996), *Breton Point* (Rhode Island, 1989), *Sea Empress* (United Kingdom, 1996), and *Exxon Valdez* (Alaska, 1989) (Brannon et al., 1995; Maki et al., 1995; Mooney, 1996; Pearson et al., 1995). The amount of oil spilled by each event and its estimated impact to fishing practices, fish resources, and fisheries economics can be used as a guideline to estimate the impacts on fisheries.

The direct effects of spilled petroleum on fish occur through the ingestion of hydrocarbons or contaminated prey, through the uptake of dissolved petroleum products through the gills and epithelium by adults and juveniles, and through the death of eggs and decreased survival of larvae (NRC, 1985). Adult fish must experience continual exposure to relatively high levels of hydrocarbons over several months before secondary toxicological compounds that represent biological harm are detected in the liver (Payne et al., 1988). Upon exposure to spilled petroleum, liver enzymes of fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies et al., 1982). Ordinary environmental stresses may increase the sensitivity of fish to petroleum toxicity. These stresses may include changes in salinity, temperature, and food abundance (Evans and Rice, 1974; NRC, 1985).

When contacted by spilled hydrocarbon, floating eggs and larvae, with their limited mobility and physiology, and most juvenile fish are killed (Linden et al., 1979; Longwell, 1977). Large numbers of fish eggs and larvae have been killed by oil spills. Sublethal effects on larvae, including genotoxic damage have been documented from sites oiled from the *Exxon Valdez* (DeMarty et al., 1997). Hose and Brown (1998) also detected genetic damage in Pacific herring from sites within the oil trajectory of the *Exxon Valdez* spill two months after the spill with decreasing rates of genotoxicity for two additional months after the spill. No detectable genotoxicity was detectable from sampling conducted two years following the spill. Mortality rates for pink salmon embryos were found to be significantly higher than controls at exposure levels of 1 ppb total polycyclic aromatic hydrocarbons (PAH) concentration (Heintz, 1999). Fish over-produce eggs on an enormous scale and the overwhelming majority of them die at an early stage, generally as food for predators. Even a heavy death toll of eggs and larvae from an oil spill may have no detectable effect on the adult populations exploited by commercial fisheries. This has been confirmed during and after the *Torrey Canyon* spill off southwest England and the *Argo Merchant* spill off Nantucket. In both cases, a 90 percent death of fish eggs and larvae of pilchard and pollack, respectively, was observed in the affected area, but this had no impact on the regional commercial fishery (Baker et al., 1991).

Adult fish are likely to actively avoid a spill, thereby limiting the effects and lessening the extent of damage (Baker et al., 1991; Malins et al., 1982; Maki et al., 1995). Observations at oil spills around the world, including the *Exxon Valdez* spill in Prince William Sound, consistently indicate that free-swimming fish are rarely at risk from oil spills (Lancaster et al., 1999; Squire, 1992). Fish swim away from spilled oil, and this behavior explains why there has never been a commercially important fish-kill on record following an oil spill. Modeling of impacts for the *North Cape* spill is an exception (French, 1998). The impact modeling for this heating oil spill off Rhode Island in 1996 included theoretical moralities of adult fish, but the model does not consider any avoidance of the spill area and mortality estimates were based on normal populations found in the area from previous trawling databases. (The *North Cape* spill was also unusual due to conditions that caused heavy entrainment of pollutants from large-wave turbulence, and hydrocarbons were retained in shallow water for many days due to tidal currents). Some recent work has demonstrated avoidance of extremely small concentrations of hydrocarbons. Farr et al. (1995) reported the behavioral avoidance of dissolved concentrations of a PAH as low as 14.7 μg/l by a species of minnow.

The only substantial adult fish-kill on record following an oil spill was on the French coast when several tons of small rock-clinging fish (not commercially harvested) were killed at the site of the *Amoco Cadiz* wreck. In addition, some concerns about the impact of spilled oil on the breeding cycle of commercial fishery resources have proved to be unfounded (Baker et al., 1991). Some recent work has reported potential sublethal impacts including the expression of subclinical viral infection correlated to experimental exposure of adult Pacific herring exposed to weathered crude oil (Carls et al., 1998).

Spills that contact coastal bays, estuaries, and waters of the OCS when pelagic eggs and larvae are present have the greatest potential to affect commercial fishery resources. For eggs and larvae contacted by a spill, the effect is expected to be lethal. Migratory species, such as mackerel, cobia, and crevalle, could be impacted if a spill contacts nearshore open waters. A spill contacting a low-energy inshore area would affect localized populations of commercial fishery resources, such as menhaden, shrimp, and blue crabs. The nearshore fishery was closed for approximately nine weeks in the case of the *North Cape* spill where dispersal of spilled oil away from shallow water was very slow. Chronic petroleum contamination in an inshore area would affect all life stages of a localized population of a sessile fishery resource such as oysters. Nonmotile shellfish (e.g., oysters) would not be able to avoid a spill but could shut down filtering for some period of time, depending on the water temperature and other environmental conditions.

For OCS-related spills to have an effect on an offshore commercial fishery resource, whether estuary dependent or not, eggs and larvae would have to be abnormally concentrated in the immediate spill area (Pearson et al., 1995). Hydrocarbon components also would have to be present in highly toxic concentrations when both eggs and larvae are in the pelagic stage (Longwell, 1977). Pearson et al. (1999) analyzed hypotheses of why the Pacific herring fisheries in Prince William Sound collapsed in 1993 and 1994, three years after the *Exxon Valdez* oil spill. A number of factors analyzed indicated that the 1989 oil spill did not contribute to the 1993 decline including the record high levels of harvests of Prince

William Sound herring in the years immediately following the oil spill, the lack of change from the expected age-class distribution, and the low level of oil exposure documented for the herring in 1989. Some reports indicate the impact of exposure of fish fry is limited. Birtwell et al. (1999) reported that exposure of populations of pink salmon fry to the aromatic hydrocarbon, water-soluble fraction of crude oil for 10 days and released to the Pacific Ocean did not result in a detectable effect on their survivability to maturity. There is no evidence at this time that commercial fisheries in the Gulf have been adversely affected on a regional population level by spills or chronic contamination.

Development abnormalities in juveniles occur naturally in wild fish populations, and the frequency of these abnormalities is increased in populations chronically exposed to petroleum. These abnormal fish do not survive long. Such delayed death is likely to have a negligible impact on commercial fisheries, as are the immediate deaths following a petroleum spill (Pearson et al., 1995).

If chemical spills occur, they will likely occur at the surface and most will rapidly dilute, affecting a small number of fish in a highly localized environment. Many of the chemical products that may be used offshore, such as methanol or hydrochloric acid, would chemically burn all exposed surfaces of fish that come in contact. The concentration of the chemical and the duration of exposure determines the extent of the chemical burn. Rapid dilution in seawater will limit the effects, and the impacts should be inconsequential. Other compounds such as zinc bromide will not readily dilute in seawater and will likely form slowly dissolving piles on the seafloor. Although these compounds may be toxic, mobile fishes will avoid them as they do oil spills. Nonmotile fish and slow-moving invertebrates could be killed. The areal extent of the impacts will be highly localized and the impacts should be inconsequential.

Proposed Action Analysis

Healthy fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Due to the wide variation of habitat requirements for all life history stages (as described in Chapter 3.2.9) for species in the WPA and CPA region, EFH for the Gulf of Mexico includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ). The effect of accidental events from a proposed action on coastal wetlands and coastal water quality is analyzed in Chapters 4.4.3.1.2 and 4.4.3.3.1, respectively.

Loss of well control and resultant blowouts seldom occur on the Gulf OCS. The potential causes and probabilities of blowouts are discussed in Chapter 4.4.1.2. A blowout with hydrocarbon release is not expected to occur. The few blowouts that could occur in the CPA or WPA as part of a proposed action would cause limited impacts to localized areas. Given the exposure of the area to high levels of suspended sediments in the CPA and WPA, and the low probability that a large blowout would occur, blowouts are not expected to significantly affect future water quality (EFH).

The potential causes, sizes, and probabilities of petroleum spills that could occur during activities associated with a proposed action are discussed in Chapter 4.4.1.1 and are listed in Table 4-44 for offshore spills and Table 4-47 for coastal spills. Information on spill response and cleanup is contained in Chapter 4.4.2.

There is a small risk of spills occurring during shore-based support activities (Chapter 4.4.1.1.7). Table 4-44 provides estimates of the number and size of spills projected to occur as a result of proposed CPA or WPA lease sale support activities in coastal waters. The great majority of these will be very small. Most of these incidents would occur at or near shore bases and are expected to affect a highly localized area with low-level impacts. Due to spill response and cleanup efforts, most of the inland spill would be recovered and what is not recovered would affect a very small area and dissipate rapidly.

The analysis of offshore spills occurring in the CPA or WPA combines both the percent chance (risk) a spill will occur with the probability the resulting spill will be transported by winds and currents to specific resources. Offshore spills <1,000 bbl estimated to occur as a result of a proposed action are not expected to reach a shoreline and impact important estuary EFH or other nearshore fishery habitat. Spills that contact coastal bays and estuaries in Texas or Louisiana would have the greatest potential to affect fish resources. The risk from a spill $\geq$1,000 bbl occurring and reaching shoreline areas of specific counties (or parishes) is presented in Figure 4-13. The risk and transport probability values for contact of a spill $\geq$1,000 bbl on Texas county or Louisiana parish shorelines with significant estuary resources are all small (including Matagorda, Brazoria, and Galveston Counties; and Lafourche, Jefferson, and Plaquemines Parishes), ranging from <0.5 to 8 percent.

The risk of a spill ≥1,000 bbl occurring, combined with transport probability for contact with the Flower Garden Banks, an EFH Habitat Area of Particular Concern (HAPC), ranges from <0.5 to 4 percent; however, the shallowest portion of the Flower Garden Banks is 18 m, and no measurable concentrations of hydrocarbon contaminants is expected to reach these depths (Chapter 4.4.1.1.8). The biological resources of other hard/live bottoms in the Gulf of Mexico (EFH) would remain unharmed as spilled substances could, at the most, reach the seafloor in minute concentrations (see also Chapter 4.4.3.2.1). These minute quantities may cause very short-term sublethal effects (changes in physiology) in benthic organisms that will recover quickly. It is also assumed that a petroleum spill will occasionally contact and affect nearshore and coastal areas of migratory Gulf fisheries. These species are highly migratory and will actively avoid the spill area.

The effect of petroleum spills on fish resources as a result of a proposed action is expected to cause less than a 1 percent decrease in fish resources or standing stocks of any population. At the expected level of impact, the resultant influence on fish populations within or in the general vicinity of the proposed CPA or WPA lease sale areas would be negligible and indistinguishable from natural population variations.

Commercial fishermen will actively avoid the area of a blowout or spill. Even if fish resources successfully avoid spills, tainting (oily-tasting fish), public perception of tainting, or the potential of tainting commercial catches will prevent fishermen (either voluntarily or imposed by regulation) from initiating activities in the spill area. This, in turn, could decrease landings and/or the value of catch for several months. However, Gulf of Mexico species can be found in many adjacent locations. Gulf commercial fishermen do not fish in one locale and have responded to past petroleum spills, such as that in Lake Barre in Louisiana, without discernible loss of catch or income by moving elsewhere for a few months. In the case of a blowout, it is unlikely that commercial fishermen will actively avoid areas of increased turbidity since many areas that receive heavy fishing pressure in the Gulf are highly turbid.

Summary and Conclusion

Accidental events resulting from oil and gas development in CPA and WPA lease sale areas of the Gulf of Mexico have the potential to cause some detrimental effects on fisheries and fishing practices. It is expected that subsurface blowouts that may occur as a result of a proposed action would have a negligible effect on Gulf fish resources or commercial fishing. If spills due to a proposed action were to occur in open waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be sublethal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. The effect of proposed-action-related oil spills on fish resources and commercial fishing is expected to cause less than a 1 percent decrease in standing stocks of any population, commercial fishing efforts, landings, or value of those landings. Any affected commercial fishing activity will recover within 6 months. At the expected level of impact, the resultant influence on fish populations and commercial fishing activities within the CPA or WPA lease sale areas would be negligible and indistinguishable from variations due to natural causes.

It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH; however, wetland loss could occur due to a petroleum spill contacting inland areas.

4.4.3.11. Impacts on Commercial Fisheries

This section was combined with the above section on fish resources and essential fish habitats.

4.4.3.12. Impacts on Recreational Beaches

Oil spills can be associated with the exploration, production, or transportation phases of OCS operations. Major oil spills contacting recreational beaches can cause short-term displacement of recreational activity from the areas directly affected, including the closure of beaches for periods of 2-6 weeks or until the cleanup operations are complete. A large oil spill resulting from the proposed actions would acutely threaten recreational beaches for up to 30 days. The risk of a spill occurring and contacting recreational beaches is described under Chapter 4.4.1.1.8. Natural processes such as weathering and dispersion and human efforts to contain and remove the spill would significantly change the nature and form of the oil. Factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, cleanup methods (if any), and publicity can have a bearing on the severity of effects on a recreational beach and its use.The primary impact-producing factors associated with offshore oil and gas exploration and development, and most widely recognized as major threats to the enjoyment and use of recreational beaches, are oil spills and offshore trash, debris, and tar. All of the respondents from a total of 39 semi-structured discussions conducted from March through May 1997 for the MMS study, "Socioeconomic and Environmental Issues Analysis of Oil and Gas Activity on the Outer Continental Shelf of the Western Gulf of Mexico," recognized environmental threats posed by the nature and specific operations of the industry (Kelley, in press). Most respondents to the study believed that a major oil spill would have devastating effects on the tourist industry. While "small" spills were deemed to occur with some frequency, it is "the big one" that people fear most. Offshore trash and tar is often noted as the second biggest threat to the conditions of the beaches in the Gulf of Mexico coastal region. Additional factors such as the physical presence of platforms and drilling rigs can affect the aesthetics of beach appreciation. Soil contamination and air and water pollution created by the refining of oil and the production of petrochemical products are other areas of concern.

Section 4.4.1 discusses the risk of spill occurrence, the number of spills estimated for the OCS Program, and the likelihood of an OCS-spill contacting the Gulf Coast. The scenarios analyzed are hypothetical oil spills of 4,600 bbl and >10,000 bbl occurring from future OCS oil and gas operations in the Gulf of Mexico. Should such a spill contact a recreational beach, short-term displacement of recreational activity from the areas directly affected would occur. Beaches directly impacted would be expected to close for periods of 2-6 weeks or until the cleanup operations were complete. Should a spill occur, factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, and cleanup methods would have a bearing on the severity of effects the spill would have on a recreational beach and its use. Sorenson (1990) reviewed the economic effects of several historic major oil spills on beaches and concluded that a spill near a coastal recreational area would reduce visitation in the area by 5-15 percent over one season but would have no long-term effect on tourism.

Tarballs (the floating residue remaining after an oil slick dissipates) are likely results from a large spill. Tarballs are known to persist as long as 1-2 years in the marine environment. An MMS-funded study investigated the abundance and sources of tarballs on the recreational beaches of the CPA (Henry et al., 1993). The study concluded that the presence of tarballs along the Louisiana coastline is primarily related to marine transportation activities and that their effect on recreational use is below the level of social and economic concern.

Summary and Conclusion

It is unlikely that a spill would be a major threat to recreational beaches because any impacts would be short-term and localized. Should a spill contact a recreational beach, short-term displacement of recreational activity from the areas directly affected would occur. Beaches directly impacted would be expected to close for periods of 2-6 weeks or until the cleanup operations were complete. Should a spill result in a large volume of oil contacting a beach or a large recreational area being contacted by an oil slick, visitation to the area could be reduced by as much as 5-15 percent for as long as one season, but such an event should have no long-term effect on tourism.

Tarballs can lessen the enjoyment of the recreational beaches but should have no long-term effect on the overall use of beaches.

4.4.3.13. Impacts on Archaeological Resources

Spills, collisions, and blowouts are accidental events that can happen in association with oil and gas operations. If an accidental event occurs as a result of one of these events, there could be an impact to archaeological resources. Oil spills have the potential to affect both prehistoric and historic archaeological resources. Impacts to historic resources would be limited to visual impacts and, possibly, physical impacts associated with spill cleanup operations. Impacts to prehistoric archaeological sites would be the result of hydrocarbon contamination of organic materials, which have the potential to date site occupation through radiocarbon dating techniques, as well as possible physical disturbance associated with spill cleanup operations.

4.4.3.13.1. Historic Archaeological Resources

The risk of contact to archaeological resources from oil spills associated with proposed action operations is described in Chapter 4.4.1.1. Should an oil spill contact a coastal historic site, such as a fort or a lighthouse, the major impact would be a visual impact from oil contact and contamination of the site and its environment. Impacts to coastal historic sites are expected to be temporary and reversible. Should such an oil spill contact an onshore historic site, the effects would be temporary and reversible.

Oil released subsea as a result of a blowout or pipeline incident would not be expected to contact an offshore sunken historic resource such as a shipwreck.

Summary and Conclusion

Impact to a historic archaeological resource could occur as a result of an accidental spill. As indicated in Chapter 4.4.1.1, it is not very likely that an oil spill will occur and contact coastal historic archaeological sites from accidental events associated with a proposed action in the WPA or CPA. The major effect from an oil-spill impact would be visual contamination of a historic coastal site, such as a historic fort or lighthouse. As historic archaeological sites are protected under law, it is expected that any spill cleanup operations would be conducted in such a way as to cause little or no impacts to historic archaeological resources. These impacts would be temporary and reversible.

4.4.3.13.2. Prehistoric Archaeological Resources

Prehistoric archaeological sites on barrier islands and along beaches may be damaged by oil spilled as the result of an accidental event. The risk of oil spills occurring and contacting coastal areas is described in Chapter 4.4.1.1. Direct physical contact of spilled oil with a prehistoric site could coat fragile artifacts or site features with oil. The potential for radiocarbon dating organic materials in the site also could be adversely affected. Ceramic or lithic seriation or other relative dating techniques might ameliorate this loss of information. It is also sometimes possible to decontaminate an oiled sample for radiocarbon dating. Recent investigations into archaeological damage associated with the *Exxon Valdez* oil spill in the Gulf of Alaska revealed that oil did not penetrate the subsoil or into wooden artifacts in the intertidal zone, apparently because of hydrostatic pressure (*Federal Archaeology*, 1994).

Coastal prehistoric sites could experience an impact from oil-spill cleanup operations, including possible site looting from oil spill cleanup crews. Cleanup equipment could destroy fragile artifacts and disturb the provenience of artifacts and site features. Some of the coastal prehistoric sites that might be impacted by beach cleanup operations may contain unique and significant scientific information. In Louisiana, Mississippi, and Alabama, prehistoric sites occur frequently along the barrier islands and mainland coast and along the margins of bays and bayous. Paleo-Indian artifacts have been recovered from barrier islands offshore Mississippi (McGahey, personal communication, 1996). Should an oil spill contact a coastal prehistoric site, there could be a loss of significant archaeological information on the prehistory of North America and the Gulf Coast region.

Summary and Conclusion

Accidental events producing oil spills may threaten the prehistoric archaeological resources of the Gulf Coast. Impacts to prehistoric sites could occur as a result of an oil spill. Should a spill contact an archaeological site, damage might include loss of radiocarbon-dating potential, direct impact from oil-spill cleanup equipment, and/or looting. Previously unrecorded sites could be impacted by oil-spill cleanup operations on beaches.

As indicated in Chapter 4.4.1.1, it is not very likely for an oil spill to occur and contact coastal and barrier island prehistoric sites as a result of a proposed action in the WPA or CPA. The proposed actions are not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost and this impact would be irreversible.

4.4.3.14. Impacts on Human Resources and Land Use

4.4.3.14.1. Land Use and Coastal Infrastructure

Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on land use. Coastal or nearshore spills could have short-term adverse effects on coastal infrastructure requiring clean up of any oil or chemicals spilled.

4.4.3.14.2. Demographics

Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on the demographic characteristics of the Gulf coastal communities.

4.4.3.14.3. Economic Factors

The resource costs of cleaning up an oil spill, either onshore or offshore, were not included in the economic analyses for a proposed action in the CPA (Chapter 4.2) and WPA (Chapter 4.3) for two reasons. First, the potential impact of oil-spill cleanup activities is a reflection of the spill's opportunity cost. The cleanup and remediation of an oil spill involves the expenditure of millions of dollars and the creation of hundreds of jobs. While such expenditures are revenues to business and employment/revenues to individuals, the cost of responding to a spill is not a benefit to society and is a deduction from any comprehensive measure of economic output. An oil spill's opportunity cost has two generic components: cost and lost opportunity. Cost is the value of goods and services that could have been produced with the resources used to cleanup and remediate the spill if the resources had been able to be used for production or consumption. The second is the value of the opportunities lost or precluded to produce (e.g., harvest oysters) or consume (e.g., recreational/tourism activities) (Pulsipher et al., 1999). The second reason for excluding the costs of cleaning up an oil-spill from the proposed action economic analyses is that the occurrence of a spill is not a certainty. Spills are random accidental events. Even if a proposed CPA or WPA lease sale was held, leases let, and oil and gas produced, the timing, numbers, sizes, offshore locations of occurrence, and onshore locations of contact of potential spills occurring over the life of a proposed action are all unknown variables. Additionally, the cost involved in any given cleanup effort is influenced by a variety of factors: whether or not the oil comes ashore; the type of coastal environment contacted by the spill; weather conditions at the time of the incident; the type and quantity of oil spilled; and the extent and duration of the oiling. Nevertheless, the same two-step model used in Chapters 4.2 and 4.3 to project employment for a proposed CPA or WPA lease sale was applied to project the opportunity cost employment associated with cleaning up an oil spill. In this case, the first step considered estimates of the expenditures resulting from oil-spill cleanup activities should a spill occur and contact land. Table 4-48 depicts the sectoral allocation of the spending associated with spill cleanup and remediation activities. The amount spent per industrial sector to clean up a spill varies depending on such factors as the water depth in which the spill occurs and whether or not the spill contacts land. In any case the legal sector receives the majority of oil-spill cleanup expenditures. The second step incorporated the IMPLAN regional model multipliers to translate those expenditures into direct, indirect, and induced employment associated with oil-spill cleanup activities.

Chapter 4.4.1.1 depicts the risks and number of spills estimated to occur for a proposed CPA or WPA lease sale. The average size (on which model results are based) estimated for a spill ≥1,000 bbl is 4,600 bbl. Based on model results, should such a spill occur and contact land, it is projected to cost 363 person-years of employment for cleanup and remediation. This represents less than 1 percent of baseline employment for the analysis area even if the spill was to occur during the peak year of employment for a CPA or WPA lease sale. The most probable area to be affected by a spill is Plaquemines Parish in the CPA and Matagorda County in the WPA. Table 4-49 summarizes the direct, indirect, and induced opportunity cost employment (by subarea and planning area) for an oil-spill cleanup should a spill occur and contact land.

Chapter 4.4.1.1 shows that over the life of a proposed CPA or WPA lease sale spills less than 1,000 bbl are likely to occur and the most likely size is less than 1 bbl. It is estimated that between 930 and 2,212 small (<1 bbl) spills may occur in the CPA and between 460 and 880 spills may occur in the WPA. A few spills ≥1 bbl and <500 bbl are also estimated to occur offshore. These spills are not expected to reach land, and cleanup employment associated with such small spills is projected to be negligible. Facilities are equipped and employees are trained for such occurrences.

Chapter 4.4.1.1 conveys there is a lesser chance that an offshore spill ≥10,000 bbl may occur over the life of the proposed actions. Even though the probability of such a spill is minimal, employment impacts were analyzed should such a spill occur. Tables 4-50 and 4-51 contains these estimates. Opportunity cost employment associated with the cleanup and remediation of a spill ≥10,000 bbl is estimated between 505 and 1,183 person-years of employment depending on the location of such a spill and whether or not oil contacts land. This employment is expected to be temporary and of short duration (less than one year aside from the legal industry involvement). Cleanup employment is not expected to exceed 1 percent of baseline employment for any subarea in any given year even if it is included with employment associated with oil and gas development activities associated with a CPA or WPA lease sale.

The immediate social and economic consequences for the region in which a spill occurs are a mix of things that include not only additional opportunity cost jobs and sales but also non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations. These negative short-term social and economic consequences of an oil spill are expected to be modest as measured by projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Negative long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill (Pulsipher et al., 1999). Chapters 4.4.3.9 and 4.4.3.11 include additional discussions of the potential consequences of an oil spill on commercial fisheries and recreational beaches.

Overall employment projected for all OCS oil and gas activities includes employment in the oil-spill response industry. Overall OCS employment is projected to be substantial (up to 6% of baseline employment in some subareas).

Tarballs (the floating residue remaining after an oil slick dissipates) are likely results from a large spill. Tarballs are known to persist as long as 1-2 years in the marine environment. Findings from an MMS study investigating the abundance and sources of tarballs on the recreational beaches of the CPA concluded that the presence of tarballs along the Louisiana coastline is primarily related to marine transportation activities and that their effect on recreational use is below the level of social and economic concern (Henry et al., 1993).

Summary and Conclusion

The short-term social and economic consequences for the Gulf coastal region should a spill ≥1,000 bbl occur includes opportunity cost of 363-1,183 person-years of employment and expenditures of $20.7-$67.5 million that could have been gone to production or consumption rather than spill-cleanup efforts. Non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations are also expected to occur in the short-term. These negative, short-term social and economic consequences of an oil spill are expected to be modest in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Negative, long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill.

4.4.3.14.4. Environmental Justice

Oil spills that enter coastal waters can have negative economic or health impacts on the many people who use those waters for fishing, diving, boating, and swimming. According to the MMS oil-spill analysis, there is a low chance that an accidental oil spill ≥1,000 bbl will occur and contact Gulf coastal waters as a result of a proposed action. That chance is <0.5-8 percent for Texas coastal waters, <0.5-18 percent for Louisiana coastal waters, and <0.5 percent for Mississippi, Alabama, and Florida coastal waters (Chapter 4.4.1.1).

Should an oil spill occur and contact coastal areas, any adverse effects would not be expected to disproportionately impact minority or low-income populations. The populations immediately adjacent to the coast are not physically, culturally, or economically homogenous. The homes and summer homes of the relatively affluent line much of the Gulf Coast, and this process of gentrification is ongoing. As shown by Figures 3-15 and 3-16 in Chapter 3.1.1.1, coastal concentrations of minority and low-income populations are few and mostly urban. The higher probabilities of oil contacting land in Louisiana are centered on South Pass and Southwest Pass at the confluence of the deltaic plain and the Gulf of Mexico (Chapter 4.4.1.1). In Louisiana, Grand Isle is the only inhabited barrier island, and this community is not predominantly minority or low income. Most of the Louisiana coast, including South Pass, Southwest Pass, and the shorelines of the census tracts around Morgan City and the lower Mississippi Delta identified as minority concentrations (Figure 3-15), are virtually uninhabited and uninhabitable.

The users of the coast and coastal waters are not physically, culturally, or economically homogenous. Recreational users of coastal waters tend to be relatively affluent. For example, a recent survey of recreational and party-boat fishing around offshore oil rigs found significant per capita costs (Hiett and Milon, in press). Offshore commercial fishing involves significant capital outlays that limit participation. One MMS-funded study of the Houma in Lafourche Parish found that they focus their commercial and subsistence activities on inland and nearshore wild resources, less capital demanding pursuits (Fischer, 1970).

The direct impacts of an oil spill are unlikely to disproportionately affect minority or low-income people. Oil spills can have indirect effects, such as through serious, short-term impacts on tourism; however, these too are unlikely to disproportionately affect minority or low-income people.

Summary and Conclusion

Considering the low likelihood of an oil spill and the nonhomogeneous population distribution along the Gulf of Mexico region, accidental spill events associated with a proposed action are not expected to have disproportionate adverse environmental or health effects on minority or low-income people.

4.5. CUMULATIVE IMPACTS

4.5.1. Coastal Barrier Beaches and Associated Dunes

This cumulative analysis considers the effects of impact-producing factors related to a proposed action, prior and future OCS sales in the Gulf of Mexico, State oil and gas activities, other governmental and private projects and activities, and pertinent natural processes that may affect barrier beaches and dunes. Specific impact-producing factors considered in this cumulative analysis include erosion and reduced sedimentation, beach protection and stabilization projects, oil spills, oil spill response and clean up activities, pipeline landfalls, navigation channels, and recreational activities.

Erosion of barrier islands in coastal Louisiana and easternmost Texas is related to the stages of construction and destruction of the Mississippi River Delta. The Mississippi River is the most influential direct and indirect source of sand-sized and other sediments to coastal landforms in Louisiana. The location of the river determines which areas of the deltaic plain accrete and erode. Typically, rivers and their distributaries build land where they flood the delta and discharge to the Gulf. Land erodes and subsides where sediments are no longer received from the river or other sources

Since the lower Mississippi River was completely leveed and channeled by the early 1930's, the vast majority of land-building sediments were channeled to the end of the Bird Foot Delta (coastal Subarea LA-3), from where they are largely distributed to deepwater areas of the continental slope. Levees and channelization ended the once-significant land building in Louisiana and set circumstances toward deltaic degradation and subsidence, as if the river had abandoned this area of the coast.

Within a decade after the Civil War, the State of Louisiana connected the Mississippi, Red, and Atchafalaya Rivers for navigational purposes, which began the diversion of the more sediment-laden waters of the Mississippi River to the Atchafalaya River. By 1932, the Federal Government diverted the Red River and increased Mississippi River flow to the Atchafalaya River for flood control. By 1962, the Federal Government constructed the Old River Control Structure, which diverts approximately 30 percent of the Mississippi River flow to the Atchafalaya River. This diversion also led to the development of a new deltaic lobe in the Atchafalaya Bay (coastal Subarea LA-2).

Since the 1950's, the suspended sediment load of the Mississippi River has decreased more than 50 percent, largely as a result of dam and reservoir construction (Turner and Cahoon, 1988) and soil conservation measures within the drainage basin. Sediment loads in the Atchafalaya River also decreased as a result.

Reduced sediment supply to the Louisiana coast has contributed to erosional forces becoming dominant. Erosional reworking of deltaic sediments winnows away the lighter sediments and retains the heavier, sand-sized materials that build barrier beaches. Unfortunately, very little of these coarser materials are present in the deltaic deposits of these regions. Consequently, these beaches are rapidly retreating landward and will continue to do so into the foreseeable future. Generally under these circumstances, installation of facilities on these beaches or dunes or removal of large volumes of sand from this littoral system can cause strong, adverse impacts. One of the least stable beach and dune systems is at Fourchon in Lafourche Parish, where tank farms and other businesses have been forced to move inland, away from the rapidly eroding beach.

The beaches and dunes of the Chandeleur Islands to the east of the Mississippi River Delta are not dependent on a fluvial source of sand. These islands are nourished by the sandy barrier platforms beneath them (Otvos, 1980). Reduced discharges of fluvial sediment into the coastal zone will not affect these barriers. Still, their sand supplies are limited and they have not recovered rapidly after hurricanes of the last decade.

Approximately 280 km of the Texas coast are experiencing erosion (Wicker et. al. 1989). The weighted average erosion rate along this stretch of coast is 5.9 m/yr. Another 212 km of coast are experiencing loss at an average rate of 2.9 m/yr. The average change over the entire Texas coast has been erosional at a rate of 2.1 m/yr. During this century, the annual rate of coastal landloss in Texas has increased from 13 ha at the turn of the century to nearly 65 ha in 1980 (Morton, 1982). These trends are caused by the following circumstances. The Texas coast has experienced a natural decrease in sediment supply as a result of climatic changes that have occurred during the past few thousand years (Morton, 1982). Dam construction upstream on coastal rivers has trapped sand-sized sediments. Shoreline stabilization using groins and jetties has trapped sediment on the updrift sides of the structures. Seawall construction along eroding stretches of islands has reduced the amount of sediment introduced into the littoral system by shore erosion. The Texas Chenier Plain receives reworked sediments that have been discharged by the Mississippi River, which have decreased by more than 50 percent since the 1950's. Reductions in sediment supply along the Texas coast will continue to have a significant adverse impact on barrier landforms there.

Subsidence, erosion, and dredging of inland coastal areas and the concurrent expansion of tidal influences, particularly as seen in Louisiana, continually increases tidal prisms around the Gulf. These changes will cause many new natural, tidal channels to be opened, deepened and widened not only to the Gulf but also between inland waterbodies to accommodate the increasing volumes of water that are moved by tides and storms. These changes will cause adverse impacts to barrier beaches and dunes that will be incremental in nature.

Efforts to stabilize the Gulf shoreline have adversely impacted barrier landscapes in Louisiana and Texas. Large numbers and varieties of stabilization techniques, such as groins, jetties, and seawalls, as well as artificially-maintained channels and jetties, installed to stabilize navigation channels have been applied along the Gulf Coast. Undoubtedly, efforts to stabilize the beach with seawalls, groins, and jetties in Texas and Louisiana have contributed to coastal erosion by depriving downdrift beaches of sediments, which accelerates erosion there (Morton, 1982), and by increasing or redirecting the erosional energy of waves. Over the last 20 years, dune and beach stabilization have been better accomplished by using more natural applications such as sand dunes, beach nourishment, and vegetative plantings.

A variety of beach and barrier island restorative measures have been brought about as the population has become more aware of barrier island and beach problems. During the mid-1980's, the U.S. Army Corps of Engineers contracted with the State of Louisiana and the Jefferson Parish governments to replenish beach sand on Grand Isle, Louisiana. During the 1990's, the State of Louisiana and Federal Government joined in a partnership through the Coastal Wetlands Protection, Planning and Restoration Act (CWPPRA) to address and, where possible, correct the deterioration of wetlands and barrier islands along Louisiana's Gulf Coast and elsewhere.

Sources and probabilities of oil entering waters of the Gulf and surrounding coastal regions are discussed in Chapter 4.1.3.4. Inland spills that do not occur in the vicinities of barrier tidal passes are more likely to contact the landward rather than the ocean side of a barrier island. Hence, no inland spills are expected to significantly contact barrier beaches (Chapters 4.2.1.1.1 and 4.3.1.1.1).

Most spills occurring in offshore coastal waters are assumed to proportionally weather and dissipate similar to the weathering described in Table 4-45. Dispersants are not expected to be used in coastal waters. The weathering model described in Chapter 4.4.1.1 attributes the dispersal of about 65 percent of the volume of a spill to the use of dispersants. No calculation has been made to estimate how much oil might be deposited on a beach if dispersants are not used. Unfavorable winds and currents would further diminish the volume of oil that might contact a beach. A persistent, northwesterly wind might preclude contact. As discussed in Chapters 3.2.1.1., 4.2.1.1.1, and 4.3.1.1.1, the probability that tide levels could reach or exceed the elevations of sand dune vegetation on barrier beaches ranges from 0 to 16 percent, depending on the particular coastal setting and the elevation of the vegetation. The strong winds that would be needed to produce unusually high tide levels would also disperse the slick over a larger area than is being considered in the current analysis. The probabilities of spill occurrence and contact to barrier beaches, and sand-dune vegetation are considered very low. Hence, contact of sand-dune vegetation by spilled oil is not expected to occur. Furthermore, the Mississippi River discharge would help breakup a slick that might otherwise contact Plaquemines Parish. The spreading would reduce the oil concentrations contacting the beach and vegetation, greatly reducing impacts on vegetation.

The barrier beaches of Deltaic Louisiana have the greatest rates of erosion and landward retreat of any known in the western hemisphere, and among the greatest rates on earth. Long-term impacts to contacted beaches from these spills could occur if significant volumes of sand were removed during cleanup operations. Removing sand from the coastal littoral environment, particularly in the sand-starved transgressive setting of coastal Louisiana, could result in accelerated coastal erosion. Spill cleanup is difficult in the inaccessible setting of coastal Louisiana. This analysis assumes that Louisiana would require the responsible party to clean the beach without removing significant volumes of sand or to replace the sand removed. Hence, cleanup operations are not expected to cause permanent effects on barrier beach stability. Within a few months, adjustments in beach configuration may result from the disturbance and movement of sand during cleanup.

The results of an investigation on the effects of the disposal of oiled sand on dune vegetation in Texas, showed no deleterious impacts on existing vegetation or colonization of the sand by new vegetation (Webb, 1988). Hence, projected oil contacts to small areas of lower elevation sand dunes are not expected to result in destabilization of the sand dune area or the barrier landform.

Some oil will penetrate to depths beneath the reach of the cleanup methods. The remaining oil would persist in beach sands, periodically being released when storms and high tides resuspend or flush through beach sediments. During hot, sunny days, tarballs buried near the surface of the beach sand may liquefy and cause a seep to the sand surface.

Many of the existing OCS-related and other pipeline landfalls have occurred on barrier landforms (Table 4-14 and Chapter 4.1.3.1.2). Construction of 23-38 new pipeline landfalls is expected as a result of the OCS Program (Chapter 4.1.2.1.7). An MMS study and other studies (Wicker et al., 1989; LeBlanc, 1985; Mendelssohn and Hester, 1988) have investigated the geological, hydrological, and botanical impacts of pipeline construction on and under barrier landforms in the Gulf. In general, the impacts of existing pipeline landfalls since 1975 were minor to nonexistent with current installation methods. In most cases, no evidence of accelerated erosion was noted in the vicinity of the canal crossings if no shore protection for the pipeline was installed on the beach and if no remnant of a canal remained landward of the beach. Wicker et al. (1989) warn that the potential for future breaching of the shoreline remains at the sites of flotation canal crossings where island width is small or diminishing because of erosion or the sediments beneath the sand-shell beach plugs are unconsolidated and susceptible to erosion.

Numerous pipelines have been installed on the bay side of barrier islands and parallel to the barrier beach. With overwash and shoreline retreat, many of these pipeline canals serve as sediment sinks, resulting in narrowing and lowering of barrier islands and their dunes and beaches. Such islands and beaches were rendered more susceptible to breaching and overwash. This type of pipeline placement was quite common in Louisiana, but has been discontinued.

An area of special concern along the south Texas coast is the Padre Island National Seashore, which is in coastal Subarea TX-1. At present, one OCS pipeline, which carries some condensate, crosses the northern end of Padre Island. For 2003-2042, 0-2 new pipeline landfalls are projected for coastal Subarea TX-1. Corpus Christi, north of Padre Island, is one of the possible shuttle tanker ports.

The contribution of the OCS Program to vessel traffic in navigation channels is described in Chapters 3.3.3.9.2 and 4.1.2.1.9. A portion of the impacts attributable to maintenance dredging and wake erosion of those channels would be in support of the OCS Program. Mitigative measures are assumed to occur, where practicable, in accordance with Executive Order 11990 (May 24, 1977). During the 40-year analysis period, beneficial use of dredged material may increase, thereby reducing the continuing impacts of navigation channels and jetties.

No new navigation channels between the Gulf and inland regions are projected for installation. The basis of this assumption is the large number of existing navigation channels that can accommodate additional navigation needs. Some new inland navigation channels will be dredged to accommodate the inland oil and gas industry, developers, and transportation interests. Some channels may be deepened or widened to accommodate projected increases in deeper-draft petroleum production and larger cargo vessels that are not related to OCS petroleum production.

Most barrier beaches in the CPA are relatively inaccessible for recreational use because they are either located a substantial distance offshore, as in Mississippi, or in coastal areas with limited road access, as in Louisiana. Few beaches in the CPA have been, or are likely to be, substantially altered to accommodate recreational or industrial construction projects in the near future.

Most barrier beaches in Texas, Alabama, and Florida are accessible to people for recreational use because of road access and their use is encouraged. The Texas Open Beaches Act (1959) guarantees the public's right to unimpeded use of the State's beaches. It also provides for public acquisition of private beach-front property. Recreational use of barrier beaches and dunes can have impacts on the stability of the landform. Vehicle and pedestrian traffic on sand dunes can stress and reduce the density of vegetation that binds the sediment and stabilizes the dune. Destabilized dunes are more easily eroded by winds waves and traffic. Judd et al. (1988) documented that as much as 18 percent of the total dune area along parts of South Padre Island had experienced damage from vehicular traffic. Recreational vehicles and even hikers have been problems where road access is available and where the beach is wide enough to support vehicle use, as in Texas, Alabama, Florida, and a few places in Louisiana. Areas without road access will have very limited impacts by recreational vehicles.

Summary and Conclusion

River channelization, sediment deprivation, and rapid submergence have resulted in severe, rapid erosion of most of the barrier and shoreline landforms along the Louisiana coast. The barrier system of coastal Mississippi and Alabama is well supported on a coastal barrier platform of sand. The Texas coast has experienced landloss because of a decrease in the volume of sediment delivered to the coast because of dams on coastal rivers, a natural decrease in sediment supply as a result of climatic changes during the past several thousand years, and subsidence along the coast.

Beach stabilization projects are considered by coastal geomorphologists and engineers to accelerate coastal erosion. Beneficial use of maintenance dredged materials could be required to mitigate some of these impacts.

The impacts of oil spills from both OCS and non-OCS sources to the sand-starved Louisiana coast should not result in long-term alteration of landform if the beaches are cleaned using techniques that do not significantly remove sand from the beach or dunes. The barrier beaches of deltaic Louisiana, the Chenier Plain, and the region around Galveston have the greatest risks of sustaining impacts from oil-spill landfalls because of their very high concentrations of oil production within 50 km of those coasts. The cleanup impacts of these spills could result in short-term (up to 2 years) adjustment in beach profiles and configurations as a result of sand removal and disturbance during cleanup operations. Some contact to lower areas of sand dunes is expected. These contacts would not result in significant destabilization of the dunes.

Under the cumulative scenario, new OCS-related and non-OCS pipeline landfalls are projected. These pipelines are expected to be installed using modern techniques, which cause little to no impacts to the barrier islands and beaches. Existing pipelines, in particular those that are parallel and landward of beaches, that had been placed on barrier islands using older techniques that left canals or shore protection structures have caused and will continue to cause barrier beaches to narrow and breach.

Recreational use of many barrier beaches in the Western Gulf is intense because of their accessibility by road. Because of the inaccessibility of most of the Central Gulf barrier coast to humans, recreational use is not expected to result in significant impacts to most beaches. Federal, State, and local governments have made efforts over the last 10 years to slow the landward retreat of Louisiana's Gulf shorelines.

In conclusion, coastal barrier beaches have experienced severe adverse cumulative impacts from natural processes and human activities. Natural processes are generally considered the major contributor to these impacts, whereas human activities cause both severe local impacts as well as the acceleration of natural processes that deteriorate coastal barriers. Human activities that have caused the greatest adverse impacts are pipeline canals, channel stabilization, and beach stabilization structures. Deterioration of Gulf barrier beaches is expected to continue in the future. Federal, Louisiana, and parish governments have made efforts over the last 10 years to slow the landward retreat of Louisiana's Gulf shorelines. The incremental contribution of a proposed action compared to cumulative impacts on coastal barrier beaches and dunes impacts is expected to be very small.

4.5.1.1. Wetlands

This cumulative analysis for the CPA and WPA considers the effects of impact-producing factors related to a proposed action, prior and future OCS sales, State oil and gas activities, other governmental and private projects and activities, and pertinent natural processes and events that may occur and adversely affect wetlands. As a result of these activities and processes, several impact-producing factors, discussed below, will contribute to impacts on wetlands and associated habitat during the life of the proposed actions. The effects of pipelines, canal dredging, navigation activities, and oil spills on wetlands are described in Chapters 4.2.1.1.2, 4.3.1.1.2, and 4.4.3.1.2. Other impact-producing factors and information relevant to the cumulative analysis are discussed below.

Many of man's activities have resulted in landloss either directly or indirectly by accelerating natural processes. Until the Mississippi River was channelized and leveed during the early 1900's, floodwaters layered sediment over the active Deltaic plain, countering ongoing submergence and also building new land. Areas that did not receive sediment-laden floodwaters continually lost elevation. Human intervention has interrupted the process of renewal. Further compounding this impact, the suspended sediment load in the Mississippi River has decreased more than 50 percent since the 1950's, largely as a result of dam and reservoir construction (Turner and Cahoon, 1988) and soil conservation practices in the drainage basin. Also, natural drainage patterns along many areas of the Texas coast have been severely altered by construction of the GIWW and other channelization projects associated with its development. Saltwater intrusion, as a result of river channelization and canal dredging, is a major cause of coastal habitat deterioration (including seagrass communities) (Tiner, 1984; National Wetlands Inventory Group, 1985; Cox et al., 1997). Productivity and species diversity associated with wetlands and submerged vegetated habitat in coastal marshes of Louisiana and Texas is greatly reduced by saltwater intrusion (Stutzenbaker and Weller, 1989; Cox et al., 1997).

Wetland loss rates in coastal Louisiana are well documented to be as high as 10,878 ha/yr (42 mi^2/yr) during the late 1960's. One analysis method indicated that the landloss rate in coastal Louisiana for the period 1972 to 1990, slowed to an estimated 6,475 ha/yr (25 mi^2/yr)(Louisiana Coastal Wetlands Conservation and Restoration Task Force, 1993). A second methodology indicated a wetland loss rate of 9,072 ha/yr (35 mi^2/yr in the coastal zone of Louisiana during the period of 1978-1990 (USDOI, GS, 1998). Presuming that the landloss rate for that period is between that indicated by these two methods, approximately 7,776 ha (30 mi^2), and continues for the period 2002-2042, then 303,264 ha (1,170 mi^2) will have been lost. If the loss rate slows by 20 percent for the referenced period and given the apparent slowing trend, the loss could be as much as 242,611 ha or 936 mi^2 (for comparison purposes, the populated Greater New Orleans area is about 108,864 ha or 420 mi^2).

Development of wetlands for agricultural, residential, and commercial uses affects coastal wetlands. During the period 1952-1974 in the Chenier Plain area of southwestern Louisiana, an estimated 1,233 ha of wetlands were converted to urban use (Gosselink et al., 1979). During the period 1956-1978, an estimated 21,642 ha of urban or industrial development occurred in the Mississippi Deltaic Plain region of southern Louisiana (Bahr and Wascom, 1984). Submergence rates in coastal Louisiana have ranged from 0.48 to 1.3 cm per year (Baumann, 1980; Ramsey et al., 1991). This submergence is primarily due to subsidence and the elimination of river flooding. Flooding normally deposited sediment over the delta plains, which either slowed subsidence, maintained land elevations, or built higher land elevations, depending upon the distances from the river and the regularity of flooding for each region of interest. A secondary cause of land submergence is sea-level rise.

Wetland contacts by oil spills can occur from a number of sources. Chapter 4.1.3.4 provides an estimate of future spill risk. Their projected effects on wetlands are described in Chapter 4.4.3.1.2. The cumulative scenario discusses petroleum and products spills from all sources, inclusive of the OCS Program, imports, and State production. The large majority of oil slicks that contact land are expected to come ashore on barrier islands. Offshore spills from non-OCS sources are assumed to display similar spill dispersion and weathering characteristics to that of OCS-related spills.

Flood tides may bring some oil through tidal inlets into areas landward of barrier beaches. The turbulence of tidal water passing through most tidal passes would break up the slick, thereby accelerating dispersion and weathering. For the majority of these situations, light oiling of vegetated wetlands may occur, contributing less than 0.1 l/m^2 on wetland surfaces. Any adverse impacts that may occur to wetland plants are expected to be very short lived, probably less than one year.

Coastal OCS spills could occur as a result of pipeline accidents and barge or shuttle tanker accidents during transit or off-loading. The frequency, size, and distribution of all coastal spills is provided in Chapter 4.1.3.4. Impacts of OCS coastal spills are also discussed in Chapter 4.4.3.1. Non-OCS spills can occur in coastal regions as a result of import tankers, coastal oil production activities, and petroleum product transfer accidents. Their distribution is believed to be similar to that described in Chapter 4.4.3.1

Under this scenario, spills that occur in or near Chandeleur or Mississippi Sounds could potentially impact wetland habitat in or near the Gulf Islands National Seashore and the Breton National Wildlife Refuge and Wilderness Area. Because of their natural history, these areas are considered areas of special importance, and they support endangered and threatened species. Although the wetland acreage on these islands is small, the wetlands make up an important element in the habitat of the islands. Because the inlets that connect Mississippi Sound with the marsh-fringed estuaries and lagoons within the islands are narrow, a small percentage of the oil that contacts the Sound side of the islands will be carried by the tides into interior lagoons.

Discharging OCS-related produced water into inshore waters has been discontinued and all OCS-produced waters transported to shore will either be injected or disposed of in Gulf waters and will not affect coastal wetlands (Chapter 4.1.2.1.10).

Projected new onshore facilities for the CPA and WPA are described in Chapter 4.1.2.1 and Table 4-8. Federal and State permitting programs discourage facility placement in wetlands as much as is feasible; however, if the placement of a facility in a wetland is unavoidable, then adequate mitigation of all unavoidable impacts is required. Therefore, no significant impacts to wetlands are expected from construction of new facilities, other than the projected 0-1 pipeline landfalls for each proposed action.

Pipeline construction projects can affect wetlands in a number of ways. Pipeline installation methods and impacts are described in Chapters 4.1.2.1.7 and 4.1.3.1.2. The State oil and gas industry is generally described in Chapter 4.1.3.1. Two-thirds of OCS pipelines entering state waters tie into existing pipeline systems, and do not result in new landfalls. Of the 70-120 new OCS pipelines projected to enter state waters, only 23-38 will result in new landfalls. Landfalls are expected to initially impact an immeasurable area of wetland habitat. After backfilling, productivity of the impacted acreage would be repressed for up to 6 years, converting some wetland habitat to open water. Secondary impacts of canals are considered more damaging to coastal wetlands and associated habitats than primary construction impacts (Tabberer et al., 1985). Such impacts include expansion of tidal influence, saltwater intrusion, hydrodynamic alterations, erosion, sediment transport, and habitat conversion (Gosselink, 1984; Cox et al., 1997). Secondary wetland loss due to OCS-related pipeline and navigation canal widening is described in Chapters 4.2.1.1.2 and 4.3.1.1.2. The combined length of non-OCS pipelines through wetlands is believed to be approximately twice that of the Gulf OCS Program. In order to understand and report the impact of OCS activities, pipelines and navigational canal systems, their locations, routes and impacts must be identified and measured.

As a result of the OCS Program (2002-2043), up to 260 km of onshore pipeline are projected to be constructed in the WPA and CPA. Based on preliminary historic landloss results from the MMS/USGS NWRC current coastal pipeline impacts study for the Louisiana study area, the predicted landloss (based on an average of 4 ha of conversion to open water per linear km of pipeline (300-m buffer zone)) from the estimated 120-260 km of new OCS pipeline construction ranges from approximately 480-1,040 ha total over the 40-year analysis period. However, this estimate does not take into consideration the following variables:

- season of construction (growing vs. non-growing);
- precipitation and/or climatic conditions;
- mitigations applied by permitting agency;

- methods of construction/installation;
- size of pipeline; and
- location of construction and associated habitats impacted.

Also, the using of new technologies of pipeline construction, such as horizontal or trenchless directional drilling, would decrease impacts to sensitive habitat to as much as zero (0).

Pipeline maintenance activities that disturb wetlands are very infrequent and are considered insignificant. During reviews of pipeline projects for Federal and State permits, agencies consistently comment with concern upon the extent of secondary impacts. As a result, structures engineered to mitigate secondary adverse impacts are included as permit requirements for canal and pipeline construction through wetlands. Maintenance of mitigation structures on pipeline canals is only required for 5 years (a rarely enforced stipulation). Structures constructed for the purpose of mitigating adverse impacts of pipeline construction frequently fail (Gosselink, 1984). Where mitigative structures are not regularly maintained, secondary impacts may hasten habitat loss to eventually equal or surpass the impacts that would have occurred had the structure not been installed. The nonmaintenance of mitigative structures can lead to their deterioration and eventual failure, allowing indirect and at times, adverse impacts on wetlands to proceed. These adverse impacts include saltwater intrusion, reduction of freshwater inflow, sediment erosion and export, expansion of tidal influence, and habitat conversion. The number of pipeline-related mitigative structures throughout coastal areas around the Gulf are unknown. Although the extent of impacts caused by failure to maintain mitigation structures is unknown, such impacts are believed to be significant (Gosselink, 1984; Tabberer et al., 1985; Turner and Cahoon, 1988).

Most canals dredged in coastal Louisiana and Texas have occurred as a result of onshore oil and gas activities. Drilling and production activity at most coastal well sites in Louisiana and Texas require rig access canals. Access canals and pipelines to service onshore development are pervasive throughout the coastal area in Louisiana; 15,285 km of pipeline canals have been installed to carry onshore production (USDOI, GS, 1984). Typical dimensions of an access canal, as indicated on permits during 1988, were 366-m long by 20-m wide with a 0.5-ha drill slip at the end.

In 1988, the U.S. Army Corps of Engineers (COE) received applications for the installation of 123 km of pipelines and for dredging more than 11 km of new oil-well access canals through wetland areas. This survey took place during a period (1984 through 1990) of suppressed oil and gas activities. Assuming that this level of activity persists for the period 2002-2042, the direct impacts from the COE-permitted dredging are hard to measure but may lead to the conversion of wetland habitat to open water. Additionally, more wetland habitat will be buried by spoil banks along the channel margins, converting some wetlands acreage to bottom land or shrub-scrub habitat.

As discussed in Chapter 4.1.1, the magnitude of future OCS activities is being directed towards deeper water, which may require larger service vessels for efficient operations. Ports housing OCS-related service bases that can accommodate deeper-water vessels are described in Chapter 4.1.2.1. Empire and Cameron, Louisiana, are considered marginally useable for OCS-related, shallow water traffic.

Ports containing service bases with access channels less than 4.5 m (15 ftz) deep may decide to deepen their channels to capture portions of OCS activities projected for deep water. Typically, channels greater than 6-7 m deep will not be needed to accommodate the deepwater needs of the OCS Program. Channels deeper than 6-7 m accommodate increasing numbers of ocean-going ships. The Corpus Christi, Houston, and Mississippi River ship channels are being considered for deepening to allow access by larger ocean-going vessels that are not related to the OCS Program. Since the Port Authority of Lafourche Parish and the COE have deepened access and interior channels of Port Fourchon to greater than 7 m NGVD, the numbers of cargo vessels not related to petroleum or fishing using Port Fourchon are projected to increase in the future. Increased population and commercial pressures on the Mississippi Gulf Coast are also causing pressures to expand ports there.

Materials dredged to deepen channels in Port Fourchon are expected to be placed to create development sites and 192 ha of saline marsh. The feasibility report anticipates no significant saltwater intrusion effects on wetlands as a result of the deepening project, probably because the project only extends approximately 8.5 km inland and will be performed in a saline environment where the existing vegetation is salt tolerant (Chapters 4.2.1.1.2 and 4.3.1.1.2 for details).

Deepening the Corpus Christi Ship Channel from -13.7 to -15.2 m NGVD is expected to displace approximately 353 million m^3 in an open bay system. The recent dredging and deepening of this channel to -13.7 m NGVD caused no significant saltwater intrusion. The dredged material generated by the deepening project will be used to enhance and create wetlands rather than be disposed of onto spoil banks adjacent to the channel. No significant adverse impacts to wetlands are expected to result from the project.

Vessel traffic within navigation channels can cause channel bank erosion in wetland areas. Tables 3-30 and 3-31 show vessel traffic using OCS-related waterways in 1999. Approximately 10 percent of the traffic using OCS-related channels is related to the OCS Program. Much of the length of these channels are through eroding canals, rivers, and bayous. Non-OCS-related navigation channels are believed to conduct lower traffic volumes and, therefore are expected to widen at a lower rate of as much as 0.95 m/yr. Maintenance dredging of existing channels will occur and could harm wetlands if the dredged material is deposited onto wetlands, resulting in burial or impoundment of marsh areas. This analysis assumes an increasing implementation of dredged material disposal for wetland enhancement and creation during the life of a proposed action. Ten percent of associated maintenance dredging of OCS-related channels and related impacts are attributed to the OCS Program. On average, every two years the four COE Districts survey the navigation channels they are responsible for to determine the need for maintenance dredging. Schedules for maintenance dredging of OCS-related navigation channels vary broadly from once per year to once every 17 years. Each navigation channel is typically divided into segments called "reaches." Each reach may have a maintenance schedule that is independent of adjacent reaches. COE data indicates an approximate average of 14,059,500 m^3 per year or 492,082,500 m^3 per 35 years are displaced by maintenance dredging activities on OCS-related navigation channels in the Gulf area; this roughly amounts to approximately 144,700 m^3 per kilometer.

Navigation channels not used by OCS navigation traffic are generally smaller, less-used channels with less frequent maintenance dredging. These channels are expected to produce 50 percent less maintenance-dredged materials per kilometer. Hence, maintenance dredging of non-OCS-related channels are estimated to produce approximately 36,576,500 m^3 of material during the period 2003-2042. This dredged material could be used to enhance or re-establish marsh growth in deteriorating wetland areas. If implemented, the damaging effects of maintenance dredging of navigation channels would be reduced.

Specific to navigation channels are the effects from saltwater intrusion (Gosselink et al., 1979; Wang 1987). Wang (1987) developed a model demonstrating that, under certain environmental conditions, salt water penetrates farther inland in deep navigation channels than in shallower channels, suggesting that navigation channels act as "salt pumps." The Calcasieu Ship Channel is a good example of how saltwater intrusion, as a consequence of channelization, results in significant habitat transition from freshwater to brackish and ultimately to salt or open-water systems. Another example is the construction of the Mississippi River Gulf Outlet that led to the transition of many of the cypress swamps east of the Mississippi River below New Orleans to open water or areas largely composed of marsh vegetation (*Spartina)* with old, dead cypress tree trunks.

Significant volumes of OCS-related produced sands and drilling fluids will be transported to shore for disposal. According to USEPA information, sufficient disposal capacity exists at operating and proposed disposal sites. Economic and political opportunities exist that may support construction of new disposal sites. Because of current regulatory policies, no wetland areas will be disturbed as a result of the establishment of new disposal sites or expansions or existing sites, without adequate mitigation. Some seepage from waste sites may occur into adjacent wetland areas and result in damage to wetland vegetation.

Miscellaneous factors that impact coastal wetlands include marsh burning, marsh buggy traffic, onshore oil and gas activities, and well-site construction. Bahr and Wascom (1984) report major marsh burns that have resulted in permanent wetland loss. Sikora et al. (1983) reported that in one 16-km^2 wetland area in coastal Louisiana, 18.5 percent of the area was covered with marsh-buggy tracks. Tracks left by marsh buggies have been known to open new routes of water flow through relatively unbroken marsh, thereby inducing and accelerating erosion and sediment export. Marsh-buggy tracks are known to persist in Louisiana intermediate, brackish, and saline marshes for 15-30 years. Well-site construction activities include board roads and ring levees. Ring levees are approximately 1.6-ha impoundments constructed around a well site. In oil and gas fields, access canal spoil banks impound large areas of wetlands. The total acreage of impounded, dredged, and filled wetlands from drilling onshore coastal wells is considered substantial.

Current Mitigation Techniques Used to Reduce Adverse Impacts to Wetlands

Despite a national goal to achieve "no net loss of the . . . wetlands base," there is no one single law that protects wetlands (Strand, 1997). Instead, numerous regulatory mechanisms, combined with a well-defined mitigation process, are used to encourage wetland protection. The Clean Water Act's Section 404 dredge and fill permit program is the strongest regulatory tool protecting wetlands from impacts; however, the key component of Section 404 is the requirement that adverse ecological impacts of a development project be mitigated by the developing agency (for OCS pipeline landfalls, this is the Corps of Engineers) or individual. The core of wetland protection revolves around the ability to mitigate or minimize impacts to wetlands and other sensitive coastal habitat.

Mitigation or the minimization of wetland impacts is particularly relevant along the northern coast of the GOM, specifically Louisiana, where significant impacts from human activities related to the oil and gas industry occur in wetland systems. As researchers document the direct and indirect consequences of pipelines canals, dredging, and dredged material placement on wetland systems, optimizing old mitigation techniques and identifying new mitigation techniques in order to reduce impacts as much as possible is a necessary component of any development plan that terminates onshore. With more than 16,000 km (about 10,000 mi) of pipelines along the coast of the northern GOM (Johnson and Cahoon, in review), and the extent to which activities related to these pipelines and any new pipelines are mitigated, may be crucially important to the long-term integrity of the sensitive habitats (i.e., wetlands, shorelines, and seagrass communities) in these sensitive and fragile areas.

The following information identifies and documents the use and effectiveness of mitigation techniques related to OCS pipelines, canals, dredging, and dredged material placement in coastal habitats along the northern coast of the GOM and associated with the proposed action. The material will provide an overview and discussion of mitigation techniques that have been studied and used, as well as new and modified mitigation techniques that may not be well documented.

Mitigation Defined

The Council on Environmental Quality (1978) defined mitigation as a five-step process

(1) Avoidance – the avoiding of the impact altogether by not taking a certain action or part of an action

(2) Minimization – the minimizing of impacts by limiting the degree or magnitude of the action and its implementation

(3) Restoration – the rectifying of the impact by repairing, rehabilitating, or restoring the affected environment

(4) Preservation through Maintenance – the reducing or eliminating of the impact over time by preservation and maintenance operations during the life of the action

(5) Compensation – the compensating for the impact by replacing or providing substitute resources of environments

Mitigation History Related to Oil and Gas Activities

Mitigation of wetland impacts from oil and gas activities has a very short history. Prior to the 1980's, wetlands were not protected and very little attention was paid to the environmental impacts of pipeline construction within wetland areas. Focus was on deciding the best (fastest and most economical) way to install the pipelines in soft sediment. With more recent requirements for considering impacts to sensitive coastal habitat, methods and techniques for mitigation impacts have developed and refined.

Because of the extensive coastal wetland systems along the northern coast of the GOM, avoidance of wetland systems is often impossible for pipelines related to OCS activities. Thus, minimization is the main focus of mitigation for pipeline-related activities. Numerous suggestions for minimization impacts have been recommended with some of the most promising ideas emerging based on past experience and field observations.

Overview of Existing Mitigation Techniques and Results

Numerous mitigation methods have been recommended and used in the field. Depending on the location, the project in question, and the surrounding environment, different mitigation techniques may be more appropriate over another. Based on permits, work documents, and interviews, 17 mitigation techniques have been implemented at least once, with no one technique or suite of techniques routinely required by permitting agencies; each pipeline mitigation process is uniquely designed to minimize damages given the particular setting and equipment to be installed. Of the identified mitigation techniques, there are, however, a number of techniques that are commonly required, while others are rarely used either because they are considered obsolete in most instances or because they are applicable only to a narrow range of settings. Table 4-63 highlights and summarizes technical evidence for the use of various mitigating processes associated with pipeline construction, canals, dredging, and dredged material placement.

Summary

Mitigation of impacts from OCS pipelines, canals, dredging, and dredged material placement evolved with the growing environmental protection laws in the United States. The "avoid, minimize, restore, and compensate" sequence has become an automatic series of events in project planning. Unfortunately, best professional judgment remains the primary guide for decisionmakers. There is no quantitative, hard evidence of the reduction in impacts as a result of any one of the many mitigation techniques.

Sources of Available Funding for Wetland Restoration

The Coastal Impact Assistance Program (CIAP) has been authorized by Congress to assist states in mitigating the impacts associated with OCS oil and gas production. Congress has appropriated approximately $150 million to the National Oceanic Atmospheric Administration (NOAA) to be allocated to Texas and Louisiana as well as five other coastal states. The money is to be used to undertake a variety of projects for protecting and restoring coastal resources and mitigating the impacts of OCS leasing and development. The Texas General Land Office and the Louisiana Department of Natural Resources are coordinating their states efforts in acquiring their proportion of these funds.

In addition to the CIAP, the Gulf of Mexico Program (GMP) sponsors the Gulf Ecological Management Site (GEMS) program. The GEMS program is an initiative of the GMP and the five Gulf of Mexico states providing a framework for ecologically important Gulf habitats. The GEMS program coordinates and utilizes existing Federal, State, local, and private programs, resources, and mechanism to identify GEMS in each state. Each Gulf State has identified special ecological sites it regards as GEMS. Louisiana and Texas have identified the areas as GEMS (see Table 4-52).

Summary and Conclusion

Impacts from residential, commercial, and agricultural and silvicultural (forest expansion) developments are expected to continue in coastal regions around the Gulf. Existing regulations and development permitting procedures indicate that development-related wetland loss may be slowed and that very few new onshore OCS facilities, other than pipelines, will be constructed in wetlands.

Impacts from State onshore oil and gas activities are expected to occur as a result of dredging for new canals and for maintenance, usage of existing rig access canals and drill slips, and preparation of new well sites. Indirect impacts from dredging new canals for State onshore oil and gas development (Chapter 4.1.3.1) and from maintenance of the existing canal network is expected to continue.

Maintenance dredging of the OCS-related navigation channels displaces approximately 492,082,500 m^3, of which 10 percent is attributed to the OCS Program. Federally maintained, non-OCS-related navigation channels are estimated to account for another estimated 36,576,500 m^3 of dredged material. Maintenance dredging of inshore, well-access canals is estimated to result in the displacement of another 5,014,300 m^3 of materials. Insignificant adverse impacts upon wetlands from maintenance dredging are expected because the large majority of the material would be disposed upon existing disposal areas. Alternative dredged material disposal methods can be used to enhance and create coastal wetlands.

Depending upon the regions and soils through which they were dredged, secondary adverse impacts of canals can be much more locally significant and boarder than direct impacts. Additional wetland losses generated by the secondary impacts of saltwater intrusion, flank subsidence, freshwater-reservoir reduction, and deeper tidal penetration have not been calculated due to a lack of quantitative documentation; the MMS has initiated a project to document and develop data concerning such losses. A variety of mitigation efforts are initiated to protect against direct and indirect wetland loss. The non-maintenance of mitigation structures that reduce canal construction impacts can have substantial impacts upon wetlands.

In Louisiana, deepening Fourchon Channel to accommodate larger, OCS-related service vessels has occurred within a saline marsh environment and will afford the opportunity for the creation of wetlands with the dredged materials. Also, deepening the Corpus Christi and Houston Ship Channels is non-OCS-related and should also afford the opportunity to create wetlands with dredged material. A variety of non-OCS-related pressures are generating a need to expand ports on the Mississippi Gulf Coast.

In conclusion, based on preliminary historic landloss results from the MMS/USGS NWRC current coastal pipeline impacts study for the Louisiana study area, the predicted landloss from the estimated 120-260 km of new OCS pipeline construction ranges from approximately 480-1,040 ha total over the 40-year analysis period. The current MMS/USGS pipeline study is continuing to develop models that will aid in quantifying habitat loss associated with OCS activities. The CPA and WPA proposed actions represent about 2 and 1 percent, respectively, of the OCS impacts that will occur during the period 2003-2042. Deltaic Louisiana is expected to continue to experience the greatest loss of wetland habitat. Wetland loss is also expected to continue in coastal Texas, Mississippi, Alabama, and Florida, but at slower rates.

4.5.1.2. Seagrass Communities

This cumulative analysis considers the effects of impact-producing factors related to the WPA and CPA proposed action, prior and future OCS activities, State oil and gas activities, other governmental and private projects and activities, and pertinent natural processes and events that may adversely affect seagrass communities and associated habitat during the life of a proposed action. The cumulative effects of pipelines, canal dredging, scaring from vessel traffic, and oil spills on seagrass communities and associated habitat are described in Chapters 4.2.1.1.3, 4.3.1.1.3, and 4.4.3.1.3. In addition to the above stated impacts, other impact-producing factors (channelization) relevant to the cumulative analysis are discussed below.

Pipelines

Pipeline construction projects can affect seagrass habitats in a number of ways, however, maintenance activities that disturb wetlands and associated habitat (submerged vegetation and seagrass beds) are very infrequent and considered insignificant. During reviews of pipeline projects for Federal and State permits, agencies consistently comment with concern upon the extent of secondary impacts. As a result, structures engineered to mitigate secondary adverse impacts are included as permit requirements for canal and pipeline construction. Pipeline installation methods and impacts to submerged vegetation are described in Chapters 4.1.2.1.7, 4.2.1.1.3, and 4.3.1.1.3. The State oil and gas industry is generally described in Chapter 4.1.3.1.2. There are 126 existing pipeline landfalls related to the OCS Program with 23-38 new pipeline landfalls from 2003-2042. There are 70-120 new OCS pipelines projected to enter state waters, however two-thirds of OCS pipelines entering state waters tie into existing pipeline systems, and will not result in new landfalls.

Dredging, Channelization, and Water Controls

Dredge and fill activities are the greatest threats to submerged vegetation and seagrass habitat (Wolfe et al., 1988). Existing and projected lengths of OCS-related pipelines and OCS-related dredging activities are described in Chapters 4.1.2.1.7 and 4.1.3.3.3. The dynamics of how these activities impact submerged vegetation is discussed in Chapters 4.2.1.1.3 and 4.3.1.1.3. The most serious impacts to submerged vegetation and associated seagrass communities generated by dredging activities are a result of removal of sediments, burial of existing habitat, and oxygen depletion and reduced light attenuation associated with increased turbidity. Turbidity is most damaging to beds in waterbodies that are enclosed, have relatively long flushing periods, and contain bottom sediments that are easily resuspended for long periods of time. An integrative model of seagrass distribution and productivity produced by Dunton et al. (1998) strongly suggests light attenuation due to dredging operations that increases turbidity will negatively impact seagrass health.

Dredging impacts associated with the installation of new navigation channels are greater than those for pipeline installations, because new canal dredging creates a much wider and deeper footprint. A greater amount of material and fine materials are disturbed; hence, turbidity in the vicinity of canal dredging is much greater, persists for longer periods of time, and the turbidity extends over greater distances and acreage. New canals and related disposal of dredged material also cause significant changes in regional hydrodynamics and associated erosion. Significant and substantial secondary impacts include wake erosion resulting from navigational traffic as evident along the Texas coast where heavy traffic utilizing the Gulf Intracoastal Waterway (GIWW) has accelerated erosion of existing salt marsh habitat (Cox et al., 1997). New canals can also encourage additional development.

Most impacts to lower-salinity species of submerged vegetation and seagrass communities by new channel dredging within the cumulative activity area have occurred in Louisiana and Texas. This will continue to be the case in the foreseeable future. Similarly, most impacts to higher-salinity species of submerged vegetation have occurred in Florida, where seagrass beds are more abundant. Reduction of submerged vegetation in the bays of Florida is largely attributed to increased turbidity, primarily due to dredge and fill activities (Wolfe et al., 1988). Channel dredging to facilitate, create, and maintain waterfront real estate, marinas, and waterways will continue to be a major impact-producing factor in the proposed cumulative activity area.

The waterway maintenance program of the COE has been operating in the cumulative activity area for decades (Chapter 4.1.2.1.9). Impacts generated by initial channel excavations are sustained by regular maintenance activities performed every 2-5 years, or perhaps less frequently. The patterns of submerged vegetation and seagrass beds have adjusted accordingly. Maintenance activities are projected to continue into the future regardless of the OCS activities. If the patterns of maintenance dredging change, then the patterns of submerged vegetation distribution may also change.

In areas where typical spoil banks are used to store dredged materials, the usual fluid nature of mud and subsequent erosion causes spoil bank widening, which may bury nearby waterbottoms and submerged vegetation/seagrass beds. Those waterbottoms may become elevated, converting some nonvegetated waterbottoms to shallower waterbottoms that may become vegetated due to increased light at the new soil surface. Some of these waterbottoms may also be converted to wetlands, or even uplands, by the increased elevation.

Plans for installation of new linear facilities and maintenance dredging are reviewed by a variety of Federal, State, and local agencies, as well as by the interested public for the purposes of receiving necessary government approvals. Mitigation may be required to reduce undesirable impacts. The most effective mitigation for direct impacts to seagrass beds and associated habitat is avoidance with a wide berth around them. Using turbidity curtains can also control turbidity.

Many of man’s activities have caused landloss either directly or indirectly by accelerating natural processes. Until the Mississippi River was channelized and leveed during the early 1900’s, floodwaters layered sediment over the active Deltaic plain, countering ongoing submergence and also building new land. Areas that did not receive sediment-laden floodwaters continually lost elevation. Human intervention interrupted this process of renewal. Further compounding this impact, the suspended sediment load in the Mississippi River has decreased more than 50 percent since the 1950’s, largely as a result of dam and reservoir construction (Turner and Cahoon, 1988) and soil conservation practices in the drainage basin. Also, natural drainage patterns along many areas of the Texas coast have been severely altered by construction of the GIWW and other channelization projects associated with its development. Saltwater intrusion, as a result of river channelization and canal dredging, is a major cause of coastal habitat deterioration (including seagrass communities) (Tiner, 1984; National Wetlands Inventory Group, 1985). Productivity and species diversity associated with submerged vegetated habitat in coastal marshes of Louisiana and Texas is greatly reduced by saltwater intrusion (Stutzenbaker and Weller, 1989).

Leveeing (or banking) and deepening of the Mississippi River has affected seagrass communities in the Mississippi and Chandeleur Sounds by reducing freshwater flows and flooding into those estuaries and by raising average salinities there. Due to increased salinities, some species of submerged vegetation including seagrass beds are able to populate areas farther inland, where sediment conditions are not as ideal. If the original beds are then subjected to salinities that are too high for their physiology, the vegetation will die which affects the habitat associated with the seagrass beds, e.g., nursery habitat for juvenile fish and shrimp. In turn, freshwater inflow increases around the mouths of rivers that have been modified for flood control, hence, beds of submerged vegetation may become established farther seaward if conditions are favorable. If the original beds are then subjected to salinities that are too low for their physiology, the vegetation will die. These adjustments have occurred in the cumulative activity area, particularly when high-water stages in the Mississippi River cause the opening of the Bonnet Carre' Spillway to divert flood waters into Lake Pontchartrain. This freshwater eventually flows into Mississippi and Chandeleur Sounds, lowering salinities there. In the past, spillway openings have been associated with as much as a 16 percent loss in seagrass vegetation acreage (Eleuterius, 1987). Conversely, the Caernarvon Freshwater Diversion into the Breton Sound Basin, east of the River, provides more regular flooding events, which have reduced average salinities there. Reduced salinities there have triggered a large increase in acreage of submerged freshwater vegetation. Seagrass communities may then reestablish in regions that were previously too saline for them.

Scarring

The scarring of seagrass beds by vessels (including various support vessels for OCS and State oil and gas activities, fishing vessels, and recreational watercraft) is an increasing concern along the Texas coast. Scarring most commonly occurs in seagrass beds that occur in water depths shallower than 6 ft as a result of boats of all classes operating in water that is too shallow for them. Consequently, their propellers and occasionally their keels plow though shallow water bottoms, tearing up roots, rhizomes, and whole plants, leaving a furrow that is devoid of seagrasses ultimately destroying essential nursery habitat. Other causes include anchor drags, trawling, trampling, and loggerhead turtles (especially in seagrass habitat of the coast of Florida) (Sargent et al., 1995; Preen, 1996). Recently, seismic activity in areas supporting seagrass nursery habitat has become a focus of concern for Texas state agencies. Although the greatest scarring of seagrasses has resulted from smaller boats operating in the vicinities of the greatest human population and boat registration densities, the greatest single scars have resulted from commercial vessels. Scarring may have a more critical effect on habitat functions in areas with less submerged vegetation. A few local and state governments in the Coastal Bend area of Texas have instituted management programs to reduce scarring. These programs include education, channel marking, increased enforcement, and limited-motoring zones. Initial results indicate that scarring can be reduced.

Oil Spills

Because of the floating nature of oil and the regional microtidal range, oil spills alone would typically have very little impact on seagrass communities and associated epifauna. Increased wave action can increase impacts to submerged vegetation and the community of organisms that reside in these beds by forcing oil from the slick into the water column. Unusually low tidal events would also increase the risk of oil having direct contact with the vegetation. Even then, epifauna residing in these seagrass beds would be more heavily impacted than the vegetation itself. Oiling of seagrass beds would result in die-back of the vegetation and associated epifauna, which would be replaced for the most part in 1-2 growing seasons, depending upon the season in which the spill occurs. Although little or no direct mortality of seagrass beds is expected as a result of oil-spill occurrences, contact of seagrasses with crude or refined oil products has been implicated as a causative factor in the decline of seagrass beds and in the observed changes in species composition within them (Eleuterius, 1987). Cleanup of slicks in shallow, protected waters (less than 5 ft deep) can cause significant scarring and trampling of submerged vegetation beds.

Oil spilled in Federal offshore waters is not projected to significantly impact submerged aquatic vegetation, which includes seagrass communities. In contrast and based on information presented in Chapter 4.1.2.1.5.1, oil spills from inland oil-handling facilities and navigational traffic has a greater potential for impacting wetlands and seagrass communities. Given the large number of existing oil wells and pipelines in eastern coastal Louisiana and the volumes of oil piped through that area from the OCS, the risk of oil-spill contacts to the few seagrass beds in that vicinity would be much higher than elsewhere in the cumulative activity area.

Summary and Conclusion

Dredging generates the greatest overall risk to submerged vegetation. Dredging causes problems for beds of submerged vegetation. These actions uproot, bury, and smother plants as well as decrease oxygen in the water and reduce the amount of necessary sunlight. Channel dredging to create and maintain waterfront real estate, marinas, and waterways will continue to cause the greatest impacts to higher salinity submerged vegetation.

The oil and gas industry and land developers perform most new dredging in the cumulative activity area. Within the cumulative activity area, most dredging that impacts lower salinity submerged vegetation has occurred in Louisiana and Texas in support of inshore petroleum development. Cumulatively, offshore oil and gas activities are projected to generate another 19-32 pipeline landfalls in Texas and Louisiana. Mitigation may be required to reduce undesirable impacts of dredging to submerged vegetation. Maintenance dredging of navigation channels may sustain the impacts of original dredging. The most effective mitigation for direct impacts to submerged vegetation beds is avoidance, as well as the use of turbidity curtains to reduce turbid conditions.

Large water control structures associated with the Mississippi River influence salinities in coastal areas, which in turn influences the location of seagrass communities and associated epifauna. Where flooding or other freshwater flow to the sea is reduced, regional average salinities generally increase. Average salinities in areas of the coast that receive increased freshwater flows as a result of the above flood controls are generally reduced. Beds of submerged vegetation (seagrass) adjust their locations based on their salinity needs. If the appropriate salinity range for a species is located where other environmental circumstances are not favorable, the new beds will be either smaller, less dense, or may not colonize at all.

When the Mississippi River is in flood condition, floodways may be opened to alleviate the threat of levee damage. The floodways of the Mississippi River direct water to estuarine areas where flood waters may suddenly reduce salinities for a couple of weeks to several months. This lower salinity can damage or kill high-salinity seagrass beds if low salinities are sustained for longer periods than the seagrass species can tolerate. Opening one of the floodways of the Mississippi River is the single action that can adversely impact the largest areas of higher-salinity submerged vegetation.

Inshore oil spills generally present greater risks of adversely impacting submerged vegetation and seagrass communities than do offshore spills for the areas in a proposed action (Mississippi, Louisiana, and Texas). Given the large number of existing oil wells and pipelines in and near Chandeleur Sound and the designation by the OSRA analysis that Plaquemines Parish has one of the highest probabilities that a spill ≥1,000 bbl will make landfall, the risk of numerous contacts to seagrass beds in this vicinity may be high. Such contacts will result in die back to the seagrass vegetation and supported epifauna, which will be replaced for the most part within one to two growing seasons, depending upon the season in which the spill occurs. Although zero to little direct permanent mortality of seagrass beds is expected as a result of oil-spill occurrences, contact of seagrasses with crude and refined oil has been implicated as a causative factor in the decline of seagrass beds and in the observed changes in species composition within them (Eleuterius, 1987).

Because of the floating nature of oil and the microtidal range that occurs in this area, oil spills alone would typically have very little impact on seagrass beds and associated epifauna. Unusually low tidal events, increased wave energy, or the use of oil dispersants increase the risk of impact. Usually, epifauna residing within the seagrass beds is much more heavily impacted than the vegetation. The cleanup of slicks can cause significant scarring and trampling of submerged vegetation and seagrass beds while the slick is over shallow, protected waters that are less than 5-ft deep.

Seagrass communities and associated habitat can be scarred by anchor drags, trampling, trawling, loggerhead turtles, occasional seismic activity, and boats operating in water that is too shallow for their keels or propellers. These actions remove or crush plants. The greatest scarring results from smaller boats operating in the vicinities of larger populations of humans and registered boats. A few State and local governments have instituted management programs that have resulted in reduced scarring.

In general, a proposed action would cause a minor incremental contribution to impacts to submerged vegetation due to dredging, boat scarring, pipeline installations and possibly oil spills. Because channel maintenance, land development, and flood control will continue, with only minor impacts attributable to OCS activities, a proposed action would cause no substantial incremental contribution to these activities or to their impacts upon submerged aquatic vegetation or seagrass communities.

4.5.2. Impacts on Sensitive Offshore Resources

4.5.2.1. Live Bottoms (Pinnacle Trend and Topographic Features)

Pinnacle Trend

This cumulative analysis considers the effects of impact-producing factors related to the proposed actions plus those related to prior and future OCS lease sales, and to tanker and other shipping operations that may occur and adversely affect live bottoms (low-relief and pinnacle trend features). Specific OCS-related impact-producing factors considered in the analysis are structure emplacement and removal, anchoring, discharges from well drilling, produced waters, pipeline emplacement, oil spills, blowouts, and operational discharges by tanker ships. Non-OCS-related impacts, including commercial fisheries, natural disturbances, additional anchoring by recreational boats, and other non-OCS commercial vessels, as well as spillage from import tankering, all have the potential to alter live bottoms.

It is assumed protective stipulations for live bottoms and the pinnacle trend will be part of appropriate OCS leases and existing site/project-specific mitigations will be applied to OCS activities on these leases or supporting activities on these leases. Stipulations and mitigations require operators to do the following:

- locate potential individual live bottoms and associated communities that may be present in the area of proposed activities and,
- protect sensitive habitat potentially impacted by OCS activities by requiring appropriate mitigation measures.

Stipulations and mitigations do not protect the resources from activities outside the MMS jurisdiction (i.e., commercial fishing, tanker and shipping operations, or recreational activities).

Most non-OCS activities have a greater potential to affect the hard-bottom communities of the region. Recreational boating and fishing, import tankering, and natural events such as extreme weather and fluctuations of environmental conditions (e.g., nutrient pulses, low dissolved oxygen levels, seawater temperature minima, and seasonal algal blooms) may severely impact low-relief, live-bottom communities of the CPA. There are no known pinnacle features located within the boundaries of the WPA. In addition, ships anchoring near major shipping fairways of the CPA, on occasion, may impact sensitive areas located near these fairways. Numerous fishermen also take advantage of the relatively shallow and easily accessible resources of the region and anchor at hard-bottom locations to fish. This is particularly the case in the pinnacle trend area. Therefore, several instances of severe and permanent physical damage to the pinnacle features and the associated live bottoms could occur as the result of non-OCS activities. It is assumed that biota associated with live bottoms of the CPA are well adapted to many of the natural disturbances mentioned above. A severe human disturbance, however, could cause important damage to live-bottom biota, possibly leading to changes of physical integrity, species diversity, or biological productivity exceeding natural variability. If such an event were to occur, recovery to pre-impact conditions could take as much as 10 years.

As with anchoring, the placement of drilling rigs and production platforms on the seafloor crushes the organisms directly beneath the legs or mat used to support the structure. The areas affected by the placement of the rigs and platforms would predominantly be soft-bottom regions where the infaunal and epifaunal communities are ubiquitous. Because of local bottom currents, the presence of conventional bottom-founded platform structures can cause scouring of the surficial sediments (Caillouet et al., 1981).

Structure placement and anchor damage from support boats and ships, floating drilling units, and pipeline-laying vessels disturb areas of the seafloor. These disturbances are considered the greatest OCS-related threat to live-bottom areas. The size of the areas affected by chains associated with anchors and pipeline-laying barges would depend on the water depth, chain length, sizes of anchor and chain, method of placement, wind, and current. Anchor damage could include crushing and breaking of live/hard bottoms and associated communities. Anchoring often destroys a wide swath of habitat when a vessel drags or swings at anchor, causing it to drag the seafloor. The biological stipulations limit the proximity of new activities to live bottoms and sensitive features. Platforms are required to be placed away from live bottoms thus, anchoring events near platforms are not expected to impact the resource. Accidental anchoring could severely impact hard-bottom substrate with recovery rates (which are not well documented) estimated at 5-20 years depending on the severity.

Both explosive and nonexplosive structure-removal operations disturb the seafloor and can potentially affect nearby live/hard-bottom communities. Structure removal using explosives (the most common removal method) can suspend sediments, which settle much in the same manner as discussed below for muds and cuttings discharges. Individual charges used in OCS structure removals are required to be 23 kg (50 lb) or less, and are detonated 5 m below the mudline, which may attenuate shock waves in the seafloor within less than 100 m from the structure (Baxter et al., 1982). Sessile and other benthic organisms are known to resist the concussive force of structure-removal-type blasts. Sediment resuspension associated with structure removals would not last long and in some cases, does not occur at all (Gitschlag, personal communication, 2001). Resuspended sediments would impact an area within a radius of approximately 1,000 m. Therefore, the explosive removal of structures is not expected to effect these sensitive areas. Should low-relief, hard-bottom communities incur any damages as a result of the explosive removal of structures, impacts would include restricted cases of mortality, and the predicted recovery to pre-impact conditions would be accomplished in less than 10 years.

Routine discharges of drilling muds and cuttings by oil and gas operations could affect biological communities and organisms through a variety of mechanisms, including the smothering of organisms through deposition or less obvious sublethal toxic effects (impacts to growth and reproduction). The protective lease stipulations and site-specific mitigations would prevent drilling activities and drilling discharges from occurring directly over pinnacle features or associated habitat. Drilling discharges should reach undetectable concentrations in the water column within 1,000 m of the discharge point, thus limiting potential toxic effects to any benthic organisms occurring within a 1,000 m radius from the discharge point. Any effects would be expected to diminish with increasing distance from the discharge area. Although Shinn et al. (1993) found detectable levels of metals from muds out to 1,500 m from a previously drilled well site in the pinnacle trend area, the levels of these contaminants in the water column and sediments are expected to be much lower than those known to have occurred in the past due to new USEPA discharge regulations and permits (Chapter 4.1.1.3.4). Regional surface currents and the water depth (>40 m) would greatly dilute the effluent. Deposition of drilling muds and cuttings in live-bottom and pinnacle trend areas are not expected to greatly impact the biota of the pinnacles or the surrounding habitat. Furthermore, because the biota of the seafloor surrounding the pinnacles are adapted to life in turbid (nepheloid) conditions and high sedimentation rates in the western portions of the pinnacle trend area, deposition and turbidity caused by a nearby well should not adversely affect this sensitive environment. The impact from muds and cuttings discharged as a result of the cumulative scenario would be temporary, primarily sublethal in nature, and the effects would be limited to small areas. Recovery to pre-impact conditions from these sublethal impacts would take place within 10 years.

The depth of the low relief hard bottoms (>40 m), currents, and offset of discharges of produced waters and domestic and sanitary wastes (required by lease stipulations and postlease mitigations) would result in the dilution of produced waters and wastes to harmless levels before reaching any of the live bottom. Adverse impacts from discharges of produced waters and domestic and sanitary wastes as a result of the cumulative case would therefore be temporary, primarily sublethal in nature, and the effects would be limited to small areas. Predicted recovery to pre-impact conditions from these sublethal impacts would take place within 5 years.

The Live Bottom (Low Relief) Stipulation, Eastern Pinnacle Trend Stipulation, and site-specific mitigations are expected to prevent operators from placing pipelines directly upon live-bottom communities. The effect of pipeline-laying activities on the biota of these communities would be restricted to the resuspension of sediments, possibly causing obstruction of filter-feeding mechanisms of sedentary organisms and gills of fishes. Adverse impacts from resuspended sediments would be temporary, primarily sublethal in nature, and the effects would be limited to small areas. Predicted recovery to pre-impact conditions from these sublethal impacts would take place within 5 years.

Assumptions of oil-spill occurrences, spill sizes, and estimates resulting from the OCS Program are described in Chapter 4.4.1.1. Oil spills have the potential to be driven into the water column. Measurable amounts have been documented down to a 10-m depth, although modeling exercises have indicated such oil may reach a depth of 20 m. At this depth, however, the concentration of the spilled oil or dispersed oil would be at several orders of magnitude lower than the amount shown to have an effect on marine organisms (Lange, 1985; McAuliffe et al., 1975 and 1981). In the unlikely event a freighter, tanker, or other ocean going vessel related to OCS Program activities sank and proceeded to collide with the pinnacle features or associated habitat releasing its cargo, recovery capabilities from such a catastrophic scenario are unknown at this time. For the purpose of this analysis, it is projected that no surface spills, regardless of size, would have an impact on the biota of live/hard bottoms, largely because the tops of the features crest at depths greater than 20 m. Surface oil spills are therefore not expected to impact the hard-bottom communities.

Subsurface pipeline oil spills are not expected to cause damage to live/hard-bottom biota because the oil would initially adhere to the sediments surrounding the buried pipeline until the sediment reached its maximum capacity to retain the oil before the oil rapidly rises (typically 100 m/hr in shallow water) (Guinasso, personal communication, 1997) in discrete droplets toward the sea surface. Oil-spill occurrence for the OCS Program is presented in Chapter 4.1.3.4. Since the lease stipulations and site-specific mitigations would prevent the installation of pipelines in the immediate vicinity of live/hard-bottom areas, there is little probability that a subsurface oil spill will impact live/hard bottoms. Should a pipeline spill occur in the immediate vicinity of a live/hard bottom, impacts, including the uptake of hydrocarbons and attenuated incident light penetration, could cause partial mortality of local biota. Most of the biota, however, would likely survive and recover once the live/hard bottoms were clear of oil. The adverse impacts from subsurface oil spills on live/hard bottoms would be minor in scope, primarily sublethal in nature, and the effects would be contained within a small area. Recovery to pre-impact conditions from these sublethal impacts could take place within 5-10 years.

Blowouts have the potential to resuspend sediments and release hydrocarbons into the water column, which may affect pinnacle-trend communities. Subsurface blowouts occurring near these communities can pose a threat to the biota. The severity and proximity of such an occurrence to live/hard bottoms cannot be predicted. The continued implementation of lease stipulations and mitigations should prevent blowouts from occurring directly on or in proximity to live/hard bottoms. What can be predicted is that such blowouts would cause sediments to be released and resuspended. A severe subsurface blowout within 400 m of a live/hard bottom could result in the smothering of the biota due to sedimentation. Since much of the live/hard-bottom biota is adapted to turbid conditions, most impacts would probably be sublethal with recovery taking place within 5 years.

Should the Live Bottom (Low Relief) and Pinnacle Trend Stipulations not be implemented for the proposed actions or for future lease sales, OCS activities could have the potential to destroy part of the biological communities and damage one or several live/hard-bottom features. The most potentially damaging of these are the impacts associated with physical damages that may result from anchors, structure emplacement, and other bottom-disturbing operations. Potential impacts from oil spills larger than 1,000 bbl, blowouts, pipeline emplacement, mud and cutting discharges, and structure removals exist. The OCS Program, without the benefit of protective lease stipulations and site-specific mitigations, would probably have an adverse impact on live/hard bottoms of the EPA, particularly from anchor damage to pinnacle-trend features.

Summary and Conclusion

Non-OCS activities in the vicinity of the hard-bottom communities include recreational boating and fishing, import tankering, and natural events such as extreme weather conditions, and extreme fluctuations of environmental conditions (e.g., nutrient pulses, low dissolved oxygen levels, seawater temperature minima, and seasonal algal blooms). These activities could cause severe damage that could threaten the survival of the live/hard-bottom communities. Ships using fairways in the vicinity of live/hard bottoms anchor in the general area of live/hard bottoms on occasion, and numerous fishermen take advantage of the relatively shallow and easily accessible resources of regional live/hard bottoms. These activities could lead to several instances of severe and permanent physical damage.

Impact-producing factors resulting from routine activities of OCS oil and gas operations include physical damage, anchoring, structure emplacement and removal, pipeline emplacement, drilling discharges, discharges of produced waters, and discharges of domestic and sanitary wastes. In addition, accidental subsea oil spills or blowouts associated with OCS activities can cause damage to live bottoms. Long-term OCS activities are not expected to adversely impact the live/hard-bottom environment if these impact-producing factors are restrained by the continued implementation of protective lease stipulations and site-specific mitigations. The inclusion of the Live Bottom (Low Relief) and Eastern Pinnacle Trend Stipulations would preclude the occurrence of physical damage, the most potentially damaging of these activities. The impacts to the live/hard bottoms are judged to be infrequent because of the small number of operations in the vicinity of live/hard bottoms. The impact to the live/hard-bottom resource as a whole is expected to be slight because of the projected lack of community-wide impacts.

Impacts from blowouts, pipeline emplacement, muds and cuttings discharges, other operational discharges, and structure removals should be minimized because of the proposed Live Bottom (Low Relief) and Eastern Pinnacle Trend Stipulations, and the dilution of discharges and resuspended sediments in the area. Potential impacts from discharges will probably be further reduced by USEPA discharge regulations and permits restrictions (Chapter 4.1.1.3.4.). Potential impact from oil spills greater than 1,000 bbl would be restricted because of the depth of the features (>20 m) (if the spill occurs on the sea surface), because subsea pipeline spills are expected to rise rapidly, and because of the low prospect of pipelines being routed immediately adjacent to live/hard bottoms. The frequency of impacts to live/hard bottoms should be rare and the severity slight. Impacts from accidents involving anchor placement on live/hard bottoms could be severe in small areas (those actually crushed or subjected to abrasions).

The incremental contribution of a proposed action (as analyzed in Chapters 4.2.1.2.1, 4.3.1.2.1, and 4.4.3.2.1) to the cumulative impact is expected to be slight, with possible impacts from physical disturbance of the bottom, discharges of drilling muds and cuttings, other OCS discharges, structure removals, and oil spills. Negative impacts should be restricted by the implementation of the Live Bottom (Low Relief) and Eastern Pinnacle Trend Stipulations and site-specific stipulations, the depths of the features, and the currents in the live/hard-bottom area.

Topographic Features

The Topographic Features Stipulation is assumed to be in effect for this cumulative analysis. The continued application of this stipulation would prevent any direct adverse impacts on the biota of the topographic features potentially generated by oil and gas operations. The cumulative impact from routine oil and gas operations includes effects resulting from a proposed action (Chapters 4.2.1.2.1 and 4.3.1.2.1) as well as those resulting from past and future OCS leasing. These operations include anchoring, structure emplacement, effluent discharge, blowouts, oil spills, and structure removal. Potential non-OCS-related factors include vessel anchoring, treasure hunting activities, import tankering, heavy storms and hurricanes, the collapse of the tops of the features due to dissolution of the underlying salt structure, commercial fishing, and recreational scuba diving.

Mechanical damage, including anchoring, is considered to be a catastrophic threat to the biota of topographic features. The proposed biological stipulation prohibits oil and gas leaseholders from anchoring vessels and placing structures in the No Activity Zones; the stipulation does not affect other non-OCS activities such as anchoring, fishing, or recreational scuba diving. No data are available on the extent to which non-OCS activities may take place; however, these activities are known to occur in proximity of the topographic features. Nearly all the topographic features are found near established shipping fairways and are apparently well known fishing areas. The Flower Gardens National Marine Sanctuary along with the USCG enforces a conventional hook and line rule (one hook per line) for fishing within the boundaries of the Sanctuary, which includes Stetson Bank. Also, several of the shallower topographic features are frequently visited by scuba divers aboard recreational vessels. Anchoring at a topographic feature by a vessel involved in any of these activities could damage the biota. The degree of damage would depend on the size of the anchor and chain (Gittings and Bright, 1986). Anchor damages incurred by live bottom may necessitate more than 10 years to recover. The Flower Gardens National Marine Sanctuary has a maximum 100-ft vessel anchor designation, enforced by the Sanctuary office in Bryan, Texas as well as the USCG.

The use of explosives in treasure hunting operations is typically not a concern on topographic features with the exception of Bright Bank. The blasting of large areas of Bright Bank by treasure hunters has resulted in the loss of extensive live coral cover (Bright, 1985), and as of this report, explosives are a continued form of excavation in and around Bright Bank. The recovery from such destructive activity may take in excess of 10 years, while partial resource loss is probably irreversible. Recovery of the system to pre-interference conditions would depend on the type and extent of damage incurred by individual structures (corals, etc.) of the topographic feature, however, recovery from the direct impacts from the use of explosives is unknown.

Impacts on the topographic features could occur as a result of spills or operational discharges from import tankering. Due to dilution and the depths of the crests of the topographic features, discharges should reach topographic features in insufficient concentrations to cause impacts.

Impacts from natural occurrences such as hurricanes occasionally result in damage to the biota of the topographic features. Coral colonies can be toppled and resuspended sand can scar live coral tissue, which could result in altering the structure of the reef. The collapse of the crest of the topographic features by the dissolution of the underlying salt structure is possible, but it is unlikely and certainly beyond the ability to regulate.

Depending on the levels of fishing pressure exerted, fishing activities that occur at the topographic features may impact local fish populations (Chapters 4.2.1.10 and 4.3.1.8). The collecting activities by scuba divers on shallow topographic features may have an adverse impact on the local biota; however, there is a no collecting designation at the Flower Gardens National Marine Sanctuary. Anchoring during recreational and fishing activities, however, would be the source of the majority of severe impacts incurred by the topographic features.

Anchoring on the topographic features during oil- and gas-related operations could have even greater impacts (Bright and Rezak, 1978; Rezak et al., 1985). The continued application of the biological stipulation should preclude anchoring of pipeline barges, drilling rigs, or service vessels, and structure emplacement (pipeline, drilling rig, or platform emplacement) by oil and gas leaseholders in the No Activity Zone, thus preventing adverse impacts on benthic communities of topographic communities.

The routine discharge of drilling muds and cuttings is probably substantial under the cumulative scenario; it is assumed that several million barrels of drilling fluids and cuttings would be discharged in water depths less than 200 m. The areal extent of the topographic features relative to the area of the entire CPA and WPA is small, so the actual amounts of these discharges in the vicinity of the topographic features would be a fraction of this total. Continued application of the Topographic Features Stipulation would require lease operators to comply with measures, such as shunting that would keep discharged materials at depths below sensitive biota. The USEPA, through its new NPDES discharge permit, also enacts further mitigating measures. As noted above under the proposed actions, drilling fluids can be moderately toxic to marine organisms (the more toxic effluents are not allowed to be discharged under new NPDES permits), and their effects are restricted to areas closest to the discharge point, thus preventing contact with the biota of topographic features. Small amounts of drilling effluent may reach a bank from wells outside the No Activity Zone; however, these amounts, where measurable, would be extremely small and would be restricted to small areas and have sublethal effects on the biota. Such impacts would occur infrequently and the severity of the impacts is assumed to be disruptive or of impact to only a few elements at the regional or local scale. Therefore, no interference to the ecosystem performance would be incurred. Potential recovery of the system to pre-interference conditions would take place within 2 years.

With the inclusion of the proposed Topographic Features Stipulation, no discharges of effluents, including produced water would take place within the No Activity Zones. Discharges in areas around the No Activity Zone will be shunted to within 10 m of the seabed. This procedure, combined with the new USEPA discharge regulations and permits, should eliminate the threat of discharges reaching and affecting the biota of a topographic high. The impacts that these discharges could cause would be primarily sublethal damages that could lead to a possible disruption or impairment of a few elements at the regional or local scale, but no interference to the general ecosystem performance should occur. Potential recovery of the impacted area to pre-interference conditions would take place within 2 years.

Blowouts outside the No Activity Zones are unlikely to impact the biota of the topographic features. Predicted cumulative blowouts for the proposed actions for 40 years are in Tables 4-2 and 4-3.

Few blowouts, if any, would occur in the immediate vicinity of the topographic features. It is assumed that a resuspension of sediments or a subsurface oil spill following a blowout could reach the biota of a topographic feature. If this were to occur, the impacts would be primarily sublethal with the disruption or impairment of a few elements at the local scale, but no interference to the general system performance would occur. Potential recovery of the impacted area to pre-interference conditions would take place within 2 years.

Oil-spill occurrence and contact probabilities for the OCS Program are presented in Chapter 4.1.3.4. However, because of the water depths in which topographic features are found, no oil from surface spills would reach the biota of concern at concentrations likely to cause impacts. However a subsurface oil spill could reach the biota of a topographic feature. It is assumed such spills would initially adhere to the sediments surrounding the buried pipeline or well site until the sediment reached its maximum capacity to retain the oil before rising (typically 100 m/hr; Guinasso, personal communication, 1997) in discrete droplets toward the sea surface. Any oil remaining at depth would be swept clear by currents moving around the topographic features (Rezak et al., 1983).

If a seafloor oil spill (e.g., pipeline) were to occur, the spill would have to come into contact with a biologically sensitive feature to have an impact. The extent of damage from a spill would probably be concentrated on one sensitive area (feature), due to the broad distribution of topographic features across the Western and Central Gulf. Given the random nature of spill locations, the potential impacts of oil spills on biological resources of a topographic feature would probably be restricted to discrete locations. The currents should steer any spilled oil around the features rather than directly upon them, lessening impact severity. Furthermore, No Activity Zones established by the proposed Topographic Features Stipulation would serve to limit OCS activity within close proximity to such features thereby reducing the source of spills. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for corals and much of the other fully developed reef biota. It is anticipated that recovery for such an event would occur within a period of 2 years. In the highly unlikely event that oil from a subsurface spill could reach a coral covered area in lethal concentrations, the area so impacted would be small, but recovery of this area could take in excess of 10 years. Finally, in the unlikely event a freighter, tanker, or other ocean going vessel related to OCS Program activities or non-OCS related activities sank and collided with the topographic features or associated habitat releasing its cargo, recovery capabilities from such a catastrophic scenario are unknown at this time. In November 1999 a +60 ft recreational vessel sank at the West Flower Garden Bank and remains unrecovered. Destructive impacts from the vessel colliding with the corals and associated biota of the West bank are unknown at this time.

Many platforms will be removed from the OCS Program each year in the vicinity of topographic features (Tables 4-4, 4-5, and 4-6).

However, the proposed Topographic Features Stipulation would prevent the installation of platforms in the No Activity Zones, thus reducing the potential for impact from platform removal. The explosive removals of platforms should not impact the biota of the topographic features. Similarly, other activities that resuspend bottom sediments are unlikely to impact the topographic features

Summary and Conclusion

Activities causing mechanical disturbance represent the greatest threat to the topographic features. This would, however, be prevented by the continued application of the Topographic Features Stipulation. Potential OCS-related impacts include anchoring of vessels and structure emplacement, operational discharges (drilling muds and cuttings, and produced waters), blowouts, oil spills, and structure removal.

The proposed Topographic Features Stipulation would preclude mechanical damage caused by oil and gas leaseholders from impacting the live-bottom communities of the topographic features and would protect them from operational discharges. As such, little impact would be incurred by the biota of the topographic features. New USEPA discharge regulations and permits would further reduce discharge-related impacts (Chapters 4.2.1.3 and 4.3.1.3). Recovery from any discharge-related impacts would take place within 2 years.

Blowouts could potentially cause damage to benthic biota, however, due to the application of the proposed Topographic Features Stipulation, blowouts would not occur in the immediate vicinity of the topographic features and associated biota; therefore, there would be little impact on the features. Potential recovery from any impact would take place within 2 years.

Oil spills can cause damage to benthic organisms when the oil contacts the organisms. The proposed Topographic Features Stipulation would keep sources of OCS spills away from the immediate biota of the topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for corals (in the case of the Flower Garden

Banks and Stetson Bank) and much of the other fully developed biota. It is anticipated that potential recovery for such an event would occur within a period of 2 years. In the highly unlikely event that oil from a subsurface spill reached an area containing coral cover (e.g., Flower Garden Banks and Stetson Bank) in lethal concentrations, the impacted area would be small, but its recovery could take in excess of 10 years. Finally, in the unlikely event a freighter, tanker, or other ocean going vessel related to OCS Program activities or non-OCS related activities sank and proceeded to collide with the topographic features or associated habitat releasing its cargo, recovery capabilities from such a catastrophic scenario are unknown at this time.

Non-OCS activities are thought to have the greatest potential of impacting the topographic features, particularly those that could mechanically disrupt the bottom (such as anchoring and treasure-hunting activities, as previously described). Natural events such as hurricanes or the collapse of the tops of the topographic features (through dissolution of the underlying salt structure) could cause severe impacts. The collapsing of topographic features is unlikely and would, at the most, impact a single feature. Impacts from scuba diving, fishing, ocean dumping, and discharges or spills from tankering of imported oil are likely to have little or no impact on the topographic features.

The incremental contribution of a proposed action (as analyzed in Chapters 4.2.1.2.1 and 4.3.1.2.1) to the cumulative impact is negligible because of the implementation of the Topographic Features Stipulation, which would limit mechanical impacts and operational discharges. Furthermore, there is a low probability and low risk of accidental OCS-related events such as blowouts and oil spills occurring in the immediate vicinity of a topographic feature.

4.5.2.2. Deepwater Benthic Communities

Cumulative factors considered to impact the deepwater benthic communities of the Gulf of Mexico include both oil- and gas-related and non-oil- and gas-related activities. The latter type of impacting factors includes activities such as fishing and trawling. There are essentially only two species considered important to deepwater bottom fisheries – the yellowedge grouper and tilefish. Yellowedge grouper habitat only extends to only about 275 m. Bottom longlining for tilefish could potentially result in cumulative impact to deepwater communities as their habitat in the Gulf of Mexico extends to 411 m (>400 m) (Dooley, 1978). If contact did occur, impacts from bottom longlines would be minimal. Damage resulting from bottom trawling would have a much greater impact. De Forges et al. (2000) report threats to deepwater biological communities by fishing activity off New Zealand. Species similar to the targeted species in Australia and New Zealand, the orange roughy (genus *Hoplostethus*), do occur in the Gulf of Mexico; however, they are not abundant and are smaller in size. Bottom fishing and trawling efforts in the deeper water of the CPA and WPA are currently minimal, and impacts to deepwater benthic communities are negligible.

Oil- and gas-related activities include pipeline and platform emplacement activities, anchoring, accidental seafloor blowouts, drilling discharges, and explosive structure removals. This analysis considers the effects of these factors related to the proposed actions and to future OCS sales.

Other sources of cumulative impact to deepwater benthic communities would be possible, but are considered unlikely to occur. Essentially no anchoring from non-OCS-related activities occurs at the water depths where these communities are found. Some impacts are highly unlikely yet not impossible, such as the sinking of a ship or barge resulting in collision or contaminant release directly on top of a high-density community. One potential significant source of impact would be carbon sequestration in the deep sea as recently proposed by some international groups as a technique to reduce atmospheric carbon dioxide. Boyd et al. (2000) reported the successful iron fertilization of the polar Southern Ocean resulting in a large drawdown of carbon dioxide for at least 13 days and a massive plankton bloom for 30 days. Recent papers have highlighted the potential serious consequences of large scale CO_2 sequestration. Seibel and Walsh (2001) report extensive literature on the physiology of deep-sea biota indicating that they are highly susceptible to the CO_2 and pH excursions likely to accompany deep-sea CO_2 sequestration. The impacts of even very small excursions of pH and CO_2 could have serious, even global, deep-sea ecosystem impacts. Substantial additional research is needed before any large-scale actions would take place.

The greatest potential for adverse impacts to occur to the deepwater benthic communities, both chemosynthetic and nonchemosynthetic, would come from those OCS-related, bottom-disturbing activities associated with pipeline and platform emplacement (including templates and subsea completions), associated anchoring activities, discharges of muds and cuttings, and seafloor blowout accidents. The potential impacts to deepwater benthic communities from these activities are discussed in detail in Chapters 4.2.1.2.2 for the CPA and 4.3.1.2.2 for the WPA. The potential impacts from seafloor blowout accidents are discussed in Chapter 4.4.3.2.2.

As exploration and development continue on the Federal OCS, activities have moved into the deeper water areas of the Gulf of Mexico. With this trend comes the certainty that increased development will occur on discoveries throughout the entire depth range of the CPA and WPA; these activities will be accompanied by impacts to the deepwater benthos from bottom disturbances and disruption of the seafloor from associated activities. The extent of these disturbances will be determined by the intensity of development in these deepwater regions, the types of structures and mooring systems used, and the effective application of the avoidance criteria required under NTL 2000-G20. Activity levels for the cumulative scenario in the CPA and WPA are shown in Tables 4-6 and 4-5, respectively. Limited activity in the EPA is projected (Table 4-7). For the CPA deepwater offshore Subareas C200-800, C800-1600, C1600-2400 and C>2400, an estimated 4,140-5,838 exploration and delineation wells and 2,307-3,207 development wells are projected to be drilled, and 219-312 production structures are projected to be installed through the years 2003-2042. In the same water depths 53-71 blowout accidents are projected (Table 4-6). For the WPA deepwater offshore Subareas W200-800, W800-1600, W1600-2400 and W>2400, an estimated 1,030-1,671 exploration and delineation wells and 1,959-2,034 development wells are projected to be drilled, and 99-145 production structures are projected to be installed through the years 2003-2042For these same water depths 21-33 blowout accidents are projected.

Routine discharges of drilling muds and cuttings have been documented to reach the seafloor in water depths greater than 400 m (discussed in Chapters 4.2.1.2.2 and 4.3.1.2.2), but these discharges are distributed across wider areas and in thinner accumulations than they would be in shallower water depths. Potential impacts could result from accumulations of muds and cuttings resulting from consistent hydrographic conditions and drilling of multiple wells from the same location causing concentrations of material in a single direction or "splay." It is not expected that detectable levels of muds and cuttings discharges from separate developments or from adjacent lease blocks would act as a cumulative impact to deepwater benthic communities due their physical separation and great water depths.

An MMS-funded study, awarded on June 30, 2000, and entitled *Effects of Oil and Gas Exploration and Development at Selected Continental Slope Sites in the Gulf of Mexico*, will further refine the effectiveness of the new avoidance criteria. An additional study, *Improving the Predictive Capability of 3-D Seismic Surface Amplitude Data for Identifying Chemosynthetic Community Sites*, has also recently begun and is intended to groundtruth the interpretation of geophysical 3-D seismic surface anomaly data and the relationship to expected or potential community sites. The results of these studies will be used to refine the existing biological review processes for exploratory or development plans.

The majority of deepwater chemosynthetic communities are of low density and are widespread throughout the deepwater areas of the Gulf. Low-density communities may occasionally sustain minor impacts from discharges of drill muds and cuttings or resuspended sediments. These impacts are most likely to be sublethal in nature and would be limited in areal extent. The frequency of such impact is expected to be low. Physical disturbance to a small area would not result in a major impact to the ecosystem. The consequences of these impacts to these widely distributed low-density communities are considered to be minor with no change to ecological relationships with the surrounding benthos.

High-density, Bush Hill-type communities are widely distributed but few in number and limited in size. They have a high standing biomass and productivity. High-density chemosynthetic communities would be largely protected by NTL 2000-G20, which serves to prevent impacts by requiring avoidance of potential chemosynthetic communities identified by association with geophysical characteristics or by requiring photodocumentation to establish the presence or absence of chemosynthetic communities prior to approval of the structure or anchor placements. Current implementation of these avoidance criteria and understanding of potential impacts indicate that high-density communities should be protected from burial by pre-riser discharges of muds and cuttings at the bottom and burial by muds and cuttings discharges from the surface.

Small impacts are expected to occur infrequently, but the impacts from bottom-disturbing activities, if they occur, could be quite severe to the immediate area affected. If it occurred, the disturbance of a Bush Hill-type environment could lead to the destruction of a community from which recovery would occur only over long intervals (200+ years for a mature tube-worm colony and 25-50 years for a mature mussel community) or would not occur at all. The severity of such an impact is such that there may be incremental losses of productivity, reproduction, community relationships, overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

In cases where high-density communities are subjected to greatly dispersed discharges or resuspended sediments, the impacts are most likely to be sublethal in nature and limited in areal extent. The impacts to ecological function of high-density communities would be minor with recovery occurring within 2 years; however, minor impacts to ecological relationships with the surrounding benthos would also be likely.

Because of the great water depths, treated sanitary wastes and produced waters are not expected to have adverse impacts to any deepwater benthic communities. These effluents would undergo a great deal of dilution and dispersion before reaching the bottom, if ever.

A blowout at the seafloor could resuspend large quantities of bottom sediments and even create a large crater, destroying any organisms in the area. Structure removals and other bottom-disturbing activities could resuspend bottom sediments, but not at magnitudes as great as blowout events. The distance of separation provided by the adherence of NTL 2000-G20 would protect both chemosynthetic and non-chemosynthetic communities from the direct effects of deep-water blowouts.

Oil and chemical spills (potentially from non-OCS related activities) are not considered to be a potential source of measurable impacts on chemosynthetic communities because of the water depth. Oil spills from the surface would tend not to sink. Oil discharges at depth or on the bottom would tend to rise some in the water column and similarly not impact the benthos. There is also reason to expect that chemosynthetic animals are resistant to at least low concentrations of dissolved hydrocarbons in the water, as communities are typically found growing in oil saturated sediments and in the immediate vicinity of active oil and gas seeps.

Deepwater coral and other hard-bottom communities not associated with chemosynthetic communities are also expected to be protected by general adherence to NTL 2000-G20 and the shallow hazards NTL 98-12 due to the avoidance of areas represented as hard bottom on surface anomaly maps derived from 3-D seismic records. Biological reviews are performed on all activity plans (exploration and production) which includes analysis of maps and avoidance of hard bottom areas that are one of several important indicators for the potential presence of chemosynthetic communities.

Summary and Conclusion

Impacts to deepwater communities in the Gulf of Mexico from sources other than OCS activities are considered negligible. The most serious impact-producing factor threatening chemosynthetic communities is physical disturbance of the seafloor, which would destroy the organisms of these communities. Such disturbance would most likely come from those OCS-related activities associated with pipelaying, anchoring, structure emplacement, and seafloor blowouts. Drilling discharges and resuspended sediments have a potential to cause minor, mostly sublethal impacts to chemosynthetic communities, but substantial accumulations could result in more serious impacts. Seafloor disturbance is considered to be a threat only to the high-density (Bush Hill-type) communities; the widely distributed low-density communities would not be at risk. The provisions of NTL 2000-G20 require surveys and avoidance prior to drilling and will greatly reduce the risk. New studies are currently refining the information and confirming the effectiveness of these provisions. Activities unrelated to the OCS Program include fishing and trawling. Because of the water depths in these areas and the low density of potentially commercially valuable fishery species, these activities are not expected to impact deepwater benthic comminutes.

The activities considered under the cumulative scenario are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience minor impacts from drilling discharges or resuspended sediments, with recovery expected within several years. If physical disturbance (such as anchor damage) or extensive burial by muds and cuttings were to occur to high-density, Bush Hill-type communities, impacts could be severe, with recovery time as long as 200 years for mature tube-worm communities. There is evidence that substantial impacts on these communities would permanently prevent reestablishment. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

The cumulative impacts on nonchemosynthetic benthic communities are expected to cause little damage to the ecological function or biological productivity of the expected typical communities existing on sand/silt/clay bottoms of the deep Gulf of Mexico. Large motile animals would tend to move, and recolonization from populations from neighboring substrates would be expected in any areas impacted by burial.

The incremental contribution of the proposed actions (as analyzed in Chapters 4.2.1.2.2, 4.3.1.2.2, and 4.4.3.2.2) to the cumulative impact is expected to be slight, and to result from the effects of the possible impacts caused by physical disturbance of the seafloor and minor impacts from sediment resuspension. Adverse impacts will be limited but not completely eliminated by adherence to NTL 2000-G20.

4.5.3. Impacts to Water Quality

Cumulative impacts to water quality will occur from the proposed actions, ongoing oil and gas activities in the OCS and State waters, and all other sources that affect water quality, both natural and anthropogenic. Non-OCS sources include industrial, recreational, agricultural, and natural activities as well as oil and gas activities in state waters. An overview of the present status of water quality in the coastal and marine waters of the potentially impacted area is given in Chapter 3.1.2. The types of impacts and impacts from the proposed actions were discussed in Chapters 4.1.1.3.4, 4.2.1.3, and 4.3.1.3.

The OCS-related activities that can impact water quality include drilling wells, installation/removal of platforms, laying pipelines, service vessel operations, and supporting infrastructure discharges. A proposed action in the CPA is projected to result in 28-49 production structures. A proposed action in the WPA is projected to result in 11-15 structures. As a result of the proposed lease sales, four in the WPA and five in the CPA, a projected 184-305 structures will be added to the Gulf. A total of 2,987 to 3,999 structures may be added from the Gulfwide OCS Program between 2003 and 2042. At the same time, structures are being removed. According to the MMS database, an average of 109 structures per year were removed between 1996 and 2000. An estimated 6,303 to 7,296 structures will be removed Gulfwide between 2003 and 2042; most removal being in water depths less than 60 m (i.e., on the continental shelf). Presently, approximately 4,000 structures exist offshore. As more structures are removed than installed over time, the impacts from discharges to water quality will decrease over the next forty years. Routine oil and gas activities potentially degrade water quality through the addition of hydrocarbons, trace metals, and suspended sediment. Accidental spills of chemicals or oil will also impair water quality temporarily.

4.5.3.1. Coastal Waters

The water quality of coastal environments will be affected by cumulative input of hydrocarbons and trace metals from activities that support oil and gas extraction. These activities include bilge water from service vessels and point and non-point source discharges from supporting infrastructure. Discharges from service vessels are regulated by USCG to minimize cumulative impacts. The USEPA regulates point-source discharges. Only non-point-source discharges are not regulated and data do not exist to evaluate the magnitude of this impact. If regulations are followed, it is not expected that additional oil and gas activities will adversely impact the overall water quality of the region.

Dredging and channel erosion can add to the suspended load of local waterways. Support vessels as well as other activities such as commercial fishing and shipping use the waterways. Accurate information concerning the direct impacts from OCS activities is not available to evaluate the degradation of water quality in the waterways.

Accidental releases of chemicals or oil would degrade water quality during the spill and after until the spill is either cleaned up or natural processes disperse the spill. The effect on coastal water quality from spills estimated to occur from a proposed action (a 4,600-bbl offshore spill projected to reach coastal waters and a 3,000-bbl spill in coastal waters) are expected to be minimal relative to the cumulative effects from hydrocarbon inputs from other sources such as river outflow, industrial discharges, and bilge water releases as discussed in the National Research Council's report *Oil in the Sea* (NRC, 1985). The cumulative impacts to coastal water quality would not be changed over the long term as a result of the proposed actions.

Summary and Conclusion

Water quality in coastal waters will be impacted by supply vessel usage and infrastructure discharges. The impacts to coastal water quality from the proposed actions is not expected to significantly add to the degradation of coastal waters as long as all regulations are followed.

4.5.3.2. Marine Waters

Water quality in marine waters will be impacted by the discharges from drilling and production activities. Sources not related to oil and gas activities that can impact marine water quality include bilge water discharges from large ships and tankers; pollutants from coastal waters that are transported away from shore, which includes runoff, river input, sewerage discharges, and industrial discharges; and natural seepage of oil and trace metals.

Drilling activities add drilling mud and cuttings to the environment. From the MMS database, an average of 1,186 wells per year were spudded from 1996 to 2000; this rate is expected to decrease. A projected 289-599 wells will be drilled in support of a proposed action in the CPA. A projected 134-281 wells will be drilled in support of a proposed action in the WPA. A projected 1,981 to 4,119 wells will be drilled over the next 40 years as a result of the 2003-2007 proposed actions. The total OCS Program is projected to result in the drilling of 26,119 to 32,385 exploratory and development wells Gulfwide between 2003 and 2042. The impacts from drilling were discussed in Chapters 4.2.1.3 and 4.3.1.3. Studies thus far indicate that as long as discharge regulations are followed, impacts to the marine environment from drilling activities are not significant.

The NRC report (1985) on oil in the sea determined that bilge water input of oil was much greater than the input of oil from oil and gas activities. Using an estimate of 10 MMbbl/yr of water produced on the OCS (Table 4-10) and an average of 29 mg/l of hydrocarbon in the water, roughly 1,300 bbl of oil are added per year to the OCS from produced water. This amount of oil is very small relative to the estimates from natural seeps (Chapter 3.1.2.2). Support vessels also add hydrocarbon contamination by discharge of bilge water, however the discharged bilge water should meet USCG regulations, thus minimizing impacts.

Limited information is available on the levels of trace metals in Gulf of Mexico marine waters and the sources of trace-metal contamination. The USEPA (1993a and b) conducted detailed analyses of trace metal concentrations in discharges and used the data to establish criteria for the discharge of drilling wastes. Impacts from trace metal contamination are not expected to be significant.

Accidental spills of chemicals and oil are expected to impact water quality on a temporary basis and only close to the spill. Winds, waves, and currents should rapidly disperse any spill and reduce impacts.

Summary and Conclusion

Cumulative impacts on the water quality of the marine environment result from the addition of discharges from exploratory and production activities to a relatively pristine environment. As long as discharge criteria are met, impacts to the marine environment are not expected to be significant.

4.5.4. Impacts on Air Quality

The Gulf of Mexico has been subdivided into subareas based on water depth (0-60, 60-200, 200-800, 800-1600, 1600-2400 and 2400+) (Figure 4-1). Table 4-4 presents the numbers of exploration, delineation, and development wells; platforms installed; and service-vessel trips for the cumulative scenario in each subarea.

The types of sources and their usage does not change from the proposed actions to the cumulative scenario. The main differences between these two analyses are that each proposed action analysis considers only the emissions associated with one lease sale and the areas analyzed were restricted to a planning area. In the cumulative analysis, the cumulative emissions from existing sources, the proposed sales, and potential future sales are combined and the area analyzed is the entire Gulf of Mexico. The cumulative Gulfwide emissions for the 40-year period under consideration are estimated in Tables 4-53 and 4-54, for the CPA and WPA, respectively.

Total OCS emissions by subarea in the WPA and CPA for the cumulative scenario are presented in Table 4-55. Pollutants are distributed to subareas proportional to the projected number of production structure installations identified for those areas.

Peak-year emissions for the entire 40 years of Gulfwide activities are presented in Table 4-56. The peak-year is expected to occur between 2003 and 2010.

The peak-year emissions are calculated by combining peak-year activity total emissions for exploratory wells, development wells, and platforms over 40 years, and superimposing peak projected activity for support vessels and other emissions into that peak year. It is important to note that well drilling activities and platform peak-year emissions are not necessarily simultaneous. However, it is assumed for this analysis that total well and platform peak-year emissions combined with vessels and other emissions occur simultaneously. Use of the peak emissions shall provide the most conservative estimates of potential impacts to onshore air quality. Peak-year emissions for each subarea for the cumulative scenario are presented in Table 4-57. Pollutants are distributed to subareas proportional to the projected number of production structure installations identified for those areas.

The platforms remain the primary source of VOC emissions. The VOC emissions are best addressed as their corresponding ozone impacts, which were studied in the Gulf of Mexico Air Quality Study (GMAQS). The GMAQS indicated that OCS activities have little impact on ozone exceedance episodes in coastal nonattainment areas, including the Houston/Galveston, Port Arthur/Lake Charles, and Baton Rouge areas. Total OCS contributions to the exceedance (greater than 120 ppb) episodes studied were less than 2 ppb. In the GMAQS, the model was also run using double emissions from OCS petroleum development activities; the resulting attributable ozone concentrations, during modeling exceedance episodes, were still small, ranging 2-4 ppb. The cumulative activities under consideration will not result in a doubling of the emissions, and because they are substantially smaller than this worst-case scenario, it is logical to conclude that their impact would be substantially smaller as well (Systems Applications International et al., 1995). Additionally, 30 CFR 250.45(f)(2) requires that, if a facility would significantly impact (defined as exceeding the MMS significance level) an onshore nonattainment area, it would have to reduce its impact fully through the application of the best available control technology (BACT) and possibly through offsets as well.

Gaseous and fine particulate matter in the atmosphere can potentially degrade the atmospheric visibility. The visibility degradation is primarily due to the presence of particulates with a size range of 1-2 microns. The sources of these particulates may come from fuel burning and the chemical transformation of the atmospheric constituents. The chemical transformation of NO_2, SO_2, and VOC may produce nitrates, sulfates, and carbonaceous particles. High humidity also may contribute to the visibility impairment in the Gulf coastal areas. Visibility is considered an important resource in the Breton National Wilderness Area, a Federal Class I area, because future air emission from all sources in the area are expected to be about the same level or less. Thus, it is expected that the impact on visibility due to the presence of fine particulates would be minor.

Approximately 1-7 percent of OCS crude-oil production is projected to be offloaded from surface vessels at shore terminals. The fugitive emissions from these offloading operations are estimated maximum of 35,019 tons of VOC. This represents about 0.38 percent of the total VOC emissions in the WPA. Safeguards to ensure minimum emissions from the offloading and loading operations have been adopted by the State of Louisiana (The Marine Vapor Recovery Act, 1989: LAC: III.2108).

Recent MMS modeling runs were conducted using the Offshore and Coastal Dispersion (OCD) Model to determine potential cumulative NO_2 and SO_2 impacts on onshore areas. Three large areas were modeled. The limiting factor on the size of the area was the run time needed to process the number of sources. The areas modeled were a 150-km circle centered over Breton Island, a 100-km circle centered over the Grand Isle area, and a 150-mi circle over the Vermilion area. Receptors were set along the coastline and also a short distance inland in order to capture coastal fumigation. Circular areas were chosen to reduce edge effect. The Breton area was chosen to capture the Class I area. The other two areas were selected to best capture most of the offshore sources and to focus on the highly concentrated areas of development. The cumulative action was modeled by comparing the projected Gulfwide cumulative emissions with the emission inventory for the GMAQS. Ratios between these two sets of total emission rates were developed and applied to the GMAQS inventory; this modified inventory was then used as the database for the sources for the OCD modeling. The emissions inventory included structures in existence prior to the PSD baseline dates. Emissions from such structures do not count toward increment consumption. Only the maximum concentrations for all of the runs are reported and are compared with the federally allowable increases in emissions, as regulated by 30 CFR 250.45(g) and 40 CFR 51.166(c).

Table 4-58 lists the highest predicted contributions to onshore pollutant concentrations from activities associated with the proposed lease sales and compares them with the maximum allowable increases over a baseline concentration established under the air quality regulations. While the table show that the OCS Program by itself would result in concentration increases that are well within the maximum allowable limits (with the exception of the annual average for NO_2 and the 24-hour average for SO_2 in the Class I area), a direct comparison between the two sets of figures is not possible. This is because the actual maximum allowable increase depends on the net change in emissions from all other sources in the area, both offshore and onshore, since the date the baseline level was established. Sources that were already in place at the applicable baseline date are included in the establishment of the baseline and the corresponding concentration and do not count in the determination of the maximum allowable increment. The increment is an additional amount of deterioration of air quality allowed under the PSD program above the baseline concentration. The baseline concentration was required to be established when the first PSD application was submitted after the trigger date for the individual pollutants. For the Breton Wilderness Class I Area, this baseline concentration was not established; therefore, the actual cap on the allowable onshore concentration is not known. Another way of thinking of this is that the baseline concentrations are a set of numbers represented by X_i and the incremental or allowable increases are another set of numbers represented by Y_i; the figures obtained by adding the X_i and the Y_i would be the correct figures to compare the modeling results to.

Because of the concern that some of the Class I area increments may be consumed, MMS has been working with FWS to initiate a study of the baseline for the Breton Wilderness Area. The MMS and FWS have been working towards this proposed Breton Air Quality Study for several years now. Questions regarding the types of sources necessary for inclusion in the inventories, as well as inventory collection practices and quality control procedures, have been the primary focus of the recent discussions. The intent of this study will be to establish a baseline inventory and then to select an appropriate model to use for modeling the baseline concentration, as well as the current concentration. These two modeled concentrations can then be compared to determine the amount of increment consumed.

The MMS has instituted a program in postlease operations to evaluate all activities within a 100-km radius of the Breton Wildlife Refuge that could result in potential SO_2 and NO_2 impacts to this Class I area. The MMS is presently coordinating the review of Development Operations Coordination Documents (DOCD's) submitted by the applicants with FWS's Air Quality Division in Denver. Mitigating measures, including low sulphur diesel fuels and stricter air emissions monitoring and reporting requirements, are required for sources that are located within 100 km of the Breton Class I Area and that exceed emission levels agreed upon by the administering agencies.

For CO, a comparison of emission rates to the MMS exemption levels will be used to assess impact. The formula to compute the emission rates in tons/yr for CO are $3,400 \bullet D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility. The CO exemption level is 7,072 tons/yr for a facility at the Federal/State boundary line, which is the nearest point to shore of any facility in Federal waters. Therefore, the 7,072 tons/yr figure is the most restrictive emissions threshold for any facility in the OCS. The average emission rate for a production platform is 11.84 tons/yr, but some vessels have a higher emission rate. Nonetheless, if the total CO emissions for the entire Gulf of Mexico (at the high end of the range) were taken and assigned to the current number of production platforms (about 3,000), this would still only result in an emissions rate of approximately 26 tons/yr per platform. Not all platforms are located at the Federal/State boundary; therefore, most platforms have even larger exemption levels than the one used in this example.

For CO, a comparison of emission rates to the MMS exemption levels will be used to assess impact. The formula to compute the emission rates in tons/yr for CO are $3,400 \bullet D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility. Offshore Texas, the CO exemption level is 14,819 tons/yr for a facility at the Federal/State boundary line, which is the nearest point to shore of any facility in Federal waters. The average emission rate for a production platform is 11.84 tons/yr, but some vessels have a higher emission rate. Nonetheless, if the peak CO emissions for the entire Gulf of Mexico (at the high end of the range) were taken and assigned to the current number of production platforms (1,820), this would still only result in an emissions rate of approximately 29 tons/yr. Not all platforms are located at the 3 league line; therefore, most platforms have even larger exemption levels than the one used in this example.

Suspended particulate matter is important because of its potential in degrading the visibility in national wildlife refuges or recreational parks designated as PSD Class I areas. The impact depends on emission rates, particle size, and chemical composition. Particle size used in this analysis represents the equivalent diameter, which is the diameter of a sphere, that will have the same settling velocity as the particle. Particle distribution in the atmosphere has been characterized as being largely trimodal (Godish, 1991) with two peaks located at diameters smaller than 2 μm and a third peak with a diameter larger than 2 μm. Particles with diameters of 2 μm or larger settle very close to the source (residence time of approximately ½ day; Lyons and Scott, 1990). For particles smaller than 2 μm, which do not settle fast, wind transport determines their impacts. The PM_{10}'s are emitted at a substantially smaller rate than the two pollutants modeled with OCD; hence, impacts from PM_{10} would be expected to be even smaller. The impacts for PM were taken by scaling the ration of the PM/SO_x emissions and multiplyig them by the SO_2 impacts. $PM_{2.5}$ is of primary importance in visibility degradation. A straight ratio can be employed to give an impact in the Class I area of 0.45 ug/m^3 for the annual average and 5.85 ug/m^3 for the 24-hr average. Therefore, suspended matter is estimated to have a minimal effect on the visibility of PSD Class I areas in the Central Gulf of Mexico. A straight ratio can be employed to give an impact of 0.01 ug/m^3 for the annual average and 0.002 ug/m^3 for the 24-hr average, which are below the Class II increments in the Western Gulf of Mexico.

The amount of power generation that occurs during the period 2003-2042 is very difficult to predict because it depends on many nonquantifiable factors. Therefore, different sets of assumptions result in different estimates. The envelope of predictions shows that energy consumption should increase up to the year 2010; after this, predictions show more variation but generally indicate an increase of energy consumption. Because energy production is the largest single pollutant generator, one would suspect emissions would also increase (USDOE, 1990). However, advances in control technology and use of alternative energy sources can change the correlation between energy production and emissions. The available information (USDOE, 1990) indicates that SO_x emissions from energy generation decreased 16.4 percent between 1970 and 1987. Other pollutants that showed a decrease over the 1970-1987 period are particulate matter and NO_x. Although CO and VOC increased over the same period, the overall amount of emitted pollutants decreased.

Other major contributors to the air pollutants are from mobile sources (transportation). Not including service vessels, there were about 2.5 million vessels trips in State waters in 1999 (Table 3-30). If the projected, annual number of OCS service vessels trips were added to the 1999 figure, it is estimated that the OCS Program accounts for about 10 percent of the traffic in State waters. Each proposed action would account for <1 percent.

Emissions of the criteria pollutants related to industrial activities decreased over the 1970-1987 period. The reduction in the total amount of pollutants was 51 percent (Godish, 1991). The projected increase in employment (Chapter 3.3.3.5.1) can be interpreted as an increase of industrial activities. However, if the decreasing trend of emissions holds during the next 40 years, it is reasonable to estimate that industrial emissions would not increase; at worst they would remain at present levels. Oil and gas activity in State waters is also predicted to decline, thus further reducing pollutants (Chapter 4.1.3.1.1).

Summary and Conclusion

Based on the cumulative scenario discussed in Chapter 4.1. (Table 4-4), it is assumed that OCS emissions will maintain present levels with projected decreases in future years in relation to projected declining trends in OCS activity in the Gulf of Mexico and advances in control technology. Future impacts are intrinsically related to the continuation of trends in energy consumption and technological developments in fuel and engine efficiency.

Emissions of pollutants into the atmosphere from the activities associated with the cumulative scenario are not projected to have significant effects on onshore air quality because of the prevailing atmospheric conditions, emission rates and heights, and the resulting pollutant concentrations. Onshore impacts on air quality from emissions from cumulative OCS activities are estimated to be within Class II PSD allowable increments.

The modeling results indicate that all concentrations are below the maximum allowable PSD increments except 24-hr SO_2 and annual NO_2 for the Class I area. However, potential cumulative impacts to the Breton Wilderness Class I Area are unknown due to the baseline problem and require further study; although it should be noted that impacts from a Central proposed action are well within the PSD Class I allowable increment. The incremental contribution of the proposed actions (as analyzed in Chapters 4.2.14 and 4.3.14) to the cumulative impacts are not significant nor expected to alter onshore air quality classifications.

The above conclusion only considers the impact on air quality from OCS sources. If the onshore sources are considered, there may beconsiderable adverse effects on ozone concentration and on visibility (see also Draft EIS on the proposed OCS Oil and Gas Leasing Program 2002-2007; USDOI, MMS, 2001c). Thus, the OCS contribution to the air quality problem in the coastal areas is small, but total impact from onshore and offshore emissions may be significant because of the ozone nonattainment problem in southeast Texas and Baton Rouge, Louisiana. As a result, the implementation of the 8-hr ozone standard would lead to more areas being classified as nonattainment areas.

4.5.5. Impacts on Marine Mammals

This cumulative analysis considers activities that may occur and adversely affect marine mammals in the same general area that may be affected by a proposed action. The combination of potential impacts resulting from a proposed action in addition to past, present, and future OCS activities, incidental take in fisheries, live captures and removals, anomalous mortality events, habitat alteration, and pollution may affect marine mammals (endangered, threatened, and/or protected) in the region. The major impact-producing factors relative to a proposed action are described in Chapters 4.2.1.5 and 4.3.1.5. Sections providing supportive material for the marine mammals analysis include Chapters 3.2.4 (description of marine mammals), 4.1.1.2 (exploration), 4.1.1.3 (development and production), 4.1.2.1 (coastal infrastructure), 4.4.1 and 4.4.3.5 (spills).

Information on drilling fluids and drill cuttings and produced waters that would be discharged offshore are discussed in Chapter 4.1.1.3.4. Effluents are routinely discharged into offshore waters and are regulated by USEPA NPDES permits. Cetaceans may periodically be exposed to these discharges. Direct effects to cetaceans are expected to be sublethal. Indirect effects via food sources are not expected due to dilution and dispersion of offshore operational discharges. It should be noted, however, that any pollution in the effluent could potentially poison, kill, debilitate, or stress marine mammals and adversely affect prey species and other key elements of the Gulf of Mexico ecosystem (Tucker & Associates, Inc., 1990). Operational discharges could periodically contact and/or affect marine mammals.

Helicopter traffic is assumed to occur on a regular basis. It is projected that 338,666-415,359 OCS-related helicopter trips would occur annually in the support of OCS activities in the WPA (Table 4-5). Similarly, estimates of annual OCS-related helicopter trips in the CPA are 378,718-883,333 trips (Table 4-6). The FAA (Advisory Circular 91-36C) and corporate helicopter policy state that helicopters must maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between offshore structures. In addition, guidelines and regulations promulgated by NOAA Fisheries under the authority of the Marine Mammal Protection Act include provisions specifying helicopter pilots to maintain an altitude of 1,000 ft within 300 ft (91 m) of marine mammals. It is unlikely that cetaceans would be affected by routine OCS helicopter traffic at these altitudes, provided pilots do not alter their flight patterns to more closely observe or photograph marine mammals that they see. It is also expected that 10 percent of helicopter trips would occur at altitudes below the specified minimums listed above as a result of inclement weather. Routine overflights may elicit a startle response from and disturb nearby cetaceans (depending on the activity of the animals) (Richardson et al., 1995). Occasional overflights probably have no long-term consequences on cetaceans; however, frequent overflights could have long-term consequences if they occur repeatedly and disrupt vital activities, such as feeding and breeding. The OCS-related helicopters are not the only aircraft that fly over the coastal and offshore areas. Military, private, and commercial aircraft also traverse these areas and may impact marine mammals.

It is projected that 31,359-36,923 OCS-related, service-vessel trips would occur annually in support of OCS activities in the WPA (Table 4-5). The estimated number of OCS-related, service-vessel trips occurring annually in the CPA is calculated at 272,923-281,948 trips (Table 4-6). Noise from service-vessel traffic may elicit a startle and/or avoidance reaction by cetaceans and mask their sound reception. It is expected that the extent of service-vessel traffic predicted in the cumulative scenario could affect cetaceans either by active avoidance or displacement of individuals or groups to less suitable habitat areas. (Reaction will most likely vary with species, age, sex, and psychological status; the most vulnerable might be perinatal females and nursing calves, and those animals stressed by parasitism and disease.) The presence of multiple noise sources is expected to increase masking, disrupt routine behavioral activities, and cause short-term displacement (Richardson et al., 1995). Although the proportion of a marine mammal population exposed to noise from any one source may be small, the proportion exposed to at least one noise source may be much greater (Richardson et al., 1995). The net result of any disturbance would be dependent upon the size and percentage of the population likely to be affected; ecological importance of the disturbed area; environmental and biological parameters that influence an animal's sensitivity to disturbance and stress; or the accommodation time in response to a prolonged disturbance (Geraci and St. Aubin, 1980).

It is expected that the extent of service-vessel traffic in the cumulative scenario will affect cetaceans either via avoidance behavior or displacement of individuals or groups. Smaller delphinids may approach vessels that are in transit to bow-ride. There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity, unless they occur frequently. Long-term displacement of animals from an area is also a possibility. It is not known whether toothed whales exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased vessel traffic will increase the probability of collisions between vessels and marine mammals, resulting in injury or death to some animals (Laist et al., 2001).

In addition to OCS-related vessel trips, there are numerous other vessels traversing coastal and offshore waters that could impact marine mammals. Chapter 3.3.3.6 discusses non-OCS-related oil tanker and barge activities and non-OCS-related vessel and freight traffic. A large number of commercial and recreational fishing vessels use these areas.

It is projected that 1,842-2,668 exploration and delineation wells and 4,510-5,864 development wells would be drilled in support of OCS activities in the WPA (Table 4-5). In the CPA, 7,108-8,584 exploration and delineation wells and 12,553-15,052 development wells would be drilled in support of OCS program activities (Table 4-2). Drilling activities produce sounds at intensities and frequencies that could be heard by cetaceans. It is estimated that noise from drilling activities would be relatively constant, lasting no longer than four months at each location. Sound levels generated by drilling operations are generally low frequency (Gales, 1982). Odontocetes echolocate and communicate at higher frequencies than the dominant sounds generated by drilling platforms. The bottlenose dolphin is sensitive to high-frequency sounds and is able to hear low-frequency sounds; however, where most industrial noise energy is concentrated, sensitivity appears to be poor (Richardson et al., 1995). Baleen whales appear to be sensitive to low- and moderate-frequency sounds, but as mentioned by Richardson et al. (1995), the lack of specific data on hearing abilities of baleen whales is of special concern since baleen whales apparently are more dependent on low-frequency sounds than are other marine mammals. The effects on cetaceans from structure noise are expected to be sublethal and may elicit some degree of avoidance behavior and temporary displacement; interference with ability to detect calls from conspecifics, echolocation pulses, or other important natural sounds; or might cause temporary reduction in hearing sensitivity. It is expected that drilling noise will periodically disturb and affect cetaceans in the Gulf of Mexico. Nonetheless, exploratory wells have been drilled in the Mississippi Canyon region since 1985. Marine mammal surveys performed for MMS show that this region is inhabited by sperm whales (chiefly cows and calves) (Weller et al., 2000). Tagging and photo-identification data gathered as recently as the summer of 2001 show that sperm whales continue to use the region, even though OCS activity has increased in this area since the 1980's. Since 1991, MMS has funded multiple studies and surveys of cetaceans in the northern Gulf of Mexico. The resulting information has greatly expanded our knowledge regarding the occurrence, ecology, and behavior of marine mammals in the area. The MMS will continue to work with the MMC, NOAA Fisheries, and others involved in the study and protection of marine mammals to enhance our understanding of whether or not OCS activities have caused behavioral modifications among marine mammals occupying the region.

Potential impacts to marine mammals from the detonation of explosives include mortality, injury, and physical or acoustic harassment. Injury to the lungs and intestines and/or auditory system could occur. Harassment of marine mammals as a result of the explosion-generated shock wave and acoustic signature of the detonation is also possible. Resuspension of bottom sediments, increased water turbidity, and mobilization of bottom sediments due to detonating explosives are considered to be temporary effects.

An estimated 629-783 and 3,676-4,183 structure removals are projected to occur in the WPA (Table 4-3) and CPA (Table 4-2) respectively, between 2001 and 2040. It is expected that structure removals would cause only minor, physiological response effects on cetaceans, basically because of MMS and NOAA Fisheries guidelines for explosive removals.

Seismic surveys generate a more intense noise than other nonexplosive survey methods. Baleen whales seem tolerant of low- and moderate-level noise pulses from distant seismic surveys but exhibit behavioral changes to nearby seismic activity (Richardson et al., 1995). Subtle effects on surfacing, respiration, and dive cycles have been noted (shorter surfacings, shorter dives, and fewer blows per surfacing) (Richardson et al., 1995; Richardson, 1997). Bowhead and gray whales often show strong avoidance within 6-8 km of an airgun array. Strong avoidance of seismic pulses has been reported for bowheads as far as 24 km from an approaching seismic boat (Richardson, 1997). Bowheads have also been seen within 18.5-37.0 km of ongoing seismic operations, well inside the ensonified area (Richardson, 1997). Whales exposed to noise from distant seismic ships may not be totally unaffected even if they remain in the area and continue their normal activities (Richardson et al., 1995); there seems to be a graduation in response with increasing distance and decreasing sound level, and conspicuousness of effects diminishes, meaning that reactions may not be easy to see at a glance (Richardson, 1997). One report of sperm whales in the Gulf of Mexico indicated that the whales ceased vocalizations when seismic activity in the area was occurring (Davis et al., 1995) and that sperm whales may have moved 50+ km away (Mate et al., 1994). Goold (1996) found that acoustic contacts with common dolphins dropped sharply as soon as seismic activity began. Sperm whales during the Heard Island Feasibility Test were found to cease calling during some times when seismic pulses were received from an airgun array >300 km away (Bowles et al., 1994). Swift et al. (1999) found few, if any, effects of airgun noise on sperm whales in an area of the northeast Atlantic. No obvious behavior modifications relative to the seismic activity were recorded during the majority of the small odontocete observations made during marine mammal monitoring carried out by Impact Sciences during an Exxon 3-D seismic survey offshore California in late 1995 (Arnold, 1996). There was also no observed obvious behavior modification or harassment of large whales attributable to the sound effects of the survey (Arnold, 1996). For baleen whales, in particular, it is not known (a) whether the same individuals return to areas of previous seismic exposure, (b) whether seismic work has caused local changes in distribution or migration routes, or (c) whether whales that tolerate strong seismic pulses are stressed (Richardson et al., 1995). There are no data on auditory damage in marine mammals relative to received levels of underwater noise pulses (Richardson et al., 1995). Indirect "evidence" suggests that extended or repeated exposure to seismic pulses is unlikely to cause permanent hearing damage in marine mammals given a study of damage risk criteria; the transitory nature of seismic exploration; the presumed ability of marine mammals to tolerate exposure to strong calls from themselves or other nearby mammals; and the avoidance responses that occur in at least some baleen whales when exposed to certain levels of seismic pulses (Richardson et al., 1995). Although any one seismic survey is unlikely to have long-term effects on any cetacean species or population, available information is insufficient to be confident that seismic activities, collectively, would not have some effect on the size or productivity of any marine mammal species or population. These effects would likely be nonlethal.

Oil spills and oil-spill response activities can adversely affect cetaceans, causing skin and soft tissue irritation, fouling of baleen plates, respiratory stress from inhalation of toxic fumes, food reduction or contamination, direct ingestion of oil and/or tar, and temporary displacement from preferred habitats or migration routes. Previous studies suggested that contact with oil and consumption of oil and oil-contaminated prey are unlikely to cause more than temporary, nonlethal effects on cetaceans (Geraci, 1990). However, evidence from the 1989 *Exxon Valdez* spill indicates that oil spills have the potential to cause greater chronic (sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on mammals than originally suggested. Sea otters have had decreased survival rates in the years following the *Exxon Valdez* spill, and the effects of the spill on annual survival increased rather than dissipated for animals alive when the spill occurred (Monson et al., 2000). Some short-term (0-1 month) effects of oil may be (a) changes in cetacean distribution associated with avoidance of aromatic hydrocarbons and surface oil, changes in prey distribution, and human disturbance; (b) increased mortality rates from ingestion or inhalation of oil; (c) increased petroleum compounds in tissues; and (d) impaired health (e.g., immunosuppression) (Harvey and Dahlheim, 1994). Several mechanisms for long-term injury can be postulated: (a) sublethal initial exposure to oil causing pathological damage; (b) continued exposure to hydrocarbons persisting in the environment, either directly or through ingestion of contaminated prey; and (c) altered availability of prey as a result of the spill (Ballachey et al., 1994). A few long-term effects include (a) change in distribution and abundance because of reduced prey resources or increased mortality rates; (b) change in age structure because certain year-classes were impacted more by oil; (c) decreased reproductive rate; and (d) increased rate of disease or neurological problems from exposure to oil (Harvey and Dahlheim, 1994). Effects of cleanup activities are unknown, but increased human presence (e.g., vessels) could influence cetacean behavior and/or distribution, thereby stressing animals more, and subsequently increasing their vulnerability to various anthropogenic and natural sources of mortality. In the event that oiling of cetaceans should occur from spills, the effects would probably be sublethal; few proximate deaths are expected; however, long-term impacts might be more lethal to some animals.

Oil spill estimates project that there will be numerous, frequent, small spills; many, infrequent, moderately sized spills, and infrequent, large spills occurring in coastal and offshore waters between 2003-2042 (Table 4-17). The probability that a marine mammal is exposed to hydrocarbons resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of marine mammals in the northern Gulf will be exposed to residuals of oils spilled stemming from past, present, and future lease sales during their lifetimes.

A wide variety of debris is commonly observed in the Gulf. Marine debris comes from a variety of terrestrial and marine sources (Cottingham, 1988). Some material is accidentally lost during drilling and production operations. The offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore (Miller et al., 1995). Both entanglement in and ingestion of debris has caused the death or serious injury of individual marine mammals. The probability of entanglement or ingestion is largely unpredictable, but it is believed to be low.

Stock structure is completely unknown for all species in the Gulf, except for the bottlenose dolphin (Waring et al., 1997). Life history parameters have not been estimated for cetacean stocks in the Gulf, except for some coastal bottlenose dolphin stocks (Odell, 1975; Urian et al., 1996). Stock definition for bottlenose dolphins is problematic; there are a variety of possible stock structures (Blaylock and Hoggard, 1994). Inshore and offshore forms of bottlenose dolphins are commonly recognized based on morphological and ecological evidence (Hersh and Duffield, 1990). Recent work has confirmed significant genetic differences between inshore and offshore bottlenose dolphins in the Gulf of Mexico (Curry et al., 1995; LeDuc and Curry, 1997). There has been speculation that the population of bottlenose dolphins along the southeastern coast of the United States is structured such that there are local, resident stocks in certain embayments and transient stocks that migrate into and out of these embayments seasonally (Scott, 1990). There is reason to believe that some genetic exchange may occur between bottlenose dolphins inhabiting coastal waters and dolphins from bays and sounds in the Gulf (Blaylock and Hoggard, 1994). Differences in bottlenose dolphin reproductive seasonality from site to site also suggest genetic-based distinctions between communities (Urian et al., 1996).

Since the inception of the Marine Mammal Protection Act (1972), over 500 bottlenose dolphins have been live-captured and removed from southeastern U.S. waters for public display and scientific research purposes (USDOC, NMFS, 1989b). The live-capture fishery is managed under the 2 percent quota rule and based on the best available information relating to the bottlenose dolphin population abundance, stock structure, and productivity in the region (Scott and Hansen, 1989). Almost half of these dolphins were caught in the Mississippi Sound area (Tucker & Associates, Inc., 1990). Captures in the past had concentrated on the female portion of the stock, which in turn could significantly lower the potential for future recruitment (Scott, 1990). Capture activities may also stress and affect the survival and productivity of animals that are chased and captured, but not removed (Young et al., 1995; Myrick, 1988). Anomalous mortality events resulted in a temporary, if not permanent, cessation of the live-capture fishery for bottlenose dolphins in the southeastern United States (USDOC, NOAA, 1996).

Several anomalous mortality events (die-offs) have been reported for cetaceans. In the Gulf of Mexico, bottlenose dolphins have been involved in several unusual mortality events since 1990. The death of 26 bottlenose dolphins in Matagorda Bay in January 1990 was attributed to cold weather (Miller, 1992). No conclusive evidence for a single or multiple causal agent(s) was provided for the other 300+ animals that were part of the 1990 die-off on the Gulf Coast (Hansen, 1992). A localized die-off of dolphins in East Matagorda Bay in 1992 was suggested to be due to agricultural run-off (trace amounts of Aldecarb were found in the water) (Worthy, personal communication, 1995). Bottlenose dolphin stocks in the northern and western coastal portion of the northern Gulf Coast may have experienced a morbillivirus epidemic in 1993 (Lipscomb et al., 1996). In 1994, 67 percent of tested samples of a die-off of bottlenose dolphins in East Texas/Louisiana revealed that morbillivirus was present (Worthy, personal communication, 1995). A period of increased stranding of bottlenose dolphins from October 1993 through April 1994 in Alabama, Mississippi, and Texas was determined to have been caused by a morbilliviral epizootic (Lipscomb et al., 1996; Taubenberger et al., 1996). A die-off of bottlenose dolphins occurred in 1995 on the west coast of Florida (Hansen, personal communication, 1997) and on the Mississippi coast in November 1996 (Rowles, personal communication, 1996). Propagation of the morbilliviral epizootic along the coast is probably determined by contact between adjacent communities and seasonal movements of transient dolphins (Duignan et al., 1995a and 1996).

Concentrations of mortality do not appear widespread, appearing to occur in localized populations. To understand the impact and long-term effects, large-scale surveys are needed to assess impacts on the offshore dolphin distribution, while localized, small-scale surveys are required to quantify pre- and post-effects of the disease (Scott and Hansen, 1989). Blaylock and Hoggard (1994) noted that bottlenose dolphins living in enclosed systems (bays) in the U.S. might be subject to increased anthropogenic mortality due to their proximity to humans. Such dolphins would also be at increased risk of being affected by catastrophic events or by chronic, cumulative exposure to anthropogenic activities or compounds.

In spring 1996, 150 manatees were involved in a die-off; brevotoxin (red tide) was determined to be the cause (Suzik, 1997). At a regional level, 20 percent of the population was involved, while at the State level, it was 6 percent (Wright, personal communication, 1996). Sixteen manatees died in November 1997 as a result of a red tide in the same region of southwestern Florida where the 1996 die-off occurred (MMC, 1998). The first well-documented, manatee mortality event associated with a red tide was in 1982 (O'Shea et al., 1991). Free-ranging manatee exposure to a morbillivirus has been reported (Duignan et al., 1995b). The authors suggested that the infection in Florida manatees is sporadic rather than enzootic (as in cetaceans); however, Florida manatees may be at risk nonetheless for disease transmission between cows and their calves, between estrus herds, and during aggregations in warm water refuges (which is also the most stressful time of year energetically for these animals). Morbillivirus could then affect manatees either directly or through immunosuppression or abortion (Duignan et al., 1995b). Papillomavirus has recently been found in Florida manatees (Bossart, personal communication, 1997).

A variety of environmental contaminants have been found in Gulf of Mexico bottlenose dolphins (e.g., Haubold et al., 1993; Davis et al., 1993; Meador et al., 1995) and manatees (O'Shea et al., 1984; Ames and van Vleet, 1996). Atlantic spotted dolphins from the Gulf have lower contaminant levels than Gulf bottlenose dolphins (Hansen, personal communication, 1997). Some marine mammals are high-order predators that may be affected by the bioaccumulation of contaminants (Reijnders, 1986a). Manatees, as herbivores, are exposed to pesticides through ingestion of aquatic vegetation containing concentrations of these compounds. The reliance of manatees on inshore habitats and their attraction to industrial and municipal outfalls has the potential to expose them to relatively high levels of contaminants (USDOI, FWS, 2001). Contaminants, siltation, and modified deliveries of freshwater to the estuary can indirectly impact manatees by causing a decline in submerged vegetation on which manatees depend (USDOI, FWS, 2001). Manatees do not appear to accumulate large quantities of chlorinated pesticides (O'Shea et al., 1984; Ames and van Vleet, 1996). Manatees, as herbivores, occupy a lower position in the food chain than most other marine mammals. Most marine mammal species have large stores of fat, acting both as insulation and as an energy reserve. Lipophilic contaminants can accumulate in this tissue and may be released at high concentrations when the energy reserves are mobilized (UNEP, 1991).

Recently, significant accumulation of butyltin compounds (tributyltin is an antifouling agent to prevent attachment of barnacles on boat hulls) has been implicated for immune suppression and consequent disease outbreak (Kannan et al., 1997). High butyltin concentrations in liver and kidney were found in bottlenose dolphins stranded along the Atlantic and Gulf Coasts of Florida (Kannan et al., 1997). Butyltin concentrations in the livers of spotted dolphin and pygmy sperm whale were found to be 3-4 times lower than in bottlenose dolphins; it was suggested that since these are offshore species, the exposure to butyltins is expected to be minimal (Kannan et al., 1997). Butyltins tend to magnify less in cetaceans as compared to organochlorines, which exert chronic toxic effects in marine mammals. Laboratory studies demonstrate that butyltin compounds are potent inhibitors of energy production in cells, followed by lymphocyte depletion and decreased phagocytic activity resulting in immunotoxicity.

Kannan et al. (1997) suggested that butyltin compounds in addition to PCB's have contributed to the immune suppression in bottlenose dolphins.

Insufficient information is available to determine how, or at what levels and in what combinations, environmental contaminants may affect marine mammals (MMC, 1999). There is growing evidence that high contaminant burdens are associated with several physiological abnormalities, including skeletal deformations, developmental effects, reproductive and immunological disorders, and hormonal alterations (e.g., Reijnders, 1986b; Addison, 1989; Brouwer et al., 1989; Colborn et al., 1993; De Swart et al., 1994; Reijnders, 1994; Lahvis et al., 1995; Smolen and Colborn, 1995). It is possible that anthropogenic chemical contaminants initially cause immunosuppression, rendering dolphins susceptible to opportunistic bacterial, viral, and parasitic infection (De Swart et al., 1995). Studies indicate an inverse relationship between hydrocarbon contaminant levels and certain bacterial and viral antigen titers in *Tursiops* from Matagorda Bay (in Waring et al., 1997). Contaminant loads were also associated with decreased levels of testosterone (Rowles, personal communication, 1996). Debilitating viruses such as morbillivirus may result in further immunosuppression and death. A study by Ross et al. (1996) indicated that present levels of PCB's in the aquatic food chain are immunotoxic to mammals. It should also be noted that emaciated animals that have mobilized their lipid stores (which accumulate high concentrations of toxic chemicals) may be more susceptible to toxic effects as a result of remobilization of the pollutants. Several Mediterranean striped dolphins that died during a morbillivirus epizootic, and had high levels of PCB's, were found to have luteinized ovarian cysts (Munson et al., 1998). Such cysts may impede population recovery from the epidemic if similar cysts occurred on surviving dolphins (Munson et al., 1998).

Air pollution is also a health factor for cetaceans. Anthracosis has been identified in the lungs of a sample of stranded dolphins in the Sarasota Bay area, but the implications of this finding are not yet clear (Rawson et al., 1991). Participants in workshops convened by MMS in 1989 and 1999 recommended that levels of environmental contaminants and natural biotoxins should be determined and monitored in representative marine mammals that occur in the northern Gulf of Mexico (e.g., Tucker & Associates, Inc., 1990). Collectively, the National Marine Mammal Tissue Bank, the quality assurance and contaminant monitoring programs, and the regional marine mammal stranding networks constitute NOAA Fisheries' marine mammal health and stranding response program.

Commercial fisheries accidentally entangle and drown or injure marine mammals during fishing operations or by lost and discarded fishing gear; they may also compete with marine mammals for the same fishery resources (e.g., Northridge and Hofman, 1999). There is little information on cetacean/fishery interactions in Gulf of Mexico waters. Bottlenose dolphins have become entangled in recreational and commercial fishing gear. Bottlenose dolphins are often seen feeding in association with shrimp fishery operations (e.g., Fertl, 1994; Fertl and Leatherwood, 1997). Dolphins in coastal and neritic waters have been killed in shrimp trawls, as well as in experimental trawling for butterfish (Burn and Scott, 1988). Although the catch rate may be low, fisheries such as the shrimp trawl fishery with large fleets may be having significant impacts on dolphins. Marine mammals may be caught and killed occasionally in the menhaden purse seine fishery (Tucker & Associates, Inc., 1990). Dolphins have been stranded on the Gulf Coast with evidence of gillnet entanglement (e.g., Burn and Scott, 1988). There are several pelagic fisheries that may potentially take dolphins during their operations. From 1957 to 1982, the Japanese fished for tuna with longlines in the Gulf of Mexico (Russell, 1993, in Jefferson, 1995). There is no information on incidental catch of cetaceans in this fishery, but cetaceans have been taken on longlines off the U.S. east coast (Burn and Scott, 1988). The most likely major pelagic fishery in the Gulf to incidentally take dolphins is the domestic tuna/swordfish longline fishery started in the offshore Gulf of Mexico in the early 1970's, and it continues today (Russell, 1993, in Jefferson, 1995). There is no marine mammal observer program for this fishery, although there are anecdotal reports of pilot whales and possibly Risso's dolphins taking fish off the longlines.

The level of take in Gulf fisheries may be small (e.g., Reynolds, 1985; Burn and Scott, 1988), but as iterated by Tucker & Associates, Inc. (1990), the effects could be causing, or contributing to, significant population declines if the affected populations also are subject to other human-produced impacts. Information continues to be insufficient to assess the nature and extent of incidental take, its impact on affected species and populations, or how it might be reduced or avoided. In addition, shooting of bottlenose dolphins occurs infrequently. A minke whale that stranded in the Florida Keys was found to have several bullets in it (USDOC, NOAA, 1997b). These few cases may be simple vandalism or may be fisheries-related (Burn and Scott, 1988) (in response to real or perceived damage to gear and/or catch). Although the extent of incidental take and death during "ghost" fishing is largely undocumented, it has been noted as an activity of concern by NOAA Fisheries and MMC. Fishermen have been reported to shoot at dolphins to scare them away from their gear (e.g., Reynolds, 1985; Fertl, 1994; Fertl and Leatherwood, 1997). It is expected that commercial fishing equipment will periodically contact and affect cetaceans in the Gulf of Mexico.

Adequate conservation strategies for marine mammals must take into account the natural history and ecology of important prey species; this is something that is currently under emphasized in research and conservation efforts (Heithaus and Connor, 1995; Trites et al., 1997). For example, Trites et al. (1997) suggested that fisheries may indirectly compete with marine mammals by reducing the amount of primary production accessible to marine mammals, thereby negatively affecting marine mammal numbers.

Habitat loss and degradation is now acknowledged to be a significant threat to cetacean populations. The impact of coastal development on Gulf of Mexico cetaceans has not been adequately investigated. It has been suggested that apparent declines in bottlenose dolphin abundance in some areas can be attributed to pollution and heavy boat traffic (e.g., Odell, 1976). Bottlenose dolphins in Sarasota Bay appear to use less-altered areas more frequently, but specific effects are uncertain (Wells, 1992). On the other hand, habitat alteration in the form of artificial passes in southern Texas may have opened up new habitat for bottlenose dolphins (Leatherwood and Reeves, 1983). Habitat alteration has the potential to disrupt the social behavior, food supply, and health of cetaceans that occur in the Gulf of Mexico. Such activities may stress animals and cause them to avoid traditional feeding and breeding areas, or migratory routes. The most serious threat to cetacean populations from habitat destruction may ultimately prove to be its impact on the lower trophic levels of their food chains (Kemp, 1996). Intensive coastal development is degrading important manatee habitat and poses perhaps the greatest long-term threat to the Florida manatee (USDOI, FWS, 2001).

Coastal bottlenose dolphin populations in the southeastern U.S. have the potential to be impacted by commercial dolphin-watching trips that feed dolphins as part of their tours. Feeding wild dolphins is likely to disrupt normal behavior, particularly feeding and migration patterns (USDOC, NMFS, 1994b). This activity could make dolphins dependent upon unnatural food sources and more vulnerable to being hit by boats, malicious shooting, and accidental or deliberate food poisoning (USDOC, NMFS, 1994b). Although the Marine Mammal Protection Act classifies such activities as "harassment," feeding continues due to lack of enforcement. In May 1997, NMFS embarked upon a media and education campaign in Florida (including Panama City Beach, which is an area of particular concern) to increase public awareness about the dangers of swimming with, feeding, and harassing wild dolphins (Seideman, 1997; USDOC, NMFS, 1998c). NOAA filed charges in Summer 1998 against a group of people in the Florida panhandle for harassing or attempting to harass dolphins by feeding or attempting to feed them (Spradlin, personal communication, 1998). Migrating baleen whales may be affected by whale-watching activities on the East Coast, as well as in the Caribbean (Hoyt, 1995). Impacts of whale watching on cetaceans may be measured in a short time-scale (i.e., startle reaction) or as a long-term effect on reproduction or survivability (IFAW, 1995). There is little evidence to show that short-term impacts have any relation to possible long-term impacts on cetacean individuals, groups, or populations (IFAW, 1995). There are six manatee sanctuaries in Kings Bay; human access to these areas is prohibited to provide manatees a place to avoid disturbance by divers and boats. A number of cases of harassment of manatees by divers have involved waters around Three Sisters Spring, located in a canal off Kings Bay (Seideman, 1997; MMC, 1998). Manatees were forced away from the spring by divers approaching to touch them or to pose for photographs with them (MMC, 1998).

It is possible that harassment in any form may cause a stress response (Young et al., 1995). Marine mammals can exhibit some of the same stress symptoms as found in terrestrial mammals (Thomson and Geraci, 1986). Stress often is associated with release of adrenocroticotrophic hormones or cortisol. Thomas et al. (1990) examined the effect of playbacks of drilling platform noise on captive belugas. They found no behavioral (swim patterns, social group interactions, and dive/respiration rates) or physiological (blood catecholamines) indications of stress from drilling noises. It is important to recognize that disturbance from vessel traffic, noise from ships, aircraft, and drilling rigs and/or exposure to sublethal levels of biotoxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases that normally would not be fatal. Chronic stress may cause damage to the heart muscle and vasculature (Curry and Edwards, 1998).

Stressed animals may also fail to reproduce at normal rates or exhibit significantly high fetotoxicity and malformations in the young, as evidenced in some small laboratory mammals. For example, a heavily fished population of spotted dolphins in the eastern tropical Pacific was found to have a substantially lower pregnancy rate and a significantly higher (i.e., delayed) age at sexual maturity than nearby, sporadically fished, spotted dolphins; chronic stress is one possibility (Myrick and Perkins, 1995). Marine mammals may stay in an area despite disturbance (such as noise) if no alternative, suitable habitat areas are available to the animals.

The incremental contribution of impacts stemming from a proposed action are expected to be primarily sublethal (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris). However, cumulative impacts of the activities discussed in this section will likely yield deleterious effects to cetaceans occurring in the Gulf of Mexico. Biological significance of any mortality would depend, in part, on the size and reproductive rates of the affected stocks, as well as the number, age, and sex of animals affected.

Summary and Conclusion

Activities considered under the cumulative scenario could affect protected cetaceans and sirenians. These marine mammals could be impacted by the degradation of water quality resulting from operational discharges, vessel traffic, noise generated by platforms, drillships, helicopters and vessels, seismic surveys, explosive structure removals, oil spills, oil-spill response activities, loss of debris from service vessels and OCS structures, commercial fishing, capture and removal, and pathogens. The cumulative impact on marine mammals is expected to result in a number of chronic and sporadic sublethal effects (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris) that may stress and/or weaken individuals of a local group or population and predispose them to infection from natural or anthropogenic sources. Few deaths are expected from oil spills, chance collisions with OCS service vessels, ingestion of plastic material, commercial fishing, and pathogens. Oil spills of any size are estimated to be recurring events that would periodically contact marine mammals. Deaths as a result of structure removals are not expected to occur due to mitigation measures (e.g., NOAA Fisheries Observer Program). Disturbance (noise from vessel traffic and drilling operations, etc.) and/or exposure to sublethal levels of toxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases that normally would not be fatal. The net result of any disturbance would be dependent upon the size and percentage of the population likely to be affected; ecological importance of the disturbed area; environmental and biological parameters that influence an animal’s sensitivity to disturbance and stress; or the accommodation time in response to prolonged disturbance (Geraci and St. Aubin, 1980). Collisions between cetaceans and ships, though expected to be rare events, could cause serious injury or mortality.

Effects of the incremental contribution of a proposed action combined with non-OCS activities may be deleterious to cetaceans occurring in the Gulf of Mexico. Biological significance of any mortality would depend, in part, on the size and reproductive rates of the affected stocks, as well as the number, age, and size of animals affected.

4.5.6. Impacts on Sea Turtles

This cumulative analysis considers the effects of impact-producing factors related to a proposed action plus those related to other OCS activities; State oil and gas activity; crude oil imports by tanker; and other commercial, military, recreational, offshore and coastal activities that may occur and adversely affect populations of sea turtles in the same general area of the proposed actions in the WPA and CPA. The combination of potential impacts 8resulting from a proposed action in addition to prior and future OCS sales, State oil and gas activity, dredge-and-fill operations, water quality degradation, natural catastrophes, pollution, recreational and commercial fishing, dredges, vessel traffic, beach nourishment, beach lighting, power plant entrainment, and human consumption affect the loggerhead, Kemp’s ridley, hawksbill, green, and leatherback turtles found in the Gulf of Mexico. Major impact-producing factors related to the proposed actions that may occur are reviewed in detail in Chapters 4.2.1.6 and 4.3.1.6. Sections providing supportive material for the sea turtle analysis include Chapters 3.2 (physical environment), 3.2.5 (description of sea turtles), 4.1.1 (offshore impact-producing factors), 4.1.2 (coastal impact-producing factors), 4.1.3 (other activities) and 4.4.3 (environmental impacts of accidental events).

Effluents are routinely discharged into offshore waters and are regulated by USEPA NPDES permits. Most operational discharges are diluted and dispersed when released in offshore areas and, given the current USEPA permit restrictions on discharges, are considered to have little effect (API, 1989; Kennicutt, 1995). Any potential that might exist for impact from drilling fluids would seem to be indirect, either by impact on prey items or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling mud discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of sea turtles or species lower in the marine food web (for further information on bioaccumulation, see Chapter 4.1.1.3.4). This may ultimately reduce reproductive fitness in turtles, an impact that the diminished population(s) cannot tolerate.

Structure installation and removal, pipeline placement, dredging, and water quality degradation may adversely affect sea turtle foraging habitat through destruction of seagrass beds and live-bottom communities used by sea turtles (Gibson and Smith, 1999). At the same time, it should be noted that structure installation creates habitat for subadult and adult sea turtles, which may enhance the recovery of some turtle populations. Potential impacts on these habitats caused by the OCS Program in the cumulative activity area are discussed in detail in Chapters 4.5.1 and 4.5.2.

Noise from service-vessel and helicopter traffic may cause a startle reaction from sea turtles and produce temporary stress (NRC, 1990). It is assumed that helicopter traffic would occur on a regular basis. It is projected that 338,666-415,359 OCS-related helicopter trips would occur annually in the support of OCS activities in the WPA (Table 4-5). Similarly, estimates of annual OCS-related helicopter trips in the CPA are 378,718-883,333 trips (Table 4-6). The FAA's Advisory Circular 91-36C encourages pilots to maintain greater than minimum altitudes near noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. The OCS-related helicopters are not the only aircraft that fly over the coastal and offshore areas. Military, private, and commercial air traffic also traverse these areas and have the potential to cause impacts to sea turtles. Other sound sources potentially impacting sea turtles include seismic surveys. Seismic surveys use airguns to generate sound pulses; these are a more intense sound than other nonexplosive sound sources. Data are limited but show that reactions of turtles to seismic pulses deserve detailed study. Seismic activities would be considered primarily annoyance and probably cause a short-term behavioral response.

The potential impacts of anthropogenic sounds on sea turtles include physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on the food chain. Noise-induced stress has not been studied in sea turtles. It is expected that drilling noise will periodically disturb and affect turtles in the Gulf of Mexico. Based on the conclusions of Lenhardt et al. (1983) and O'Hara and Wilcox (1990), low-frequency sound transmissions (such as those produced by operating platforms) could cause increased surfacing and deterrence behavior from the area near the sound source.

Increased surfacing places turtles at greater risk of vessel collision. Collisions between service vessels or barges and sea turtles would likely cause fatal injuries. It is projected that 31,359-36,923 OCS-related, service-vessel trips would occur annually in support of OCS activities in the WPA (Table 4-5). The estimated number of OCS-related, service-vessel trips occurring annually in the CPA is calculated at 272,923-281,948 trips (Table 4-6). Vessel traffic in general is estimated to cause about 9 percent of all sea turtle deaths in the southeastern U.S., and this mortality would likely increase if fishing, recreational, and OCS Program vessel traffic continue to increase in the Gulf. Regions of greatest concern may be those with high concentrations of recreational boat traffic, such as the many coastal bays in the Gulf. Chapter 3.3.3.6 discusses non-OCS-related oil tanker and barge activities and non-OCS-related vessel and freight traffic. Numerous commercial and recreational fishing vessels also use these areas.

Explosive discharges such as those used for structure removals can cause capillary injury to sea turtles (Duronslet et al., 1986). Although sea turtles far from the site may suffer only disorientation, those near detonation sites would likely sustain fatal injuries. Injury to the lungs and intestines and/or auditory system could occur. Other potential impacts include physical or acoustic harassment. To minimize the likelihood of removals occurring when sea turtles may be nearby, MMS has issued guidelines for explosive platform removal to offshore operators. These guidelines include daylight-limited detonation, staggered charges, placement of charges 5 m below the seafloor, and pre- and post-detonation surveys of surrounding waters. Resuspension of bottom sediments, increased water turbidity, and mobilization of bottom sediments due to explosive detonation are considered to be temporary effects. An estimated 629-

783 and 3,676-4,183 structure removals are projected to occur in the WPA (Table 4-3) and CPA (Table 4-2) respectively, between 2001 and 2040. With existing protective measures (NOAA Fisheries Observer Program and daylight-only demolition) in place, it is expected that "take" of sea turtles during structure removals would be limited.

Sea turtles may be seriously affected by marine debris. Trash and flotsam generated by the OCS Program in the Gulf and other users of the Gulf (Miller and Echols, 1996) is transported around the Gulf and Atlantic via oceanic currents (Plotkin and Amos, 1988; Hutchinson and Simmonds, 1992). Turtles that consume or become entangled in trash or flotsam may become debilitated or die (Heneman and the Center for Environmental Education, 1988). Monofilament line is the most common debris to entangle turtles (NRC, 1990). Fishing-related debris is involved in about 68 percent of all cases of sea turtle entanglement (O'Hara and Iudicello, 1987). Floating plastics and other debris, such as petroleum residues drifting on the sea surface, accumulate in sargassum drift lines commonly inhabited by hatchling sea turtles; these materials could be toxic. In a review of worldwide sea turtle debris ingestion and entanglement, Balazs (1985) found that tar was the most common item ingested. High rates of oiling of hatchlings netted from sargassum rafts suggest that bioaccumulation may occur over their naturally long lifespan. Sea turtles, particularly leatherbacks, are attracted to floating plastic because it resembles food, such as jellyfishes. Ingestion of plastics sometimes interferes with food passage, respiration, and buoyancy and could reduce the fitness of a turtle or kill it (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988; Lutz and Alfaro-Shulman, 1992). The MMS prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), prohibits the disposal of plastics at sea or in coastal waters.

Since sea turtle habitat in the Gulf includes both inshore and offshore areas, sea turtles are likely to encounter spills. Oil spill estimates project that there will be numerous, frequent, small spills; many, infrequent, moderately sized spills, and infrequent, large spills occurring in coastal and offshore waters between 2003-2042 (Table 4-17). The probability that a sea turtle is exposed to hydrocarbons resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of sea turtles in the northern Gulf will be exposed to residuals of spilled oils. Oil spills can adversely affect sea turtles by toxic ingestion or blockage of the digestive tract, inflammatory dermatitis, ventilatory disturbance, disruption or failure of salt gland function, red blood cell disturbances, immune responses, and displacement from important habitat areas (Witham, 1978; Vargo et al., 1986; Lutz and Lutcavage, 1989; Lutcavage et al., 1995). Sea turtles may become entrapped by tar and oil slicks and rendered immobile (Witham, 1978; Plotkin and Amos, 1988). In the past, tanker washings were a major source of oil in GOM waters (Van Vleet and Pauly, 1987). Although disturbances may be temporary, turtles chronically ingesting oil may experience organ degeneration accumulate in tissues. Exposure to oil may be fatal, particularly to juvenile and hatchling sea turtles. Hatchling and juvenile turtles are particularly vulnerable to contacting or ingesting oil because currents that concentrate oil spills also form the habitat mats in which these turtles are sometimes found (Carr, 1980; Collard and Ogren, 1990; Witherington, 1994). There is also evidence that sea turtles feed in surface convergence lines, which could also prolong their contact with viscous weathered oil (Witham, 1978; Hall et al., 1983). Fritts and McGehee (1982) noted that sea turtle eggs were damaged by contact with weathered oil released from the 1979 *Ixtoc* spill. Epidermal damage in turtles is consistent with an acute, primary contact or irritant dermatitis. A break in the skin barrier could act as a portal of entry for pathogenic organisms, leading to infection, neoplastic conditions, and debilitation (Vargo et al., 1986). Captive turtles exposed to oil either reduced the amount of time spent at the surface, possibly avoiding oil, or became agitated and demonstrated short submergence levels (Lutcavage et al., 1995). Sea turtles sometimes pursue and swallow tarballs, and there is no conclusive evidence that wild turtles can detect and avoid oil (Odell and MacMurray, 1986; Vargo et al., 1986). A loggerhead turtle sighted during an aerial survey in the Gulf of Mexico surfaced repeatedly within a surface oil slick for over an hour (Lohoefener et al., 1989). Oil might have a more indirect effect on the behavior of sea turtles. Assuming olfaction is necessary to sea turtle migration, oil-fouling of a nesting area may disturb imprinting of hatchling turtles or confuse turtles during their return migration after a 6- to 8-year absence (Geraci and St. Aubin, 1985). The effect on reproductive success could therefore be significant.

When an oil spill occurs, the severity of effects and the extent of damage to sea turtles are affected by geographic location, oil type, oil dosage, impact area, oceanographic conditions, and meteorological conditions (NRC, 1985). Eggs, hatchlings, and small juveniles are particularly vulnerable upon contact (Fritts and McGehee, 1982; Lutz and Lutcavage, 1989). Potential toxic impacts to embryos will depend on the type of oil and degree of weathering, type of beach substrate, and especially upon the developmental stage of the embryo. Although many observed physiological insults are resolved in a 21-day recovery period, the impact of tissue oil intake on the long-term health and survival of sea turtles remains unknown (Lutcavage et al., 1995).

Oil-spill response activities, such as vehicular and vessel traffic in coastal areas of seagrass beds and live-bottom communities, can alter sea turtle habitat and displace sea turtles from these areas. Effects on seagrass and reef communities have been noted (reviewed by Coston-Clements and Hoss, 1983). Impacting factors include artificial lighting from night operations, booms, machine and human activity, equipment on beaches and in intertidal areas, sand removal and cleaning, and changed beach landscape and composition. Some resulting impacts from cleanup could include interrupted or deferred nesting, crushed nests, entanglement in booms, and increased mortality of hatchlings due to predation during the extended time required to reach the water (Newell, 1995; Lutcavage et al., 1997; Witherington, 1999). The strategy for cleanup operations should vary, depending on season, recognizing that disturbance to nests may be more detrimental than oil (Fritts and McGehee, 1982). As mandated by the Oil Pollution Act of 1990 (Chapter 1.3), these areas are expected to receive individual consideration during oil-spill cleanup. Required oil-spill contingency plans include special notices to minimize adverse effects from vehicular traffic during cleanup activities and to maximize protection efforts to prevent contact of these areas with spilled oil. Studies are lacking of the effects of dispersants and coagulants on sea turtles (Tucker & Associates, Inc., 1990).

Information on nesting areas for turtles in the Gulf may be found in Chapter 3.2.5.

Sea turtles may be harmed by a variety of human activities throughout their ranges, particularly because of their wide-ranging movements in coastal waters. Major activities affecting sea turtles inhabiting the Gulf include commercial fishing, hopper dredging, pollutant discharge, ingestion of or entanglement in debris, coastal boat traffic, human consumption, and contact with foreign, inshore, or processed oil (reviewed in NRC, 1990; Lutcavage et al., 1997). Demographic analyses suggest reducing human-induced mortality of juvenile, subadult, or adult life stages will significantly enhance population growth, more so than reducing human-induced mortality of eggs and hatchlings (NRC, 1990).

The chief areas utilized by Kemp's ridleys (coastal waters less than 18 m in depth) overlap with that of the shrimp fishery (Renaud, 1995). A major source of mortality for loggerhead and Kemp's ridleys is capture and drowning in shrimp trawls (Murphy and Hopkins-Murphy, 1989); 70-80 percent of turtle strandings are related to interactions with this fishery (Crowder et al., 1995). Recent analysis of loggerhead strandings in South Carolina indicates a high turtle mortality rate from the shrimp fishery through an increase in strandings, and that the use of turtle excluder devices (TED's) could greatly reduce strandings (a 44% reduction) (Crowder et al., 1995). On the other hand, Caillouet et al. (1996) found a significant positive correlation between turtle stranding rates and shrimp fishing intensity in the northwestern Gulf of Mexico. The Kemp's ridley population, due to its distribution and small numbers, is at greatest risk. In response to increased numbers of dead sea turtles that washed up along the coasts of Texas, Louisiana, Georgia, and northeast Florida in 1994-1995, and coincident with coastal shrimp trawling activity, NMFS increased enforcement efforts (relative to TED's), which decreased the number of strandings. However, deaths are believed to occur in association with some inshore shrimping operations that do not presently require TED use (Crouse, 1992). Other fisheries and fishery-related activities are important sources of mortality, but are collectively only one-tenth as important as shrimp trawling (NRC, 1990). Turtles may be accidentally caught and killed in finfish trawls, seines, gill nets, weirs, traps, longlines, and driftnets, but deaths are neither fully documented nor regulated (Hillestad et al., 1982; NRC, 1990; Witzell, 1992; Brady and Boreman, 1994). Cannon et al. (1994) reported a number of Kemp's ridleys being caught by hook and line (Cannon et al., 1994). It is possible that some Kemp's ridleys surviving capture by hook and line may suffer from ill effects of hooks lodged in the esophagus or stomach following their release. Collisions with boats may also disable or kill sea turtles. In most cases, it is not possible to determine whether the injuries resulted in death or were post-mortem. An animal with an open wound has an increased probability of predation. Of the turtles stranded in the Gulf, approximately 9 percent exhibited injuries attributed to boats (Teas and Martinez, 1992). Regions of increased concern are those with high concentrations of recreational-boat traffic, such as the coastal bays of the Gulf.

Dredge-and-fill activities occur in many of the coastal areas inhabited by sea turtles. Operations range in scope from propeller dredging (scarring) by recreational boats to large-scale navigation dredging and fill for land reclamation. Dredging operations affect turtles through accidental take and habitat degradation. Hopper dredging has caused turtle mortality in coastal areas, including Cape Canaveral Ship Channel in Florida and the King's Bay Submarine Channel in Georgia (Slay and Richardson, 1988); deaths in the Gulf of Mexico have not been estimated. Nearly all sea turtles entrained by hopper dredges are dead or dying when found, but an occasional small green turtle has been known to survive (NRC, 1990). In addition to direct take, channelization of the inshore and nearshore areas can degrade foraging and migratory habitats via spoil dumping, degraded water quality/clarity, and altered current flow.

Sea turtles frequent coastal areas such as algae and seagrass beds to seek food and shelter (Carr and Caldwell, 1956; Hendrickson, 1980). Coastal areas are also used by juvenile Kemp's ridleys in Louisiana (Ogren, 1989) and Texas (Manzella and Williams, 1992). Juvenile hawksbill, loggerhead, and green turtles are typically found in coastal Texas waters (Shaver, 1991). Submerged vegetated areas may be lost or damaged by activities altering salinity, turbidity, or natural tidal and sediment exchange. Natural catastrophes, including storms, floods, droughts, and hurricanes, can also substantially damage nesting beaches and coastal areas used by sea turtles (Agardy, 1990). Abnormally high tides and waves generated by storms may exact heavy mortality on sea turtles by washing them from the beach, inundating them with sea water, or altering the depth of sand covering them. Furthermore, excessive rainfall associated with tropical storms may reduce the viability of eggs. Turtles could be harmed in rough seas by floating debris (Milton et al., 1994). In addition, the hurricane season for the Caribbean and Western Atlantic (June 1-November 1) overlaps the sea turtle nesting season (March through November) (NRC, 1990). Nests are vulnerable to hurricanes during the incubation period as well as when hatchlings evacuate the nest. Hurricanes can cause mortality at turtle nests through immediate drowning from ocean surges, nest burial or exhumation before hatching, and after hatching as a result of radically altered beach topography. The greatest surge effect from Hurricane Andrew in 1992 was experienced at beaches closest to the "eye" of the hurricane; egg mortality was 100 percent (Milton et al., 1994). In areas farther from the "eye," the surge was lower and mortality was correspondingly decreased. Sixty-nine percent of eggs on Fisher Island in Miami, Florida did not hatch after Hurricane Andrew and appeared to have "drowned" during the storm (Milton et al., 1994). Further mortality occurred when surviving turtles suffocated in nests situated in the beach zone where sand had accreted. This subsequent mortality may be reduced if beach topography is returned to normal and beach debris removed after a hurricane (Milton et al., 1994). Species that have limited nesting ranges, such as the Kemp's ridley, would be greatly impacted if a hurricane made landfall at its nesting beach (Milton et al., 1994). Hurricane Erin in 1995 caused a 40.2 percent loss in hatchling production on the southern half of Hutchinson Island (Martin, 1996). A beach can be completely closed to nesting after a hurricane. For example, at Buck Island Reef National Monument on St. Croix, after Hurricane Hugo in 1989, 90 percent of the shoreline trees on the North Shore were blown down parallel to the water, blocking access to nesting areas (Hillis, 1990). "False crawl ratios" for hawksbill turtles doubled after the hurricane, mostly due to fallen trees and eroded root tangles blocking nesting attempts (Hillis, 1990). Other direct impacts of Hurricane Hugo on sea turtle habitats include destruction of coral reef communities important to hawksbill and green turtles. Nooks and crannies in the reef used by these turtles for resting were destroyed in some areas (Agardy, 1990). Seagrass beds, which are important foraging areas for green turtles, were widely decimated in Puerto Rico (Agardy, 1990). Indirect effects (contamination of food or poisoning of reef-building communities) on the offshore and coastal habitats of sea turtles include pollution of nearshore waters from storm-associated runoff.

Construction, vehicle traffic, beachfront erosion, and artificial lighting are activities that disturb sea turtles or their nesting beaches (Raymond, 1984; Garber, 1985). Traffic may compress nests and beach cleaning may compact or destroy nests, lowering hatching success (Coston-Clements and Hoss, 1983). Physical obstacles, such as deep tire tracks and expanded sand piles, may obstruct hatchling turtles from entering the sea or increase their stress and susceptibility to predation (Witham, 1995). Obstructions to the high water mark prevent nesting, and breakwalls are the most common and severe type of obstruction. Erosion of nesting beaches results in the loss of nesting habitat. Human interference has hastened erosion in many places. Artificial lighting from buildings, street lights, and beachfront properties may disorient hatchlings, as well as adults (Witherington and Martin, 1996). Females tend to avoid areas where beachfront lighting is most intense; turtles also abort nesting attempts more often in lighted areas.

Hatchlings are attracted to lights, and may delay their entry into the sea, thereby increasing their vulnerability to terrestrial predators. Condominiums sometimes block sunlight on nesting beaches, which could presumably affect sex ratios of hatchlings (the sex of a turtle is dependent on egg temperature) by increasing the number of males produced (discussed by Mrosovsky et al., 1995). Increased human activities, such as organized turtle watches, on nesting beaches may affect nesting activity (Fangman and Rittmaster, 1994; Johnson et al., 1996).

Sea turtles can become entrained in intake pipes for cooling water at coastal power plants (NRC, 1990). An offshore intake structure may appear as suitable for resting at to some turtles, and these turtles may be subsequently drawn into a cooling system (Witham, 1995). Feeding leatherbacks probably follow large numbers of jellyfish into the intake (Witham, 1995). Deaths result from injuries sustained in transit through the intake pipe, from drowning in the capture nets, and perhaps from causes before entrainment. Mortality from entrainment in power plants is believed to be generally low, although there has been a high number of turtle fatalities at the St. Lucie plant in southeastern Florida (NRC, 1990). Thermal effluents from power plants may cause hatchlings to become disoriented and reduce their swimming speed (O'Hara, 1980). These effluents may also degrade seagrass and reef habitats (reviewed by Coston-Clements and Hoss, 1983).

Sand mining, beach renourishment, and oil-spill cleanup operations may remove sand from the littoral zone and temporarily disturb onshore sand transport, potentially disturbing nesting activities. The main causes of permanent nesting beach loss within the Gulf of Mexico are the reduction of sediment transport, rapid rate of relative sea-level rise, coastal construction and development, and recreational use of accessible beaches near large population centers. Crain et al. (1995) reviewed the literature on sea turtles and beach nourishment and found certain problems repeatedly identified. For nesting females, characteristics induced by nourishment can cause (a) beach compaction, which thereby may decrease nesting success, alter nest-chamber geometry, and alter nest concealment; and (b) escarpments, which can block turtles from reaching nesting areas. For eggs and hatchlings, nourishment can decrease survivorship and affect development by altering beach characteristics such as sand compaction, gaseous environment, hydric environment, contaminant levels, nutrient availability, and thermal environment. Additionally, nests can be covered with excess sand if beach nourishment occurs in areas with incubating eggs.

Human consumption of turtle eggs, meat, or byproducts occurs worldwide and depletes turtle populations (Cato et al., 1978; Mack and Duplaix, 1979). Commercial harvests are no longer permitted within continental U.S. waters, and Mexico recently banned such activity (Aridjis, 1990). Since sea turtles are highly migratory species, the taking of turtles in subsistence and commercial sea turtle fisheries is still a concern.

Chronic pollution, including industrial and agricultural wastes and urban runoff, threatens sea turtles worldwide (Frazier, 1980; Hutchinson and Simmonds, 1991). Some turtle species have lifespans exceeding 50 years (Congdon, 1989; Frazer et al., 1989) and are secondary or tertiary consumers in marine environs, creating the potential for bioaccumulation of heavy metals (Hillestad et al., 1974; Stoneburner et al., 1980; Davenport et al., 1990), pesticides (Thompson et al., 1974; Clark and Krynitsky, 1980; Davenport et al., 1990), and other toxins (Lutz and Lutcavage, 1989) in their tissues. Organochlorine pollutants have been documented in eggs, juveniles, and adult turtles (Rybitski et al., 1995). Not all species accumulate residues at the same rate; loggerheads consistently have higher levels of both PCB's and DDE than green turtles, and it has been hypothesized that the variation is due to dietary differences (George, 1997). Contaminants could stress the immune system of turtles or act as cocarcinogens indirectly by disrupting neuroendocrine functions (Colborn et al., 1993). In some marine mammals, chronic pollution has been linked with immune suppression, raising a similar concern for sea turtles.

Herbst and Jacobson (1995) and George (1997) reviewed sea turtles diseases. Green turtle fibropapillomatosis (GTFP) (debilitating tumors occurring primarily in green turtles) is a growing threat to the survival of green turtle populations worldwide (Herbst, 1994). The disease was documented in the 1930's (Smith and Coates, 1938), and its incidence has increased in the last century, especially from 1985 to 1990, in turtles found in Florida, Hawaii, and Puerto Rico. This disease may cause an increased susceptibility to marine parasites and anemia, as well as impairing feeding and swimming, increased vulnerability to entanglement, disorientation, and impaired vision or blindness (Norton et al., 1990; Barrett, 1996). Similar lesions have been reported in loggerhead turtles (Herbst, 1994). Previous studies suggest that turtles in coastal habitats with nearby human disturbance have a greater incidence of GTFP (Herbst and Klein, 1995). Turtles with GTFP are chronically stressed and immunosuppressed (Aguirre et al., 1995). Spirorchidiasis has been reported in loggerheads (Wolke et al., 1982). Severe infestations of spirorchid (blood flukes) result in emaciation, anemia, and enteritis, or conversely, emaciation and anemia could render a turtle more susceptible to spirorchid infestation. Infestations can result in death or make turtles more susceptible to mortality stemming from other stresses (Wolke et al., 1982).

Summary and Conclusion

Activities considered under the cumulative scenario may harm sea turtles and their habitats. Those activities include structure installation, dredging, water quality and habitat degradation, OCS-related trash and flotsam, vessel traffic, seismic surveys, explosive structure removals, oil spills, oil-spill response activities, natural catastrophes, pollution, dredge operations, vessel collisions, commercial and recreational fishing, human consumption, beach lighting, and power plant entrainment. Sea turtles could be killed or injured by chance collision with service vessels or eating marine debris, particularly plastic items, lost from OCS structures and service vessels. It is expected that deaths due to structure removals would rarely occur due to mitigation measures (e.g., NOAA Fisheries Observer Program). The presence of, and noise produced by, service vessels and by the construction, operation, and removal of drill rigs may cause physiological stress and make animals more susceptible to disease or predation, as well as disrupt normal activities. Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification; there is uncertainty concerning the possible effect. Oil spills and oil-spill response activities are potential threats that may be expected to cause turtle deaths. Contact with, and consumption of oil and oil-contaminated prey, may seriously impact turtles. Sea turtles have been seriously harmed by oil spills in the past. The majority of OCS activities are estimated to be sublethal (behavioral effects and nonfatal exposure to intake of OCS-related contaminants or debris). Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas could cause declines in survival or productivity, resulting in either acute or gradual population declines. The incremental contribution of a proposed action to cumulative impacts on sea turtles is slight.

4.5.7. Impacts on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

This cumulative analysis considers the effects of OCS-related and non-OCS-related impact-producing factors related to (1) oil and gas operations for the proposed multisale actions, prior and future OCS sales, and import tankering; (2) alteration and destruction of habitat by oil-spill cleanup with accompanying motorized traffic, dredge-and-fill activities by residential and commercial coastal construction and associated vehicular traffic, and natural catastrophes; (3) predation and competition in the ecological community; and (4) beach trash and debris. The effects from these major impact-producing factors are described below. This analysis incorporates the discussion of the effects from these impact-producing factors on beach mice in Chapters 4.2.1.7 and 4.4.3.7.

Oil spills can result from import tankering, barging, platform accidents, pipeline malfunctions, and other sources (Table 4-19). Spilled oil can cause skin and eye irritation, asphyxiation from inhalation of toxic fumes, food reduction, food contamination, increased predation, and displacement from preferred habitat. Contamination of food (for example, oiling of sea oat grains) may result in oil ingestion or make food tasteless or distasteful. The effects of oil that contacts a beach mouse are mentioned above. A slick cannot wash over the foredunes into beach mouse habitat unless carried by a heavy storm swell. Given the probabilities of a spill occurring, persisting long enough to reach beach mouse habitat, arriving ashore coincidentally with a storm surge, and affecting beach mice, impacts of oil spills on beach mice from the cumulative scenario are expected to be low.

In the event of an oil spill, protection efforts to prevent contact of these areas with spilled oil are mandated by the Oil Pollution Act of 1990. Vehicular traffic associated with oil-spill cleanup activities may degrade preferred habitat and cause displacement from these areas.

Present beach mice habitat is no longer of optimal quality because of historical beach erosion, construction, and tropical storm damage. Coastal construction can be expected to threaten beach mouse populations on a continual basis. Natural catastrophes including storms, floods, droughts, and hurricanes may substantially reduce or eliminate beach mice. Some of these are expected to occur and periodically contact beach mouse habitat.

Predation from both feral and nonferal domestic cats and dogs and competition with common house mice may also reduce and disturb their populations, but estimates of this mortality are unreliable (USDOI, FWS, 1987; Humphrey and Frank, 1992).

Trash and debris may be mistakenly consumed by beach mice or entangle them.

The beach mouse has a maximum expected lifespan of one year, and disturbances are not expected to last for more than one or two generations, provided some relict population survives.

Summary and Conclusion

Cumulative activities have a potential to harm or reduce the numbers of Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice. Those activities include oil spills, alteration and reduction of habitat, predation and competition, and beach trash and debris. Most multisale-related spills, as well as oil spills stemming from import tankering and prior and future lease sales, are not expected to contact beach mice or their habitats. The expected incremental contribution of oil spill assumed in a proposed action (as analyzed in Chapter 4.4.3.7) to the cumulative oil-spill impact (as analyzed in Table 4-17) is negligible. Non-OCS activities or natural catastrophes could potentially deplete some beach mice populations to unsustainable levels, especially if reintroduction could not occur.

4.5.8. Impacts on Coastal and Marine Birds

This cumulative analysis considers the effects of impact-producing factors related to the proposed actions; prior and future OCS sales; State oil and gas activity; crude oil imports by tanker; and other commercial, military, and recreational offshore and coastal activities that may occur and adversely affect populations of nonendangered/nonthreatened and endangered/threatened birds. Air emissions; degradation of water quality; oil spills and spill-response activities; aircraft and vessel traffic and noise, including OCS helicopter and service-vessels; habitat loss and modification resulting from coastal construction and development; OCS pipeline landfalls and coastal facility construction; and trash and debris are OCS-related sources of potential adverse impacts. Non-OCS impact-producing factors include habitat degradation; disease; bird watching activities; fisheries interactions; storms and floods; pollution of coastal waters resulting from municipal, industrial, and agricultural runoff and discharge; and collisions of coastal and marine birds with structures such as power line towers. This analysis incorporates the discussion of the effects from these impact-producing factors on coastal and marine birds in Chapters 4.2.1.8 and 4.3.1.7 with additional information as cited.

Chapters 4.2.1.4, 4.3.1.4, and 4.5.4 consider air emissions including the amount of sulfur dioxide expected to be released due to a proposed action as well as from prior and future OCS sales, and State oil and gas activity. These emissions may adversely affect coastal and marine birds. Pollutant emission into the atmosphere from the activities under the cumulative analysis are projected to have minimum effects on offshore air quality because of the prevailing atmospheric conditions, emission heights, and pollutant concentrations. Onshore impact on air quality from emissions under the OCS cumulative analysis is estimated to be within both Class I and Class II PSD allowable increments as applied to the respective subareas. Emissions of pollutants into the atmosphere under the cumulative analysis are projected to have little effect on onshore air quality because of the atmospheric regime, the emission rates, and the distance of these emissions from the coastline. These judgments are based on average steady state conditions and the dispersion equation for concentration estimates; however, there will be days of low mixing heights and wind speeds that could further decrease air quality. These conditions are characterized by fog formation, which in the Gulf averages about 30-40 days a year, mostly during winter. Impacts from offshore sources are reduced in winter because the frequency of onshore winds decreases (19-34%) and the removal of pollutants by rain increases. The summer is more conducive to air quality effects as onshore winds occur more frequently, approximately 52-85 percent of the time. Increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} under the cumulative analysis are estimated to be less than Class I and Class II PSD allowable increments for the respective subareas per both the steady state and plume dispersion analyses, and are below concentrations that could harm coastal and marine birds. Indirect impacts on coastal and marine birds due to direct impacts on air quality under the cumulative analysis will have a negligible effect on coastal and marine birds.

Degradation of coastal and inshore water quality resulting from factors related to the proposed actions plus those related to prior and future OCS sales; crude oil imports by tanker; and other commercial, military, and recreational offshore and coastal activities is expected to impact coastal and marine birds. The effects of the cumulative activities scenario on coastal water quality is analyzed in detail in Chapter 4.5.3.1. There exists a wide variety of contaminant inputs into coastal waters bordering the Gulf of Mexico. The dominant pollution source is the large volume of water from the Mississippi River, which drains over two-thirds of the contiguous United States. Major activities that have added to the contamination of Gulf coastal waters include the petrochemical industry, agriculture, forestry, urban expansion, extensive dredging operations, municipal sewerage treatment processes, marinas and recreational boating, maritime shipping, and hydromodification activities. Not as significant are large commercial waste disposal operations, livestock farming, manufacturing industry activities, power plant operations, and pulp and paper mills. Vessel traffic is likely to impact water quality through routine releases of bilge and ballast waters, chronic fuel and tank spills, trash, and domestic and sanitary discharges. Projected large oil spills represent an acute significant impact to coastal waters while small spills serve as a low-level, chronic source of petroleum contamination to regional coastal water quality.

Coastal and marine birds will likely experience chronic physiological stress from sublethal exposure to or intake of contaminants or discarded debris. This will cause disturbances and displacement of single birds or flocks. Chronic sublethal stress is often undetectable in birds. It can serve to weaken individuals (especially serious for migratory species) making them susceptible to infection and disease. The extensive oil and gas industry operating in the Gulf area has caused low-level, chronic, petroleum contamination of coastal waters. Lethal effects are expected primarily from uncontained inshore oil spills and associated spill response activities in wetlands and other biologically sensitive coastal habitats. Primary physical effects are oiling and the ingestion of oil, and secondary effects are the ingestion of oiled prey. Recruitment of birds through successful reproduction is expected to take up to many years, depending upon the species and existing conditions. In Chapter 4.4.3.8 generic effects of oil on raptors, pelicans and plovers is discussed.

Helicopter and service-vessel traffic related to OCS activities could sporadically disturb feeding, resting, or nesting behavior of birds or cause abandonment of preferred habitat. The FAA (Advisory Circular 91-36C) and corporate helicopter policy states that helicopters must maintain a minimum altitude of 700 ft while in transit offshore, and 500 ft while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas or across coastlines and 2,000 ft over populated areas and biologically sensitive areas such as wildlife refuges and national parks. Generic importance of the flight altitude regulation to birds is discussed in Chapters 4.2.1.8 and 4.3.1.7. The net effect of OCS-related flights on coastal and marine birds is expected to result in sporadic disturbances, which may result in displacement of localized groups. During nesting periods, this could ultimately result in some reproductive failure from nest abandonment or predation on eggs and young when a parent is flushed from a nest.

An average of 300,000 OCS-related service-vessel trips may occur annually under the cumulative activities scenario. Service vessels will use selected nearshore and coastal (inland) navigation waterways, and adhere to protocol set forth by the USCG for reduced vessel speeds within these inland areas. Routine presence and low speeds of service vessels within these waterways diminishes the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. It is expected that service-vessel traffic will seldom disturb populations of coastal and marine birds existing within these areas. Recreational vessel traffic is a much greater source of impact to birds in coastal habitats. These vessels are, in most cases, not required to comply with strict speed/wake restrictions (small recreational fishing boats, ski boats, etc.) often flush coastal and marine birds from feeding, resting, and nesting areas. Such disturbances displace local groups from these preferred habitats and could lead to abandonment of the areas in general or reproductive failure. Disturbance may result in increased energy expenditures due to avoidance flights and decreased energy intake due to interference with feeding activity. It is estimated that the effects of non-OCS vessel traffic on birds within coastal areas are substantial.

Historic census data shows that many of these species are declining in numbers and are being displaced from areas along the coast (and elsewhere) as a result of the encroachment of their preferred habitat(s) by the aforementioned sources. As these birds move to undisturbed areas of similar habitat, their presence may create or augment habitat utilization pressure on these selected areas as a result of intra- and interspecific competition for space and food. Under the cumulative activities scenario, factors contributing to coastal land loss or modification include construction of approximately 23-38 pipeline landfalls (State and OCS), 140-280km of onshore pipeline (OCS and State), and potentially 4-16 gas processing plants (OCS only) as well as other facilities. The contribution of development from urban and other industrial growth will be substantial, causing both the permanent loss of lands and increased levels of disturbance associated with new construction and facilities.

Coastal and marine birds are commonly entangled and snared in discarded trash and debris. Many species will readily ingest small plastic debris, either intentionally or incidentally. Interaction with plastic materials may lead to permanent injuries and death. Much of the floating material discarded from vessels and structures offshore drifts ashore or remains within coastal waters. These materials include lost or discarded fishing gear such as gill nets and monofilament lines, which cause the greatest damage to birds. It is expected that coastal and marine birds will seldom become entangled in or ingest OCS-related trash and debris as a result of MMS prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics at sea or in coastal waters, went into effect January 1, 1989. Despite these regulations, quantities of plastic materials are accidentally discarded and lost in the marine environment, and so remain a threat to individual birds within these areas.

Non-OCS impact-producing factors include habitat degradation; disease; bird watching activities; fisheries interactions; storms and floods; pollution of coastal waters resulting from municipal, industrial, and agricultural runoff and discharge; and collisions of coastal and marine birds with structures such as power line towers. Coastal storms and hurricanes can often cause deaths to coastal birds through high winds; associated flooding destroys active nests. Nesting territories and colonial bird rookeries with optimum food and/or nest-building materials may also be lost. Elevated levels of municipal, industrial, and agricultural pollutants in coastal wetlands and waters expose resident birds to chronic physiological stress. Collisions with power lines and supporting towers can occur during inclement weather and during periods of migration, often causing death or permanent injury to birds (Avery et al., 1980; Avian Power Line Interaction Committee, 1994). Vital habitat needs to be protected so that the life-support system continues for the birds and their prey. Habitat alteration has the potential to disrupt social behavior, food supply, and health of birds that occur in the Gulf of Mexico. Such activities may stress the animals and cause them to avoid traditional feeding and breeding areas or migratory routes. Commercial fisheries may accidentally entangle and drown or injure birds during fishing operations or by lost and discarded fishing gear. Competition for prey species may also occur between birds and fisheries.

Summary and Conclusion

Activities considered under the cumulative activities scenario will detrimentally affect coastal and marine birds. It is expected that the majority of effects from the major impact-producing factors on coastal and marine birds are sublethal (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris) and will usually cause temporary disturbances and displacement of localized groups inshore. The net effect of habitat loss from oil spills, new construction, and maintenance and use of pipeline corridors and navigation waterways will alter species composition and reduce the overall carrying capacity of disturbed area(s) in general.

The incremental contribution of a proposed action (Chapters 4.2.1.8 and 4.3.1.7 to the cumulative impact is negligible because the effects of the most probable impacts, such as sale-related operational discharges and helicopters and service-vessel noise and traffic, are estimated to be sublethal and some displacement of local individuals or groups may occur. It is expected that there will be little interaction between OCS-related oil spills and coastal and marine birds.

The cumulative effect on coastal and marine birds is expected to result in a discernible decline in the numbers of birds that form localized groups or populations, with associated change in species composition and distribution. Some of these changes are expected to be permanent, as exemplified in historic census data, and to stem from a net decrease in preferred and/or critical habitat.

4.5.9. Impacts on the Gulf Sturgeon

This cumulative analysis considers the effects of impact-producing factors related to (1) oil spills involving the proposed actions and prior and future OCS sales; (2) dredge-and-fill operations and natural catastrophes that alter or destroy habitat, and (3) commercial fishing on the Gulf sturgeon. Sections providing supportive material for the Gulf sturgeon analysis include Chapters 3.2.8 (description of Gulf sturgeon), 4.4.1.1.3.1(offshore oil spills), 4.4.1.1.3.2 (coastal oil spills), 4.1.1-4.1.2 (other major onshore/coastal activities), and 4.1.3.4 (non-OCS oil spills).

Extant occurrences of Gulf sturgeon in 1993 extended from Lake Pontchartrain in southeastern Louisiana to Charlotte Harbor in western Florida (USDOI, FWS and Gulf States Marine Fisheries Commission, 1994). Although spawning may occur from the Pearl River in western Mississippi eastward, the most important spawning populations occur within the Florida Panhandle in the Apalachicola and Suwannee Rivers (Patrick, personal communication, 1996). Spawning grounds are located upriver in bottomland hardwood forested wetlands that are flooded during winter, not within coastal wetlands (Barkuloo, 1988; Clugston, 1991).

The direct effects of spilled oil on Gulf sturgeon occur through the ingestion of oil or oiled prey and the uptake of dissolved petroleum through the gills by adults and juveniles. Contact with or ingestion/absorption of spilled oil by adult Gulf sturgeon can result in mortality or sublethal physiological impact, especially irritation of gill epithelium and disturbance of liver function.

For spills greater than or equal to 1,000 bbl, concentrations of oil below the slick are within the range that cause sublethal effects on marine organisms. The maximum observed concentration of 1.5 ppm was observed at depth of 2 m below the slick from the 1979 *Ixtoc* blowout (McAuliffe, 1987). This value is within the range of LC_{50} values for many marine organisms; such values are typically 1-100 ppm for adults and subadults (Connell and Miller, 1981; Capuzzo, 1987). However, when exposure time beneath accidental spills, hydrocarbon composition, and the change in this composition during weathering are considered, exposure doses (measured as ppm-hr) are assumed to be far less than doses reported to cause even sublethal effects (McAuliffe, 1987). Given the low probability of occurrence, low probability that the low-population Gulf sturgeon would occur in the specific area when a spill occurs, small likelihood of contact of a surface oil slick with a demersal fish and its benthic habitat, and minimal concentrations of toxic oil relative to levels that would be toxic to adult or subadult Gulf sturgeon, the impacts of spilled oil on this endangered subspecies are expected to be very low.

It is expected that the extent and severity of effects from oil spills will be lessened by active avoidance of oil spills by adult sturgeon. Sturgeon are demersal and would forage for benthic prey well below an oil slick on the surface. Adult sturgeon only venture out of the rivers into the marine waters of the Gulf for roughly three months during the coolest weather. This reduces the likelihood of sturgeon coming into contact with oil. It is expected that contact will cause sublethal irritation of gill epithelium and an increase in liver function for less than a month. Tarballs resulting from the weathering of oil “are found floating at or near the surface” (NRC, 1985) with no effects expected to demersal fishes such as the Gulf sturgeon.

Natural catastrophes and non-OCS activities such as dredge-and-fill may destroy Gulf sturgeon habitat. Natural catastrophes including storms, floods, droughts, and hurricanes can result in substantial habitat damage. Loss of habitat is expected to have a substantial effect on the reestablishment and growth of Gulf sturgeon populations.

Dredge-and-fill activities occur throughout the nearshore areas of the United States. They range in scope from propeller dredging (scarring) by recreational boats to large-scale navigation dredging and fill for land reclamation. Non-OCS operations, such as dredge-and-fill activities and natural catastrophes, indirectly impact Gulf sturgeon through the loss of spawning and nursery habitat.

Commercial fishing techniques such as trawling, gill netting, or purse seining, when practiced nonselectively, may impact species other than the target species. For example, Gulf sturgeon are a small part of the shrimp bycatch. It is estimated that for every 0.5 kilograms (kg) of shrimp harvested, 4 kg of bycatch is discarded (Sports Fishing Institute, 1989). The death of several Gulf sturgeon is expected from commercial fishing.

Summary and Conclusion

The Gulf sturgeon can be impacted by activities considered under the cumulative scenario, activities such as oil spills, alteration and destruction of habitat, and commercial fishing. The effects from contact with spilled oil will be sublethal and last for less than one month. Substantial damage to Gulf sturgeon habitats is expected from inshore alteration activities and natural catastrophes. As a result, it is expected that the Gulf sturgeon will experience a decline in population sizes and a displacement from their current distribution that will last more than one generation. Deaths of adult sturgeon are expected to occur from commercial fishing. The incremental contribution of a proposed action (as analyzed in Chapter 4.2.1.9) to the cumulative impact is negligible because the effect of contact between sale-specific oil spills and Gulf sturgeon is expected to be sublethal and last less than one month.

4.5.10. Impacts on Fish Resources and Essential Fish Habitat

This cumulative analysis considers activities that could occur and adversely affect fish resources and essential fish habitat (EFH) in the north-central and northwestern Gulf of Mexico during the years 2003-2042. These activities include effects of the OCS Program (proposed actions, and prior and future OCS sales), State oil and gas activity, coastal development, crude oil imports by tanker, commercial and recreational fishing, and natural phenomena. Specific types of impact-producing factors considered in this cumulative analysis include coastal environmental degradation; marine environmental degradation; commercial and recreational fishing techniques or practices; hypoxia; red or brown tides; hurricanes; removal of production structures; petroleum spills; subsurface blowouts; pipeline trenching; and offshore discharges of drilling muds and produced waters.

Healthy fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Due to the wide variation of habitat requirements for all life history stages (as described in Chapter 3.2.9) for marine species, EFH for the Gulf of Mexico includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ). The effects of cumulative actions on coastal wetlands and coastal water quality are analyzed in detail in Chapters 4.5.1.2 and 4.5.3.1, respectively. Collectively, the adverse impacts from these effects are called coastal environmental degradation. The effects of cumulative actions on offshore live bottoms and marine water quality are analyzed in detail in Chapters 4.5.2.1 and 4.5.3.2, respectively. Collectively, the adverse impacts from these effects are called marine environmental degradation. The direct and/or indirect effects from cumulative coastal and marine environmental degradation on EFH and commercial fisheries are summarized and considered below.

Conversion of wetlands for agricultural, residential, and commercial uses has been substantial. The trend is projected to continue into the future, although at a slower rate in consideration of regulatory pressures. The most serious impact to EFH is the cumulative effects on wetlands that are occurring at an ever-increasing rate as the Gulf States' populations increase (GMFMC, 1998). Residential, commercial, and industrial developments are directly impacting EFH by dredging and filling coastal areas or by affecting the watersheds.

The cumulative impacts of pipelines to wetlands are described in Chapter 4.5.1.2. Permitting agencies require mitigation of many of these impacts. Unfortunately, many of these efforts are not as productive as intended. The MMS and USGS are performing a study of these problems to help identify solutions.

Canal dredging primarily accommodates commercial, residential, and recreational development. Increased population and commercial pressures on the coasts of all Gulf states in the CPA and WPA are also causing the expansion of ports and marinas there. Where new channels are dredged, wetlands would be adversely impacted by the channel, disposal of dredged materials, and the development that it attracts.

The continuing erosion of waterways maintained by the COE is projected to adversely impact productivity of wetlands along channel banks. Expansion of tidal influence, saltwater intrusion, hydrodynamic alterations, erosion, sediment export, and habitat conversion can be significant in basins with low topographic relief, as seen in deltaic Louisiana. Secondary impacts are projected to generate the loss of wetlands over the next 30-40 years, primarily in Louisiana.

Other factors that impact coastal wetlands include marsh burning, marsh-buggy traffic, and well-site construction. Tracks left by marsh buggies open new routes of water flow through relatively unbroken marsh and can persist for up to 30 years, thereby inducing and accelerating erosion and sediment export. Well-site construction activities include board roads, ring levees, and impoundments.

Conversion of wetland habitat is projected to continue in the foreseeable future. Within the northern Gulf coastal areas, river channelization and flood protection have greatly restricted the most effective wetland creation activities. Flood control has fostered development, which has most impacted wetlands and reduced their area.

State oil production and related activities, especially in Texas, Louisiana, and Alabama, are projected to have greater and more frequent adverse impacts on wetlands than would the OCS Program offshore activities, because of their proximity. Construction of new facilities will be more closely scrutinized, although secondary impacts on wetlands will continue to be the greatest and should receive greater attention.

The present number of major navigation canals appears to be adequate for the OCS Program and most other developments. Some of these canals may be deepened or widened. Navigation canal construction will continue in coastal Louisiana and will be an important cause of wetland loss there. Secondary impacts of canals to wetlands will continue to cause impacts.

The incremental contribution of the proposed actions (Chapters 4.2.1.1.2 for the CPA, 4.3.1.1.2 for the WPA and 4.4.3.1.2 for accidental events) would be a very small part of the cumulative impacts to wetlands.

The coastal waters of Texas, Louisiana, Mississippi, Alabama, and the Florida Panhandle are expected to continue to experience nutrient enrichment, low-dissolved oxygen, and toxin and pesticide contamination, resulting in the loss of both commercial and recreational uses of the affected waters. Fish kills, shellfish-ground closures, and restricted swimming areas will likely increase in numbers over the next 30-40 years. Degradation of water quality is expected to continue due to contamination by point- and nonpoint-source discharges and spills due to eutrophication of waterbodies, primarily due to runoff and hydrologic modifications. Contamination of the coastal waters by natural and manmade noxious compounds coming from point and nonpoint sources and accidental spills derived from both rural and urban sources will be both localized and pervasive. Runoff and wastewater discharge from these sources will cause water quality changes that will result in a significant percentage of coastal waters not attaining Federal water quality standards. Increased turbidity from extensive dredging operations projected to continue within the coastal zone constitutes another considerable type of pollution. Contamination from oil and hazardous substance spills should be primarily localized and not long term enough to preclude designated uses of the waters.

The incremental contribution of the proposed actions (Chapters 4.2.1.3.1 for the CPA, 4.3.1.3.1 for the WPA and 4.4.3.3.1 for accidental impacts) would be a very small part of the cumulative impacts to coastal water quality. Localized, minor degradation of coastal water quality is expected from the proposed actions within the immediate vicinity of the waterbodies proximate to the proposed service bases, commercial waste-disposal facilities, and gas processing plants as a result of routine effluent discharges and runoff. Only a very small amount of dredging would occur as a result of the proposed actions.

Non-OCS sources of impacts on biological resources and the structure of live bottoms include natural disturbances (e.g., turbidity, hypoxia, and storms), anchoring by recreational and commercial vessels, and commercial and recreational fishing. These impacts may result in severe and permanent mechanical damages to live-bottom communities that serve as essential fish habitat.

Commercial fishing activities that could impact live bottoms would include trawl fishing and trap fishing. With the exception of localized harvesting techniques, most wild-caught shrimp are collected using bottom trawls – nets towed along the seafloor – held apart with heavy bottom sled devices called "doors" made of wood or steel. In addition to the nonselective nature of bottom trawls, they can be potentially damaging to the bottom community as they drag. Trawls pulled over the bottom disrupt the communities that live on and just below the surface and also increases turbidity of the water (GMFMC, 1998).

Throughout the Gulf Coast, commercial trap fishing is used for the capture of reef fish, and commercial and recreational trap fishing is used for the capture of spiny lobster, stone crab, and blue crab. Reef fish traps are primarily constructed of vinyl-covered wire mesh and include a tapered funnel where the fish can enter but not escape. Traps, like trawls, can potentially damage the bottom community, depending on where they are placed. If they are deployed and retrieved from coral habitats or live bottom, they can damage the corals and other attached invertebrates on the reef. Seagrasses can also be broken or killed by placement and retrieval of traps (GMFMC, 1998).

The OCS-related activities could impact the biological resources and the structure of live bottoms by the anchoring of vessels, emplacement of structures (drilling rigs, platforms, and pipelines), sedimentation (operational waste discharges, pipeline emplacement, explosive removal of platforms, and blowouts), and chemical contamination (produced water, operational waste discharges, and petroleum spills). The Live Bottom (Pinnacle Trend) Stipulation (in the CPA), and the Topographic Features Stipulation (in the CPA and WPA) would prevent most of the potential impacts on live-bottom communities and EFH from the

OCS Program and from bottom-disturbing activities (anchoring, structure emplacement and removal, pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, produced waters), and blowouts. Recovery from impacts caused by unregulated operational discharges or an accidental blowout would take place within several years. For any activities associated with the proposed actions, USEPA's Region 4, in the northeast part of the CPA, and Region 6 for the rest of the CPA and WPA, will regulate discharge requirements through their USEPA NPDES individual discharge permits. In the unlikely event of an offshore spill, the biological resources of hard/live bottoms would remain unharmed as the spilled substances could, at the most, reach the seafloor in minute concentrations. These minute quantities may cause very short-term sublethal effects (changes in physiology) in benthic organisms that will recover quickly.

Surface oil spills would have the greatest chance of impacting high relief live bottoms (includes topographic features and pinnacles) located in depths less than 20 m (mostly sublethal impacts). A comprehensive survey of all low relief live bottoms in the CPA and WPA has yet to be conducted but all major topographic features are well described and most of the Pinnacle Trend is well mapped and described (Chapters 3.2.2.1 and 3.2.2.2). Only three high-relief features in the Gulf rise to water depths shallower than 20 m. These are the East Flower Garden Bank (16 m), Stetson Bank (17 m) and Sonnier Bank (17 m). Subsurface spills (pipeline spills) could cause localized, sublethal (short-term, physiological changes) impacts on the live bottoms; however, such events would be highly unlikely since the protective lease stipulations would prevent oil lines from being installed in the immediate vicinity of high-relief live bottoms. The impact of OCS-related activities on the live bottoms of the cumulative activity area would probably be slight because community-wide impacts should not occur.

The incremental contribution of impacts on fisheries and EFH from the proposed actions (as analyzed in Chapters 4.2.1.3.1 for the CPA, 4.3.1.3.1 for the WPA, and 4.4.3.3.10 for accidental impacts) to the cumulative impacts would be small. The proposed actions would add slightly to the overall offshore water quality degradation through the disposal of offshore operational wastes and sedimentation/sediment resuspension. Other activities of the proposed actions potentially contributing to regional impacts would be the effects of petroleum spills and anchoring. The extent of these impacts would be limited by the implementation of the protective lease stipulations and the depths of all but three high-relief live bottom habitats (>20 m).

Municipal, agricultural, and industrial coastal discharges and land runoff would impact the health of marine waters. As the assimilative capacity of coastal waters is exceeded, there will be a subsequent, gradual movement of the area of degraded waters farther offshore over time. This degradation will cause short-term loss of the designated uses of some shallow offshore waters due to hypoxia and red or brown tide impacts and to levels of contaminants in some fish exceeding human health standards. Coastal sources are assumed to exceed all other sources, with the Mississippi River continuing to be the major source of contaminants to the north central Gulf area. Offshore vessel traffic and OCS operations would contribute in a small way to regional degradation of offshore waters through spills and waste discharges. All spill incidents (OCS and others) and activities increasing water-column turbidity are assumed to cause localized water quality changes for up to three months for each incident. The incremental contribution of the proposed actions to degradation of marine water quality would be small.

The impact of coastal and marine degradation from the OCS Program and non-OCS activities is expected to cause no more than a 10 percent decrease in fish populations or EFH. At the expected level of cumulative impact, the resultant influence on fish resources and EFH could be substantial and easily distinguished from effects due to natural population variations. The incremental contribution of the proposed actions to these cumulative impacts would be small and would be almost undetectable.

Competition between large numbers of commercial and recreational fishermen for a given fishery resource, as well as natural phenomena such as weather, hypoxia, and red or brown tides, may reduce fish resource standing populations. Fishing techniques such as trawling, gill netting, or purse seining, when practiced nonselectively, may reduce the standing stocks of the desired target species as well as significantly impact species other than the target. Hypoxia and red or brown tides may impact fish resources and EFH by suffocating or poisoning offshore populations of finfish and shellfish and live-bottom reef communities. Finally, hurricanes may impact fish resources by destroying offshore live-bottom and reef communities and changing physical characteristics of inshore and offshore ecosystems.

Many of the important species harvested from the Gulf of Mexico are believed to have been overfished, while overfishing is still taking place (USDOC, NMFS, 2001b). The new managed species listed as overfished in 2000 that were not listed in 1999 are King mackerel, red snapper, red grouper, Nassau grouper, goliath grouper, and red drum. Continued fishing at the present levels may result in declines of fish resource populations and eventual failure of certain fisheries. It is expected that overfishing of targeted species and trawl fishery bycatch will adversely affect fish resources. The impact of overfishing on fish resources is expected to cause a measurable decrease in populations. At the estimated level of effect, the resultant influence on fish resources is expected to be substantial and easily distinguished from effects due to natural population variations.

Those species that are not estuary dependent, such as mackerel, cobia, and crevalle, are considered coastal pelagics. Populations of these species exhibit some degree of coastal movement. These species range throughout the Gulf, move seasonally, and are more abundant in the eastern portions of the northern Gulf during the summer (GMFMC, 1985). In general, the coastal movements of these species are restricted to one or two regions within the Gulf of Mexico region and are not truly migratory, as is the case with salmon. The coastal movements of these species are related to reproductive activity, seasonal changes in water temperature, or other oceanographic conditions. Discernible effects to regional populations or subpopulations of these species as a result of the OCS Program in the Gulf of Mexico area are not expected because pelagic species are distributed and spawn over a large geographic area and depth range.

Removal of structures by using explosives results in loss of artificial habitat and causes fish kills. It is estimated that 3,676-4,183 structures would be removed using explosives as a result of the OCS Program in the CPA and 629-783 in the WPA. An estimated 4-5 structures will be removed from the EPA area between 2003-2042. It is expected that structure removals would have a major effect on fish resources near the removal sites. However, only those fish proximate to the removal sites would be killed and these expected impacts to fish resources have been shown to be small overall, and would not alter determinations of status for impacted species or result in changes in management strategies (Gitschlag et al., 2000).

In the following analysis, the estimates of impacts to fish resources from petroleum spills comes from examinations of recent spills such as the *North Cape*, Breton Point, *Sea Empress*, and *Exxon Valdez* (Brannon et al., 1995; Maki et al., 1995; Mooney, 1996; Pearson et al., 1995). The amount of petroleum spilled by each event and its estimated impact to fish resources was used as a guideline to estimate the impacts to fisheries in this EIS.

Spills that contact coastal bays, estuaries, and offshore waters when pelagic eggs and larvae are present have the greatest potential to affect fish resources. If spills were to occur in coastal bays, estuaries, or waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be sublethal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. For eggs and larvae contacted by spilled diesel, the effect is expected to be lethal.

It is estimated that 1,875 coastal spills of <1,000 bbl will occur along the northern Gulf Coast annually (Table 4-17). About 95 percent of these spills are projected to be from non-OCS-related activity. Of coastal spills <1,000 bbl, the assumed size is 6 bbl therefore, the great majority of coastal spills would affect a very small area and dissipate rapidly. The small coastal spills that do occur from OCS-related activity would originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, and Alabama but primarily within the Houston/Galveston area of Texas and the Deltaic area of Louisiana. It is expected that small coastal oil spills from non-OCS sources would often affect coastal bays and marshes essential to the well-being of the fish resources and EFH.

It is estimated that 10-15 coastal spills ≥1,000 bbl from all sources would occur annually along the northern Gulf (Table 4-17). Between 80 and 100 percent of these spills are expected to be non-OCS related (Table 4-17). One large (≥1,000 bbl) coastal spill is projected to originate from OCS-related activity annually. A large coastal spill that could occur from OCS-related activity would likely originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, or Alabama, but primarily within the Houston/Galveston area of Texas and the Deltaic area of Louisiana. It is expected that large coastal spills from non-OCS sources would often affect coastal bays and marshes essential to the well-being of the fishery resources and EFH in the cumulative activity area.

A total of 4-5 large (≥1,000 bbl) offshore spills are projected to occur annually from all sources Gulf wide. One large (≥1,000 bbl) offshore spill is estimated to occur every 1 to 2 years from the Gulfwide OCS Program (Table 4-17). A total of 1,550 to 2,150 smaller offshore spills (<1,000 bbl) are projected annually Gulfwide. The majority of these (1,350-1900) will originate from OCS program sources. Chapter 4.4.1.1 describes projections of future spill events in more detail. The OCS-related spills in the cumulative area are expected to cause a 1 percent or less decrease in fish resources. The impact of non-OCS-related spills in this area is expected to cause a 10 percent or less decrease in fish resources.

Subsurface blowouts of both oil and natural gas wells and pipeline trenching have the potential to affect adversely commercial fishery resources. Loss of well control and resultant blowouts seldom occur on the Gulf OCS (7 blowouts per 1,000 well starts; <10% would result in some spilled oil). Considering the entire OCS program from 2003 to 2042, it is projected that there would be 164-192 blowouts in the CPA, 51-66 in the WPA, and only 1 blowout in the EPA. In addition, sediment would be resuspended during the installation of pipelines. Sandy sediments would be quickly redeposited within 400 m of the crater, and finer sediments would be widely dispersed and redeposited over a period of hours to days within a few thousand meters of the crater. Resuspension of vast amounts of sediments due to hurricanes occurs on a regular basis in the northern Gulf of Mexico (Stone et al., 1996). It is expected that the infrequent subsurface blowout that may occur on the Gulf OCS would have a negligible effect on fish resources. The effect on fish resources from pipeline trenching is expected to cause a 5 percent or less decrease in standing stocks. Drilling-mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than those found more than a few meters from the discharge point. Offshore discharges of drilling muds would dilute to very near background levels within 1,000 m of the discharge point and would have a negligible effect on fisheries. Produced-water discharges contain components and properties detrimental to commercial fishery resources. Moderate petroleum and metal contamination of sediments and the water column would occur out to several hundred meters downcurrent from the discharge point. Offshore discharges of produced water would disperse, dilute to very near background levels within 1,000 m of the discharge point, and have a negligible effect on fisheries. Offshore live bottoms will not be impacted. Offshore discharges and subsequent changes to marine water quality will be regulated by a USEPA NPDES permits.

Summary and Conclusion

Activities resulting from the OCS Program and non-OCS events in the northern Gulf of Mexico have the potential to cause detrimental effects on fish resources and EFH. Impact-producing factors of the cumulative scenario that are expected to substantially affect fish resources and EFH include coastal and marine environmental degradation, overfishing, petroleum spills, and pipeline trenching. At the estimated level of cumulative impact, the resultant influence on fish resources and EFH is expected to be substantial, but not easily distinguished from effects due to natural population variations.

The incremental contribution of the proposed actions' impacts on fish resources and EFH (as analyzed in Chapters 4.2.1.10 for the CPA, 4.3.1.8 for the WPA, and 4.4.3.10 for accidental impacts) to the cumulative impact is small. The effects of impact-producing factors (coastal and marine environmental degradation, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters) related to the proposed actions are expected to be negligible (resulting in less than a 1% decrease in fish populations or EFH) and almost undetectable among the other cumulative impacts.

The cumulative impact is expected to result in a less than 10 percent decrease in fish resource populations or EFH. It would require 2-3 generations for fishery resources to recover from 99 percent of the impacts. Recovery cannot take place from habitat loss.

4.5.11. Impacts on Commercial Fisheries

This cumulative analysis considers activities that could occur and adversely affect commercial fishing for the years 2003-2042. These activities include effects of the OCS Program (proposed action and prior and future OCS sales), State oil and gas activity, the status of commercial fishery stocks, oil transport by tankers, natural phenomena, and commercial and recreational fishing. Specific types of impact-producing factors considered in this cumulative analysis include commercial and recreational fishing techniques or practices, hurricanes, installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters.

Competition between large numbers of commercial fishermen, between commercial operations employing different fishing methods, and between commercial and recreational fishermen for a given fishery resource, as well as natural phenomena such as hurricanes, hypoxia, and red or brown tides, may impact commercial fishing activities. Fishing techniques such as trawling, gill netting, or purse seining, when practiced nonselectively, may reduce the standing stocks of the desired target species as well as significantly impact species other than the target. In addition, continued fishing of most commercial species at the present levels may result in rapid declines in commercial landings and eventual failure of certain fisheries. These effects will likely result in State and Federal constraints, such as closed seasons, excluded areas, quotas, size and weight limits on catch, and gear restrictions on commercial fishing activity. Space-use conflicts and conflicts over possession of the resources can result from different forms of commercial operations and between commercial and recreational fisheries. These effects will likely result in State and Federal constraints, such as weekday only, quotas, and/or gear restrictions, on commercial fishing activity. Finally, hurricanes may impact commercial fishing by damaging gear and shore facilities and dispersing resources over a wide geographic area. The availability and price of key supplies and services, such as fuel, can also affect commercial fishing. The impact from the various factors described above is expected to result in a 10 percent or less decrease in commercial fishing activity, landings, or value of landings.

A range of 2,360-3,134 structures is projected to be installed as a result of the OCS Program in the CPA, 622-856 in the WPA, and 5-9 in the EPA. Approximately 88-89 percent of these installations are in typical trawling water depths of 200 m or less. If all of the structures are major production structures, a maximum of 18,804, 5,136 and 54 ha (6 ha per platform) would be eliminated from trawl fishing for up to 40 years from the CPA, WPA, and EPA, respectively. It is assumed that the total area lost to commercial fishing due to the presence of OCS production platforms would continue to be less than 1 percent of the total area available to commercial trawl fishing. For example, the maximum number of 18,804 structures installed in the CPA represents only 0.1 percent of the total area of the Central Planning Area. It is expected that platform emplacement would infrequently affect trawling activity.

Structure removals result in artificial habitat loss and cause fish kills when explosives are used. It is estimated that 3,676-4,183 structures would be removed using explosives as a result of the OCS Program in the CPA and 629-783 in the WPA. An estimated 4-5 structures will be removed from the EPA area between 2003-2042. It is expected that structure removals will have a negligible effect on commercial fishing because of the inconsequential number of removals and the consideration that removals kill only those fish proximate to the removal sites. However, only those fish proximate to the removal sites would be killed and these expected impacts to fish resources have been shown to be small overall, and would not alter determinations of status for impacted species or result in changes in management strategies (Gitschlag et al., 2000).

Seismic surveys will occur in both shallow and deepwater areas of the Gulf of Mexico under the OCS Program. Usually, fishermen are precluded from a very small area for several days. This should not impact the annual landings or value of landings for commercial fisheries in the Gulf. Gulf of Mexico species can be found in many adjacent locations and Gulf commercial fishermen do not fish in one locale. Gear conflicts between seismic surveys and commercial fishing are also mitigated by the Fishermen's Contingency Fund. All seismic survey locations and schedules are published in the USCG Local Notice to Mariners, a free publication available to all fishermen. Seismic surveys will have a negligible effect on commercial fishing.

The potential causes, sizes, and probabilities of petroleum spills that could occur during activities associated with the proposed actions are discussed in Chapters 4.4.1.1. Information on spill response and cleanup is contained in Chapter 4.4.2. In the following analysis, the estimations of impacts to fisheries from oil spills come from examinations of recent spills such as the *North Cape*, *Breton Point, Sea Empress*, and *Exxon Valdez* (Brannon et al., 1995; Maki et al., 1995; Mooney, 1996; Pearson et al., 1995). The amount of oil spilled by each event and its estimated impact on fishing practices and fisheries economics was used as a guideline to estimate the impacts on commercial fishing under the OCS Program.

It is estimated that 1,875 coastal spills of <1,000 bbl will occur along the northern Gulf Coast annually (Table 4-17). About 95 percent of these spills are projected to be from non-OCS-related activity. Of coastal spills <1,000 bbl, the assumed size is 6 bbl; therefore, the great majority of coastal spills would affect a very small area and dissipate rapidly. The small coastal spills that do occur from

OCS-related activity would originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, and Alabama, but primarily within the Houston/Galveston area of Texas and the Deltaic area of Louisiana. It is expected that small, coastal oil spills from non-OCS sources would often affect coastal bays and marshes. Commercial fishermen will actively avoid the area of a spill. Even if fish resources successfully avoid spills, tainting (oily-tasting fish), public perception of tainting, or the potential of tainting commercial catches will prevent fishermen (either voluntarily or imposed by regulation) from initiating activities in the spill area. This in turn could decrease landings and/or value of catch for several months.

It is estimated that 10-15 coastal spills >1,000 bbl would occur annually along the northern Gulf (Table 4-17). Between 80 and 100 percent of these spills are expected to be non-OCS related. Only one large coastal spill is projected to originate from OCS-related activity annually. A large coastal spill that could occur from OCS-related activity would likely originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, or Alabama, but primarily within the Houston/Galveston area of Texas and the Deltaic area of Louisiana. It is expected that large coastal spills from non-OCS sources would often affect coastal bays and marshes essential to the well-being of the commercial fishery resources in the cumulative activity area.

A total of 4-5 large (≥1,000 bbl) offshore spills are projected to occur annually from all sources Gulfwide. Only 1 of these offshore spills is estimated to occur every 1 to 2 years from the Gulfwide OCS Program (Table 4-17).

A total of 1,550 to 2,150 smaller offshore spills (<1,000 bbl) are projected annually Gulfwide. The impact of OCS-related spills in the cumulative area is expected to cause a 1 percent or less decrease in commercial fishing. The impact of non-OCS-related spills in this area is expected to cause a 10 percent or less decrease in commercial fishing. At the expected level of impact, the resultant influence on commercial fishing, landings, or the value of those landings is expected to be considerable but not easily distinguished from effects due to natural population variations.

Subsurface blowouts of both oil and natural gas wells and pipeline trenching have the potential to adversely affect commercial fishery resources. Loss of well control and resultant blowouts seldom occur on the Gulf OCS (7 blowouts per 1,000 well starts; <10% would result in some spilled oil). Considering the entire OCS program from 2003 to 2042, it is projected that there would be 164-192 blowouts in the CPA, 51-66 in the WPA, and only 1 blowout in the EPA. In addition, sediment would be resuspended during the installation of pipelines. Sandy sediments would be quickly redeposited within 400 m of the trench, and finer sediments would be widely dispersed and redeposited over a period hours to days within a few thousand meters of the trench. Resuspension of vast amounts of sediments due to hurricanes occurs on a regular basis in the northern Gulf of Mexico (Stone et al., 1996). It is expected that the infrequent subsurface blowout that may occur on the Gulf OCS would have a negligible effect on commercial fishing. The effect on commercial fisheries from pipeline trenching is expected to cause a 5 percent or less decrease in commercial fishing, landings, or value of those landings. At the estimated level of effect, the resultant influence on commercial fishing is not expected to be easily distinguished from effects due to natural population variations.

Drilling-mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than those found more than a few meters from the discharge point. Offshore discharges of drilling muds would dilute to very near background levels within 1,000 m of the discharge point and would have a negligible effect on fisheries.

Produced-water discharges contain components and properties detrimental to commercial fishery resources. Moderate petroleum and metal contamination of sediments and the water column would occur out to several hundred meters downcurrent from the discharge point. Offshore discharges of produced water would disperse, dilute to very near background levels within 1,000 m of the discharge point, and have a negligible effect on fisheries.

Summary and Conclusion

Activities resulting from the OCS Program and non-OCS events have the potential to cause detrimental effects to commercial fishing, landings, and value of those landings. Impact-producing factors of the cumulative scenario that are expected to substantially affect commercial fishing include commercial and recreational fishing techniques or practices, hurricanes, installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters. At the estimated level of cumulative impact, the resultant influence on commercial fishing, landings, and value of those landings is expected to be substantial and easily distinguished from effects due to natural population variations.

The incremental contribution of the proposed actions impacts to commercial fisheries (as analyzed in Chapters 4.2.1.11 for the CPA, 4.3.1.9 for the WPA and 4.4.3.11 for accidental impacts) to the cumulative impact is small. The effects of impact-producing factors (installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, oil spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters) related to a proposed action are expected to be negligible (less than a 1 percent decrease in commercial fishing, landings, or value of those landings) and almost undetectable among the other cumulative impacts.

The cumulative impact is expected to result in a less than 10 percent decrease in commercial fishing, landings, or value of those landings. It would require 3-5 years for fishing activity to recover from 99 percent of the impacts.

4.5.12. Impacts on Recreational Beaches

This cumulative analysis considers the effects of impact-producing factors related to the proposed actions (Chapters 4.2.1.12 and 4.3.1.10), plus those related to prior and future OCS sales, State offshore and coastal oil and gas activities throughout the Gulf of Mexico, tankering of crude oil imports, merchant shipping, commercial and recreational fishing, military operations, recreational use of beaches, and other offshore and coastal activities that result in debris, litter, trash, and pollution, which may adversely affect major recreational beaches. Specific OCS-related impact-producing factors analyzed include trash and debris, the physical presence of platforms and drilling rigs, support vessels and helicopters, oil spills, and spill clean-up activities. Other factors such as land development, civil works projects, and natural phenomena have affected, and will continue to affect, the quality of the beach environment and public use and appreciation of major recreational beaches. Ultimately, all these factors plus the health of the U.S. economy and the price of gasoline can affect the travel and tourism industry and the level of beach use along the U.S. Gulf Coast.

Trash and debris are a recognized problem affecting enjoyment and maintenance of recreational beaches along the Gulf Coast. From extensive aerial surveys conducted by NMFS over large areas of the Gulf of Mexico, floating offshore trash and debris was characterized by Lecke-Mitchell and Mullin (1997) as a ubiquitous, Gulfwide problem. Coastal and offshore oil and gas operations contributing to trash and debris washing up on Texas and Louisiana beaches (Miller and Echols, 1996; Lindstedt and Holmes, 1988). Annual reports from the results of the International Beach Cleanup each fall (Center for Marine Conservation, 1996-1998) indicate volunteers remove thousands of pounds of trash and debris from coastal recreational beaches from Texas to Florida. Regulatory, administrative, educational, and volunteer programs involving government, industry, environmental, school, and civic groups; specific marine user groups; and private citizens are committed to monitoring and reducing the beach litter problem Gulfwide.

Continued and expanded oil and gas operations throughout the Gulf of Mexico have contributed to the trash and debris on coastal beaches. Trash and debris detract from the aesthetic quality of beaches, can be hazardous to beach users, and can increase the cost of maintenance programs. Other offshore activities (such as merchant shipping; Naval operations; offshore and coastal commercial and recreational fishing, State offshore oil and gas activities), coastal activities (such as recreation; State onshore oil and gas activities; condominiums and hotels), and natural phenomena (such as storms, hurricanes, and river outflows) contribute to debris and pollution existing on the major Gulf of Mexico recreational beaches.

The OCS oil and gas industry has improved offshore waste management practices and evidenced a strong commitment to participate in the annual removal of trash and litter from recreational beaches affected by their offshore operations. Furthermore, MARPOL Annex V and the special efforts to generate cooperation and support from all Gulf user groups through the Gulf of Mexico Program should lead to a decline in the overall level of human-generated trash adversely affecting recreational beaches throughout the Gulf.

At present, there are approximately 4,000 OCS platforms on the Gulf of Mexico OCS. About 1,200 of these platforms are within visibility range (approximately 12 mi) of shore; most (about 1,000) are located in the CPA west of the Mississippi River. In the CPA east of the Mississippi River, less than 50

OCS platforms are within 12 mi of the Mississippi or Alabama coast. About 50 platforms are located within 12 mi of the shore in the WPA. Based on these numbers and peak-year projections, a maximum of about 1,200 OCS production structures will be visible from shore at one time and this number will drastically decrease during the 40-year analysis period as operations move into deeper water. Oil and gas operations in State waters off Texas, Louisiana, and Alabama are also visible form shore. Aesthetic impacts of the visible presence of offshore drilling rigs and platforms are unlikely to affect the level of beach recreation, but they may affect the experience of some beach users, especially at beach areas such as the Padre Islands National Seashore in Texas and the Gulf Islands National Wilderness Area on Mississippi's outer barrier islands.

Vessels and helicopter traffic servicing OCS operations will be seen and heard by beach users from time to time. Existing and future oil and gas developments in the State waters contribute to these impacts. Commercial and recreational maritime traffic add to the visual and noise impacts.

The primary impact-producing factors associated with offshore oil and gas exploration and development, and most widely recognized as major threats to the enjoyment and use of recreational beaches, are oil spills and offshore trash, debris, and tar. All of the respondents from a total of 39 semi-structured discussions conducted from March through May 1997 for the MMS study, "Socioeconomic and Environmental Issues Analysis of Oil and Gas Activity on the Outer Continental Shelf of the Western Gulf of Mexico," recognized environmental threats posed by the nature and specific operations of the industry (Kelley, in press). Most respondents to the study believed that a major oil spill would have devastating effects on the tourist industry. While "small" spills were deemed to occur with some frequency, it is "the big one" that people most fear. Offshore trash and tar is often noted as the second biggest threat to the conditions of the beaches in the Gulf of Mexico coastal region. Additional factors such as the physical presence of platforms and drilling rigs can affect the aesthetics of beach appreciation. Soil contamination and air and water pollution created by the refining of oil and the production of petrochemical products are other areas of concern.

Section 4.4.1 discusses the risk of spill occurrence, the number of spills estimated for the OCS Program, and the likelihood of an OCS-spill contacting the Gulf Coast. The scenarios analyzed are a hypothetical oil spills of 4,600 bbl and ≥10,000 bbl occurring from future OCS oil and gas operations in the Gulf of Mexico. Should a such a spill contact a recreational beach, short-term displacement of recreational activity from the areas directly affected would occur. Beaches directly impacted would be expected to close for periods of 2-6 weeks, or until the cleanup operations were complete. Should a spill occur, factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, and cleanup methods would have a bearing on the severity of effects the spill would have on a recreational beach and its use. Sorenson (1990) reviewed the economic effects of several historic major oil spills on beaches and concluded that a spill near a coastal recreation area would reduce visitation in the area by 5-15 percent over one season but would have no long-term effect on tourism.

The estimated annual oil spill occurrences expected in the future in the WPA or CPA, based on historical data maintained by MMS and USCG, are presented in Table 4-17. The great majority of coastal spills that do occur from OCS-related activities are likely to originate near terminal locations in the coastal zone around marinas, refineries, commercial ports, pipeline routes, and marine terminal areas, usually during the transfer of fuel. The average fuel-oil spill is 18 bbl. It is expected that these frequent, but small, spills will not affect coastal beach use.

Although hundreds of small spills are documented annually from all sources within the marine and coastal environment of the Gulf Coast, it is primarily large spills (≥1,000 bbl) that are a major threat to coastal beaches. Should a large spill impact major recreational beaches, no matter the source, it will result in unit and park closures until cleanup is complete. Oil-pollution events impacting recreational beaches will generate immediate cleanup response from responsible oil and gas industry sources. Recreational use will be displaced from impacted beaches and closed parks (generally 2-4 weeks). Recreational use and tourism impacts will be more significant if spills affect beaches during peak-use seasons and if publicity is intensive and far-reaching.

Summary and Conclusion

Debris and litter derived from both offshore and onshore sources are likely to diminish the tourist potential of beaches and to degrade the ambience of shoreline recreational activities, thereby affecting the enjoyment of recreational beaches throughout the area. The incremental beach trash resulting from the proposed actions is expected to be minimal.

Platforms and drilling rigs operating nearshore may affect the ambience of recreational beaches, especially beach wilderness areas. The sound, sight, and wakes of OCS-related and non-OCS-related vessels, as well as OCS helicopter and other light aircraft traffic, are occasional distractions that are noticed by some beach users.

Oil that contacts the coast may preclude short-term recreational use of one or more Gulf Coast beaches at the park or community levels. Displacement of recreational use from impacted areas will occur, and a short-term decline in tourism may result. Beach use at the regional level is unlikely to change from normal patterns; however, closure of specific beaches or parks directly impacted by a large oil spill is likely during cleanup operations.

4.5.13. Impacts on Archaeological Resources

The following cumulative analysis considers the effects of the impact-producing factors related to a proposed action, OCS activities in the cumulative activity area, trawling, sport diving, commercial treasure hunting, seismic exploration in State waters, and tropical storms on archaeological resources. Specific types of impact-producing factors associated with OCS activities that are considered in this analysis include drilling rig and platform emplacement, pipeline emplacement, anchoring, oil spills, dredging, new onshore facilities, and ferromagnetic debris.

4.5.13.1. Historic Archaeological Resources

Archaeological surveys are assumed to be highly effective in reducing the potential for an interaction between an impact-producing activity and a historic resource. The surveys are expected to be most effective in areas where there is only a thin veneer of unconsolidated Holocene sediments. In these areas shipwreck remains are more likely to be exposed at the seafloor where they can be detected by the side-scan sonar as well as the magnetometer. In areas of thicker unconsolidated sediments, shipwreck remains are more likely to be completely buried with detection relying solely on magnetometer. According to estimates presented in Table 4-4, an estimated 26,119-32,385 exploration, delineation and development wells will be drilled, and 2.987-3,999 production platforms will be installed as a result of the OCS Program. Of this range, between 10,774-12,131 exploration, delineation, and development wells will be drilled, and 2,239-2,969 production structures will be installed in water depths of 60 m or less. The majority of lease blocks in this water depth have a high probability for historic shipwrecks. Archaeological surveys were first required for Lease Sale 32 held in December 1973; therefore, it is assumed that any major impacts to historic resources resulted from development prior to this time.

Of the 15,886 lease blocks in the OCS Program area, less than half of these blocks are leased. There are 1,562 blocks that fall within the Gulf of Mexico Region's high probability areas for historic resources. Of these blocks, 1,189 blocks are in water depths of 200 m or less and will require a 50 m survey. The potential of an interaction between rig or platform emplacement and a historic shipwreck is greatly diminished by requisite site surveys, but still exists. Such an interaction could result in the loss of or damage to significant or unique historic information.

Table 4-4 indicates the placement of between 27,590-52,364 km of pipelines is projected in the cumulative activity area. While the required archaeological survey minimizes the chances of impacting a historic shipwreck, there remains a possibility that a wreck could be impacted by pipeline emplacement. Such an interaction could result in the loss of significant or unique historic information.

The setting of anchors for drilling rigs, platforms, and pipeline lay barges, and anchoring associated with oil and gas service-vessel trips to the OCS have the potential to impact historic wrecks. Archaeological surveys serve to minimize the chance of impacting historic wrecks; however, these surveys are not infallible and the chance of an impact from future activities does exist. Impacts from anchoring on a historic shipwreck may have occurred. There is also a potential for future impacts from anchoring on a historic shipwreck. Such an interaction could result in the loss of or damage to significant or unique scientific information.

The probabilities of offshore oil spills ≥1,000 bbl occurring from OCS Program activities is presented in Chapter 4.1.3. Oil spills have the potential to impact coastal historic sites directly or indirectly by physical impacts caused by oil-spill cleanup operations. The impacts caused by oil spills to coastal historic archaeological resources are generally short term and reversible. Table 4-17 presents the coastal spill scenario from both OCS and non-OCS sources. It is assumed that the majority of the spills will occur around terminals and be contained in the vicinity of the spill. Should such oil spills contact a historic site, the effects would be temporary and reversible.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for historic shipwrecks; the greatest concentrations of historic wrecks are likely associated with these features (Garrison et al., 1989). It is reasonable to assume that significant or unique historic archaeological information has been lost as a result of past channel dredging activity. In many areas, the COE requires remote-sensing surveys prior to dredging activities to minimize such impacts.

Past, present, and future OCS oil and gas exploration and development and commercial trawling will result in the deposition of tons of ferromagnetic debris on the seafloor. Modern marine debris associated with these activities will tend to mask the magnetic signatures of historic shipwrecks, particularly in areas that were developed prior to requiring archaeological surveys. Such masking of the signatures characteristic of historic shipwrecks may have resulted or may yet result in OCS activities in the cumulative activity area impacting a shipwreck containing significant or unique historic information.

Trawling activity specifically would only affect the uppermost portions of the sediment column (Garrison et al., 1989). On many wrecks, the uppermost portions would already be disturbed by natural factors and would contain only artifacts that have lost all original context.

Because MMS does not have jurisdiction over pipelines in State waters, the archaeological resource protection requirements of the National Historic Preservation Act (NHPA) are enforcable by MMS in those areas. However, other Federal agencies, such as the COE, which issues permits associated with pipelines in State waters, are responsible for the protection of archaeological resources under the NHPA. Therefore, the impacts that might occur to archaeological resources by OCS-related pipeline construction within State waters should be mitigated under the requirements of the NHPA.

Sport diving and commercial treasure hunting are significant factors in the loss of historic data from wreck sites. Efforts to educate sport divers and to foster the protection of historic shipwrecks, such as, those of the Texas Historical Commission and the Southwest Underwater Archaeological Society (Arnold, personal communication, 1997), will serve to lessen these potential impacts. While commercial treasure hunters generally impact wrecks with intrinsic monetary value, sport divers may collect souvenirs from all types of wrecks. Since the extent of these activities is unknown, the impact cannot be quantified. A Spanish war vessel, *El Cazador*, was discovered in the Central Gulf of Mexico, which contained a large amount of silver coins and has been impacted by treasure hunting salvage operations (*The Times Picayune*, 1993). The historic data available from this wreck and from other wrecks that have been impacted by treasure hunters and sport divers represent a significant or unique loss.

Much of the coast along the northern Gulf was hit with 16-20 tropical cyclones between the years 1901 and 1955 (DeWald, 1982). Shipwrecks in shallow waters are exposed to a greatly intensified, longshore current during tropical storms (Clausen and Arnold, 1975). Under such conditions, it is highly likely that artifacts (e.g., ceramics and glass) would be dispersed. Some of the original information contained in the site would be lost in this process, but a significant amount of information would also remain. Overall, a significant loss of data from historic sites has probably occurred, and will continue to occur, in the northeastern Gulf from the effects of tropical storms. Some of the data lost have most likely been significant or unique.

Summary and Conclusion

Several impact-producing factors may threaten historic archaeological resources. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a historic shipwreck located on the continental shelf. The archaeological surveys and resulting archaeological analysis and clearance that are required prior to an operator beginning oil and gas activities in a lease are expected to be highly effective at identifying possible historic shipwrecks. The OCS development prior to requiring archaeological surveys has possibly impacted wrecks containing significant or unique historic information.

The loss or discard of ferromagnetic debris associated with oil and gas exploration and development and trawling activities could result in the masking of historic shipwrecks.

Loss of significant or unique historic archaeological information from commercial fisheries (trawling) is not expected. It is expected that dredging, sport diving, commercial treasure hunting, and tropical storms have impacted and will continue to impact historic period shipwrecks. Additionally, it is possible that explosive seismic surveys on the OCS and within State waters, prior to 1989, could have impacted historic shipwrecks. Explosive seismic charges set near historic shipwrecks could have displaced the vessel's surrounding sediments acting like a small underwater fault and moving fragile wooden, ceramic and metal remains out of their initial cultural context. Such of an impact would have resulted in the loss of significant or unique archaeological information.

Onshore development as a result of a proposed action could result in the direct physical contact between a historic site and pipeline trenching. It is assumed that archaeological investigations prior to construction will serve to mitigate these potential impacts. The expected effects of oil spills on historic coastal resources are temporary and reversible.

The effects of the various impact-producing factors discussed in this analysis have likely resulted in the loss of significant or unique historic archaeological information. In the case of factors related to OCS Program activities in the cumulative activity area, it is reasonable to assume that most impacts would have occurred prior to 1973 (the date of initial archaeological survey and clearance requirements). The incremental contribution of the proposed actions is expected to be very small due to the efficacy of the required remote-sensing survey and archaeological report. However, there is a possibility of an interaction between bottom-disturbing activity (rig emplacement, pipeline trenching, and anchoring) and a historic shipwreck.

4.5.13.2. Prehistoric Archaeological Resources

Future OCS exploration and development activities in the Gulf of Mexico between 2003 and 2042 referenced in Table 4-4 project drilling 10,774-12,131exploration, delineation, and development wells in water depths <60 m. Relative sea-level curves for the Gulf of Mexico indicate there is no potential for the occurrence of prehistoric archaeological sites in water depths greater than 60 m. Archaeological surveys are assumed to be highly effective in reducing the potential for an interaction between an impact-producing activity and a prehistoric resource. Archaeological surveys were first required for Lease Sale 32 held in December 1973; therefore, it is assumed that the major impacts to prehistoric resources resulted from development prior to this time. The potential of an interaction between rig or platform emplacement and a prehistoric site is diminished by the survey, but still exists. Such an interaction would result in the loss of or damage to significant or unique prehistoric information.

The placement of 160-480 km and 160-320 km of pipelines in water depths <60 m is projected as a result OCS Program activities in the CPA and WPA, respectively. For the OCS Program, 9,800-24,374 km of pipelines are projected in water depths <60 m. While the archaeological survey minimizes the chances of impacting a prehistoric site, there remains a possibility that a site could be impacted by pipeline emplacement. Such an interaction would result in the loss of significant or unique archaeological information.

The setting of anchors for drilling rigs, platforms, and pipeline lay barges, and anchoring associated with oil and gas service vessel trips to the OCS have the potential to impact shallowly buried prehistoric sites. Archaeological surveys minimize the chance of impacting these sites; however, these surveys are not seen as infallible and the chance of an impact from future activities exists. Impacts from anchoring on a prehistoric site may have occurred. Such an interaction could result in the loss of significant or unique archaeological information.

The probabilities of offshore oil spills ≥1,000 bbl occurring from the OCS Program in the cumulative activity area is presented in Chapter 4.1.3. Oil spills have the potential to impact coastal prehistoric sites directly or indirectly by physical impacts caused by oil-spill cleanup operations. Coastal, oil-spill scenario numbers are presented in Table 4-17 for both OCS and non-OCS sources. It is assumed that the majority of the spills will occur around terminals and will be contained in the vicinity of the spill. There is a small possibility of these spills contacting a prehistoric site. The impacts caused by oil spills to coastal prehistoric archaeological resources can severely distort information relating to the age of the site.

Contamination of the organic site materials by hydrocarbons can make radiocarbon dating of the site more difficult or even impossible. This loss might be ameliorated by using artifact seriation or other relative dating techniques. Coastal prehistoric sites might also suffer direct impact from oil spill cleanup operations as well as looting resulting from interactions between persons involved in cleanup operations and unrecorded prehistoric sites. Interaction between oil-spill cleanup equipment or personnel and a site could destroy fragile artifacts or disturb site context, possibly resulting in the loss of information on the prehistory of North America and the Gulf Coast region. Some coastal sites may contain significant or unique information.

Most channel dredging occurs at the entrances to bays, harbors, and ports. Bay and river margins have a high probability for the occurrence and preservation of prehistoric sites. Prior channel dredging has disturbed buried and/or inundated prehistoric archaeological sites in the coastal plain of the Gulf of Mexico. It is assumed that some of the sites or site information were unique or significant. In many areas, the COE requires surveys prior to dredging activities to minimize such impacts.

Trawling activity would only affect the uppermost portion of the sediment column (Garrison et al., 1989). This zone would already be disturbed by natural factors, and site context to this depth would presumably be disturbed. Therefore, no effect of trawling on prehistoric sites is assumed. Investigations prior to construction can determine whether prehistoric archaeological resources occur at these sites.

Table 4-8 indicates the projected coastal infrastructure related to OCS Program activities in the cumulative activity area. Investigations prior to construction can determine whether prehistoric archaeological resources occur at these sites.

Because MMS does not have jurisdiction over pipelines in State waters, the archaeological resource protection requirements of the NHPA are not within MMS's jurisdiction. However, other Federal agencies, such as the COE, which lets permits associated with pipelines in State waters, are responsible for the protection of archaeological resources under the NHPA. Therefore, the impacts that might occur to archaeological resources by pipeline construction within State waters should be mitigated under the requirements of the NHPA.

About half of the coast along the northern Gulf was hit with 16-20 tropical cyclones between the years 1901 and 1955 (DeWald, 1982). Prehistoric sites in shallow waters and on coastal beaches are exposed to the destructive effects of wave action and scouring currents. Under such conditions, it is highly likely that artifacts would be dispersed and the site context disturbed. Some of the original information contained in the site would be lost in this process. Overall, a significant loss of data from prehistoric sites has probably occurred, and will continue to occur, in the northeastern Gulf from the effects of tropical storms.

Summary and Conclusion

Several impact-producing factors may threaten prehistoric archaeological resources of the Gulf of Mexico. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric archaeological site located on the continental shelf. The required archaeological surveys and resulting archaeological analysis and clearance that are required prior to an operator beginning oil and gas activities in a lease are expected to be highly effective at identifying possible prehistoric sites. OCS development prior to requiring archaeological surveys has possibly impacted sites containing significant or unique prehistoric information.

The likelihood of an oil spill occurring and contacting the coastline is very high. Such contact could result in loss of significant or unique information from coastal prehistoric sites.

The initial dredging of ports and navigation channels and tropical storms are assumed to have caused the loss of significant archaeological information.

Onshore development as a result of the OCS Program could result in the direct physical contact between a prehistoric site and new facility construction and pipeline trenching. It is assumed that archaeological investigations prior to construction will serve to mitigate these potential impacts.

The shallow depth of sediment disturbance caused by commercial fisheries activities (trawling) is not expected to exceed that portion of the sediments that have been disturbed by wave-generated forces.

The effects of the various impact-producing factors discussed in this analysis have likely resulted in the loss of significant or unique prehistoric archaeological information. In the case of factors related to OCS Program activities in the cumulative activity area, it is reasonable to assume that most impacts would have occurred prior to 1973 (the date of initial archaeological survey and clearance requirements). The incremental contribution of the proposed actions is expected to be very small due to the efficacy of the required remote-sensing survey and concomitant archaeological report and clearance.

4.5.14. Impacts on Human Resources and Land Use

The cumulative analysis considers the effects of OCS-related, impact producing as well as non-OCS-related factors. The OCS-related factors consist of prior, current, and future OCS lease sales; non-OCS factors include fluctuations in workforce, net migration, relative income, oil and gas activity in State waters, wetland loss, and tropical storms. Unexpected events that may influence oil and gas activity within the analysis area but cannot be predicted are not considered in this analysis.

4.5.14.1. Land Use and Coastal Infrastructure

Chapters 3.3.3.1.2 and 3.3.3.8 discuss land use and OCS-related oil and gas infrastructure associated with the analysis area. Land use in the analysis area will evolve over time. While the majority of this change is estimated as general regional growth, activities associated with the OCS Program are expected to minimally alter the current land use of the area. Except for 4-16 projected new gas processing plants, the OCS Program will require no new oil and gas coastal infrastructure. There may be some expansion at current facilities, but the land in the analysis area is sufficient to handle development. There is also sufficient land to construct the projected new gas processing plants in the analysis area.

Shore-based OCS servicing should also increase in the ports of Galveston, Texas; Port Fourchon, Louisiana; and the Mobile, Alabama, area due to deepwater activities. There is sufficient land designated in commercial and industrial parks and adjacent to the Galveston and Mobile area ports to minimize disruption to current residential and business use patterns. Port Fourchon, though, has limited land available; operators have had to create land on adjacent wetland areas. Any changes in the infrastructure at Port Fourchon that lead to increases in Louisiana Highway 1 (LA Hwy 1) usage, will contribute to the increasing deterioration of the highway. LA Hwy 1 is not able to handle projected OCS activities. In addition, any changes that increase OCS demand of water will further strain Lafourche Parish’s water system. In 2003, construction of Edison Chouest’s C-Port at Galveston, Texas, to service the WPA and Mexico should be completed and fully operational. This service facility may act to distribute OCS impacts to onshore infrastructure. Other ports in the analysis area that have sufficient available land plan to make OCS-related infrastructure changes.

Since the State of Florida and many of its residents reject any mineral extraction activities off their coastline, OCS-focused businesses are not expected to be located there.

Summary and Conclusion

Activities relating to the OCS Program are expected to minimally affect the analysis area’s land use. Most subareas in the analysis area have strong industrial bases and designated industrial parks to accommodate future growth in OCS-related businesses. Any changes (mostly expansions, except for the 4-16 projected new gas processing plants) are expected to be contained on available land. Port Fourchon is expected to experience significant impacts to its land use from OCS-related expansion. Increased OCS-related usage from port clients is expected to significantly impact LA Hwy 1 in Lafourche Parish. Also, increased demand of water by the OCS will further strain Lafourche Parish’s water system.

4.5.14.2. Demographics

This section projects how and where future demographic changes will occur and whether they correlate with the OCS Program. The addition of any new human activity, such as oil and gas development resulting from the proposed actions, can effect local communities in a variety of ways. Typically, these effects are in the form of people and money that can translate into changes in the local social and economic institutions and land use.

Population

Chapter 3.3.3.4.1 discusses the analysis area's baseline population and projections. Population impacts from the OCS Program, Tables 4-59 and 4-60 mirror those assumptions associated with employment described below in Chapter 4.5.14.3. Projected population changes reflect the number of people dependent on income from oil and gas-related employment for their livelihood. This figure is based on the ratio of population to employment in the analysis area over the throughout the 40-year analysis period. Activities associated with the OCS Program are projected to have minimal effects on population in most of the coastal Subareas. Regions in Louisiana coastal subareas, the Lafourche Parish area in particular, are expected to experience noteworthy increases in population resulting from increases in demand for OCS labor. Chapter 4.5.14.3 below discusses this issue in more detail.

Age

The age distribution of the analysis area is expected to remain virtually unchanged with respect to OCS Program activities. Given both the low levels of population growth and industrial expansion associated with the OCS Program, the age distribution pattern discussed in Chapter 3.3.3.4.2 is expected to continue throughout the 40-year analysis period.

Race and Ethnic Composition

The racial distribution of the analysis area is expected to remain virtually unchanged with respect to the OCS Program. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the racial distribution pattern described in Chapter 3.3.3.4.3 is expected to continue throughout the 40-year analysis period.

Education

Activities relating to the OCS Program are not expected to significantly affect the analysis area's educational levels described in Chapter 3.3.3.4.4. Some regions in the analysis area, Lafourche Parish in particular, will experience some strain to their education system, but the level of educational attainment will not be affected.

Summary and Conclusion

Activities relating to the OCS Program are expected to minimally affect the analysis area's demography. Baseline patterns and distributions of these factors, as described in Chapter 3.3.4, are not expected to change for the analysis area as a whole. Some regions within Louisiana coastal Subareas, Port Fourchon in particular, are expected to experience some impacts to population and their education system as of a result of increase demand of OCS labor.

4.5.14.3. Economic Factors

This cumulative economic analysis focuses on the potential direct, indirect, and induced impacts of the OCS Program's oil and gas activities in the Gulf of Mexico on the population and employment of the counties and parishes in the analysis area. The regional economic impact assessment methodology used to estimate changes to employment for a proposed lease sale was used for the cumulative analysis.

Tables 4-61 and 4-62 present employment associated with the OCS Program and the percentage to total employment in each coastal subarea. Based on these model results, direct employment associated with OCS Program activities is estimated to range between 55,000 and 74,000 jobs during peak activity years (year 2 through year 11) for the low and high resource estimate scenarios, respectively. There is no clear year of peak impact. Employment quickly grows to the peak, stays at relatively high levels from year 2 to year 11, and then gradually declines throughout the life of the proposal. Indirect employment is projected between 21,000 and 28,000 jobs, while induced employment is calculated between 25,000 and 33,000 jobs for the same peak period. Therefore, total employment resulting from OCS Program activities is not expected to exceed 101,000-136,000 jobs in any given year over the 40-year impact period.

In Texas, the majority of OCS-related employment is expected to occur in coastal Subarea TX-2; however, this employment is expected to exceed 1 percent but is never expected to exceed a maximum of 1.6 percent of the total employment in that coastal subarea. The OCS-related employment for all Louisiana coastal subareas is projected to be substantial. Employment in coastal Subarea LA-1 is projected to have the most significant impact in Louisiana and in the analysis area at 6.3 percent of total employment for that area. The OCS-related employment for coastal Subareas LA-2 and LA-3 is 3.3 and 3.9 percent of total employment, respectively. The OCS-related employment for Mississippi and Alabama's coastal Subarea MA-1 is not expected to exceed 1 percent of the total employment in that area. Model results also reveal there would be little to no economic stimulus to the Florida coastal subareas as a result of OCS Program activities. Population impacts, as conveyed in Tables 4-59 and 4-60, mirror those assumptions associated with employment.

Employment demand will be met primarily with the existing population and available labor force in most coastal subareas. The MMS does expect some employment will be met through in-migration due to the shadow effect and a labor force lacking requisite skills for the oil and gas and supporting industries. In addition, MMS expects sociocultural impacts to be minimal in most coastal subareas. Some localized impacts to family life in a small number of cases may result from the offshore work schedule of two weeks on and two weeks off.

On a regional level, the cumulative impact on the population, labor, and employment of the counties and parishes of the impact area is considerable for some focal points. Peak annual changes in the population, labor, and employment of all coastal subareas in the CPA and WPA resulting from the OCS Program are minimal, except in Louisiana. However, on a local level, Port Fourchon is experiencing full employment, housing shortages, and stresses on local infrastructure—roads (LA Hwy 1), water supply, schools, hospitals, etc. Port Fourchon is a focal point for OCS development, especially deepwater OCS operations. Any additional employment, particularly new residential employment, and the resultant strain on infrastructure, due to the OCS Program, are expected to have a significant impact on the area.

The resource costs of cleaning up an oil spill, either onshore or offshore, were not included in the above cumulative analysis. The cleanup and remediation of an oil spill involves the expenditure of millions of dollars and the creation of up to hundreds of temporary jobs. While such expenditures are revenues to business and employment/revenues to individuals, spills represent a net cost to society and are a deduction from any comprehensive measure of economic output. In economic terms, spills represent opportunity costs. An oil spill's opportunity cost has two generic components. The first cost is the direct cost to clean up the spill and to remediate the oiled area. This is the value of goods and services that could have been produced with these resources had they gone to production or consumption rather than the cleanup. The second is the value of the opportunities lost or precluded to produce (e.g., harvest oysters) or consume (e.g., recreational/tourism activities) (Pulsipher et al., 1999).

Chapter 4.4.1 discusses the risk of spill occurrence, the number of spills estimated for the OCS Program, and the likelihood of an OCS-spill contacting the Gulf Coast. The scenarios for the analysis are hypothetical spills of 4,600 bbl and ≥10,000 bbl occurring from future OCS oil and gas operations in the Gulf of Mexico. The magnitude of the impacts discussed below depend on many factors including the season of spill occurrence and contact, the volume and condition of the oil that reaches shore, the usual use of the shoreline impacted, the diversity of the economic base of the shoreline impacted, and the time required for cleanup and remediation activities. In addition, the extent and type of media coverage of a spill may affect the magnitude and length of time that tourism is reduced to an impacted area.

The immediate social and economic consequences for a region contacted by an oil spill also included non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations. These negative, short-term social and economic consequences of an oil spill are expected to be modest as measured by projected cleanup expenditures and the number of people employed in cleanup and remediation activities.

Negative, long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill (Pulsipher et al., 1999). Chapters 4.4.3.10 and 4.4.3.12 contain more discussions of the consequences of a spill on fisheries and recreational beaches.

Summary and Conclusion

The OCS Program will produce only minor economic changes in the Texas, Mississippi, and Alabama coastal subareas. With the exception of Subarea TX-2, it is expected to generate a less than 1 percent increase in employment in any of the coastal subareas in these states. Employment associated with the OCS Program only marginally exceeds 1 percent of total employment for coastal Subarea TX-2. There will be very little economic stimulus in the Florida coastal subareas assuming that the State of Florida remains in opposition to mineral extraction anywhere along its coastline. However, the OCS Program is projected to substantially impact the Louisiana coastal subareas. The OCS-related employment is expected to peak during the peak-activity years of 2004-2012 at 6.3 percent, 3.3 percent, and 3.9 percent of total employment for coastal Subareas LA-1, LA-2, and LA-3, respectively. On a regional level, activities relating to the OCS Program are expected to significantly impact employment in Lafourche Parish in Subarea LA-2. Therefore, the population, housing, roads (LA Hwy 1), water supply, schools, and hospitals in the parish will be affected and strained.

The short-term social and economic consequences for the Gulf coastal region should a spill ≥1,000 bbl occur includes opportunity cost of 363-1,183 person-years of employment and expenditures of $20.7-$67.5 million that could have gone to production or consumption rather than spill-cleanup efforts. Non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations are also expected to occur in the short-term. These negative, short-term social and economic consequences of an oil spill are expected to be modest in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Negative, long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill. Overall employment projected for all OCS oil and gas activities, including employment in the oil-spill response industry, is projected to be substantial (up to 6.3% of baseline employment in some subareas).

4.5.14.4. Environmental Justice

This analysis addresses environmental justice concerns related to cumulative impacts. These concerns center on increases in onshore activity (such as employment, migration, commuter traffic, and truck traffic) and on additions to the infrastructure supporting this activity (such as fabrication yards, supply ports, and onshore disposal sites for offshore waste). The MMS estimates that OCS production in during 2003-2042 will range from between 15.493 and 22.428 BBO and 153.420 and 207.983 tcf of gas (Table 4-1). After addressing the effects to environmental justice of the OCS Program, this section analyzes the cumulative effects of non-OCS factors that affect environmental justice in the study area. This section also considers the contribution of a proposed action in the CPA and of a proposed action in the WPA to the cumulative impacts.

Chapter 3.3.3.5 describes the widespread and extensive OCS-support system and associated labor force, as well as economic factors related to OCS activities. The widespread nature of the OCS-related infrastructure serves to limit the magnitude of effects that a proposed action or the OCS Program may have on any particular community. The continuing and future OCS Program will serve mostly to maintain ongoing activity levels. Generally, effects will be widely yet thinly distributed across the Gulf Coast and will consist of slightly increased employment and even more slightly increased population. For the OCS Program, employment will increase less than 1 percent in Mississippi, Alabama, and coastal Subarea TX-1, and slightly more than 1 percent in Subarea TX-2. In Louisiana, employment impacts will be more substantial and is expected to peak during the peak-activity years of 2004-2012 at 6.3 percent, 3.3 percent, and 3.9 percent of total employment for coastal Subareas LA-1, LA-2, and LA-3, respectively. For most of the Gulf Coast, the OCS Program will result in only minor economic changes. Some places could experience elevated employment, population, infrastructure, and/or traffic effects because of local concentrations of fabrication and supply operations. Lafourche Parish, Louisiana, is one community where concentrations of industry activity and related employment are likely to strain the local infrastructure.

Environmental justice issues involve questions of disproportionate and negative effects on minority and low-income populations. In the cumulative OCS Program case, employment opportunities will increase slightly in a wide range of businesses over the entire Gulf Coast. These conditions preclude a prediction of where much of this employment will occur or who will be hired. Figures 3-15 and 3-16 provide distributions of census tracts of high concentrations of minority groups and low-income households. As stated in Chapter 3.3.3.10, pockets of concentrations of these populations scattered throughout the Gulf of Mexico coastal counties and parishes, most in large urban areas where the complexity and dynamism of the economy and labor force preclude a measurable effect. Low-income populations are almost exclusively minority and urban. Because the distribution of low-income and minority populations does not parallel the distribution of OCS-related industry activity, the effects of the cumulative OCS Program are not expected to be disproportionate with regard to minority and low-income populations.

The cumulative OCS Program's widespread economic effects on minority and low-income populations are not expected to be negative. Ongoing MMS research includes gathering information on race and employment. Offshore workers in the production sector are almost entirely male and white (Rosenberg, personal communication, 2001). Other sectors, such as the fabrication industry and support industries (e.g., trucking), do employ minority workers and provide jobs across a wide range of pay levels and educational/skill requirements (Austin et al., 2002a and b; Donato, 1998). A study of oil industry trends between 1980 and 1990 found that downsizing was concentrated in the production sector, hence it affected white male employment more than that of women or minorities (Singelmann, in press). Evidence also suggests that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations. One MMS study in Louisiana found income inequality decreased during the oil boom and increased with the decline (Tolbert, 1995). Another MMS-funded study found that reemployment rates for poorly educated black and white women laid off in the closing of an plant in one rural Louisiana town were much higher than reemployment rates after similar closings elsewhere because Louisiana's oil industry had created a complex local economy (Tobin, 2001). While, except in Louisiana, the OCS Program is expected to provide little additional employment, it will have the effect of maintaining current activity levels, which is expected to be beneficial to low-income and minority populations.

Environmental justice often concerns infrastructure siting, which may have disproportionate and negative effects on minority and low-income populations. Since OCS lease sales help maintain ongoing levels of activity rather than expand them, no one sale will generate significant new infrastructure demand. Over the next 40 years, the cumulative OCS Program is expected to result in new pipeline landfalls, pipeline shore facilities, and gas processing plants. Because of existing capacity, no new waste disposal sites are projected for the cumulative case (Louis Berger Group, Inc., in preparation).

At present, there are 126 OCS-related pipeline landfalls and 50 OCS-related pipeline shore facilities in the GOMR. Pipeline shore facilities are small structures, such as oil metering stations, associated with pipeline landfalls. For the OCS Program, 23-38 new pipeline landfalls (Chapter 4.1.2.1.7) and 12-20 pipeline shore facilities (Chapter 4.1.2.1.5.1) are projected. The projections mirror the current distribution landfalls: 15-22 landfalls are projected for Louisiana, which currently has 106; 8-16 are projected for Texas, Mississippi, and Alabama, which currently have 20;,and none are projected for Florida. For Louisiana, 8-12 pipeline shore facilities are projected, currently there are 37; 2-6 are projected for Texas, Mississippi, and Alabama, which currently have 13; and none for Florida. As discussed in the environmental justice analysis for oil spills (Chapter 4.4.3.14.4), existing coastal populations are not generally minority or low-income. While several census tracts around Morgan City and in the lower Mississippi River delta area are identified as having 50 percent or greater minority populations (Figure 3-15), the coastal areas of these tracts, like Louisiana's coastline in general, are virtually uninhabited. Pipeline landfalls and their associated facilities will not disproportionately affect minority or low-income populations.

Generally, MMS does not address downstream activities, stopping the analysis at the point offshore product is mixed with onshore and/or imported products. The MMS projects 4-16 new gas-processing plants will be needed in support of the OCS Program over the next 40-years; this need will be due in part to the proposed actions addressed in this EIS. Unlike pipelines, the geographic distribution of projected gas-processing plants differs markedly from the current distribution, a reflection of the location of offshore reserves, available capacity in existing facilities, and onshore demand. Between 3 and 9 new gas-processing plants are projected for Louisiana, which currently has 28; up to 5 gas-processing plants are projected for Texas, Mississippi, and Alabama, which currently have 7. As described in Chapter 3.3, the Gulf's extensive OCS-related infrastructure is widely distributed. This distribution is based on economic and logistical considerations unrelated to the distribution of concentrations of minority or low-income populations. The MMS cannot predict and does not regulate the siting of future gas-processing plants. The MMS assumes that sitings of any future facilities will be based on the same economic, logistical, zoning, and permitting considerations that determined past sitings, and that they will not disproportionately affect minority and low-income populations.

Each OCS-related facility that may be constructed onshore must receive approval by the relevant Federal, State, county or parish, and involved communities. Each onshore pipeline must obtain similar permit approval and concurrence. The MMS assumes that any onshore pipeline construction will be approved only if it is consistent with appropriate land-use plans, zoning regulations, and other State/regional/local regulatory mechanisms. Should a conflict occur, MMS assumes that approval will not be granted or that appropriate mitigating measures will be enforced by the responsible political entities.

Chapters 3.3.3.5.1 and 3.3.3.10 describe Louisiana's extensive oil-related support system. As a result of the concentration of OCS-support infrastructure, Louisiana has experienced more employment effects than the other Gulf Coast States. In Louisiana, Lafourche Parish is likely to experience the greatest concentration, and is the community where the additional OCS-related activities and employment will be sufficiently concentrated to be significant and to affect and strain its local infrastructure. While the addition of a C-Port in Galveston, Texas, is expected to increase Texas's share of future effects, Louisiana is likely to continue to experience more effects than the other Gulf Coast States.

The concentrated socioeconomic impacts in Lafourche Parish are not expected to have disproportionate effects on minority and low-income populations for several reasons. The parish is not predominately low-income or minority (Figures 3-15 and 3-16). The Houma, a Native American tribe recognized by the State of Louisiana, have been identified by the MMS as a possible environmental justice concern. The MMS is funding a study focused on Lafourche Parish, the Houma, and other possible concerns, although existing information indicates that the Houma will not be disproportionately affected because they are not residentially segregated but, rather, live interspersed among the non-minority population (Fischer 1970).

Two local infrastructure issues described in Chapter 3.3.3.2 could possibly have related environmental justice concerns: traffic on LA Hwy 1 and Port Fourchon expansion. The most serious concern raised during scoping for this multisale EIS is high level of traffic on LA 1. Increased truck traffic destined for Port Fourchon physically stresses the highway, inconveniences and sometimes disrupts local communities, and may pose health risks in the form of increased accident rates and possible interference to hurricane evacuations (Keithly, 2001; Hughes, in preparation). As described in Chapter 3.1.1.1, the area's "string settlement pattern" means that rich and low-income alike live on a narrow band of high ground along LA 1 and will be equally affected by any increased traffic.

Port Fourchon is relatively new and mostly surrounded by uninhabited land. Existing residential areas close to the port are new and not low-income. While the minority and low-income populations of Lafourche Parish will share with the rest of the population the negative impacts of the OCS Program, most effects are expected to be economic and positive. While the link between a healthy oil industry and indirect economic benefits to all sectors of society may be weak in some communities, in Lafourche Parish it is strong. The Parish is part of an area of relatively low unemployment due to the concentration of petroleum industry activity (Hughes, in preparation).

Many studies of social change in the Gulf of Mexico coastal region suggest that the offshore petroleum industry, and even the offshore and onshore petroleum industry, has not been a critical factor except in limited in small areas for limited periods of time. This was a key conclusion of an MMS-funded study of the historical role of the industry in the Gulf, a study that addressed social issues related to environmental justice (Wallace et al., 2001). The MMS 5-Year Programmatic EIS (USDOI, MMS, 2001c) analyzed the contribution of the OCS program in the Gulf of Mexico (i.e., its cumulative effects) to the cumulative effects of both OCS and non-OCS factors affecting environmental justice. The MMS 5-Year Programmatic EIS notes that the characterization of the Gulf of Mexico's sociocultural systems suggests that the historical impacts of offshore oil and gas activities on the sociocultural environment have not been sweeping regional effects. Impacts, including how communities respond to fluctuations in industry activity, vary from one coastal community to the next. While regional impacts may be unnoticed or very limited, individual communities may or may not realize adverse sociocultural impacts. Expansion or contraction of offshore or onshore oil and gas activity has produced moderate impacts in some communities, whereas other communities have dealt with episodes of rapid industry change with negligible to minor impact. Further, non-OCS activities also have the potential for sociocultural impacts. These activities can lead to changes in social organization by being a catalyst for such things as in-migration, demographic shifts, population change, job creation and cessation, community development strategies, and overall changes in social institutions (family, government, politics, education, religion).

The MMS 5-Year Programmatic EIS analysis concludes that the cumulative environmental justice impacts from non-OCS activities have made, and will make, substantially larger contributions to the environmental justice effects than will the OCS Program.

Summary and Conclusion

Because of the presence of an extensive and widespread support system for OCS and associated labor force, the effects of the cumulative case are expected to be widely distributed and, except in Louisiana, little felt. In general, the cumulative effects of the OCS Program are expected to be economic and have a limited but positive effect on low-income and minority populations. In Louisiana, these positive economic effects are expected to be greater. In general, who will be hired and where new infrastructure might be located is impossible to predict, although a new C-Port in Galveston is likely to increase Texas's share of effects. Given the existing distribution of the OCS-related industry and the limited concentrations of minority and low-income peoples, the cumulative OCS Program will not have a disproportionate effect on these populations. Lafourche Parish will experience the most concentrated effects of cumulative impacts. Because the parish is not heavily low-income or minority and because the effects of road traffic and port expansion will not occur in areas of low-income or minority concentration, these groups are not expected to be differentially affected. In general, the more concentrated cumulative impacts in Lafourche Parish are expected to be mostly economic and positive. A proposed action in either the WPA or CPA is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people. In the Gulf of Mexico coastal area, the contribution of a proposed action and the OCS Program to the cumulative effects of all activities and trends affecting environmental justice issues over the next 40 years is expected to be negligible to minor. The cumulative effects will be concentrated in coastal areas, and particularly Louisiana. Most OCS Program effects are expected to be in the areas of job creation and the stimulation of the economy and are expected to make a positive contribution to economic justice. The contribution of the cumulative OCS Program to the cumulative impacts of all factors affecting environmental justice is expected to be minor (USDOI, MMS, 2001c).

4.6. UNAVOIDABLE ADVERSE IMPACTS OF THE PROPOSED ACTIONS

The short-term uses of the environment considered in this Draft EIS and the cumulative development of OCS oil and gas resources in the Gulf of Mexico are compatible with the maintenance of long-term productivity. Unavoidable adverse impacts are anticipated to be primarily short-term and localized in nature.

Sensitive Coastal Habitats: If an oil spill were to contact a barrier beach, the removal of beach sand during cleanup activities could result in adverse impacts if the sand is not replaced. If an oil spill contacts coastal wetlands, adverse impacts could be high in localized areas. In some areas, wetland vegetation would experience suppressed productivity for several years. Much of the wetland vegetation would recover over time, but some wetland areas would be converted to open water. Unavoidable impacts resulting from maintenance dredging, wake erosion, and other secondary impacts related to channels would occur as a result of the proposed actions.

Sensitive Offshore Habitats: If an oil spill occurred and contacted sensitive offshore habitats, there would be some adverse impacts on organisms contacted by oil.

Water Quality: Routine offshore operations would have unavoidable effects to varying degrees on the quality of the surrounding water if the proposal is implemented. Drilling, construction, and pipelaying activities would cause an increase in the turbidity of the affected waters for the duration of the activity periods. A turbidity plume would also be created by the discharge of drill cuttings and drilling fluids. This, however, would only affect water in the immediate vicinity of the rigs and platforms. The discharge of treated sewage from the rigs and platforms would increase the levels of suspended solids, nutrients, chlorine, and BOD in a small area near the discharge point for a short period of time. Accidental spills from platforms and the discharge of produced waters could result in increases of hydrocarbon levels and trace metal concentrations in the water column in the vicinity of the platforms.

Unavoidable impacts to onshore water quality occurs as a result of chronic point- and nonpoint-source discharges such as runoff and effluent discharges from existing onshore infrastructure used in support of sale activities. Vessel traffic contributes to the degradation of impacted bodies of water through inputs of chronic oil leakage, treated sanitary and domestic waste, bilge water, and contaminants known to exist in ship paints. Regulatory requirements of the State and Federal water authorities and some local jurisdictions would be applicable to point-source discharges from support facilities such as refineries and marine terminals.

Air Quality: Unavoidable adverse impacts to air quality could occur onshore adjacent to crude oil refineries, gas processing plants, and areas of concentrated OCS-related activities. Unavoidable short-term impacts to air quality could occur near catastrophic events (e.g., oil spills and blowouts) due to evaporation and combustion. Mitigation of long-term effects would be accomplished through existing regulations and development of new control emission technology. However, short-term effects from nonroutine catastrophic events (accidents) are uncontrollable.

Endangered and Threatened Species: Unavoidable adverse impacts to endangered and threatened marine mammals, birds, sea turtles, mice, and the Gulf sturgeon due to activities associated with a proposed action (e.g., water quality and habitat degradation, helicopter and vessel traffic, oil spills and spill response, and discarded trash and debris) would be primarily sublethal. Lethal impacts to endangered species are expected to be rare.

Marine Mammals: Unavoidable adverse impacts to marine mammals due to activities associated with a proposed action (e.g., water quality degradation, helicopter and vessel traffic, oil spills and spill response, and discarded trash and debris) would be primarily sublethal. Lethal impacts to nonendangered and nonthreatened marine mammals are expected to be rare.

Coastal and Marine Birds: Some injury or mortality to coastal birds could result in localized areas from OCS-related oil spills, pipeline landfalls and coastal facility construction, helicopter and OCS service-vessel traffic, and trash and debris. Marine birds could be affected by noise and disturbances associated with offshore activities. If an oil spill occurs and contacts marine or coastal bird habitats, some birds could experience sublethal impacts, and some birds could experience lethal effects if they are coated with oil while feeding or resting. Oil spills and oil-spill cleanup activities could also affect local bird prey species.

Fish Resources and Commercial Fisheries: Losses to fishing resources and fishing gear could occur from production platform placement, oil spills, and produced-water discharges. Localized populations of fish species are expected to experience sublethal effects. This could result in a temporary decrease in a local population. It is unlikely that fishermen would harvest fish in the area of an oil spill, as spilled oil could coat or contaminate commercial fish species rendering them unmarketable. Other unavoidable adverse impacts include loss of fishing space caused by the installation of pipelines, rigs, platforms, or by other OCS-related structures.

Recreational Beaches: Even though existing regulations prohibit littering of the marine environment with trash, offshore oil and gas operations involving people at work, machines, equipment, and supplies may result in some contribution to floatable debris in the ocean environment. Debris may eventually come ashore on major recreational beaches. Accidents can lead to oil spills; larger spills (≥1,000 bbl) may contact recreational beaches, causing them to become temporarily soiled by weathered crude oil.

Archaeological Resources: As a result of the proposed actions, unique or significant archaeological information may be lost. Required archaeological surveys significantly lower the potential for this loss by identifying potential archaeological sites prior to an impact, thereby making avoidance or mitigation of impacts possible. In some cases (e.g., in areas of high sedimentation rates), survey techniques may not be effective at identifying a potential resource.

4.7. IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible or irretrievable commitments of resources refers to impacts or losses to resources that cannot be reversed or recovered. Examples are when a species becomes extinct or when wetlands are permanently converted to open water. In either case, the loss is permanent.

Wetlands: An irreversible or irretrievable loss of wetlands and associated biological resources could occur if wetlands are permanently lost due to impacts from dredging, construction activities, and oil spills. Dredging and construction activities can result in direct and indirect loss of wetlands, and oil spills can damage or destroy wetland vegetation, which leads to increased erosion and conversion of wetlands to open water. Construction and emplacement of onshore pipelines in coastal wetlands could result in the loss of coastal wetlands due to mechanical destruction and due to land loss facilitated by erosion of the marsh soils.

Sensitive Offshore Resources: Oil spills and chronic low-level pollution can injure and kill organisms at virtually all trophic levels. Mortality of individual organisms can be expected to occur, and possibly a reduction or even elimination of a few small or isolated populations. The proposed biological stipulations, however, are expected to eliminate most of these risks.

Fish Resources and Commercial Fisheries: Structure removal by explosives causes mortality to fish resources, including commercial and recreational species. Fish kills, including such valuable species as red snapper, are known to occur when explosives are used to remove structures in the Gulf of Mexico. If structure removal by explosives is continued, it will adversely impact the commercial fishing industry proximate to the removal site. However, in view of the positive impact of offshore platforms to fish resources and commercial fishing as a result of the platforms serving as artificial reefs and fish attracting devices, continued structure removal, regardless of the technique used, would reduce the net benefits to commercial fishing due to the presence of these structures.

Recreational Beaches: Beached litter, debris, oil slicks, and tarballs may result in decreased enjoyment or lost opportunities for enjoyment of coastal recreational resources.

Archaeological Resources: Although the impact to archaeological resources as a result of a proposed action is expected to be low, any interaction between an impact-producing factor (drilling of wells, emplacement of platforms, subsea completions, and pipeline installation) and a significant historic shipwreck or prehistoric site could destroy information contained in the site components and in their spatial distribution. This could cause a permanent loss of potentially unique archaeological data.

Oil and Gas Development and Production: Leasing and subsequent development and extraction of hydrocarbons as a result of the proposed actions would represent an irreversible and irretrievable commitment of nonrenewable oil and gas resources. The estimated amount of resources to be recovered as a result of the proposed actions is presented in Table 4-1.

Loss of Human and Animal Life: The OCS oil and gas exploration, development, production, and transportation are carried out under comprehensive, state-of-the-art, enforced regulatory procedures designed to ensure public safety and environmental protection. Nonetheless, some loss of human and animal life is inevitable from unpredictable and unexpected acts of man and nature (accidents, human error and noncompliance, and adverse weather conditions). Some normal and required operations, such as structure removal, can result in the destruction of viable marine life. Although the possibility exists that individual marine mammals, marine turtles, birds, and fish can be injured or killed, there is unlikely to be a lasting effect on baseline populations.

4.8. RELATIONSHIP BETWEEN THE SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

In this section, the short-term effects and uses of various components of the environment in the vicinity of proposed actions are related to long-term effects and the maintenance and enhancement of long-term productivity.

Short-term refers to the total duration of oil and gas exploration and production activities, whereas long-term refers to an indefinite period beyond the termination of oil and gas production. The specific impacts of the proposed actions vary in kind, intensity, and duration according to the activities occurring at any given time. Initial activities, such as seismic surveying and exploration drilling, result in short-term, localized impacts. Development drilling and well workovers occur sporadically throughout the life of the proposed actions, but also result in short-term, localized impacts. Activities during the production life of a platform may result in chronic impacts over a longer period of time (25-35 years), potentially punctuated by more severe impacts as a result of accidental events. Platform removal is also a short-term activity with localized impacts; the impacts of site clearance may be longer lasting. Over the long-term, several decades to several hundreds of years, natural environmental balances are expected to be restored.

Many of the effects discussed in Chapters 4.2 and 4.3 are considered to be short-term (being greatest during the construction, exploration, and early production phases). These impacts could be further reduced by the mitigative measures discussed in Chapter 2.

The principal short-term use of the leased areas in the Gulf would be for the production of 0.276-0.654 billion barrels of oil (BBO) and 1.590-3.300 trillion cubic feet (tcf) of natural gas from a typical proposed action in the CPA and 0.136-0.262 BBO and 0.810-1.440 tcf of natural gas from a proposed action in the WPA. The short-term recovery of hydrocarbons may have long-term impacts on biologically sensitive offshore areas or archaeological resources.

The OCS activities could temporarily interfere with recreation and tourism in the region, in the event of an oil spill contacting popular tourist beaches. The proposed leasing may also result in onshore development and population increases that could cause very short-term adverse impacts to local community infrastructure, particularly in areas of low population and minimal existing industrial infrastructure (Chapters 4.2.1.14 and 4.3.1.12). A return to equilibrium could be quickly expected as population changes and industrial development are absorbed in expanded communities. After the completion of oil and gas production, the marine environment is generally expected to remain at or return to its normal long-term productivity levels. To date, there has been no discernible decrease in long-term marine productivity in OCS areas where oil and gas have been produced for many years; in some circumstances, such as at rigs-to-reefs sites, productivity has increased. Areas such as the Atlantic coast, which experienced repeated incidents of oil pollution as a result of tanker torpedoings and groundings during World War II, show no apparent long-term productivity losses, although baseline data do not exist to verify this. In other areas that have experienced apparent increases in oil pollution, such as the North Sea, some long-term effects do appear to have taken place. Populations of pelagic birds have decreased markedly in the North Sea in recent years—prior to the beginning of North Sea oil production. Until more reliable data become available, the long-term effects of the chronic and major spillage of hydrocarbons and other drilling-related discharges cannot be accurately projected. In the absence of such data, it must be concluded that the possibility of decreased long-term productivity exists as a result of the proposed actions.

The OCS development off Louisiana and Texas has enhanced recreational and commercial fishing activities, which in turn has stimulated the manufacture and sale of larger private fishing vessels and special fish recreational equipment. Commercial enterprises such as charter boats have become heavily dependent on offshore structures for satisfying recreational customers. The proposed actions could increase these incidental benefits of offshore development. Offshore fishing and diving has gradually increased in the past three decades; platforms have been the focus of much of that activity. As mineral resources become depleted, platform removals would occur and may result in a decline in these activities. To maintain the long-term productivity of site-specific, artificial reefs attractive to fishermen and divers may need to eventually replace removed platforms.

Short-term environmental socioeconomic impacts could result from the proposed actions, including possible short-term losses in productivity as a result of oil spills. Long-term adverse environmental impacts would not be expected because archaeological regulations and the proposed biological stipulations are proposed as part of the proposed actions. However, some risk of long-term adverse environmental impacts remains due to the potential for accidents. No long-term productivity or environmental gains are expected as a result of the proposed actions; the benefits of the proposed actions are expected to be principally those associated with a medium-term increase in supplies of domestic oil and gas. While no reliable data exist to indicate long-term productivity losses as a result of OCS development, such losses are possible.

CHAPTER 5

CONSULTATION AND COORDINATION

5. CONSULTATION AND COORDINATION

5.1. DEVELOPMENT OF THE PROPOSED ACTIONS

The proposed Central and Western Gulf of Mexico OCS lease sales, as scheduled in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007*, would offer for lease all unleased blocks in Central and Western Planning Areas (CPA and WPA) of the Gulf of Mexico OCS. The proposed actions include existing regulations and proposed lease stipulations designed to reduce environmental risks.

The MMS conducted early coordination with appropriate Federal and State agencies and other concerned parties to discuss and coordinate the prelease process for the proposed lease sales and EIS. Key agencies and organizations included the National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries), formerly known as the National Marine Fisheries Service (NMFS); Fish and Wildlife Service (FWS); Department of Defense (DOD); U.S. Coast Guard (USCG); U.S. Department of Defense (DOD); U.S. Environmental Protection Agency (USEPA); State Governors' offices; and industry groups.

5.2. CALL FOR INFORMATION AND NOTICE OF INTENT TO PREPARE AN EIS

On September 12, 2001, the Call/NOI for the proposed Central and Western Gulf of Mexico lease sales were published in the *Federal Register.* The comment period closed on October 12, 2001. Additional public notices were distributed via newspaper notices, mailed notices, and the Internet. The MMS received four comment letters in response to the Call. These comments are summarized below.

American Petroleum Institute—The API and its members state that they fully support the provisions of the Coastal Zone Management Act. The API and its members state that they also support the need for coordination, consultation, and cooperation between States, Federal agencies, and permit applicants to determine whether proposed projects in the Federal OCS are consistent with States' coastal management plans. The API is concerned that a State may object to a consistency certification for a Federal OCS plan on the basis that activities located wholly within Federal waters seaward of another State could affect the objecting State's coastal zone. According to API, in a number of cases, their member companies are experiencing interminable delays and impediments in oil and gas exploration and development in Federal waters due to vague and unsubstantiated objections from certain coastal States that these development activities are, by definition, necessarily inconsistent with a State's coastal zone management plan. The API maintains that these broad interstate consistency review provisions represent a significant Federal problem affecting interstate commerce and national security.

ExxonMobil Exploration Company—ExxonMobil states that it is imperative that the proposed lease sales cover the entire CPA and WPA. ExxonMobil says that, in light of the current situation of declining domestic production, it would be counterproductive to restrict the size of these sales.

Shell Exploration & Production Company—Shell strongly supports the continued annual offering of all acreage in the CPA and WPA and ranks these areas as Priority 1 (high). Shell commented on one specific area of conflict that might bear upon the potential leasing and development of particular areas, the Coastal Zone Management Act. Shell reiterated the concerns expressed by API.

Texaco Exploration and Production Inc.—Texaco recommends that MMS continue the approach of offering all available acreage during each sale listed in the Proposed 5-Year Program. Texaco believes the historical activities in the OCS speak for themselves in regard to comments concerning the particular geological, environmental, biological, archaeological, and socioeconomic conditions or conflicts, or other information that might bear upon the potential leasing and development of the CPA and WPA. Texaco is concerned that certain States may continue to use the Coastal Zone Management Act and their associated approved programs, as a tool to inhibit OCS exploration and development when such activity will have little, if not any, effect on their coastline.

The MMS received 10 comment letters in response to the NOI. These comments are summarized below.

Alabama, Office of the Governor—The State requested that blocks within 15 mi south of Baldwin County be excluded from consideration for leasing throughout the proposed 5-Year OCS oil and gas leasing program for 2002-2007 to minimize the visual impact of new natural gas structures within the area. The State also has concerns regarding the cumulative impacts of OCS production to onshore air quality in Mobile County and requests that MMS continue to evaluate this matter in the Environmental Impact Statement for the Proposed 5-Year Outer Continental Shelf Oil and Gas Leasing Program for 2002-2007. The State believes that there have been significant impacts to their coastal area from oil and gas activities in the OCS, that some of these impacts have been negative, and that the proposed actions will result in additional adverse impacts to coastal Alabama. The Governor stated that Alabama has not been fairly and equitably compensated for these impacts, and will be seek MMS assistance in determining the proper mechanisms for addressing these inequities. The State of Alabama supports a balanced and reasonable OCS leasing program that leads to exploration, development and production, with the stipulation that all OCS activities be carried out in full compliance with relevant Alabama laws, rules and regulations, and be consistent with Alabama's Coastal Zone Management Program. The State looks forward to working cooperatively with MMS in the successful and safe development of the hydrocarbon resources located offshore Alabama and in sharing in the benefits of OCS leasing and production activities.

American Petroleum Institute—The API supports the development of a multisale EIS as part of the planning process of the 5-year program. However, according to API, objective studies such as this EIS do not appear relevant to the planning process or to subsequent decisions. The API states that OCS lease sales and OCS development actions are repeatedly being thwarted in a manner inconsistent with a functioning planning process. The fact that an EIS states that there will be minimal environmental impact does not prevent sales from being altered and leases from being developed. According to API, EIS's and the planning process appear to have lost much of their usefulness.

Gaubert Oil Company Incorporated—Kevin J. Gaubert, President of Gaubert Oil Company Incorporated, requests that the multisale EIS adequately address landside impacts, such as infrastructure and especially at focal point areas like Port Fourchon, and that the EIS incorporate specific mitigative measures for well-documented impacts such as those to LA Highway 1. The EIS should clearly state the impacts, identify strategic focal point support infrastructure, properly evaluate energy security issues, and provide a mitigation plan that offsets the identified impacts.

Greater Lafourche Port Commission—Ted M. Falgout, Executive Director, states that past EIS's have not adequately addressed landside impacts such as infrastructure, especially at focal point areas like Port Fourchon. The Commission feels very strongly that the multisale EIS should incorporate specific mitigative measures for well-documented impacts such as those to LA Highway 1. The multisale EIS should clearly state the impacts, identify strategic focal point support infrastructure, properly evaluate energy security issues, and provide a mitigation plan that offsets the identified impacts.

LA 1 Coalition, Inc.—Roy P. Francis, Executive Director of the LA 1 Coalition, states that he, along with other members of his community, have in the past provided written and oral testimony regarding the impacts to the infrastructure in Lafourche Parish that supports OCS activities in the Gulf of Mexico. The EIS should address potential impacts to LA Highway 1 and a mitigation plan. Mr. Francis feels that his community is suffering the brunt of the impacts with no direct financial benefit or assistance to offset the impacts. The LA 1 Coalition would be willing to meet with MMS to formulate a plan to address their concerns.

Lafourche Parish Council—Gerald "Buzz" Breaux, Parish President, states that the parish recognizes the importance of oil and gas activity and certainly welcomes it in their area. According to Mr. Breaux, oil and gas operators in the Gulf of Mexico are paying billions of dollars a year to the Federal Government in lease revenues and the Federal Government spends very little of this money on mitigating the onshore impacts caused by the offshore leasing policies. The parish is left to deal with the detrimental impacts to the coastal infrastructure. Past EIS's have not adequately addressed impacts upon coastal infrastructure. The multisale EIS should incorporate specific mitigation measures for well-documented impacts such as those to LA Highway 1. Mr. Breaux requested that the multisale EIS address the impacts to LA Highway 1 and a mitigation plan. The multisale EIS should clearly state the impacts, identify strategic focal point support infrastructure, properly evaluate energy security issues, and provide a mitigation plan that offsets the identified impacts.

Louisiana, Office of the Governor—The State fully supports the comments and impact concerns expressed in the letter written by Mr. Jack C. Caldwell, Secretary, Louisiana Department of Natural Resources (LADNR) (summarized below).

Louisiana Department of Natural Resources—The LADNR states that it is in favor of reducing unnecessary paperwork involved in bringing about an OCS lease sale, provided that the concerns of the State are given the appropriate level of attention in the environmental documentation. The LADNR states that past EIS's have not dealt adequately with their concerns about socioeconomic impacts or cumulative or secondary environmental impacts, and none appear to have correctly estimated the direct effects to Louisiana's wetland and infrastructure. As stated by LADNR, the Louisiana coastal zone is exposed to the adverse impacts of OCS exploration and development activities to a far larger extent than any other State. The benefits of OCS development to the State, while large, are disproportionately small when compared to the costs and benefits experienced by other coastal states, says LADNR. The multisale EIS should include analysis of the indirect and cumulative costs to Louisiana's coastal communities, economies, infrastructure, and wetlands. One essential aspect of such studies is a critical review of the predictions made in previous EIS's, comparing the anticipated impacts with actual results. The LADNR requests that the multisale EIS also examine new alternative actions, with the goal of achieving a more equitable balance of the benefits and costs of OCS development borne by the State of Louisiana. The LADNR states that alternatives should be examined that both increase the benefits to Louisiana and avoid, reduce, and/or compensate for impacts resulting from OCS activities. The LADNR suggests that one such alternative would be to offer annual lease sales in the adjacent EPA, which would stimulate oil and gas employment in Louisiana. The LADNR strongly recommends that MMS prepare two multisale EIS's—one for the CPA and one for the WPA. The LADNR does not believe that the two planning areas are comparable and is concerned that real and potential impacts will not be fully represented if treated in one multisale EIS. The LADNR suggests that MMS closely coordinate the preparation of the draft document EIS with LADNR's Consistency Section staff to identify means to reduce or offset the negative impacts of OCS activities on the Louisiana coastal zone.

Louisiana, House of Representatives—Loulan Pitre, Jr., State Representative, District 54, requests that MMS fully consider all previous testimony, written statements, and interviews in connection with the previous EIS for multiyear lease sales, as well as in connection with the EA for Lease Sale 182.

Florida, Office of the Governor—State representatives will be unable to attend the scoping meetings.

5.3. DEVELOPMENT OF THE DRAFT EIS

In accordance with the Council on Environmental Quality's (CEQ) regulations implementing NEPA, scoping was conducted to solicit comments on the proposed Central and Western Gulf lease sales. Scoping also serves as an opportunity to update the Gulf of Mexico Region's environmental information base for the CPA and WPA. Scoping provides those with an interest in the OCS Program an early opportunity to participate in the events leading to the publication of the Draft EIS. The scoping process for the proposed sale was officially initiated by the Call for Information and Nominations (Call) and the Notice of Intent to Prepare an EIS (NOI) on September 12, 2001. Federal, State, and local governments, along with other interested parties, were requested to send written comments to the Region on the scope of the EIS. Formal scoping meetings were held in three Gulf States.

The dates, times, locations, and public attendance of the scoping meetings for the proposed Central and Western Gulf lease sales were as follows:

October 15, 2001 6:30-8:30 p.m. Galveston, Texas 1 registered attendee	October 16, 2001 1:00-3:00 p.m. Houston, Texas 4 registered attendees
October 18, 2001 6:30-8:30 p.m. Mobile, Alabama 3 registered attendees	October 22, 2001 1:00-3:00 p.m. New Orleans, Louisiana 8 registered attendees

Attendees at the meetings identified many items of concern. The MMS received four letters in response to the Call. Ten written scoping letters were received in response to the NOI. Written comments are considered in the EIS in the same manner as the verbal comments received at the scoping meetings. Chapter 2 presents a summary of the issues, alternatives, and mitigation measures related to proposed actions.

Galveston, Texas, October 15, 2001

One person attended the meeting. No concerns were identified.

Houston, Texas, October 16, 2001

Four people attended the meeting. The attendees included two Exxon/Mobil representatives, one *Daily Oil* representative, and one person whose affiliation was not identified. None of the individuals voiced any concerns at the meeting.

Mobile, Alabama, October 18, 2001

Three people attended the meeting, including one person affiliated with Amerada Hess. None of the individuals spoke at the meeting. However, the Amerada Hess Corporation in Houston submitted written comments addressing the following concerns and issues.

Amerada Hess Corporation	Supports the EIS process. They commented that it captures relevant factors for use in decisionmaking for upcoming OCS lease sales. The Amerada Hess Corporation is also pleased that the multisale EIS proposed by MMS does assist with streamlining the NEPA process into a more efficient process. However, there is concern that the process allows the potentiality for abuse by those with motives to frustrate the objectives for the EIS process.

New Orleans, Louisiana, October 22, 2001

Seven people attended the meeting. Six individuals presented comments. The presenters represented the Sierra Club, Marathon Oil, Lafourche Parish Water District No. 1, the Chamber of Lafourche, Port Fourchon, Louisiana House of Representative District 54, and Texaco. The comments presented addressed the following concerns and issues.

Sierra Club	Opposes the socioeconomic impact that is placed on the host State during these OCS activities. The spokesmen stated that for every dollar put into OCS support activities dollars are taken from our schools and infrastructure. A big concern is that the highway department renewed taxes for ports and port roads, but not for Louisiana roads. Pipelines are also a concern because they are built by dredging across the bay in shallow water. This results in crawfish kill and poor water quality when interrupted by pipelines. The spokesmen strongly recommend that MMS take a closer look at support vessels, which are getting larger; the impact of waves through coastal Louisiana is enormous. There is a growing concern for the amount of waste that is being transported from offshore locations. We need a new landfill. Which parish will pay for this landfill? The MMS should study the impact of older pipelines that are not marked; vessels have hit these pipelines and people have been killed.
Marathon Oil	Supports the sale process and known schedule, and urged MMS to continue this process.
Lafourche Parish Water District No. 1	Lafourche Parish informed MMS they are not able to keep up with the water demand for drilling activities. The parish asked MMS to be more aware that, when someone attempts to develop property, this activity is creating an impact. The parish believes that MMS should be requiring mitigation work to be done to help alleviate the burden that is placed on the local infrastructure.

Chamber of Lafourche	Supports and looks forward to the proposed OCS oil and gas lease sales scheduled for 2003-2007. However, it has concerns about the fragile infrastructure because of a substandard highway (LA Hwy. 1). Saltwater intrusion is also a concern of the Chamber. Additional concerns are increased vessel traffic in Bayou Lafourche and money is not spent here, it is spent elsewhere. The Chamber of Lafourche requests land-side impacts be addressed in EIS.
Port Fourchon	Port Fourchon pointed out that the EIS, as prepared by MMS, has not addressed land-side impacts and a mitigation proposal to offset impacts of the leasing program. At minimum, the proposed EIS should incorporate, as part of the document, specific mitigative measures for well-documented impacts, such as LA Hwy. 1 and the water supply. Other concerns addressed by Port Fourchon were as follows: cumulative impacts need to be addressed, have not mitigated impacts from previous lease sales, finally a recent study shows states impacts on LA Hwy. 1 and water system and other public services.
Louisiana House of Representative District 54	The Louisiana House of Representative District 4 asked MMS for confirmation that we will incorporate by reference into the record of this proceeding. And fully consider, all previous testimony, written statements, and interviews, in connection with the previous EIS for multiyear lease sale, as well as in connection with the EA in connection with lease Sale 182.
Texaco	Supports MMS's approach for a single EIS for nine sales.

Although the scoping process is formally initiated by the publication of the Call and NOI, scoping efforts and other coordination meetings continue throughout the sale process. The Gulf of Mexico Region's annual Information Transfer Meetings (ITM) provide an opportunity for EIS analysts to attend technical presentations related to OCS Program activities and to meet with representatives from Federal, State, and local agencies; industry; MMS contractors; and academia. Specific opportunities are presented during MMS requests for information, comments, input, and review, which included the following:

- Public Hearing comments on the Draft EIS on the *Proposed Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007*;
- Scoping and comments on the Draft Proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007*;
- Requests for comments on the Environmental Assessments for CPA lease sales 172, 175, 178, and 182;
- Requests for comments on the Environmental Assessments for WPA lease sales 174, 177, and 180; and
- NOI, scoping meetings, public hearings, and comments on the EIS for the Proposed Use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico Outer Continental Shelf, Western and Central Planning Areas.

On January 24, 2002, representatives of the MMS's Gulf of Mexico Region met with Secretary Caldwell and LADNR staff to discuss their concerns regarding the impacts of OCS activities on Louisiana's wetlands and coastal infrastructure. The MMS staff presented a status report on MMS's study to assess changes to coastal habitats from OCS-related pipeline canals, navigation canals, and mitigation activities. This study was developed based on previous discussions with LADNR. Secretary Caldwell was pleased with the progress of the study and said the results would be very useful in their efforts to obtain funding for coastal restoration projects.

5.4. Distribution of the Draft EIS for Review and Comment

The following public and private agencies and groups were provided copies of the Draft EIS for review and comment. Local libraries along the Gulf Coast were also provided copies of the Draft EIS.

The list of libraries and their locations is available on the MMS website at http://www.gomr.mms.gov. The comment period on the Draft EIS closed May 31, 2002.

Federal Agencies

Congress
- Congressional Budget Office
- House Resources Subcommittee on Energy and Mineral Resources
- Senate Committee on Energy and Natural Resources

Department of Commerce
- National Marine Fisheries Service
- National Oceanic and Atmospheric Administration

Department of Defense
- Department of the Air Force
- Department of the Army
- Corps of Engineers
- Department of the Navy

Department of Energy
- Strategic Petroleum Reserve PMD

Department of the Interior
- Fish and Wildlife Service
- Geological Survey
- Minerals Management Service
- National Park Service
- Office of Environmental Policy and Compliance
- Office of the Solicitor

Department of State
- Office of Environmental Protection
- Department of Transportation
- Coast Guard
- Office of Pipeline Safety
- Environmental Protection Agency
- Region 4
- Region 6
- Marine Mammal Commission

State and Local Agencies

Alabama
- Governor's Office
- Alabama Highway Department
- Alabama Historical Commission and State
- Historic Preservation Officer
- Alabama Public Service Commission
- Department of Environmental Management
- Department of Conservation and Natural Resources
- South Alabama Regional Planning Commission
- State Docks Department
- State Legislature Natural Resources Committee
- State Legislature Oil and Gas Committee

Florida
- Governor's Office
- Department of Community Affairs
- Department of Environmental Protection
- Department of State Archives, History and Records Management
- Bureau of Archaeological Research
- Florida Coastal Zone Management Office
- State Legislature Natural Resources and Conservation Committee
- State Legislature Natural Resources Committee
- West Florida Regional Planning Council

Louisiana
- Governor's Office
- Calcasieu Regulatory Planning Commission
- Department of Culture, Recreation, and Tourism
- Department of Environmental Quality
- Department of Natural Resources
- Department of Transportation and Development
- Department of Wildlife and Fisheries
- Louisiana Geological Survey
- State Legislature Natural Resources Committee
- State House of Representatives Natural Resources Committee

Mississippi
- Governor's Office
- Department of Archives and History
- Department of Natural Resources
- Department of Wildlife Conservation
- State Legislature Oil, Gas, and Other Minerals Committee

Texas
- Governor's Office
- Attorney General of Texas
- Department of Water Resources
- General Land Office
- Southeast Texas Regional Planning Commission
- State Legislature Natural Resources Committee
- State Senate Natural Resources Committee

Texas Historical Commission
Texas Legislation Council
Texas Parks and Wildlife Department
Texas Water Conservation Association
Texas Water Development Board

Industry/Companies

Amoco Production Company
Cartwright & Co., Inc.
John E. Chance and Associates, Inc.
Kerr-McGee Corp.
Louisiana Land and Exploration Company
Louisiana Offshore Oil Port, Inc.
Groups
American Littoral Society, Project Reefkeeper
Audubon Society, Austin, Texas
Clean Gulf Associates
Coastal Conservation Association
Gulf of Mexico Fishery Management Council
Gulf States Marine Fisheries Council
Louisiana Gulf Coast Conservation Association
Louisiana Wildlife Biologists Association
Louisiana Wildlife Federation, Inc.
Natural Resources Defense Council, Inc.
New England Aquarium
Petroleum Information Corporation
Save Our Coast
Sierra Club, Lone Star Chapter
Sierra Club, New Orleans Chapter
Sierra Club, Southern Plains
Representatives
Texas Conservation Foundation
Texas Nature Conservancy
Texas Shrimp Association

As required by Section 7 of the Endangered Species Act, MMS requested a formal consultation with NOAA Fisheries on April 17, 2002, and with FWS on April 15, 2002. These consultations are to ensure that activities in the OCS under MMS jurisdiction do not jeopardize the continued existence of threatened or endangered species and/or result in adverse modification or destruction of their critical habitat. The MMS receives the results of each consultation in a Biological Opinion (BO). You may obtain copies of the final BO's by contacting the Minerals Management Service, Gulf of Mexico OCS Region, Public Information Office (MS 5034), 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123-2394 (1-800-200-GULF) or by emailing a request to environment@mms.gov.

5.5. PUBLIC HEARINGS

In accordance with 30 CFR 256.26, the MMS held public hearings soliciting comments on the Draft EIS for proposed 2003-2007 Central and Western Gulf of Mexico Lease Sales. The hearings provide the Secretary of the Interior with information from interested parties to help in the evaluation of potential effects of the proposed lease sales. Announcement of the dates, times, and locations of the public hearings were included in the Notice of Availability for the Draft EIS. Notices of the public hearings were also included with the Draft EIS's mailed to the parties indicated above and posted on the MMS Website. In addition, notices of the public hearings were published in local newspapers (*The Times-Picayune, The Houston Chronicle*, and *The Mobile Register*).

The hearings were held on the following dates and at the times and locations indicated below:

April 30, 2002	May 1, 2002	May 2, 2002
Houston, Texas 1:00-3:00 p.m. Houston Airport Marriott 18700 Kennedy Boulevard Houston, Texas	New Orleans, Louisiana 1:00-4:00 p.m. Minerals Management Service Gulf of Mexico OCS Region 1201 Elmwood Park Boulevard Jefferson, Louisiana	Mobile, Alabama 2:00-4:00 p.m. and 6:30-8:30 p.m. Adams Mark Hotel 64 South Water Street Mobile, Alabama

The comments presented at each of the public hearings are summarized below.

Houston, Texas, April 30, 2002

One person was in attendance. No comments were presented.

New Orleans, Louisiana, May 1, 2002

Seven people attended the hearing. Three individuals presented comments. The speakers included one individual from industry, the Port Director for Port Fourchon, and one individual from an environmental organization. The oil industry spoke in support of Alternative A—the Proposed Action. Both Mr. Ted Falgout, representing Port Fourchon, and Mr. Mark Davis, Executive Director, Coalition to Restore Coastal Louisiana, made the following comments:

- serious impacts to the infrastructure of the Lafourche Corridor;
- feels that some mechanism needs to be put in place to sustain and support infrastructure that is critical to the Federal OCS; and
- coastal Louisiana is essentially subsidizing the national energy policy and the energy strategy of the rest of the Nation, without being proportionally compensated.

Mobile, Alabama, May 2, 2002

No attendees.

5.6. Major Differences Between the Draft and Final EIS's

Comments on the proposed 2003-2007 CPA and WPA Lease Sales and the Draft EIS were received during the public hearing in New Orleans and were received via written and electronic correspondence. As a result of these comments, changes have been made between the Draft and Final EIS's. The text has been revised or expanded to provide clarification on specific issues. In particular, using the preliminary results of the ongoing *Coastal Impacts of Pipeline and Navigation Canals* study, an effort has been made to present some quantification of wetland losses and to more fully describe the relation of OCS-related activities.

5.7. Letters of Comments on the Draft EIS and Agency Responses

The Draft EIS for proposed 2003-2007 Central and Western Gulf of Mexico Lease Sales was released on April 1, 2002. The NOA and announcement of public hearings were published in the *Federal Register* on April 8, 2002, and posted on the MMS website. The comment period on the Draft EIS ended May 31, 2002. Comment letters on the Draft EIS were received from the following:

Federal Agencies

U.S. Department of the Navy
Office of the Assistant Secretary
U.S. Environmental Protection Agency,
Region 6

State Agencies

Alabama Department of Environmental Management
Alabama Historical Commission
Alabama, Office of the Governor
Louisiana Department of Natural Resources

Organizations and Associations

Coalition to Restore Coastal Louisiana
National Ocean Industries Association

Industry

Shell Exploration & Production Company

The remainder of Chapter 5 includes copies of the comment letters. Specific responses to these comments or an indication of how the Draft EIS was modified in response to a comment, if appropriate, are also included.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

MAY 28 2002

Gulf of Mexico OCS Region
MMS
MAY 31 2002
Office of the Regional Director

Chris C. Oynes, Regional Director
Minerals Management Service
Gulf of Mexico OCS Region (MS-5410)
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

Dear Mr. Oynes:

In accordance with our responsibilities under Section 309 of the Clean Air Act (CAA), the National Environmental Policy Act (NEPA), and the Council on Environmental Quality's Regulations for Implementing NEPA, the Environmental Protection Agency (EPA) Region 6 Office in Dallas, Texas, completed its review of the Draft Environmental Impact Statement (DEIS) on the Proposed Gulf of Mexico OCS Oil and Gas Lease Sales: 2003-2007 for Central Planning Areas 185, 190, 194, 198 and 201; and Western Planning Areas 187, 192, 196 and 200, dated April 2002.

EPA has rated the DEIS as **LO, Lack of Objections, with Requests for Clarification in the Final EIS**. Additional clarification requested in the Final EIS includes: more balance between the affected resources and the assessment of the nature and extent of likely environmental impacts, and correction or clarification of apparent inconsistencies or contradictions in the document. Our classification will appear in the *Federal Register* according to EPA's responsibility under Section 309 of the CAA, to inform the public of our views on proposed federal actions.

General and specific comments on the DEIS are enclosed which more clearly identify the areas to be clarified. If you have any questions, please contact Joe Swick at (214) 665-7456. Please send our office five copies of the Final EIS when it is sent to the Office of Federal Activities, EPA (Mail Code 2252A), Ariel Rios Building, 1200 Pennsylvania Ave, N.W., Washington, D.C. 20460.

Sincerely yours,

Robert D. Lawrence, Chief
Office of Planning and
Coordination (6EN-XP)

JUN 3 - 2002

Enclosure

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MMS DEIS on Gulf of Mexico OCS Oil and Gas Lease Sales: 2003-2007

General Comments:

USEPA-GC1

1. As noted on pages 1-28 and 1-29, pollution prevention can be an effective way to mitigate adverse impacts under NEPA. The Council on Environmental Quality instructs federal agencies to address pollution prevention in the proposed action and reasonable alternatives [40 CFR 1502.14(f), 1502.16(h) and 1508.20]. The proposed action provides an opportunity to integrate pollution prevention measures into both construction activities and the decision-making process. Pollution prevention can include: recycling, including using recycled materials in project construction and operation; increasing efficiency and conservation of energy and water resources; and reducing or eliminating contributions to point or non-point source pollution. Pollution prevention can be implemented with techniques such as waste stream segregation or best management practices. Both site-specific EISs and the Record of Decision, documenting the final decision, can be a valuable tools to inform the public and others how pollution prevention was not only included in the NEPA process, but also how it will be implemented.

<u>Executive Order (EO) 12856</u> - Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements (August 1993) includes commitments that the federal government "should become a leader in the field of pollution prevention through the management of its facilities, its acquisition practices, and in supporting the development of innovative pollution prevention programs and technologies."

<u>EO 12873</u> - Federal Acquisition, Recycling, and Waste Prevention (October 1993) directs the federal government to more efficiently use natural resources by maximizing recycling and preventing waste whenever possible, and to "serve as a model in this regard for private and other public institutions."

USEPA-GC2

2. The DEIS provides a well-developed assessment on cultural resources. It also refers (on page 1-17) to Section 106 of the National Historic Preservation Act as the federal review process designed to ensure that historic properties are considered during project planning, in consultation with the Advisory Council on Historic Preservation (ACHP) and State Historic Preservation Offices (SHPOs). EPA believes any mitigation for adverse effects agreed to through the Section 106 process should be included in the NEPA documentation so the public and other interested parties have a complete picture of the action and all its potential impacts to the environment, both natural and man-made. The Final EIS would be strengthened by clarification of the connection between Section 106 compliance and regulations 30 CFR 250.194 to protect archeological resources, as well as documenting any completed consultation between the ACHP, SHPOs, and/or other interested parties, including affected Indian Tribe or Tribes, if any.

1

USEPA-GC3

3. Considering the total length of the DEIS, any effort to shorten the Final EIS probably would be beneficial to reviewers [and also for future DEISs, especially with minimal review time (15 days) prior to scheduled public hearings]. For example, much of the length of the DEIS appears to be directly related to formatting. Two suggestions to help reduce the overall length and redundancy (e.g., between Sections 4.2 and 4.3) in the technical analysis presented are: a) combining the affected resources and impacts (including cumulative) into one Chapter; and b) after presenting the impact-producing factors and scenarios, evaluate one "typical" proposed action for both the central and western planning areas focusing more on the similarities and differences, as applicable, between these two regions of the Gulf of Mexico.

USEPA-GC4

4. We appreciate the updated information presented in Sections 4.1 and 4.2 pertaining to the fate and effects of drilling fluids discharges and the regulation of them. It should also be noted that the NPDES General Permits for OCS discharges in Region 6 (western and central planning areas) and Region 4 (central and eastern planning areas) will expire in April 2004, and October 2003, respectively.

USEPA-GC5

5. Various spacial zones of benthic impact from OCS discharges are mentioned with the maximum stated to be 500m from the drilling site. We could not find discussion of the nature of these effects on biota. Potential changes in species richness, community composition and diversity should all be addressed.

USEPA-GC6

6. Bioaccumulation of mercury in Gulf fishery products is presently an issue. MMS, EPA and the industry are engaged in forums on the topic. Therefore, additional discussion in the document is timely regarding the impact of oil and gas OCS discharges. In several places in the document contaminants contained in the drilling fluids, mercury and others, are discussed but we could not find any discussion about the composition of the drill cuttings. These are deposited on the seabed thereby exposing marine organisms to contaminants within the cuttings.

Specific Comments:

USEPA-SC1

1. Page 2-25 and 2-42 - suggest clarification of the referenced 167 and 200 blocks in paragraphs 2.3.2.1 and 2.4.2.1, respectively, to explain the differences between these and the actual sales blocks related to the proposed action.

USEPA-SC2

2. Pages 4-120 and 4-183, Land Use - since it is also likely that affected infrastructures may not develop in a similar manner whether the proposed project action is implemented or not, a critical aspect of the NEPA process is to provide the local communities with a basic understanding of the land use implications expected from implementation of the proposal. Additional clarification and analysis appears to be warranted regarding the expected two percent increase of OCS-related activities. For example, paragraph 3.3.3.8 discusses the many affected land use and coastal activities,

USEPA-SC2 (CON'T)

including: service bases in Morgan City, Port Fourchon, and the Port of Mobile; navigation channels; helicopter hubs; construction facilities such as platform fabrication yards, pipecoating plants and yards, and shipyards; processing facilities such as refineries, petrochemical plants and gas processing plants; barge terminals and tanker port areas; and disposal and storage facilities. Recognizing the existing oil and gas infrastructure is considered sufficient to handle (secondary) development associated with the proposed action, the Final EIS would be strengthened by improving the balance between these listed affected resources and certain potential effects (e.g., more similar to the level of detail in the Environmental Justice evaluation).

USEPA-SC3

3. Pages 4-85 and 4-86 - the number references to Sections 4.1.1.2.4.8 and 4.1.2.1.11.2 appear to be incorrect. Considering the topics and other available numbers in Section 4, the correct paragraph numbers may be 4.1.1.3.4.8 and 4.1.2.1.10.2.

USEPA SC4

4. Page 4-86, second paragraph - regarding regulated run-off, the Final EIS should also include the applicability of EPA's NPDES storm water general permit. For additional information see: www.epa.gov/earth1r6/sws.

USEPA SC5

5. Tables 4-25 and 4-26 should be footnoted for Class I and II maximum allowable increases to show the appropriate source(s) for these limits.

USEPA-SC6

6. Page 4-104 - Noise is evaluated in Section 4 but there is no affected noise environment or baseline for comparison of impacts included in Section 3. The Final EIS should include a noise baseline to improve the balance between potential affected resource and impacts. Also, the Final EIS analysis should include examples of noise levels associated with aircraft, such as helicopters, in determining potential impacts on affected wildlife.

USEPA-SC7

7. Pages 4-108 and 4-172 - it is unclear why the proposed action analyses on Essential Fish Habitat (EFH), including listed managed species, were summarized and considered collectively under coastal and marine environmental degradation. Since both lists of EFH managed species and endangered and threatened species are included in Section 3, the Final EIS would be strengthened by evaluating the impacts on EFH managed species in the same level of detail as the Federally-listed endangered and threatened species.

USEPA SC8

8. The Final EIS should document that construction and operation activities associated with the proposed action will follow the label instructions for proper storage, transportation, use and disposal of all hazardous materials.

USEPA SC9

9. Synthetic-based drilling fluids are discussed in Section 4.2.1.3.2. Reference is made to industry use of "duel density drilling techniques". These techniques are not defined nor have the effects of these techniques been studied, according to the text. Some

USEPA SC9

next steps should be given and some indication of whether these discharges would be allowable discharges.

USEPA SC10

10. Since one of the assumptions stated in Section 4.1.1.3.4.9 is that use of SBF will increase, it would be appropriate to relate the concern about mercury bioaccumulation to this trend toward use of SBF. The terminology of the second assumption regarding discharge of drilling cuttings "...wetted with SBF..." is not at all clear.

4

DEPARTMENT OF THE NAVY
OFFICE OF THE ASSISTANT SECRETARY
(INSTALLATIONS AND ENVIRONMENT)
1000 NAVY PENTAGON
WASHINGTON, D.C. 20350-1000

MAY 29 2002

Gulf of Mexico OCS Region
MMS
JUN 05 2002
Office of the Regional Director

Mr. Thomas A. Readinger
Associate Director for Offshore Minerals Management
Minerals Management Service
Washington, DC 20240

Dear Mr. Readinger:

This responds to your March 15, 2002, letter to Deputy Under Secretary of Defense DuBois requesting that we review your draft Environmental Impact Statement for leasing activities in the Western and Central Gulf of Mexico.

NAVY-1

We have no objections to the proposed leases in the Western and Central Gulf Planning Areas. We continue to examine our training area and testing requirements in the Gulf of Mexico that support essential military operations. If that assessment identifies any conflicts with proposed oil and gas activity, we will coordinate with the Minerals Management Service in accordance with our Memorandum of Agreement.

Staff level coordination points of contact are: Mark Bellis at (703) 5886685, (bellis.mark@hq.navy.mil) and Jarrell N. Henson at (703) 6929369, (henson.jarrell@hq.navy.mil).

Sincerely,

Duncan Holaday
Deputy Assistant Secretary
(Installations and Facilities)

JUN 10 2002

OFFICE OF THE GOVERNOR

DON SIEGELMAN
GOVERNOR

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May 28, 2002

Gulf of Mexico OCS Region
MMS
JUN 10 2002
Office of the Regional Director

Mr. Chris C. Oynes
Regional Director
Minerals Management Service
United States Department of the Interior
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

Re: Draft Environmental Impact Statement for OCS Lease Sales scheduled for 2003-2007

Dear Chris:

This correspondence is in response to your letter of April 2, 2002, concerning the Draft Environmental Impact Statement for the Proposed Outer Continental Shelf Oil and Gas Leasing Program for 2002–2007. The state of Alabama has no comments regarding proposed Western Gulf Sales 187, 192, 196 and 200; and it offers the following comments regarding proposed Central Gulf Sales 185, 190, 194, 198 and 201.

ALGOV-1

As you are aware, our state consistently has supported protection for environmentally sensitive areas that might be impacted by oil and gas exploration and development activities in the OCS. Specifically, we request that the Minerals Management Service provide adequate protection for the live bottom areas, pinnacle reefs and chemosynthetic communities offshore Alabama throughout the new five-year program.

ALGOV-2

The state of Alabama continues to oppose the offering for lease blocks south and within 15 miles of the Baldwin County coast, including the Central Gulf of Mexico Planning Area. Our desire is to minimize the visual impact of new natural gas structures within the area. We believe the state's position on minimizing the visual impact of new natural gas structures is consistent with the proper development of offshore Alabama. We request that MMS exclude these blocks from consideration for leasing throughout the proposed five-year OCS oil and gas leasing program for 2002–2007.

ALGOV-3

We appreciate the information provided in the DEIS concerning the potential impacts of OCS production to onshore air quality in Mobile County. This remains an issue with which we have concerns, and we intend to seek additional information from MMS regarding this matter.

ALGOV-4

As you are aware, we are concerned about the potential for mercury contamination associated with OCS platforms. We are pleased to learn that the OCS Scientific Committee is addressing this matter. It is our desire that the best science available be brought to bear on this matter as soon as possible. Please keep my office and Alabama's state geologist apprised of any

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MS 5400

Mr. Chris C. Oynes
May 28, 2002
Page 2

ALGOV-4 (CONT'D)

recommendations or conclusions of the Scientific Committee regarding the potential for mercury contamination associated with any oil- and gas-related OCS activity.

ALGOV-5

We believe the state of Alabama has received significant impacts to its coastal area from oil and gas activities in the OCS. Some of these impacts have been adverse, and the five proposed Central Gulf Sales undoubtedly will result in additional adverse impacts to coastal Alabama. We believe that Alabama has not been fairly and equitably compensated for these impacts, and we seek your input in determining the proper mechanisms for addressing these inequities.

ALGOV-6

Alabama supports a balanced and reasonable OCS leasing program that leads to exploration, development and production, with the stipulation that all OCS activities be carried out in full compliance with relevant Alabama laws, rules and regulations, and be consistent with our Coastal Zone Management Program.

We appreciate the opportunity to comment on the Draft Environmental Impact Statement for proposed Western Gulf Sales 187, 192, 196 and 200, and proposed Central Gulf Sales 185, 190, 194, 198 and 201. We look forward to working cooperatively with MMS in the successful and safe development of the hydrocarbon resources located offshore Alabama and in sharing in the benefits of OCS leasing and production activities.

Sincerely,

Don Siegelman
Governor

DS/lb/me

cc: Dr. Donald F. Oltz
Commissioner Riley Boykin Smith
Mr. James Warr
Mr. Lance Brown

ADEM

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

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Laboratory: 277-6718
Mining: 394-4326
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May 1, 2002

Minerals Management Service
Office of Leasing and Environment
Attn: Regional Supervisor (MS5410)
Gulf of Mexico, OCS Region
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

RE: Response to Draft EIS for MMS Proposed OCS Lease Sale 2003-2007, Central Planning Area 185, 190, 194, 198, and 201, Western Planning Area 187, 192, 196, and 200 in the Central Gulf of Mexico

Dear Sir:

The Alabama Department of Environmental Management (ADEM) has completed its review of the Draft Environmental Impact Statement (DEIS) submitted by the Department of the Interior, Minerals Management Service, in reference to the proposed Gulf of Mexico OCS Oil and Gas Lease Sales in the Central and Western Planning Areas 2003-2007.

ADEM-1 ADEM emphasizes the Governor's response, as stated in a letter dated January 2, 2002 to the Draft EIS for the proposed OCS Oil and Gas Leasing Program for 2002-2007. Governor Siegelman expressed opposition to offering for lease any tracts located within 15 miles of the Baldwin County, Alabama coast. The Governor also states "We believe that the state of Alabama has received significant impacts to its coastal area from oil and gas activities in the OCS. Some of these impacts have been adverse and the new program undoubtedly will result in additional adverse impacts to coastal Alabama."

ADEM-2 Based on the material submitted, Alternative C describes the anticipated environmental impacts from a scenario which excludes unleased blocks within 15 miles of the Baldwin County coast. The EIS process is a decision making process and ADEM advises and recommends that Alternative C be selected by the MMS.

ADEM-3 The ADEM appreciates the opportunity to review and comment on the DEIS. Should you have any questions concerning this matter, please contact Allen Phelps , in Mobile, at 334/432-6533.

Sincerely,

Steven O. Jenkins, Chief
Field Operations Division

cc: Bob Mink, GSA
Phillip Hinesley, ADCNR
Steve Heath, ADCNR
Allen Phelps, ADEM

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April 29, 2002

Minerals Management Service
Gulf of Mexico OCS Region
Office of Leasing and Environment
Attn: Regional supervisor (MS 5410)
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

Re: AHC 02-0788; Draft EIS for Minerals Management Service, Gulf of Mexico

Dear Sir or Madam:

AHC-1 Thank you for forwarding to our office a copy of the Draft Environmental Impact Statement for the above referenced project. We can concur with project activities with the stipulation that each proposed project is submitted to our office for review and determination prior to project initiation, as stated in the document. We look forward to receiving a copy of the Final EIS as soon as it becomes available.

We appreciate your commitment to helping us preserve Alabama's non renewable resources. Should you have any questions, please contact Amanda McBride of this office and **include the AHC tracking number referenced above.**

Very truly yours,

Elizabeth Ann Brown
Deputy State Preservation Officer

EAB/ALM/alm

THE STATE HISTORIC PRESERVATION OFFICE
www.preserveala.org

State of Louisiana

M.J. "MIKE" FOSTER, JR.
GOVERNOR

JACK C. CALDWELL
SECRETARY

DEPARTMENT OF NATURAL RESOURCES

May 27, 2002

Chris C. Oynes
Regional Director
Minerals Management Service
Gulf of Mexico OCS Region (MS 5410)
Office of Leasing and Environment
1201 Elmwood Park Boulevard,
New Orleans, Louisiana 70123-2394

RE: **C20020118** Solicitation of Views
Minerals Management Service
Direct Federal Action
MMS Request for Comments on the Draft Environmental Impact Statement (DEIS) for proposed Central Gulf of Mexico Planning Area Lease Sales 185, 190, 194, 198 and 201, and proposed Western Gulf of Mexico Planning Area Lease Sales 187, 192, 196 and 200

Dear Mr. Oynes:

LADNR-1

We have reviewed the above referenced DEIS for the nine Gulf of Mexico OCS Lease Sales and offer the following preliminary comments for your consideration in meeting Louisiana's Coastal Zone Consistency requirements. Final Consistency Concurrence by this Office, however, must await your agency submitting a Consistency Determination in advance of each of the nine individual Lease Sales covered in the DEIS.

LADNR-2

Unlike the previous DEIS's for Central and Western Gulf of Mexico Planning Areas published in 1997, the present DEIS does not make any wetland loss projections for OCS pipelines, navigation canals or oil spill scenarios. We believe this is a serious oversight as Louisiana's primary concern with the OCS Leasing Program relates to the direct and secondary losses of wetlands due to OCS oil and gas exploration, development and transport within the Louisiana Coastal Zone. To bring into focus the enormity of Louisiana's wetland loss problem, it should be pointed out that this state currently experiences 80% of the nation's coastal wetland loss at a rate of 25 to 35 square miles per year. Current estimates are that a further 640,000 acres of coastal wetlands, an area about the size of the state of Rhode Island, will be lost by 2050, a period not much longer than the expected life span of all activities associated with the present nine proposed Lease Sales. It is the primary mission of the Louisiana Coastal Resources Program to stop or reverse this process to the extent possible.

LADNR-3

One type of wetland impact that the DEIS does not appear to fully address or consider as a cause of OCS wetland loss is navigational canal deepening and associated saltwater intrusion.

Chris C. Oynes
May 27, 2002
Page 2

LADNR-3 (CONT'D)

While the DEIS mentions that some navigation canals may be deepened in the future, there is not adequate treatment of the impacts that occur to wetlands when and if these canals are deepened. MMS identifies the Port Fouchon Canal as a canal likely to be deepened due to OCS activities, but we know of several other cases where navigation canals are likely to be deepened in coastal Louisiana that have OCS related activities, including the Atahfalaya River below Morgan City, the Calcasieu River below Lake Charles, and the Sabine River below Beaumont. As is demonstrated by the case of the dredging of the Mississippi River Gulf Outlet, devastating losses of wetlands occur from canal dredging or deepening, largely due to saltwater intrusion. We believe the DEIS does not adequately address these wetland impact issues, or the part played by OCS-generated activities in them.

LADNR-4

Loss of wetlands in Louisiana also results from such OCS-generated activities as bankline erosion along navigation canals caused by waterborne traffic, pipeline canal dredging and subsequent pipeline canal widening, and from such diverse causes as degradation of marshes, canals and valuable estuarine water bodies due to water pollution. Other wetland losses derive from saltwater intrusion; overuse and unsustainable over-development of onshore infrastructure (often at a high financial cost for the state to maintain); and environmental contamination associated with hazardous wastes produced and often stored or disposed of in the Louisiana Coastal Zone. While wetland losses may sometimes be attributed to specific petroleum industry activities, it is usually not possible to identify the specific companies responsible for each wetland loss because many of these losses result along waterways traveled in common by all users, and from a multitude of indirect and secondary effects of petroleum development activities. Hence, Louisiana views the Federal agency responsible for promoting and benefitting from the development and exploration of energy resources these activities produce as responsible for the wetland impacts arising from them. An issue that MMS should address in these Lease Sale documents is the program/process MMS should implement to adequately compensate Louisiana for these secondary and cumulative impacts, as required by the LCRP and 15 CFR 930.36. We note that Louisiana has repeatedly made this request for previous OCS Lease Sales, and has yet to see the issue addressed in any way.

LADNR-5

Although the DEIS does point out on Page 4-65 that MMS is conducting an OCS pipeline study that will provide basic information for environmental impact assessments and for mitigation development by MMS, no specific wetland loss figures are estimated for OCS pipelines, navigational canals or oil spills associated with these nine Lease Sales, and no wetland mitigation plan is offered for compensation for OCS-related wetland losses. Louisiana has a no net wetlands loss policy embodied in the Louisiana Conservation Plan, in which the entity responsible for the wetland loss must mitigate or otherwise provide adequate compensation for the loss. This Plan, approved by Federal partners, including the Department of Interior, permits the state to reduce our match for wetlands restoration projects under the Coastal Wetlands Planning, Protection, and Restoration Act. This saves the state millions of dollars a year. If the state does not meet this "no net wetland loss due to development", we stand to lose that match benefit. It is also noteworthy that Executive Order 11990 establishes that each Federal agency

Chris C. Oynes
May 27, 2002
Page 3

shall provide leadership and take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the values of wetlands. For these reasons, it is essential that MMS provide us with direct and secondary wetland loss figures in all Lease Sale DEIS and Consistency Determination documents.

LADNR-6

Another issue we believe should be addressed in the FEIS, is a review of the impacts predicted in earlier 5-Year Programs and OCS Lease Sale documents, as compared to the actual impacts which resulted. We are not aware of any monitoring data supporting either the methodology or conclusions of these predictions as espoused in previous plans. This is particularly true of wetland impacts. If MMS does not have the data with which to make this analysis, we strongly recommend that appropriate studies and/or monitoring be included in this and future MMS 5-Year Programs so that we may assess the accuracy of DEIS impact estimates.

LADNR-7

Finally, it must be noted that Louisiana has enjoyed many benefits from OCS exploration and development in the Gulf of Mexico. We are grateful for the opportunity to comment on and coordinate with MMS in the development of DEIS and Lease Sale documents for the Gulf of Mexico Planning Areas. It is our hoped that our concerns are adequately addressed and incorporated into the Consistency Determinations for each of the nine Lease Sales covered in the DEIS. If you should have questions with regards any of these matters, please feel free to contact me at (225) 342-7591.

Sincerely,

Terry W. Howey
Administrator, CMD

TWH/GD/JH/bgm

cc: Jack C. Caldwell, Secretary, DNR

Coalition to Restore Coastal Louisiana

746 Main Street, Suite B101 • Baton Rouge, LA 70802
225-344-6555 • Fax 225-344-0590 • coalition@crcl.org • www.crcl.org

May 31, 2002

Minerals Management Service
Gulf of Mexico OCS Region
Office of Leasing and the Environment
Attention: Regional Supervisor (MS 5410)
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

Re: Draft EIS for Central and Western Planning Area Sales 185, 187, 190, 192, 194, 196, 198, 200, and 201

Dear Sir or Madam:

We have reviewed the draft Environmental Impact Statement for the above mentioned proposed sales and have the following comments for your consideration.

CRCL-1

General Comments: On the whole we find the draft EIS to have done a better job of identifying potential types of impacts that may ensue leases than was often the case in the past. That said, the level of detail to describe those impacts and to place them in the context of what is happening in our coast--and what needs to happen under the Coast 2050 plan--seems far too sparse to allow this draft to be viewed as complete. In some ways the level of detail is well below that was developed for Lease Sale 181 (LS181). In other ways it relies on assumptions and that contradict experience and even are inconsistent with the analysis that supported LS 181.

CRCL-2

Additionally, the ultimate assessment of several major impacts seems to hinge on the results of various studies that are vaguely described in the document. The studies of secondary and cumulative impacts to wetlands and related mitigative efforts (page 4-68) and the study of the wetland impacts of canal widening and the effectiveness of mitigation (page 4-65) seem particularly important. Yet it appears that the decisions with respect to the sales may be made before those studies are complete and their results made public. Given the fact that much of the degradation of our coastal environment is attributable to the secondary and cumulative effects of canals, embankments and other hydrologic alterations, this is not a trifling matter.

CRCL-3

The draft EIS also does not seem to track recent developments that suggest that mercury contamination (at least partially associated with OCS activity) is far less benign and localized than MMS is suggesting on pages 4-16 and 4-86. Not only has the Mobile Register raised the issue of mercury contamination of several gulf fish species (including

Our Coast ... Our Future

tree free

CRCL-3 (CONT'D)

ling, redfish, and amberjack) and in human populations that consume those fish but it was reported by the Associated Press on May 20, 2002 that the White House is convening a National Science and Technology Council task force (with the support of Senator Jeff Sessions) to address the issue of mercury contamination. We believe the current level of attention to this issue in the EIS falls far short of what is necessary to label even a draft EIS complete.

CRCL-4

We realize that a certain level of detail will always be missing in a programmatic EIS, but this is more than just a programmatic EIS. This is supposed to be good enough to serve as a final EIS for LS 185 in 2003. Right now it is not. Indeed, given the fact that each lease sale proposal and projected activities are very similar for each year it seems to us that there is sufficient certainty about these proposed sales and their likely impacts to warrant a level of detail generally associated with a final EIS. We do not feel that those deficiencies can be adequately addressed through the preparation of additional Environmental Assessments for the outyear sales.

Despite that lack of detail, there is enough in the draft to demonstrate the historic and on-going impacts of supporting Outer Continental Shelf (OCS) oil and gas development on our coast and its communities. Those impacts are very real and very substantial. The rather formulaic environmental justice section (4.2.1.14.4) is the only place where the qualitative impacts are really discussed and it misses the mark by a wide margin. Simply put, the OCS sales covered by this EIS, alone and in combination with previous OCS related activity, will be a significant stressor on the vitality and viability of our coastal and its communities and that is not adequately reflected in the draft. It is not conjecture to suggest that this EIS must reflect the fact that OCS energy development is being subsidized by the ecology, communities, cultures, and very landscape of coastal Louisiana and that the impacts to those resources are not being mitigated.

Specific Comments:

CRCL-5

Wetlands: The section (4.4.1.1.2) of the draft EIS dealing with the impacts to the wetlands of the Central Planning Area (virtually all of which is in Louisiana) is seriously deficient. In essence the section says there will be impacts, perhaps significant, but MMS has no way of knowing where or how bad they will be. That is not good enough, particularly with respect to direct impacts. Considering the fact that you expect no major new navigation channels and only one new pipeline landfall as a result of this 5-year leasing program (though the number of new landfalls from all OCS activities could be as high as 22 according to Table 4-14) there should no great mystery about where and how significant the impacts should be. For LS 181, MMS had no trouble predicting the loss of up to 1,330 hectares of land in Plaquemines Parish by the installation of up to 7 pipelines. Similarly, MMS knows exactly where the navigation channels and service ports are and the likely depths that will need to be maintained to support the proposed OCS work. To claim that the OCS activities are too diffuse and broadly scattered to allow more precision is not acceptable nor is it acceptable to pass the burden on to a vaguely described study that supposedly will let you better evaluate these impacts and related mitigative effects. And to suggest that you don't know more at this stage of the game is frankly a bit stunning. MMS is no stranger to these issues or to NEPA. You can do better, you have done better and you must do better now.

CRCL-6

Channels, Pipelines, and Vessel Traffic: The portions of the Wetlands section dealing with pipelines, dredging and vessel traffic suffer from the same vagueness problem described above. These sections talk around the issue of impacts rather than actually addressing them. The draft acknowledges the fact that impacts from channel-widening, spoil banks, saltwater intrusion, and bank erosion from boat wakes, and failed or inadequate mitigation but either defers any substantive analysis of those impacts to separate studies (see pages 4-65 and 4-68) or to resorts to unhelpful sweeping statements (e.g. " An increase in the number of vessels creating wakes could potentially impact coastal habitat including wetlands." (page 4-66)) or statistical analyses.

An example of the latter can be seen on page 4-86. The draft concludes that the impacts of from OCS related navigation attributable to the proposed sale will "remain negligible" due to the fact that it will make up only 2% of the usage of the channels (the total usage attributable to OCS related navigation is reported to be 10%). These are meaningless figures. Percentage of use does not correlate to causation of impact. Impacts are much more a function of vessel size, speed, draft, and cargo-- and future OCS related navigation will be characterized by larger, faster, deeper draft vessels (page 4-28). It is not the more numerous fishing and recreational vessels that cause the most damaging wakes and require deep channels that induce tidal exchange and salt water intrusion. An accident involving a smaller vessel does not pose the same risks as an accident involving a crewboat, supply vessel or a platform under tow and those facts cannot be denied or minimized by a superficial statistical presentation.

We believe that a more rigorous discussion of the reasonably anticipated impacts to coastal habitats is required. We also disagree with the premise that OCS related navigation has had a negligible impact in the past, a premise which is used to further justify the cursory treatment of navigation impacts (page 4-68). On the whole we believe additional work is necessary on these issues before the draft can be considered complete.

CRCL-7

Spills: The risk analysis for coastal spills (the most likely source of problems for coastal Louisiana) is based on a proportional analysis of the U.S. Coast Guard Marine Safety Information System database. Inherent in this approach is presumption that historical experience is an adequate basis for predicting the future. In a static system that might be sufficient but in a dynamic coastal environment such as we have here it is not. Currently much of coastal Louisiana is experiencing dramatic landloss that could result in the undermining and exposure of pipelines, navigation channels and collection, processing and supply facilities. We can find no discussion of this pervasive risk factor in this document nor of the proposed systemic effects of the Coast 2050 coastal restoration plan adopted by the state and five federal agencies in 1998.

CRCL-8

The manner in which risk and risk management are viewed in connection with this proposed sale must reflect both the

CRCL-8 (CON'T)

prospective continued collapse of our coast and its proposed rehabilition--a rehabilitation we believe should be actively supported through any OCS leasing program.

CRCL-9

Waste: While we do not pretend to be experts on the issue of waste management, much less OCS waste management, we do find it hard to reconcile the discussion of the issue in this draft with the approach taken in previous lease sale documents. We find it hard to believe that when Lease Sale 181 was being reviewed it was envisioned that the associated OCS development would result in the need for three new land fills over the next 35-40 years--two of which would be in Louisiana. Similarly, it was envisioned that several new waste facilities for Nonhazardous Oil-field Waste would be required. (Pages IV-87 and 88 of DEIS for LS 181). Yet the current draft predicts no increase in waste storage needs. We cannot help but be struck by the more comprehensive discussion--and the conclusions--in the NEPA documentation for LS 181. There is no explanation for this disparity in the current draft and it further fuels our concern that this draft displays a pervasive understatement of the expected impacts of the proposed lease sale.

CRCL-10

Table 4-14: *This table showing existing and proposed* coastal pipelines resulting from the OCS Program has several problems. First, the total column does not agree with the sub-columns in regard to existing landfalls and pipelines entering state waters. Second, it is not clear whether the projected pipelines includes any pipelines related to the proposed sale (i.e., is Table 4-13 a subset of Table 4-14?). And finally there is no indication of the source of the information set forth in the table. For this table to be understandable each of these problems needs to be addressed.

Conclusion: We thank you for considering these comments and we offer them with hope that they help improve both the process of drafting the EIS and in making any ultimate

CRCL-11

decisions about the proposed sale. At present we believe there are sufficient material gaps in this draft to deem it incomplete. We urge that it be reviewed, revised and reissued in draft format for additional comment. If we can be any assistance in that process we would be pleased to help. Do not hesitate to call us if you have any questions about these comments or would like our assistance in helping you to respond to them.

Sincerely yours,

Mark Davis
Executive Director

Cc: CRCL board
Sec. Jack Caldwell, LDNR
Mr. Randy Hanchey, LDNR
Mr. Terry Howey, LDNR
Dr. Len Bahr, Governor's Office
Ms. Karen Gautreaux, Governor's Office

Shell Exploration & Production Company

One Shell Square
PO Box 61933
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May 14, 2002

Department of the Interior
Minerals Management Service
Office of Leasing and Environment
Regional Supervisor (MS-5410)
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

RE: *MMS Draft EIS*
Gulf of Mexico OCS Oil and Gas Lease Sales: 2003-2007
Central Planning Area Sales 185, 190, 194, 198, and 201
Western Planning Area Sales 187, 192, 196, and 200

Gentlemen;

Shell Exploration & Production Company and other affiliates of Shell Oil Company (all referred to as "Shell") appreciates the opportunity to comment on the Draft Environmental Impact Statement (DEIS) for the Gulf of Mexico OCS Oil and Gas Lease Sales: 2003-2007. Being actively involved in oil and natural gas development projects, Shell is very interested in the proposed lease sales and DEIS.

SHELL-1

Shell supports Alternative A, the MMS Proposed Action, as laid out in the DEIS for both the Central and Western GOM Lease Sales. We recognize the importance of a strong military and are committed to working cooperatively with the military in the GOM.

The Minerals Management Service (MMS) has done an excellent job in preparing this detailed DEIS. It is comprehensive and evaluates in detail a vast array of issues related to Outer Continental Shelf (OCS) operations and their potential environmental impact to both offshore and onshore areas. The DEIS analyzed in detail many resources and activities that included: coastal environments, offshore resources, water and air quality, marine mammals, sea turtles, coastal and marine birds, fisheries, recreational resources, archaeological resources and socioeconomic activities. Shell believes the document and the scientific data included therein demonstrate that petroleum resources can be developed while ensuring that the GOM ecosystem is protected.

In Section 1.3 of the DEIS, MMS has done an excellent job in summarizing the regulatory framework for the OCS leasing program, and the extensive regulations that are already in place. Also, Sections 1.4 and 1.5 provide an excellent overview of the various MMS programs and involvement in the review and planning of proposed OCS development activities to ensure that

they are conducted in a safe manner, with full consideration of the potential effects to the environment.

These lease sales are very important for the development of the GOM's gas and oil resources. Shell agrees with MMS's assessment that development of these gas and oil reserves will help industry and the government meet some of the future energy needs of the United States. Industry has demonstrated that it can explore for and produce offshore resources in a manner that is compatible with and protective of the environment while ensuring the safety of our employees and the public. MMS has played a strong role as a steward of the Gulf, making sure that exploration and development activities are conducted in accordance with well established laws and regulations.

If you have any questions or need further clarification, please do not hesitate to call me, or Rick Meyer at (504) 728-6393.

Very truly yours,

R. B. Meyer, P.E. for

Peter K. Velez
Manager, Regulatory Affairs, Operations HSE, and Incident Command

NOIA

May 31, 2002

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ATTN: Regional Supervisor (MS 5410)

RE: Draft Environmental Impact Statement for Proposed Lease Sales in the Central and Western Planning Areas

Dear Sir or Madam:

The National Ocean Industries Association (NOIA) appreciates the opportunity to respond to your request for comments on the draft environmental impact statement for proposed lease sales in the Central and Western Planning Areas. NOIA is the only national trade association representing all segments of the offshore energy industry. The NOIA membership comprises more than 300 companies engaged in activities ranging from producing to drilling, engineering to marine and air transport, offshore construction to equipment manufacture and supply, shipyards to communications, and geophysical surveying to diving operations. The draft environmental impact statement (DEIS) for the proposed lease sales is, therefore, of particular importance to NOIA.

NOIA-1

NOIA strongly supports the MMS decision to prepare one environmental impact statement for nine lease sales in the proposed Five-Year Program in accordance with National Environmental Policy Act regulation 40 CFR 1502.4. Analyzing these similar proposals in one document allows for a more thorough analysis of cumulative impacts and more expeditious planning by the agency and the companies operating in the central and western Gulf of Mexico. In addition, NOIA applauds the schedule in the proposed five-year plan and reinforced in the DEIS which allows for areawide lease sales. This will eliminate unnecessary duplication, and allow for site-specific environmental assessments for each successive sale. These processes allow the agency to carry out its mandate under the Outer Continental Shelf Lands Act (OCSLA) for expedited exploration and development of the OCS.

Proposed Central Gulf Sales

NOIA-1 (CON'T)

The proposed Central Gulf lease sales are 185 in 2003, 190 in 2004, 194 in 2005, 198 in 2006 and 201 in 2007. The DEIS analyzes four alternatives for this area. Alternatives B and C would remove areas from consideration for leasing that analysis indicates would not be harmed from routine oil and gas activities. Alternative D would cancel one or more of the proposed sales in the Central Planning Area. Alternative A would offer for lease all unleased blocks within the Central Planning Area for oil and gas operations, except for those blocks that are deferred under the "Treaty Between the Government of the United States of American and the Government of the United Mexican States on the Delimitation of the Continental Shelf in the Western Gulf of Mexico Beyond 200 Nautical Miles."

NOIA supports Alternative A as the Proposed Action. The alternative estimates that any one of the lease sales in the Central Planning Area would produce 276,000,000 to 654,000,000 barrels of oil and 1.590 to 3.300 trillion cubic feet of natural gas. These resources are needed to achieve a portion of the nation's economic and energy policy goals, in accordance with the OCSLA and the President's Energy Program.

There are three lease stipulations included in the Proposed Action. The first of these is the live bottom (pinnacle trend) stipulation which would require that prior to any drilling activities or the construction or placement of any structure for exploration or development in any live bottom areas, the lessee would submit to the Regional Director a live bottom survey report containing a bathymetry map prepared using remote sensing techniques. If analysis of the map indicates that live bottoms might be adversely impacted by the proposed activity, the Regional Director would require that the lessee undertake any measure economically, environmentally and technically feasible to protect the area, including the relocation of operations and the monitoring to assess the impact on the live bottoms.

The second stipulation is the topographic features stipulation. Stipulations to protect these coral reef communities have been imposed on leases since 1973. Among other things, the stipulation establishes "no activity zones" around sixteen banks in the Central Planning Area. The third stipulation, the military areas stipulation, has been applied to all blocks leased in military areas in the Gulf of Mexico since 1977.

2

NOIA-1 (CON'T)

While NOIA generally believes that stipulations should not be sweepingly imposed over numerous lease sales, we appreciate the fact that these stipulations are results-oriented, rather than prescriptive, and that the Assistant Secretary has the discretion to apply them or not as needed.

Proposed Western Gulf Sales

The Proposed Western Gulf sales are 187 in 2003, 192 in 2004, 196 in 2005, and 200 in 2006. The DEIS analyzes three alternatives for this area. Alternative B would remove areas from consideration for leasing that analysis indicates would not be harmed from routine oil and gas activities, and Alternative C would cancel one or more of the proposed sales in the Western Planning Area. Alternative A would offer for lease all unleased blocks within the Western Planning Area for oil and gas operations except for portions within the Flower Garden Banks National Marine Sanctuary, areas identified by the Navy as needed for testing equipment and training, and blocks that are deferred under the "Treaty Between the Government of the United States of American and the Government of the United Mexican States on the Delimitation of the Continental Shelf in the Western Gulf of Mexico Beyond 200 Nautical Miles."

NOIA supports Alternative A as the Proposed Action. The alternative estimates that any one of the lease sales in the Western Planning Area would produce 136,000,000 to 262,000,000 barrels of oil and 0.810 to 1.440 trillion cubic feet of natural gas. These resources are needed to achieve a portion of the nation's economic and energy policy goals, in accordance with the OCSLA and the President's Energy Program.

There are three lease stipulations included in the Proposed Action. The first of these is the topographic features stipulation, described above. The second and third stipulation, the military areas stipulation and the naval mine warfare stipulation, are intended to reduce potential multiple use conflicts between oil and gas operations and Department of Defense activities.

As mentioned previously, NOIA generally believes that stipulations should not be sweepingly imposed over numerous lease sales, but we appreciate the fact that these stipulations are results-oriented, rather than prescriptive, and that the Assistant Secretary has the discretion to apply them or not as needed.

NOIA strongly encourages the expeditious completion of this Environmental Impact Statement and compliance with the schedule set out in the proposed Five-Year Program. With so many of our offshore natural gas and oil resources

NOIA-1 (CON'T)

eliminated from consideration for leasing by the government, these sales are vital to the nation. If you have any questions or need additional information, please feel free to contact me at (202)347-6900.

Sincerely,

Kim Harb
Director of Government Affairs

U.S. ENVIRONMENTAL PROTECTION AGENCY

USEPA-GC1 Comments noted. The MMS's operational regulations and inspection program are specifically intended to ensure safe operations and prevention of pollution.

USEPA-GC2 The MMS's operational manual for archaeological resources management, entitled *Handbook for Archaeological Resource Protection* (MMSM 620.1-H) (USDOI, MMS, 1985), has been officially reviewed and accepted by both the Advisory Council on Historic Preservation (ACHP) and the Chief Consulting Archaeologist of the U.S. Department of the Interior as operating regulations at 30 CFR 250.194. To date, there has been no official consultation for the proposed 2003-2007 lease sales between the MMS's Gulf of Mexico OCS Region and the ACHP State Historic Preservation Officer for each state. No archaeological concerns were raised during the public hearings held on the Draft EIS. At present, no existing Indian tribes are expected to be affected by the proposed OCS lease sales (Chapters 4.2.1.14.4 and 4.3.1.12.4). The MMS has archaeological resources management responsibility only in the Federal Exclusive Economic Zone, which extends from the State/Federal offshore boundaries out to 200 nmi.

USEPA-GC3 The MMS policy is to allow at least 30 days from the publication of a draft lease sale EIS to the public hearings. The MMS policy also provides for an extended public comment period of 60 days. For this EIS, the Draft EIS was released April 1, 2002; the first scheduled public hearing was held on April 30, 2002, in Houston, Texas; the public comment period ended May 31, 2002.

The MMS agrees that shortening the EIS could be beneficial to the reviewers. This multisale EIS replaces multiple individual or annual EIS's and is intended to support EA's prepared for each lease sale. As such, MMS decided that the proposed action analyses for the CPA and the WPA proposed actions should be "self-contained" to allow ready incorporation by reference and tiering for the individual lease sale EA's. From a practical standpoint, major reformatting of the EIS at this point in the overall schedule could result in loss of text, incomplete discussions in some sections, or introduction of errors. For future EIS's, MMS will reconsider putting the generic impact discussion into an appendix as was done for the Draft EIS for the Destin Dome 56 Unit Development and Production Plan and Right-of-Way Pipeline Application USDOI, MMS, 1999).

The MMS does not agree with the recommendation to analyze one typical proposed action for lease sales in both the WPA and CPA. The existing infrastructure, the projected levels of activities, the estimated oil and gas resources, and the proportion of oil versus gas is very different for each of the planning areas.

USEPA-GC4 The expiration dates for the current NPDES General Permits for OCS discharges in USEPA Regions 4 and 6 have been added to the text in several appropriate places in the EIS.

USEPA-GC5 Many references appear in various discussions related to discharges and to regulations and NTL's requiring avoidance of certain areas of biological concern. A number of studies have described the impacts of various drilling effluents on the benthic environment. These studies are referenced in many of the EIS discussions. The reviewer's comment appears to be referring only to infauna or sediment-dwelling animals. These communities are not addressed in detail (e.g., species-level) due to the ubiquitous nature of soft bottom in the Gulf of Mexico, limited impact areas from drilling discharges, and expected rapid recolonization of impacted areas from surrounding infauna communities. It is impossible to address "potential" changes in species richness, community composition, and diversity without knowledge of site-specific, pre-drilling community structure and physical characteristics of the benthic habitat. Kennicutt (1995), referenced numerous times in Chapter 4, does present some of the most detailed data from the Gulf of Mexico on the alteration of benthos around three continental shelf platforms. However, recent studies have determined that some of the major changes in soft-bottom communities near platforms reported here are due to an artificial reef effect not related to discharges or any other source of contamination.

USEPA-GC6 Many Gulf Coast States now sample the edible tissue of estuarine and marine fish for total mercury. The USEPA merged both State and Federal mercury data into the Gulfwide Mercury in Tissue Database to characterize the occurrence of mercury in Gulf of Mexico fishery resources (Ache, 2000). The report found that all Gulf Coast States have published fish consumption advisories for large king mackerel. The report recommends testing of additional species through a coordinated approach. In May 2002, the Mercury Forum was held in Mobile, Alabama. The first meeting of the Interagency Working Group (IWG) on Methyl Mercury, which was organized by the Office of Science and Technology Policy in coordination with the Council on Environmental Quality, was held in June 2002. In addition to MMS, participants included USEPA, FDA, the National Institutes of Health, and NOAA, as well other agencies.

In the spring of 2002, the NOAA Fisheries began a fish-sampling program designed to measure mercury in noncommercially harvested fish. These fish, for which there is only limited mercury concentration data, may be frequently consumed by subsistence, commercial, and recreational fishermen and their families. The sampling program, titled the *NOAA Fisheries Synoptic Survey of Total Mercury in Recreational Finfish of the Gulf of Mexico*, has three objectives: (1) to seek information about a possible relationship between fish and oyster mercury concentrations, which would allow for the use of oysters to predict fish mercury concentration; (2) to determine any difference in mercury concentrations between reef fish obtained at oil and gas rigs and reef fish caught at non-rig reefs; and (3) to compare mercury concentrations between the Western and Eastern Gulf of Mexico migratory pelagic species (e.g., tunas, mackerels, and cobia) (Garrett and Lowery, 2002).

Information on the composition of drill cuttings has been added to the text.

USEPA-SC1 Clarifying text has been added.

USEPA-SC2 The text on page 4-120 was incorrect and has been corrected. As stated in the text on page 4-183, no increase in overall OCS activities is expected.

USEPA-SC3 The section references have been corrected.

USEPA-SC4 The text has been revised to include the additional information.

USEPA-SC5 Footnotes have been added to Tables 4-25 and 4-26.

USEPA-SC6 At present, there are no published studies documenting baseline underwater ambient-noise levels in the Gulf of Mexico (ambient noise is environmental background noise). A study is being conducted by scientists at the Naval Research Laboratory at Stennis Space Center, Mississippi, and the University of New Orleans, Louisiana, to measure ambient-noise levels in the northern Gulf of Mexico (Newcomb et al., 2002). Three autonomously recording hydrophones have been placed at the 600-m, 800-m, and 1,000-m isobaths of the northern Gulf. Once measurements are completed and analyzed, other noises of interest (e.g., vessel traffic) may be measured and compared with the ambient-noise levels obtained in this study. Chapter 4.1.1.3.7 provides a description of industry-related noise sources in the northern Gulf of Mexico, including noise levels associated with aircraft (including helicopters). Interested readers may wish to consult Richardson et al. (1995) for more information regarding manmade noises and their potential impacts to marine mammals.

USEPA-SC7 The MMS believes the level of detail evaluating the level of impacts on EFH and managed species is adequate. The National Marine Fisheries Service has concurred; their review summary and EFH consultation agreement states ". . . potential impacts to EFH and associated fishery resources are thoroughly addressed." Potential effects to managed fish species and to habitats designated as EFH are addressed in Chapters 4.2.1.10, 4.3.1.8, 4.4.3.10, and 4.5.10.

USEPA-SC8 Most OCS operators have high-profile worker and operations safety programs. Operators are required to comply with all applicable laws and regulations – from USCG requirements for firefighting equipment and flotation devices to OSHA requirements for protective clothing to FDA guidelines for safe handling of foods. The USCG, USEPA, and OSHA have primary regulatory authority over the proper storage, transportation, use, and disposal of hazardous materials.

USEPA-SC9 In dual-density or dual-gradient drilling, two distinct pressure gradients exist for the drilling fluids. A mud properly weighted for the formation is used in the borehole (one pressure gradient). The mud is carried from the seafloor to the surface through one or more lines (second gradient) that are separate from the drill string annulus. A subsea pump circulates the drilling fluid from the wellbore to the surface through the riser. A more detail discussion of dual-density drilling has been added to Chapter 4.1.1.2.2 of this Final EIS.

USEPA-SC10 The increased use of synthetic-based drilling fluids (SBF) does not imply an increase in drilling activity. Instead, the increased use of SBF is a reflection of a change in the type of fluid used during drilling. Since the use of SBF means that drilling fluids are more likely to be recycled rather than discharged and since the use of SBF could lead to smaller diameter wellbores with discharge of less cuttings, the overall use of SBF could result in less volume of discharged drilling muds and cuttings and a reduction in the discharge of any mercury associated with the muds and cuttings.

The text has been revised to clarify the terminology.

U.S. DEPARTMENT OF THE NAVY

Navy-1 Comments noted.

ALABAMA OFFICE OF THE GOVERNOR

ALGov-1 The MMS recognizes the need to protect live-bottom areas, pinnacle and topographic features, and chemosynthetic communities. Lease stipulations and NTL's to protect these resources are included in the proposed actions evaluated in this EIS.

ALGov-2 The MMS and the Alabama Geological Survey/Oil and Gas Board together developed a lease stipulation to minimize potential visual impacts. The stipulation (text below) would be included only on leases on CPA blocks south of and within 15 mi of Baldwin County, Alabama. The stipulation would be applied under Alternatives A and B as analyzed in this EIS. This stipulation has been adopted for Central Gulf Sales since 1999. This stipulation will be considered for adoption by the Assistant Secretary of the Interior for

Land and Minerals (ASLM) at the completion of the EIS/prelease process. The analysis of any stipulations as part of Alternative A does not ensure that the ASLM will make a decision to apply the stipulations to leases that may result from any proposed lease sale, nor does it preclude minor modifications in wording during subsequent steps in the prelease process if comments indicate changes are necessary or if conditions change.

Lease Stipulation for Blocks within 15 Miles South of Baldwin County, Alabama

In order to minimize visual impacts from development operations on this block, you will contact lessees and operators of leases in the vicinity prior to submitting a Development Operations Coordination Document (DOCD) to determine if existing or planned surface production structures can be shared. If feasible, your DOCD should reflect the results of any resulting sharing agreement, propose the use of subsea technologies, or propose another development scenario that does not involve new surface structures.

If you cannot formulate a feasible development scenario that does not call for new surface structure(s), your DOCD should ensure that they are the minimum necessary for the proper development of the block and that they will be constructed and placed, using orientation, camouflage, or other design measures, to limit their visibility from shore. The MMS will review and make decisions on your DOCD in accordance with applicable Federal regulations and MMS policies, and in consultation with the State of Alabama (Geological Survey/Oil and Gas Board).

Alternative C would exclude from the proposed lease sales any unleased blocks within 15 mi of Baldwin County, Alabama. At the completion of the EIS/prelease process, the ASLM considers the conclusions of the EIS analyses and the comments received during scoping and on the Draft and Final EIS's. At that time, the ASLM decides which of the proposed alternatives will be implemented.

ALGov-3 Comment noted. The MMS shares your concerns about the potential impacts to onshore air quality from OCS activities. The MMS staff is available to meet with State representatives to discuss air quality issues.

ALGov-4 The MMS will keep the State of Alabama informed of any recommendations from the OCS Scientific Committee regarding potential mercury contamination associated with OCS platforms.

In addition, the Interagency Working Group (IWG) on Methyl Mercury was organized by the Office of Science and Technology Policy in coordination with the Council on Environmental Quality. The first meeting of the IWG was held in June 2002. In addition to MMS, participants include the USEPA, FDA, the National Institutes of Health, and NOAA, as well as other agencies.

ALGov-5 Section 1.2.5.1 of the Final EIS for the 5-year program explains the U.S. Department of the Interior's position on "revenue sharing" to compensate coastal States for impacts.

The U.S. Department of the Interior has supported the concept of greater sharing of revenues with the States and communities most heavily affected by OCS oil and gas activities, as well as the principle of using impact assistance as a means of protecting coastal and marine resources and mitigating the environmental impacts of OCS activities. The *Commerce, State, and Justice Fiscal Year 2001 Appropriations Act* created a Coastal Impact Assistance Program (CIAP) for which Congress authorized $150 million. The Program is intended to support projects and activities related to coastal stewardship and specifically allows a State to use a potion of the monies received to mitigate the impacts of the OCS activities. Further, the Oil Pollution Act of 1990 (P.L. 101-380) includes provisions requiring compensation for damages created by onshore and offshore oil spills. Levels of compensation specified in the legislation should prove adequate for physical, environmental, and social damages.

ALGov-6 To ensure conformance with State Coastal Zone Management (CZM) program policies and local land use plans, MMS will prepare the appropriate consistency determination prior to each proposed OCS lease sale addressed in this multisale EIS. In addition, MMS sends copies of OCS plans, including the consistency certifications and other necessary information, to the designated State CZM agency for review to determine whether the proposed activities will be conducted in a manner consistent with the State's approved CZM program.

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

ADEM-1 As the comment notes, the same comments were submitted in relation to the Draft EIS for the proposed OCS Oil and Gas Leasing Program for 2002-2007 (the 5-Year Program). The response to the comment on the 5-Year Program is addressed as Issue 13 and appears on page 5-32 of the Final EIS.

The MMS and Alabama Geological Survey/Oil and Gas Board together developed a stipulation to minimize potential visual impacts. The stipulation (text provided in the response to Comment ALGov-2 above) would be included only on leases on CPA blocks south of and within 15 mi of Baldwin County, Alabama. The stipulation would be applied under Alternatives A and B analyzed in this EIS. Alternative C would exclude from the proposed lease sales any unleased blocks within 15 mi of Baldwin County, Alabama.

ADEM-2 At the completion of the EIS/prelease process, the Assistant Secretary of the Interior for Land and Minerals (ASLM) considers the conclusions of the EIS analyses and the comments received during scoping and on the draft and final EIS's. At that time, the ASLM decides which of the proposed alternatives and/or lease stipulations will be implemented. Please see the responses to Comments ALGov-2 and ALGov-5 above.

ADEM-3 Comment noted. Please also see the response to Comment ADEM-1 above.

ALABAMA HISTORICAL COMMISSION

AHC-1 To ensure conformance with State Coastal Zone Management (CZM) program policies and local land use plans, MMS will prepare the appropriate consistency determination prior to each proposed OCS lease sale addressed in this multisale EIS. In addition, MMS sends copies of OCS plans, including the consistency certifications and other necessary information, to the designated State CZM agency for review to determine whether the proposed activities will be conducted in a manner consistent with the State's approved CZM program.

LOUISIANA DEPARTMENT OF NATURAL RESOURCES

LADNR-1 Comment noted. The MMS submits Consistency Determinations to the affected Gulf Coast States prior to each lease sale.

LADNR-2 It is MMS's intention and goal to provide systematic and thorough scientific evidence to support predictions of coastal habitat loss in response to OCS activities. The ongoing

Coastal Impacts of Pipeline and Navigation Canals study is a comprehensive and detailed analysis of specific major OCS pipelines occurring in the four-State region of the Gulf coast where OCS activities take place (i.e., Texas, Louisiana, Mississippi, and Alabama). The pipelines that have been selected and the associated analyses that have been applied will give MMS some measure of historic loss that can be translated into a plausible, quantitatively predictive context of what might occur if more pipelines are constructed using the described emplacement techniques. These pipelines vary in regards to the timing (1960's to mid-1990's) and methodology of their placement. The pipelines and canals surveyed have been related to historic datasets (1956) in an effort to determine the loss associated with direct impacts of pipeline construction and increased navigation in association with OCS activities.

A composite of current mitigation techniques has been included in the Final EIS to familiarize permitting agencies and State-maintenance providers with the past and present mitigation techniques that are available for the protection of sensitive coastal habitat. The ongoing study will also evaluate the effectiveness of mitigation techniques for selected pipelines.

Various estimates of the total relative direct and indirect impacts of pipeline and navigation canals on wetland loss vary enormously—ranging from a low of 9 percent to estimates of greater than 50 percent. The MMS agrees that narrowing this range of estimates is paramount to guiding the choice of management approaches to reduce and recover wetland losses.

Preliminary data developed by the U.S. Geological Survey from the ongoing study for coastal Louisiana reflects the following:

(1) Total length of OCS pipelines included in the Louisiana study area from offshore or the the 3-mi line (offshore State/Federal boundary) to the inland coastal zone boundary for Louisiana was approximately 15,400 km or 9,570 mi. Sources of data were PennWell Mapsearch, National Pipeline Mapping System, and Louisiana Geological Survey pipeline data. Of that total, approximately 8,000 km (4,971 mi) or over half of these pipelines crossed wetland (marsh) or upland habitat. Additionally, based on USGS 1978 habitat data, approximately 56% of the length of pipelines crossed marsh habitat and 44% percent crossed upland habitat. Using USGS land loss data from 1956 to 2002, the total amount of land loss attributed to OCS pipelines was 34,400 ha (85,120 ac), within a 300 m (984 ft) buffer for each OCS pipeline. This number represents .04 km^2 (4.00 ha/9.88 ac) per linear km of pipeline installed. When one divides 34,400 ha by the 46-year period (1956-2002), the loss per year is 746 ha (1,843 ac) for the 8,000 km (4,971 mi) of OCS pipeline or 11.9% of total land loss in the entire Louisiana pipeline study area. Note that from the period 1990 to 2002 (based on the preliminary data by USGS) the total pipeline land loss for the study area was approximately 25 km^2 (~10 mi^2) or 525 ac/yr, which represents a dramatic decline from the 1956-1978 and 1978-1990 analysis.

(2) Many of these pipelines were installed prior to the implementation of the NEPA of 1969 and more recently, the State of Louisiana's Coastal Permit Program in 1981. Additionally, given the width of the buffer – 300 m (984 ft) versus the actual pipeline canal width, which may be a 31 to 61 m (100 to 200 ft) wide, an unknown portion of water increase is attributed to other factors unrelated to OCS pipelines. To address this, selected OCS pipelines are being studied in greater detail to ascertain direct and

secondary impacts to the extent possible and the information from that analysis will be included in future NEPA documents.

Navigation channels subjected to new or increased water flow (such as boat wakes) is an assumed secondary impact. The MMS recognizes that past studies have concluded that the enlargement of existing canals by erosion may be indicative of substantial secondary impacts from erosion in canals from vessel usage. As stated in the EIS, OCS-related vessel usage is approximately 12 percent of all navigation that uses these channels. The current study will address the measurable extent of landloss due to vessel usage of existing channels and canals used by OCS vessels.

Unfortunately, difficulties occur in attempting to quantify the exact effect of secondary impacts for various reasons: (1) changes in hydrology and sedimentation occur naturally over long periods of time, requiring investigators to separate out background changes; (2) impacts may occur over very long periods; and (3) effects may occur in areas somewhat removed from the original impacted site. Secondary impacts are often subtle, involving small changes in salinity, hydrology, or erosion patterns. Over the long term, these types of changes can have substantial impacts on not only the extent of wetland area but the character and health of the wetland system. Over the short term, these impacts may not be discernable by large-scale studies.

The MMS's Environmental Studies Program is continuing to develop studies profiles that will help address the following impacts:

- wetlands loss projections for OCS-related pipelines and navigational canals;
- navigational canal deepening and associated saltwater intrusion;
- bankline erosion along navigational canals caused by waterborne traffic and pipeline canal dredging; and
- potential impacts to marshes, canals, and estuarine waters due to water pollution.

The MMS will be happy to provide interested stakeholders a copy of the Studies Plan for 2003-2005. The MMS Studies Plans are updated annually.

LADNR-3 Please see the response to Comment LADNR-2 above.

LADNR-4 Please see the response to Comment ALGov-5 above.

LADNR-5 The exploration, development, and production activities resulting from a particular lease sale in the Gulf of Mexico that could cause impacts to wetlands are projected to occur over an extended period of time. The resulting impacts from these lease sales overlap with those occurring from other lease sales. It is not possible to distinguish impacts from one lease sale to another. This multisale EIS can only generally address the potential for impacts attributed to the Gulfwide OCS oil and gas leasing program.

The MMS acknowledges the State of Louisiana's no-net-wetlands-loss policy embodied in the Louisiana Conservation Plan. The MMS has funded various studies during the 1980's and 1990's, and in the present to address and assist resource managers and permitting agencies in their efforts to reduce or eliminate habitat loss attributed to OCS activities. Recently, BP was praised by the Louisiana Department of Natural Resources for their efforts in reducing impacts to wetlands from the construction of the Endymion Pipeline by using trenchless or directional drilling. This technique is considered to be extremely protective of sensitive habitats and is currently required almost without exception for crossing barrier islands, shore faces, and wetlands.

Please also see the response to Comment LADNR-2 above.

LADNR-6 As indicated in the response to Comment LADNR-5 above, the exploration, development, and production activities resulting from a particular lease sale in the Gulf of Mexico that could cause impacts to wetlands are projected to occur over an extended period of time. The impacts resulting from the proposed actions would overlap with those occurring from past and future lease sales. It is not possible to distinguish impacts from one lease sale to another. This multisale EIS can only generally address the potential for impacts attributed to Gulfwide OCS oil and gas leasing program.

LADNR-7 Comment noted.

COALITION TO RESTORE COASTAL LOUISIANA

CRCL-1 The level of detail in this EIS is consistent with that found in past Central and Western Gulf of Mexico EIS's and is appropriate for the regional analysis required at this stage in the OCS Program. The amount and detail of information needed for a NEPA analysis depends upon the decision that it is intended to support. The analysis in this EIS must support decisions on whether to hold specific lease sales scheduled in the Outer Continental Shelf Oil & Gas Leasing Program for 2002-2007 and on the specific configuration and conditions for each of the proposed sales. This EIS addresses proposed areawide lease sales with potential impacts over broad and diverse geographic areas. NEPA analyses prepared for proposed post-lease activities will be site-specific and hence will provide more detail about the particular projects in question.

With regard to any inconsistencies with the Lease Sale 181 EIS, we are constantly incorporating new information into our NEPA documents, and therefore what may appear to be inconsistencies between older documents and this one are in fact simply the incorporation of new and improved analyses. We continually update our information base with results of studies from numerous sources including MMS's extensive environmental studies program. As more and better information is available, our methodologies and analyses are improved, resulting in changes from one lease sale EIS to the next.

CRCL-2 While some additional information would be useful to the current analysis, it is not essential for this EIS or in support of informed decisionmaking relative to the proposed lease sales. The amount and detail of information needed for a NEPA analysis depends upon the decision it is intended to support. The analysis in this EIS must support decisions on whether or not to hold specific proposed lease sales scheduled for specific times and which protective alternatives and lease stipulations will be applied. The NEPA analyses for specific exploration and development proposals will be prepared at the time those actions are ripe for decision. These subsequent NEPA analyses will incorporate any new information available since the preparation of this EIS.

Studies related to mitigation efforts, such as mentioned in this comment, would not affect the lease sale decisions, but rather are considered for application of mitigation measures for specific projects. The NEPA document prepared on a lease sale is an ideal way of obtaining input concerning potential problems and impacts, such as wetlands loss, thus helping to identify research and studies that may be needed to address the problem, and exposing to the public the progress and eventual results of such studies. This does not mean that lease sale decisions cannot be made until the results of such studies are available.

Please also see the response to Comment LADNR-2 above.

CRCL-3 As with any, new developing issue, information is being collected and studies are ongoing or being initiated. Again, while some additional information would be useful to the current analysis, it is not essential for this EIS or in support of informed decisionmaking relative to the proposed lease sales. The amount and detail of information needed for a NEPA analysis depends upon the decision it is intended to support. We believe that the available information on mercury (and other such compounds) and the analysis in this EIS are sufficient to support decisions on the lease sales. The basic premise of the analysis in this EIS is that all offshore discharges comply with the NPDES permit limitations, which are developed and issued by the USEPA.

The Interagency Working Group (IWG) on Methyl Mercury was organized by the Office of Science and Technology Policy in coordination with the Council on Environmental Quality. The first meeting of the IWG was held in June 2002. In addition to MMS, participants include the USEPA, FDA, the National Institutes of Health, and NOAA, as well as other agencies.

CRCL-4 The amount and detail of information needed for a NEPA analysis depends upon the decision that it is intended to support. The analysis in the EIS for the proposed Outer Continental Shelf Oil & Gas Leasing Program for 2002-2007 supported a program-level planning decision on future OCS leasing proposals. The analysis in this EIS is intended to support informed decisionmaking on specific proposed Gulf of Mexico lease sales. The environmental analyses prepared for the proposed lease sales in subsequent years will tier from this multisale EIS and examine any new issues, alternatives, mitigation measures, information, and potential impacts. The NEPA analyses for specific proposed exploration, development, and production activities will be prepared at the time that these actions are ripe for decision. This 'tiered" approach to NEPA compliance and decisionmaking is encouraged by NEPA regulations (40 CFR 1502.20 and 1508.28) and upheld in Federal court.

CRCL-5 Chapter 4.4.1.1.2 of the Draft EIS presents a general overview of the approach MMS used to evaluate spill risk. The risk of spill occurrence and contact to wetlands is discussed in detail in Chapter 4.4.1.1.7 (pages 4-202 and 4-203 of the Draft EIS). The extensive analysis of the potential impacts of oil spills on wetlands is presented in Chapter 4.4.3.1.2 (pages 4-220 through 4-222 of the Draft EIS). Although oil spills are reasonably foreseeable events resulting from the proposed actions and the Gulfwide OCS Program, they are unpredictable events except in statistical terms. Where a spill occurs, the composition of the oil, the existing oceanographic and meteorological conditions, and the timing and effectiveness of the spill response all effect the risk of a spill contacting wetlands, where such contact might occur, and the potential impacts to wetlands.

Please also see the response to Comment CRCL-2 above.

CRCL-6 Please see the response to Comment LADNR-2 above.

CRCL-7 The MMS relied on general historical spill records, using data from the USCG's Marine Safety Information System database, to estimate a spill rate for coastal spills that could occur from a proposed action. Unfortunately, there were no other data sources available at the time of writing of this document. The MMS is working closely with the Louisiana Applied Oil Spill Research and Development Program, which has funded a researcher to gather spill data specific to Louisiana. The funded research will provide a detailed analysis of the data to identify causes and sources of spills in Louisiana. The study is not yet finalized. The MMS will use these data to make future projections of coastal spills as soon as the data can be analyzed. We realize that there are inherent problems with relying on past data to project future spill rates, especially data that may not reflect possible new causes of spills, such as exposed and old pipelines or new spill-prevention requirements. At present, it is not known if the spill rate in coastal Louisiana is increasing or decreasing. The MMS factors information about Louisiana infrastructure into the assessment of spill risk—the likely locations of possible spill events are assumed to be at existing coastal infrastructure and pipeline landfalls. If the Louisiana study shows that facilities experiencing increasing rates of spill events are also located in coastal areas experiencing increasing rates of landloss, that phenomena will also be factored into the projections of future spill risk.

CRCL-8 Please see the responses to Comments LADNR-5 and CRCL-7 above.

CRCL-9 The Draft EIS for Gulf of Mexico OCS Oil and Gas Lease Sales: 2003-2007 was written with more current and accurate information with respect to waste disposal than was available for the Lease Sale 181 EIS. The MMS has hired a nationally respected expert (Steve Mobley with Research and Planning Consultants, Inc.) in the field of waste disposal to study the effects of OCS waste on the Gulf of Mexico coastal States (*Deepwater Program: OCS-Related Infrastructure in the Gulf of Mexico Fact Book*, Louis Berger Group, Inc., in preparation). The key findings of the study are:

- Capacity to manage waste generated by OCS drilling and production activities is adequate for the present and for a hypothetical future that includes a doubling of current waste volumes.
- Oil and gas waste management facilities along the Gulf Coast have adequate capacity, and some new entrants into the market have added to industry capacity and the diversity of technologies available for the industry to use.
- Facilities that accept OCS-generated waste that is not unique to oil and gas operations, such as municipal waste landfills and hazardous waste treatment, storage, and disposal facilities, are diverse and specialized, and manage waste for the broad base of U.S. industry. The OCS industry does not generate a large part of the waste stream into these facilities and is not expected to be material to the overall capacity of the industry. Capacity of industrial waste management facilities is, for the most part, abundant as U.S. industries have learned to minimize wastes they ship to offsite facilities for management.

It is Mr. Mobley's expert opinion that the capacity at onshore NOW facilities is more than sufficient to accommodate OCS waste, which totals less than 600,000 bbl per year or 0.09 percent of total NOW waste. In addition, it is this expert's opinion that solid waste landfills receive only a small fraction of their total loading from OCS activities.

> Municipal solid waste disposal from OCS activities currently imposes only a small incremental load on the landfills examined in this study—probably no more than 5 percent of total receipts by all the landfills serving south Louisiana. . . . Furthermore, assuming a landfill 1) presently had OCS waste constituting 5 percent of its waste stream, 2) the remaining life of a landfill was 20 years at current fill rates, and 3) OCS waste doubled but the rest of the incoming waste stream remained flat, then the OCS activities would cause the landfill to be close at the end of 19 years as a result of the OCS contribution increase. With no waste received from OCS activities at all, the

> landfill would close in 21 years. . . . Lastly, the use of landfarming of OCS waste is likely to decline further, particularly with greater availability of injection methods for wastes containing solids. Future regulatory efforts are likely to discourage the practice by adding requirements that damage the economics if not by an outright ban on future permits.

CRCL-10 The "totals" for existing pipeline landfalls and pipelines entering State waters have been corrected.

The proposed actions addressed in Table 4-13 represent a typical CPA lease sale and a typical WPA lease sale as scheduled in the *Outer Continental Shelf Oil & Gas Leasing Program for 2002-2007*. The OCS Program activities addressed in Table 4-14 include activities resulting from the proposed actions, and past and future OCS lease sales. As the proposed actions are part of the Gulfwide OCS Program activities for 2003-2004, Table 4-13 is a subset of Table 4-14.

CRCL-11 Comments noted.

SHELL EXPLORATION & PRODUCTION COMPANY

Shell-1 Comments noted.

NATIONAL OCEAN INDUSTRIES ASSOCIATION

NOIA-1 Comments noted.

CHAPTER 6

REFERENCES

6. REFERENCES

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CHAPTER 7

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7. PREPARERS

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CHAPTER 8

GLOSSARY

8. GLOSSARY

Acute — Sudden, short term, severe, critical, crucial, intense, but usually of short duration.

Anaerobic — Capable of growing in the absence of molecular oxygen.

Anthropogenic — Coming from human sources, relating to the effect of humankind on nature.

Aphotic zone — Zone where the levels of light entering through the surface are not sufficient for photosynthesis or for animal response.

API gravity — A standard adopted by the American Petroleum Institute for expressing the specific weight of oil.

Aromatic — Class of organic compounds containing benzene rings or benzenoid structures.

Attainment area — An area that is shown by monitored data or by air-quality modeling calculations to be in compliance with primary and secondary ambient air quality standards established by the USEPA.

Barrel (bbl) — A volumetric unit used in the petroleum industry; equivalent to 42 U.S. gallons or 158.99 liters.

Benthic — On or in the bottom of the sea.

Biological Opinion — FWS or NMFS evaluation of the impact of a proposed action on endangered and threatened species, in response to formal consultation under Section 7 or the endangered Species Act.

Block — A geographical area portrayed on official MMS protraction diagrams or leasing maps that contains approximately 2,331 ha (9 mi^2).

Blowout — Uncontrolled flow of fluids from a wellhead or wellbore.

Cetacean — Aquatic mammal of the order Cetacea, such as whales, dolphins, and porpoises.

Chemosynthetic — Organisms that obtain their energy from the oxidation of various inorganic compounds rather than from light (photosynthetic).

Coastal waters — Waters within the geographical areas defined by each State's Coastal Zone Management Program.

Coastal wetlands — Forested and nonforested habitats, mangroves, and marsh islands exposed to tidal activity. These areas directly contribute to the high biological productivity of coastal waters by input of detritus and nutrients, by providing nursery and feeding areas for shellfish and finfish, and by serving as habitat for birds and other animals.

Coastal zone — The coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder) strongly influenced by each other and in proximity to the shorelines of the several coastal states; the zone includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches and extends seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject to the discretion of or which is held in trust by the Federal Government, its officers, or agents.

Completion — Conversion of a development well or an exploratory well into a production well.

Condensate — Liquid hydrocarbons produced with natural gas; they are separated from the gas by cooling and various other means. Condensates generally have an API gravity of 50^{o}-120^{o}.

Continental margin — The ocean floor that lies between the shoreline and the abyssal ocean floor, includes the continental shelf, continental slope, and continental rise.

Continental shelf — The continental margin province that lies between the shoreline and the abrupt change in slope called the shelf edge, which generally occurs in the Gulf of Mexico at about 200 m. water depth. The continental shelf is characterized by a gentle slope (about 0.1^{o}).

Continental slope — The continental margin province that lies between the continental shelf and continental rise, characterized by a steep slope (about 3^{o}-6^{o}).

Critical habitat — Specific areas essential to the conservation of a protected species and that may require special management considerations or protection.

Crude oil — Petroleum in its natural state as it emerges from a well, or after it passes through a gas-oil separator but before refining or distillation. An oily, flammable, bituminous liquid that is essentially a complex mixture of hydrocarbons of different types with small amounts of other substances.

Deferral — Action taken by the Secretary of the Interior at the time of the Area Identification to remove certain areas/blocks from the proposed sale.

Delineation well — A well that is drilled for the purpose of determining the size and/or volume of an oil or gas reservoir.

Demersal — Living at or near the bottom of the sea.

Designated environmental preservation areas — Gulf of Mexico shorefront areas legislatively, administratively, or privately protected in recognition of the quality and significance of their natural environments. Included are National Parks and Preserves, National and State Wilderness Areas, National Marine and Estuarine Sanctuaries, National Landmarks, Wildlife Sanctuaries, Florida Aquatic Preserves, and Environmentally Endangered Lands.

Development — Activities that take place following discovery of economically recoverable mineral resources, including geophysical surveying, drilling, platform construction, operation of onshore support facilities, and other activities that are for the purpose of ultimately producing the resources.

Development Operations Coordination Document (DOCD) — A document that must be prepared by the operator and submitted to MMS for approval before any development or production activities are conducted on a lease in the Western Gulf.

Development well — A well drilled to a known producing formation to extract oil or gas; a production well; distinguished from a wildcat or exploratory well and from an offset well.

Direct employment — Consists of those workers involved the primary industries of oil and gas exploration, development, and production operations (Standard Industrial Classification Code 13—Oil and Gas Extraction).

Discharge — Something that is emitted; flow rate of a fluid at a given instant expressed as volume per unit of time.

Dispersion — A suspension of finely divided particles in a medium.

Drilling mud — A mixture of clay, water or refined oil, and chemical additives pumped continuously downhole through the drill pipe and drill bit, and back up the annulus between the pipe and the walls of the borehole to a surface pit or tank. The mud lubricates and cools the drill bit, lubricates the drill pipe as it turns in the well bore, carries rock cuttings to the surface, serves to keep the hole from crumbling or collapsing, and provides the weight or hydrostatic head to prevent extraneous fluids from entering the well bore and to downhole pressures; also called drilling fluid.

Economically recoverable resources — An assessment of hydrocarbon potential that takes into account the physical and technological constraints on production and the influence of costs of exploration and development and market price on industry investment in OCS exploration and production.

Effluent — The liquid waste of sewage and industrial processing.

Effluent limitations — Any restriction established by a State or the USEPA on quantities, rates, and concentrations of chemical, physical, biological, and other constituents discharged from point sources into U.S. waters, including schedules of compliance.

Epifaunal — Animals living on the surface of hard substrate.

Essential habitat — Specific areas crucial to the conservation of a species and that may necessitate special considerations.

Estuary — Coastal semienclosed body of water that has a free connection with the open sea and where freshwater meets and mixes with seawater.

Eutrophication — Enrichment of nutrients in the water column by natural or artificial methods accompanied by an increase of respiration, which may create an oxygen deficiency.

Exclusive Economic Zone (EEZ) — The maritime region extending 200 nmi from the baseline of the territorial sea, in which the United States has exclusive rights and jurisdiction over living and nonliving natural resources.

Exploration Plan (EP) — A plan that must be prepared by the operator and submitted to MMS for approval before any exploration or delineation drilling is conducted on a lease in the Western Gulf.

Exploration well — A well drilled in unproven or semi-proven territory to determining whether economic quantities of oil or natural gas deposit are present; exploratory well.

False crawls — Refers to when a female sea turtle crawls up on the beach to nest (perhaps) but does not and returns to the sea without laying eggs.

Floating production, storage, and offloading (FPSO) system — A tank vessel used as a production and storage base; produced oil is stored in the hull and periodically offloaded to a shuttle tanker for transport to shore..

Gathering lines — A pipeline system used to bring oil or gas production from a number of separate wells or production facilities to a central trunk pipeline, storage facility, or processing terminal.

Geochemical — Of or relating to the science dealing with the chemical composition of and the actual or possible chemical changes in the crust of the earth.

Geophysical survey — A method of exploration in which geophysical properties and relationships are measured remotely by one or more geophysical methods.

Habitat — A specific type of environment that is occupied by an organism, a population, or a community.

Hermatypic coral — Reef-building corals that produce hard, calcium carbonate skeletons and that possess symbiotic, unicellular algae within their tissues.

Harassment — an intentional or negligent act or omission that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, feeding or sheltering.

Hydrocarbons — Any of a large class of organic compounds containing primarily carbon and hydrogen. Hydrocarbon compounds are divided into two broad classes: aromatic and aliphatics. They occur primarily in petroleum, natural gas, coal, and bitumens.

Hypoxia — Depressed levels of dissolved oxygen in water, usually resulting in decreased metabolism.

Incidental take — Takings that result from, but are not the purpose of, carrying out an otherwise lawful activity (e.g., fishing) conducted by a Federal agency or applicant (see Taking).

Indirect employment — Secondary or supporting oil- and gas-related industries, such as the processing of crude oil and gas in refineries, natural gas plants, and petrochemical plants.

Induced employment — Tertiary industries that are created or supported by the expenditures of employees in the primary or secondary industries (direct and indirect employment), including consumer goods and services such as food, clothing, housing, and entertainment.

Infrastructure — The facilities associated with oil and gas development, e.g., refineries, gas processing plants, etc.

Irrutption – in reference to species population, an irregular abrupt increase in population size or density typically associated with favorable changes in the environment and often resulting in the mass movement of the population

Jack-up rig — A barge-like, floating platform with legs at each corner that can be lowered to the sea bottom to raise the platform above the water.

Landfall — The site where a marine pipeline comes to shore.

Lease — Authorization that is issued under Section 8 or maintained under Section 6 of the Outer Continental Shelf Lands Act and that authorizes exploration for, and development and production of, minerals.

Lease sale — The competitive auction of leases granting companies or individuals the right to explore for and develop certain minerals under specified conditions and periods of time.

Lease term — The initial period for oil and gas leases, usually a period of 5, 8, or 10 years depending on water depth or potentially adverse conditions.

Lessee — A party authorized by a lease, or an approved assignment thereof, to explore for and develop and produce the leased deposits in accordance with regulations at 30 CFR 250.

Marshes — Persistent, emergent, nonforested wetlands characterized by predominantly cordgrasses, rushes, and cattails.

Military warning area — An area established by the Department of Defense within which military activities take place.

Minerals — As used in this document, minerals include oil, gas, sulphur, and associated resources, and all other minerals authorized by an Act of Congress to be produced from public lands as defined in Section 103 of the Federal Land Policy and Management Act of 1976.

Nepheloid — A layer of water near the bottom that contains significant amounts of suspended sediment.

Nonattainment area — An area that is shown by monitoring data or by air-quality modeling calculations to exceed primary or secondary ambient air quality standards established by the USEPA.

Nonhazardous oil-field wastes (NOW) — Wastes generated by exploration, development, or production of crude oil or natural gas that are exempt from hazardous waste regulation under the Resource Conservation and Recovery Act (*Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes,* dated June 29, 1988, 53 FR 25446; July 6, 1988). These wastes may contain hazardous substances.

Naturally occurring radioactive materials (NORM) — naturally occurring material that emits low levels of radioactivity, originating from processes not associated with the recovery of radioactive material. The radionuclides of concern in NORM are Radium-226, Radium-228, and other isotopes in the radioactive decay chains of uranium and thorium.

Offloading — Unloading liquid cargo, crude oil, or refined petroleum products.

Operational discharge — Any incidental pumping, pouring, emitting, emptying, or dumping of wastes generated during routine offshore drilling and production activities.

Operator — An individual, partnership, firm, or corporation having control or management of operations on a leased area or portion thereof. The operator may be a lessee, designated agent of the lessee, or holder of operating rights under an approved operating agreement.

Organic matter — Material derived from living plants or animals.

Outer Continental Shelf (OCS) — All submerged lands that comprise the continental margin adjacent to the United States and seaward of State offshore lands.

Pelagic — Of or pertaining to the open sea; associated with open water beyond the direct influence of coastal systems.

Penaeids — Chiefly warm water and tropical prawns belonging to the family Penaeidae.

Plankton — Passively floating or weakly motile aquatic plants (phytoplankton) and animals (zooplankton).

Platform — A steel or concrete structure from which offshore development wells are drilled.

Primary production — Organic material produced by photosynthetic or chemosynthetic organisms.

Produced water — Total water discharged from the oil and gas extraction process; production water or production brine.

Production — Activities that take place after the successful completion of any means for the extraction of resources, including bringing the resource to the surface, transferring the produced resource to shore, monitoring operations, and drilling additional wells or workovers.

Recoverable reserves — The portion of the identified hydrocarbon or mineral resource that can be economically extracted under current technological constraints.

Recoverable resource estimate — An assessment of hydrocarbon or mineral resources that takes into account the fact that physical and technological constraints dictate that only a portion of resources can be brought to the surface.

Recreational beaches — Frequently visited, sandy areas along the Gulf of Mexico shorefront that support multiple recreational activities at the land-water interface. Included are National Seashores, State Park and Recreational Areas, county and local parks, urban beachfronts, and private resorts.

Refining — Fractional distillation of petroleum, usually followed by other processing (for example, cracking).

Relief — The difference in elevation between the high and low points of a surface.

Reserves — Proved oil or gas resources.

Rig — A structure used for drilling an oil or gas well.

Royalty — A share of the minerals produced from a lease paid in either money or "in-kind" to the land owner by the lessee.

Saltwater intrusion — Saltwater invading a body of freshwater.

Sciaenids — Fishes belonging to the croaker family (Sciaenidae).

Seagrass beds — More or less continuous mats of submerged, rooted, marine, flowering vascular plants occurring in shallow tropical and temperate waters. Seagrass beds provide habitat, including breeding and feeding grounds, for adults and/or juveniles of many of the economically important shellfish and finfish.

Sediment — Material that has been transported and deposited by water, wind, glacier, precipitation, or gravity; a mass of deposited material.

Seeps (hydrocarbon) — Gas or oil that reaches the surface along bedding planes, fractures, unconformities, or fault planes.

Sensitive area — An area containing species, populations, communities, or assemblages of living resources, that is susceptible to damage from normal OCS-related activities. Damage includes interference with established ecological relationships.

Shunting — A method used in offshore oil and gas drilling and production activities where expended cuttings and fluids are discharged through a downpipe, which terminates no more than 10 m from the ocean floor, rather than discharged at the ocean surface.

Structure — Any OCS facility that extends from the seafloor to above the waterline; in petroleum geology, any arrangement of rocks that may hold an accumulation of oil or gas.

Subarea — A discrete analysis area.

Supply vessel — A boat that ferries food, water, fuel, and drilling supplies and equipment to an offshore rig or platform and returns to land with refuse that cannot be disposed of at sea.

Surface convergence lines — An oceanic area in which surface waters of different origins come together and where the denser water sinks beneath the lighter watermass.

Symbiont — Either of two organisms of different species living together in intimate association with each other.

Taking — To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any endangered or threatened species, or to attempt to engage in any such conduct (including actions that induce stress, adversely impact critical habitat, or result in adverse secondary or cumulative impacts). Harrassment is the most common form of taking associated with OCS Program activities.

Tension leg platform (TLP) — A production structure that consists of a buoyant platform tethered to concrete pilings on the seafloor with flexible cable.

Total dissolved solids — The total amount of solids that are dissolved in water.

Total suspended particulate matter — The total amount of suspended solids in water.

Total suspended solids — The total amount of suspended solids in water.

Trunk line — A large-diameter pipeline receiving oil or gas from many smaller tributary gathering lines that serve a large area; common-carrier line; main line.

Turbidity — Reduced water clarity due to the presence of suspended matter.

Volatile organic compound (VOC) — Any organic compound that is emitted to the atmosphere as a vapor.

Water test areas — Areas within the Eastern Gulf where Department of Defense research, development, and testing of military planes, ships, and weaponry take place.

Weathering (of oil) — The aging of oil due to its exposure to the atmosphere, causing marked alterations in its physical and chemical makeup.

CHAPTER 9

APPENDICES

APPENDIX 9.1

PHYSICAL AND ENVIRONMENTAL SETTINGS

9.1. Physical and Environmental Settings

9.1.1. Geography and Geology

General Description

The present day Gulf of Mexico is a small ocean basin with a water-surface area of more than one and half million square kilometers. The greatest water depth is approximately 3,700 m. It is almost completely surrounded by land, opening to the Atlantic Ocean through the Straits of Florida and to the Caribbean Sea through the Yucatan Channel. Underlying the present Gulf of Mexico and the adjacent coast is a large geologic basin that began forming during Triassic time (approximately 240 Million years ago (Mya)).

The northern Gulf of Mexico may be divided into several physiographic sub-provinces. In the OCS area, these include: the Texas-Louisiana Shelf, the Texas-Louisiana Slope, the Rio Grande Slope, the Mississippi Fan, the Sigsbee Escarpment, the Sigsbee Plain, the Mississippi-Alabama-Florida Shelf, the Mississippi-Alabama-Florida Slope, the Florida Terrace, the Florida Escarpment, and the Florida Plain. In the Gulf of Mexico, the continental shelf extends seaward from the shoreline to about the 200 m water depth and is characterized by a gentle slope of a few meters per kilometer (less than one degree). The shelf is wide off Florida and Texas, but it is narrower where the Mississippi River delta has extended seawards to near the shelf edge. The continental slope extends from the shelf edge to the Sigsbee and Florida Escarpments, in about 2,000-3,000 m water depth. The topography of the slope is irregular, and characterized by canyons, troughs, and salt structures. The gradient on the slope is normally 1-2 degrees, while the gradient of the Florida Escarpment may reach 45 degrees in some places. The Mississippi Fan has a gentle incline, with slopes of 4 m or less per km with the lower Mississippi Fan having an even flatter slope at 1 m or less per km. The Sigsbee and Florida abyssal plains (ocean floor) are basically horizontal physiographic subprovinces, and are surrounded by features with higher topography.

There are two major sedimentary provinces in the Gulf Coast Region: Cenozoic (the western and central part of the Gulf) and Mesozoic (the eastern Gulf) (Figure 1-1). The Cenozoic Province is a clastic regime, characterized by thick deposits of sand and shale of Paleocene to Recent age (65 Mya to present) underlain by carbonate rocks (limestone, chalk, reefs) of Jurassic and Cretaceous age (205-65 Mya). Approximately 40,000 wells have been drilled in the Western Gulf. The geology has been studied in detail for the identification, exploration, and development of natural gas and oil resources. The Mesozoic Province is a largely carbonate (limestone and reefs) area that extends eastward from the Cretaceous Shelf Edge off the coast of Mississippi, Alabama, and Florida towards the coastline of Florida. Fewer than 350 wells have been drilled in the Mesozoic Province of the Federal offshore, and less is known about the subsurface geology and its natural gas and oil resource potential. Over the last 65 million years, the Cenozoic Era, clastic sediments, (sands, silts, and clays) from the interior North American continent, have entered the Gulf of Mexico basin from the north and west (Apps et al., 1994). The Cenozoic Era is commonly divided into 2 geologic periods – Tertiary and Quaternary. The Tertiary Period (65-1.77 Mya) comprises almost all of the Cenozoic. The most recent part is the Quaternary Period (1.77 Mya-Recent). Geologists also divide the Cenozoic into time periods (Series) of variable duration; from oldest, Paleocene, Eocene, Oligocene, Miocene, Pliocene, Pleistocene, and Holocene. The centers of thick sediment deposition shifted progressively eastward and southward through time in response to changes in the source of sediment supply. In Early Tertiary (65-24 Mya), the Rio Grande River and a system of smaller rivers (Brazos, Colorado, Nuecs, etc.) draining the Texas coastal plain were the main source of sediment supply, resulting in a thick sediment accumulation in the WPA of the Gulf of Mexico. In Late Tertiary (24-1.77 Mya), the center of sediment deposition shifted eastward as the Mississippi River became the major source of sediments entering the Gulf of Mexico. The modern Mississippi River delta complex is the present day reflection of a depositional system that has been periodically shifting positions due to the sediment loading and up-building of the delta since early Miocene time (approximately 24 Mya). Each sedimentary layer is different, reflecting the source of the material, the climate, and the geologic processes occurring during deposition. It is estimated that greater than 15 km of sediments have been deposited locally beneath Texas-Louisiana continental shelf in deep basins.

To produce economically viable accumulations of oil and gas, four things must occur in the geologic setting (petroleum system). First, rocks must contain an enriched supply of organic material capable of forming oil and gas by the chemical and physical changes that occur during burial process (the source). Second, a rock with pores and openings sufficiently connected to hold and transmit oil or gas after it is generated (the reservoir rocks). Third, the layers of rock must be structurally and/or stratigraphically configured so as to capture a large accumulation of hydrocarbon resource (the trap). And fourth, the trapping structure and the reservoir rock must be overlain or configured so that the trap is sealed to prevent the escape of oil or gas (the seal).

Upper Jurassic deposits are considered the major source rocks for gas and oil generation in the Gulf of Mexico. Other source rocks that have been identified in the Gulf of Mexico which may have generated hydrocarbons are as young as Pleistocene (approximately 2 Mya).

Cenozoic Province (Western Gulf)

The Cenozoic Province extends from offshore Texas eastward across the north-central Gulf of Mexico to the edge of the Cretaceous Shelf Edge (commonly called the Florida Escarpment) offshore Mississippi, Alabama and Florida. It incorporates all of the WPA, a large portion of the CPA, and the southwestern portion of the EPA (Figure 1-1). To date, all of the hydrocarbon production on the OCS in the Cenozoic Province is from sands ranging in age from Oligocene to Pleistocene (approximately 34-0.2 Mya).

Two major events laid the template for the structural tectonics and stratigraphy of the Western Gulf: the rifting and drifting of the North American Plate to form the Gulf of Mexico, and the periodic breaching of the land mass to the west, which allowed marine waters into the young basin. The arid climate during the Jurassic inhibited the transport of most clastic materials to the Gulf Basin, allowing for the predominance of carbonate deposition. These two events still influence the depositional patterns of the sediments within the Gulf of Mexico.

Major faulting during the ocean spreading stage created a horst (high block) and graben (low block) system in the Gulf basin that was surrounded by higher more stable land mass (Salvador, 1991). During the Upper Jurassic emergent highs were exposed and subjected to erosion, while adjacent lows filled with sediment. Due to the arid conditions, shallow waters, and the isolated lows formed within the horst and graben system, the eroded sediments were transported only a short distance to the adjacent lows. Repeated flooding and evaporation of the shallow saline waters that filled the basin resulted in a thick, widespread, salt bed (Louann Salt) that was often deposited directly onto basement rocks. Through time the basin cooled, subsided, and was gradually filled with deeper water in which more carbonates (limestone, chalk, reefs) were deposited. At the end of the Mesozoic era, the climate became more temperate which facilitated the erosion of the surrounding mountains. During the last 65 million years (Cenozoic era), several river systems brought the eroded material (clastic) into the Gulf of Mexico.

Because salt is less dense than sand, silt, or clay, it tends to become mobilized as denser sediments are deposited on it. The movement of salt upward pierces overlying rocks and sediment forming structures that have trapped the prolific hydrocarbon resources in the Gulf of Mexico. The updip sediment loading on the shelf and the upward movement of salt during the Tertiary has formed a vast canopy of mobilized salt over most of the outer continental shelf and slope sediments. Individual, isolated salt bodies are called diapirs. Sands in proximity to salt structures have the greatest potential for hydrocarbon accumulation because it is the optimum zone for the successful cross strata migration and accumulation of oil and gas. First, salt structures create pathways for migration of hydrocarbon from Upper Jurassic, Lower Cretaceous, and/or Lower Tertiary source beds to the reservoir sands. Second, thick sands deposited in deltas or in deep sea fans with good porosity (pore space between the sand grains where oil and gas can accumulate) and permeability (connections between the pore spaces through which oil and gas can flow) provide reservoir space. Third, impermeable shales, salt, and/or faults serve as seals for trapping of oil and gas in the pore spaces of the reservoir rocks.

The hydrocarbon-producing horizons on the continental shelf and slope of the Cenozoic Province are mainly Miocene, Pliocene, and Pleistocene, and production generally comes from progressively younger sands in the seaward direction. These Cenozoic productive intervals become thinner and younger with less hydrocarbon potential eastward in the direction of the Cretaceous shelf edge (Mesozoic Province). The Mesozoic section has been penetrated by only a few wells in the Cenozoic Province with no commercial hydrocarbons being identified to date.

Exploration and development in the Gulf of Mexico have resulted in the identification of more than 1,200 fields, of which 1,051 were being developed or producing from the shelf in the Western and Central

Planning Areas. The *2000 Assessment of Conventionally Recoverable Resources of the Gulf of Mexico and Atlantic Outer Continental Shelf as of January 1, 1999* (Lore et al., 2001) has identified sixty-nine plays in the Cenozoic Province; fifty-eight proven, three frontier and eight conceptual plays. As of January 1, 1999, the mean total endowment (reserves plus resources) for these plays is estimated to be 125.190 billion barrel of oil equivalent (BBOE).

Mesozoic Province (Eastern Gulf)

The Mesozoic Province in the OCS extends eastward from the Cretaceous Shelf Edge off the coast of Mississippi, Alabama, and Florida towards the coastline of Florida (Figure 1-1). Although this area has experienced limited drilling and most control points are on the shelf, some general statements can be made concerning resources. This province is dominated by carbonate rocks with some Cenozoic clastic sediments. The geologic age of the sediments above basement rock ranges from the Jurassic to Recent marine sediments at the seafloor. The hydrocarbon potential has been realized throughout the entire geologic interval- from the very shallow, young portion of the Tertiary Pleistocene (1,500-4,000 ft; 450-1,200 m)), to the intermediate Cretaceous James (14,000-16,000 ft; 4,250-4,900 m) and the deep, older Jurassic Norphlet (15,000-24,000 ft; 4,575-7,300 m). Approximately two dozen fields in the Mesozoic Province produce gas from the shallow Cenozoic. In the area offshore of the Florida Panhandle (Pensacola and Destin Dome), a total of 31 wells have been drilled, with 18 of the wells penetrating the Norphlet Formation. The depths at which the Norphlet Formation is found in the Gulf coast region varies from less than 5,000 ft (1,525 m) onshore to more than 24,000 ft (7,300 m) subsea offshore Mississippi and 15,000 ft (4,575 m) subsea in Apalachicola Embayment.

This province has several potential Mesozoic hydrocarbon plays that are downdip equivalents of onshore productive fields. Carbonate rocks often require favorable diagenesis (physical and chemical alterations to the sediments after deposition), faulting, fracturing, and stratigraphy to enhance the low porosity and permeability. The variability of the porosity and permeability within a carbonate rock increases the risk in the determination of potential drainage area, production rates, and resource volume when hydrocarbons are discovered.

To date, the only Mesozoic fields in the OCS are the Jurassic Norphlet (13 fields), the Cretaceous James (4), and the Cretaceous Andrews (1). Most of these fields are located in the northeastern portion of the CPA. The *2000 Assessment of Conventionally Recoverable Resources of the Gulf of Mexico and Atlantic Outer Continental Shelf as of January 1, 1999* (Lore et al., 2001) has identified twenty-three plays in the Mesozoic Province: two proven, five frontier, and sixteen conceptual. As of January 1, 1999, the mean total endowment of these plays is estimated by MMS to be 11.006 BBOE.

Deep Tertiary Gas (Continental Shelf)

The clastic sediments of the Gulf of Mexico are deposited mostly in deltaic environments of sands and shales that are influenced by the location of the sediment source, morphology of the seabed, and the edge of the shelf. Usually the most abundant reservoir rocks are deposited as channel or delta front sands on the shelf. Shifting of the delta complex and ocean currents tend to widely disperse these sands laterally along the shelf. Drilling on the shelf targeted these sands as potential hydrocarbon traps. It was a general belief that on the slope and abyssal fans the sands gradually became less dense and less continuous further from the proximity of the channels. Seismic interpretation (DeVay et al., 2000) and drilling in the deep waters of the Gulf of Mexico over the last 20 years have proven that prolific sands can be deposited in the slope environment and probably on the abyssal plain. In fact, some of the largest fields in the Gulf of Mexico (Thunder Horse (MC 778), Mad Dog (GC 826), Mars (MC 807), Ursa (MC 810), Auger (GB 426), Ram-Powell (VK 956), etc.) have hydrocarbon accumulations in sands deposited in the slope environment (traditionally oil companies name the fields they discover).

The present day shelf was once the slope environment during the Oligocene and Miocene age (approximately 34-7 Mya). The shelf area holds the potential for deepwater delta systems with channels, distributary bars, levees, overbank deposits, and large fan lobes in the older and deeper section. Subsequent faulting and salt movement created traps and supplied conduits for the migration of hydrocarbons. These reservoirs would be subjected to high pressures and temperatures with increasing depth and burial history. Pore pressure increases with depth because of the overburden of the sediments and the amount of water trapped within the sediments. Temperature also increases with depth and can be even higher in areas with less salt intrusions into the sediments. The presence of salt has a cooling effect on the surrounding sediments, causing areas with salt intrusions to have lower temperatures. It is anticipated that these older, deeper reservoirs will be more likely located adjacent to or under the present shelf fields.

Lore et al. (2001) combined the deep Tertiary shelf hydrocarbon potential into two conceptual plays – Lower Tertiary Clastic Gas and Lower Tertiary Clastic Gas and Oil. As of January 1, 1999, the mean total endowment for these two plays is estimated by MMS to be 2.807 BBOE.

Deepwater (Continental Slope and Abyssal Plain)

The continental slope, in the Gulf of Mexico, extends from the shelf edge to approximately 2,000 m water depth. The seafloor gradient on the slope varies from 3-6 degrees to in excess of 20 degrees in some places along escarpments. At the base of the Cenozoic Province slope is an apron of thick sediment accumulation referred to as the continental rise. It gently inclines seaward with slopes of less than one degree, into the abyssal plain (ocean floor).

Bathymetric maps of the continental slope in the northwestern Gulf of Mexico (Bryant et al., 1990; Bouma and Bryant, 1995) reveal the presence of over 105 intraslope basins with relief in excess of 150 m, 28 mounds, and five major and three minor submarine canyons. These intraslope basins occupy much of the area of the continental slope. Intraslope-interlobal and intraslope-supralobal basins occupy the upper and lower continental slope, respectively. Intraslope-interlobal basins are formed by the coalescing of salt canopies, where as supralobal basins are formed by down-warping into a salt sheet.

The middle and lower portions of the Cenozoic Province continental slope contain a canopy of salt, which has moved down-slope in response to sediment loading on the shelf and upper slope. The Sigsbee Escarpment is the southern edge of the canopy within the Gulf of Mexico. The intraslope basins of the slope are essentially Holocene and Pleistocene sediment depocenters. Fewer basins are found on the uppermost continental slope. In general, these basins have lower gradient slopes. The lower continental slope contains eight submarine canyons and the Sigsbee Escarpment, each feature evolving from, in part, the coalescing and migration of salt canopies, an unusual process for the formation of submarine canyons.

The geology and topography of the near-surface continental slope (which is the area of greatest concern with regard to submarine slope stability) offshore Texas and Louisiana result from an interplay between episodes of rapid shelf edge progradation and contemporaneous modification of the sea bed by diapirism and mass-movement processes. Many slope sediments have been uplifted, folded, fractured, and faulted by diapiric action. Between diapirs (topographic highs) were fairways for sand-rich channels. Oversteepening on the basin flanks and resulting mass movements have resulted in the appearance of highly overconsolidated sediments underlying extremely weak pelagic sediments. The construction of the Mississippi Canyon is in part a function of sidewall slumping and pelagic draping of low- shear-strength sediments. In contrast, slope oversteepening and subsequent mass movement have resulted in high pore pressures in rapidly deposited debris flows on the upper slope and on basin floors, resulting in unexpected decreased shear strengths. Biologically generated gas (from microbial activity) and thermally generated gas (from burial maturation) induces the accumulation of hydrates and underconsolidated gassy sediments, which are common on the upper slope. On the middle and lower slope, gassy sediments are uncommon except in basins that do not have a salt base, such as Beaumont Basin; the salt canopy restricts the upward movement of gas from below.

Piston cores are a means to sample the surficial few meters of sediment on the waterbottom. Holocene and Pleistocene piston cores recovered from the continental slope off Texas and Louisiana and from Deep Sea Drilling Project activities indicate the presence of unconsolidated gassy clays, silty clays, sands, and clayey sands, many containing gas hydrates. Most Pleistocene cores recovered on the slope contain hemipelagic (fine-grained) sediments with lesser amounts of turbidites and debris flow material. Holocene sediments on the middle and lower portions of the slope are usually less than a meter thick, but on the upper slope these sediments are found to be several meters thick (Silva et al., 1999).

Water depths over the intraslope intralobal basins located on the middle and lower slope range from 1,500 to 2,200 m. The bathymetry of the upper to middle continental slope area consists of relatively flat ridges and basin floors separated by intraslope escarpments. The intraslope basin escarpments have relief up to 700 m, with slopes generally ranging from 5 to 30 degrees and in some locations up to 50 degrees. Ridges that rim the basins correspond to late, laterally spreading; flat-topped salt tongues overlain by thin sediment cover (Bryant et al., 1992).

The deeper portions of intraslope-intralobal basins are salt free and exhibit a dissected topography consisting of a multitude of small submarine canyons along the walls. Cores taken on the walls of some basins indicate that as much as 3 m of sediment has been removed by slumping. The intraslope-supralobal basin on the lower continental slope, where the physiography is comparatively smooth, shows that relief exists mainly as a rounded depression. The slopes of these basin walls generally range from 4 to 8 degrees, but in some areas are as much as 15 degrees. Basins form on the lower slope where subsidence is due to the evacuation of under-lying salt (i.e., salt withdrawal). This process is particularly evident in basins such as Vaca Basin, where initial basin subsidence appears to have been relatively slow and accompanied by the accumulation of relatively concordant strata (Bryant et al., 1992). A possible scenario for the creation of intraslope supralobal basins is that subsidence of the basin was initially controlled by differential loading caused by lateral variations in sediment thickness while the sediments were still relatively buoyant compared to the salt.

The submarine canyons along the Sigsbee Escarpment (Alaminos, Keathly, Bryant, Cortez, Farnella, and Green Canyons) are the result of the coalescing of salt canopies, the migration of the salt over the abyssal plain, and erosion of the escarpment during periods of low-stand sea level (Bryant et al., 1992). In addition to these large submarine canyons, numerous small submarine canyons and gullies and large slumps occur along the escarpment. Submarine fans of various sizes extend seaward of the canyons onto the continental rise. Slopes along a significant portion of the canyon walls and the escarpment range from 5 to 10 degrees, although slopes in excess of 15 degrees occur.

The major faults on the OCS are extensional faults, referred to as “growth faults,” that form contemporaneously with rapid accumulation of massive volumes of sediments. Growth faults are found mostly on the outer shelf and upper slope where sediment accumulation is thickest (Rowan et al., 1999). Faulting resulting from the formation of salt diapirs is the most common type of faulting on the upper slope. On the middle and lower continental slope, faulting related to salt-stock and salt canopies is the most common type of faulting. Extensive faulting is present on the rim of most intraslope-intralobal and supralobal basins on the middle and lower continental slope. These faults are extensional faults caused by the upward movement of salt resulting from pressures created by sediment accumulation within basins. This type of faulting results in the occurrence of a large number of small faults in the area of the seafloor undergoing extension. In some areas of the slope, the upward migration of salt results in the seafloor being extensively fractured (i.e., faulted) and continuously displaced.

Portions of some of the submarine canyons (e.g., Bryant Canyon) are being filled with salt. Turbidity current flows that are active during times of low-stand sea level create the canyons. Subsequently, sediments that accumulate on the margins of the canyon create a differential loading on the salt causing the salt to migrate into the canyon. The migration of salt into the canyon can occur at a rate of centimeters per year. On the middle and lower continental slope, salt may occur very close to the seafloor. For example, on the salt plug called “Green Knoll,” salt is exposed at the seafloor and is being dissolved by seawater, resulting in the collapse of the cap of the knoll. In the intraslope-intralobal Orca Basin, salt is exposed at the bottom of the northern portion of the basin forming a famous brine pool.

The *Outer Continental Shelf Petroleum Assessment 2000* (USDOI, MMS, 2001) estimates the total endowment of the deepwater (200-2,400 m water depth) to be 63.214 BBOE. The most prolific play in the deepwater continental slope is identified to be the deposits of slope-fan-environment ranging in age from Oligocene to Pleistocene. The total endowment of the abyssal plain (greater than 2,400 m water depth) is estimated by MMS to be 8.166 BBOE with the major play being the Foldbelt ranging in age from Jurassic to Miocene.

Geologic Hazards

The seafloor geology of the Gulf of Mexico reflects the interplay between episodes of diapirism, mass sediment movement, and sea-level fluctuations. Geologic features on most of the continental shelf (shoreline to about 200-m water depth) are simple and uniform. The main hazards in this area are faulting, shallow-gas pockets, and buried channels. Deepwater regions in the Gulf of Mexico have complex regional salt movement, both horizontal and vertical, which makes it a unique ocean basin. This movement greatly alters the seafloor topography forming sediment uplifts, mini-basins, and canyons. Salt moves horizontally like a glacier and can be extruded to form salt tongues, pillows, and canopies below an ever-increasing weight of sediment. Vertical salt forms range from symmetric bulb-shaped stocks to walls. While salt creates traps that are essential to petroleum accumulation, salt movement can cause potential hazards such as seafloor fault scarps, slumping from steep unstable slopes, shallow gas pockets, seeps and vents, and rocky or hard bottom areas.

Gas hydrates (gas trapped in ice crystals) have been found in the Gulf of Mexico in localized deepwater areas of very cold temperature and high pressure at or near the seafloor. Gas hydrates can rapidly dissociate when heated or otherwise disturbed (for example, by an anchor) and cause sediment instability. Although the Gulf of Mexico has had no drilling incident associated with hydrates, they are a problem in other parts of the world.

The Mississippi River delta presents a unique set of geologic hazards because of high sedimentation rates, which cause very unconsolidated, high-water-content, and low-strength sediments. Under these conditions, the sediments can be unstable, and slope failure or mass transport of sediments can result. These failures can be triggered by cyclic leading associated with hurricanes, overloading or oversteepening of the slope sediments, or uplift associated with movement of salt. These failures can form mudflow gullies, overlapping mudflow lobes, collapse depressions, slumps, and slides. Small, buried, river channels can result in differential sediment compaction and pose a hazard to jackup rigs.

Over-pressure conditions in sedimentary section can result from loading by rapid deposition, sand collapse, in-leaking gas, or salt tectonics. Drilling through an over-pressured shallow-gas pocket can cause loss of mud circulation or a blowout (a blowout occurs when improperly balanced well pressure results in sudden uncontrolled release of fluids from a well bore or well head). A shallow water flow can cause similar drilling problems. Over-pressured conditions can develop in deepwater when a “water sand” is trapped by a shale seal. Over-pressured formation water may escape around or through the wellbore to the seafloor and wash out the well foundation. No shallow water flow event in the Gulf of Mexico has resulted in an oil spill.

Deep drilling may encounter abnormally high geopressures. Deep drilling may also encounter hydrogen sulfide, which can occur near salt domes overlain by caprock and is the product of sulfate reducing microbes.

Potential Mitigation Measures

The best mitigation for most hazards is avoidance after detection by a geophysical survey. Leaseholders are required to run geophysical surveys before drilling in order to locate potential geologic or man-made hazards (CFR 250.203). In deepwater, most companies do a remotely operated vehicle (ROV) inspection of the seafloor for a pre-spud location. Companies are also required to take and analyze sediment borings for platform sites. Areas of hydrogen sulfide occurrences can be predicted and sensors installed on drilling rigs to warn operators. Certain leases also require archaeological surveys and live-bottom surveys to protect sensitive areas. Every application for permit to drill a well in the Gulf of Mexico is reviewed by MMS geologists, geophysicists, and engineers to ensure compliance with standard drilling practices and MMS regulations. All rigs and platforms are inspected by the MMS on a regular basis to ensure all equipment and procedures comply with Federal regulations for safety and environmental protection.

Geologic Condition	Hazard	Mitigations
Fault	Bend/shear casing Lost circulation Gas conduit	Stronger casing/heavier cement
Shallow Gas	Lost circulation Blowout Crater	Kill mud Pilot hole Circulate mud/drill slower Blow-out preventer/diverter Pressure while drilling log
Buried Channel	Jack-up leg punch through	Pre-load rig Mat support All rig legs in same type of sediment
Slump	Bend/shear casing	Thicker casing Coil/flexible pipeline
Water Flow	Erosion/washout Lost circulation	Kill mud, foam cement Pilot hole Pressure while drilling

9.1.2. Physical Oceanography

The Gulf of Mexico is a semi-enclosed, subtropical sea with an area of approximately 1.5 million km^2. The main physiographic regions of the Gulf Basin are the continental shelf (including the Campeche, Mexican, and U.S. shelves), continental slopes and associated canyons, abyssal plains, the Yucatan Channel, and Florida Straits. The continental shelf width along the U.S. coastline is about 16 km off the Mississippi River, and 156 km off Galveston, Texas, decreasing to 88 km off Port Isabel near the Mexican border. The depth of the central abyss ranges to approximately 3,700 m. The water volume of the entire Gulf, assuming a mean water depth of 2 km, is 2 million km^3. The water volume of the continental shelf, assuming a mean water depth of 50 m, is 25,000 km^3.

The Loop Current, the dominant circulation feature in the Gulf, enters through the Yucatan Channel and exits through the Florida Straits. The sill depth at the Florida Straits is about 800 m; the effective sill depth at the Yucatan Channel is about 1,820 m (Sturges et al., 1993). Water masses in the Atlantic Ocean and Caribbean Sea that occur at greater depths cannot enter the Gulf of Mexico. The Loop Current is a part of the western boundary current system of the North Atlantic. This is the principal current and source of energy for the circulation in the Gulf. The Loop Current has a mean area of 142,000 km^2 (Hamilton et al., 2000). It may be confined to the southeastern Gulf of Mexico or it may extend well into the northeastern or north-central Gulf, with intrusions of Loop Current water even to the shelf edge along Louisiana and the Florida Panhandle (e.g., Huh, 1981; Paluszkiewicz, 1983).

Closed rings of clockwise-rotating (anticyclonic) water, called Loop Current Eddies (LCE's), separate periodically from the Loop Current. Studies on the frequency of Loop Current intrusions into the eastern Gulf and the frequency of LCE separation (Sturges, 1992 and 1994; Sturges et al., 1993; Vukovich, 1988 and 1995) clearly show these to be chaotic processes. Currents associated with the Loop Current and its eddies extend to at least depths of 800 m, the sill depth of the Florida Straits, and geostrophic shear is observed to extend to the sill depth of the Yucatan Channel. These features may have surface speeds of 150-200 cm/s or more; speeds of 10 cm/s are not uncommon at a depth of 500 m (Cooper et al., 1990). Near the bottom of the Loop Current, velocities are low and fairly uniform in the vertical although with bottom intensification, a characteristic of topographic Rossby waves (TRW's). This indicates that the Loop Current is in fact a source of the TRW's, which are a major component of deep circulation below 1,000 m in this part of the Gulf (Sturges et al., 1993; SAIC, 1989; Hamilton, 1990). Anticyclonic eddies separate from the Loop Current from 4 to 16 months apart, with frequencies peaked at 8-9 months and at 13-14 months (Sturges, 1994). These Loop Current eddies are also called warm-core eddies, since they surround a central core of warm Loop Current water. These eddies can have surface speeds of 150-200 cm/s or more; speeds of 10 cm/s are not uncommon at 500 m (Cooper et al., 1990). Although the Loop Current and LCE's have been studied since the early 1960's, details of their velocity distributions and variability remain virtually unknown. Only a few estimates of three-dimensional velocity fields have been reported (e.g., Cooper et al., 1990; Forristall et al., 1992). The Sturges et al. (1993) model suggests a surprisingly complex circulation pattern beneath these anticyclones, with vortex-like and wave-like features that interact with the bottom topography (Welsh and Inoue, 2000). These model findings are consistent with Hamilton's (1990) interpretation of observations. Warm-core eddies can have lifespans of one year or more (Elliot, 1982). Therefore, their effects can persist at one location for long periods – weeks or even months (e.g., Nowlin et al., 1998). The average diameter of warm-core eddies is about 200 km, and they may be as large as 400 km in diameter. Initially, these features have diameters greater than 250 km, with typical values closer to 350 km, which decrease by 45 percent within 150 days and by 70 percent within 300 days (Elliot, 1982). After separation from the Loop Current, these eddies often translate westward across the Gulf of Mexico at a speed of about 5 km/day (range 1-20 km/day), and interact with other eddies or with continental margins in the western Gulf, generating secondary cyclones and anticyclones (SAIC, 1988). They have typical lifetimes of 350-400 days (Elliott, 1982) and decay by interactions with boundaries, ring shedding, and ring-ring interactions. The net result is that at almost any given time, the Gulf is populated with numerous eddies, which are interacting with one another and with the margins. Warm eddy water is present over only 15 percent or less of the approximately 1.5 million km^2 total surface area of the Gulf of Mexico (SAIC, 1989).

Cold-core cyclonic (counter-clockwise rotating) eddies have been observed in the study region as well, and surface waters within these cyclones are cooler and fresher than adjacent waters. Cyclonic circulation is associated with upwelling, which brings cooler, deeper water towards the surface. Small cyclonic eddies around 50-100 km in diameter have been observed over the continental slope off Louisiana (Hamilton, 1992). These eddies can persist for six months or longer and are relatively stationary. Very little published information is available concerning the velocity fields within cyclonic and ancillary anticyclonic eddies, though a few reports exist (e.g., Hamilton, 1992; Forristall et al., 1992). Hamilton (1992) reports the existence in the central Gulf and over the Louisiana continental shelf of cold cyclones with strong temperature gradient to a depth of 800 m (upper layer currents of 30-50 cm/s), little surface temperature expression, diameters of 100-150 km, and long lifetimes.

Energetic, high-frequency currents have been observed when LCE's flow past structures, but they are not well documented. Such currents would be of concern to offshore operators because they could induce structural fatigue of materials.

Current meters at depths of up to 3,175 m have directly measured abyssal currents in the Gulf of Mexico. The major low-frequency fluctuations in velocity of these currents in the bottom 1,000-2,000 m of the water column have the characteristics of TRW's. These long waves have wavelengths of 150-250 km, periods greater than ten days, and group velocities estimated at 9 km/day. They are characterized by columnar motions that are intensified near the seafloor. They move westward at higher group velocities than the translation velocity of 3-6 km/day that is typical of anticyclonic eddies. The Loop Current and LCE's are thought to be major sources of these westward propagating TRW's (Hamilton, 1990).

In general, past observations of currents in the deepwater Gulf of Mexico have revealed decreases in current speed with depth. During late 1999, a limited number of high-speed current events, at times approaching 2 kn, were observed at depths exceeding 1,500 m in the northern Gulf of Mexico (Hamilton and Lugo-Fernandez, 2001). Furrows on the seafloor, apparently resulting from the erosional effects of high-speed currents, have also been discovered in the northern Gulf.

In deepwater, several oil and gas operators have observed very high-speed currents in the upper portions of the water column. These high-speed currents can last as long as a day. Such currents may have vertical extents of less than 100 m, and they generally occur within the depth range of 100-300 m in total water depths of 700 m or less over the upper continental slope. Maximum speeds exceeding 150 cm/s have been reported. The higher-speed currents appear to propagate upward, characteristic of baroclinic waves (either sub- or super-inertial). It seems possible that such phenomena could be intensified near topographic irregularities and slopes. The mechanisms by which these currents are generated are unknown and presently under investigation.

A general circulation pattern that most closely approximates the time-averaged, or background, circulation for the Gulf of Mexico has been constructed from the limited available hydrography and will be described below. Few hydrographic surveys of the entire Gulf of Mexico have been conducted during the past several decades. Examples of data sources from which similar resulting patterns result include a series of cruises in the 1960's (e.g., the *R/V Hidalgo* 62-H-3 cruise, and the *R/V Geronimo* and *R/V Kane* cruises). The general circulation pattern based on the *R/V Hidalgo* cruise completed in 1962 is illustrated in Figure 9-1 (after Nowlin, 1972). The contours in Figure 9-1 represent the flow paths (streamlines) of the geostrophic surface currents calculated relative to the 1,000-m reference surface. These currents reflect the medium- to large-scale distributions of temperature and salinity, and thus density. This pattern also is characteristic of time-averaged outputs from numerical models of the circulation in the Gulf (e.g., see Hurlbert and Thompson, 1980 and 1982).

The major large-scale permanent circulation feature present in the Western and Central Gulf of Mexico is an anticyclonic (clockwise-rotating) feature oriented about ENE-WSW with its western extent near lat. 24° N. off Mexico. There has been debate regarding the mechanism for this anticyclonic circulation and the possible associated western boundary current along the coast of Mexico. Elliott (1979) attributed LCE's as the primary source of energy for the feature, but Sturges (1993) argued that wind stress curl over the western Gulf is adequate to drive an anticyclonic circulation with a western boundary current. Sturges (1993) found annual variability in the wind stress curl corresponding to the strongest observed boundary current in July and the weakest in October. Based on ship-drift data, Sturges (1993) showed the maximum northward surface speeds in the western boundary current were 25-30 cm/s in July and about 5 cm/s in October; the northward transport was estimated to vary from 2.5 to 7.5 m^3/s. He reasoned that the contribution of LCE's to driving this anticyclonic feature must be relatively small. Others have attributed the presence of a northward flow along the western Gulf boundary to ring-slope-ring interactions (Vidal et al., 1999).

Perhaps the currents of greatest concern are those resulting from strong, episodic wind events such as tropical cyclones (especially hurricanes), extratropical cyclones, and cold-air outbreaks. Such wind events can result in extreme waves and cause currents with speeds of 100-150 cm/s over the continental shelves. Recent examples for the Texas-Louisiana shelf and upper slope are given in Nowlin et al. (1998). Other researchers (e.g., Brooks, 1983 and 1984) have measured the effects of such phenomena down to depths of 700 m over the continental slope in the northwestern Gulf.

Cold fronts, as well as diurnal and seasonal cycles of heat flux at the air/sea interface, affect near-surface water temperatures, although water at depths greater than about 100 m remains unaffected by surface boundary heat flux. Water temperature is greater than air temperature at the air/sea interface during all seasons. Frontal passages over the region can cause changes in temperature and velocity structure in the upper layers, specifically increasing current speeds and variability. These fronts tend occur with frequencies from 3-10 days (weatherband frequency). In the winter, the shelf water is nearly homogeneous due to wind stirring and cooling by fronts and winter storms.

Tropical conditions normally prevail over the Gulf from May or June until October or November. Hurricanes increase surface current speeds to 100-150 cm/s over the continental shelves, and cool the surface waters in much the same way as do cold fronts, but may stir the mixed layer to an even greater depth. Brooks (1983 and 1984) has measured the effects of hurricanes down to depths of 700 m over continental slopes in the northwestern Gulf. Hurricane Allen affected currents on the Texas slope in early August 1980. A strong southward, alongshore current occurred with the landward passage of this hurricane, exceeding 90 cm/s at 200 m and 15 cm/s at 700 m, triggering a series of internal waves with near inertial period. Surface waves and sea state may limit normal oil and gas operations as well as oil-spill response activities (Brower et al., 1972).

From October or November until March or April, the Gulf experiences intrusions of cold, dry continental air masses. During passage of a cold front, the cold-air mass is warmed as it travels over surface waters. In deeper waters, the mixed layer deepens. In the summer, vertical density stratification increases with the development of a seasonal thermocline. The transition between summer and winter is believed to occur with passage of the first cold front, and the transition from winter to summer coincides with the last cold front (Molinari and Festa, 1978). The formation of extratropical cyclones and cold-air outbreaks can both cause highly energetic surface currents. On March 12, 1993, a Class 5 extratropical cyclone moved from west to east across the Texas-Louisiana shelf with its center approximately over the 1,500-m isobath. Initially, the flow over the outer shelf and slope was toward the northeast as part of an induced cyclonic circulation over the Texas-Louisiana shelf. Following the passage of the storm out of the area on 13 March, a surge occurred to the southwest, followed by a period (14-17 March) of strong motion toward the northeast, with diurnal modulation. This was followed by an energetic near-inertial oscillation with decreasing amplitude lasting over a week. Speeds as high as 67 cm/s at 10 m and 35 cm/s at 190 m were observed.

During the MMS-sponsored Texas-Louisiana Shelf Circulation and Transport Process (LATEX) program of the early 1990's, a class of energetic surface currents previously unreported in the Gulf of Mexico were found over the Texas and Louisiana shelves (Nowlin et al., 1998). July 1992 observations in 200 m water offshore of Louisiana were of maximum amplitudes of 40-60 cm/s at a depth of 12 m during conditions of light winds. The period of diminished amplitudes followed an atmospheric frontal passage. These are near-circular, clockwise-rotating oscillations with a period near 24 hours. They seem to be an illustration of thermally induced cycling (DiMarco et al., 2000) in which high-amplitude rotary currents can exist in thin mixed layers typical of summer. By contrast, December 1992 measurements evidence no such behavior. Many examples of such currents, in phase at distinct locations, exist for the Texas-Louisiana shelf and, by implication, further offshore. Currents at a depth of 1 m have been observed to reach 100 cm/s.

Clearly episodic wind events can cause major currents in the deep waters of the Gulf. The initial currents give rise to inertial oscillations with decreasing amplitudes, which last for up to about 10 days and are superimposed on longer period signals.

During the mid-1980s, barotropic (i.e., depth independent) currents were observed to extend from depths near 1,000 m to the bottom. Hamilton (1990) concluded that such currents result from topographic Rossby waves triggered by the Loop Current, perhaps on separation of LCE's. Propagation speeds for these currents found into the western Gulf are higher (perhaps 9 km/day) than the average propagation speeds (5 km/day) of the separated LCE's. Sturges et al. (1993) observed similar phenomena from numerical model results for the Gulf. Deep circulation patterns distinct from those associated with the surface-intensified eddies also were seen in numerical model studies by Inoue and Welsh (1997). Proprietary oil-company measurements have indicated such barotropic currents with maximum speeds near 40 cm/s and periods of weeks. Moreover, data give some indication of current intensification near the bottom. This class of barotropic currents, with possible bottom intensification, is of high interest to offshore operators attempting oil and gas production in water depths of 1,000 m and greater; measurements in the CPA and WPA are ongoing by MMS and offshore operators.

Furrows oriented nearly along depth contours have been observed recently in the region of long. 90° W. just off the Sigsbee Escarpment and near the Bryant Fan, south of Bryant Canyon, from long. 91° W. to 92.5° W. Depths in those regions range from 2,000 to 3,000 m. Speculation based partly on laboratory experimentation is that near-bottom speeds of currents responsible for the furrows that are closest to shore might be 50 cm/s, and possibly in excess of 100 cm/s, and these currents may be oriented along isobaths and increase in strength toward the escarpment. These currents might be sporadic or quasi-permanent.

Continental shelf waves may propagate westward and southward along the slope in the central and western Gulf of Mexico. These are long waves similar to TRW's, but their energy is concentrated along a sloping bottom with shallow water to the right of the direction of propagation, and due to this constraint they are effectively "trapped" by the sloping bottom topography. Cold water from deeper off-shelf regions moves onto and off of the continental shelf by cross-shelf flow associated with upwelling and downwelling processes.

Inner-shelf currents on the Louisiana-Texas continental shelf flow in the downcoast (south or west) direction during non-summer months, reversing to upcoast flow in the summer (Cochrane and Kelly, 1986; Nowlin et al., 1998). Modeling results show that the spring and fall reversals in alongshore flow can be accounted for by local wind stress alone (Current, 1996). Monthly averaged alongshore currents on the outer shelf are upcoast in the mean, but showed no coherent pattern in the annual signal and were not often in the same alongshore direction at different outer-shelf locations (Nowlin et al., 1998). Mean cross-shelf geostrophic transport observed at the Louisiana-Texas shelf break was offshore during the winter (particularly in the upper 70 m of the water column), and onshore during the summer (Current and Wiseman, 2000).

Historical hydrographic cruises include several surveys of the entire Gulf of Mexico in the 1960's (including *R.V. Hidalgo* 62-H-3, *R.V. Geronimo* 67-G-12 and *R.V. Geronimo* 67-G-16) from which nearly synoptic circulation for the entire Gulf can be inferred. In addition to these synoptic cruises, a number of hydrographic cruises of more limited scope were carried out in the northeast Gulf of Mexico and surrounding regions aboard the *R.V. Alaminos,* the *R.V. Gyre,* and other research vessels.

Table 9-1 gives the names, depth ranges, densities, and identifying features of the remnants of the principal water masses. This table excludes the highly variable surface waters observed in 1) the eastern Gulf of Mexico by Morrison and Nowlin (1977) and Nowlin and McLellan (1967); and 2) the western

Gulf of Mexico by Morrison et al. (1983) and Nowlin and McLellan (1967). Water mass property extremes are closely associated with specific density surfaces. All of these subsurface waters derive from outside the Gulf and enter from the Caribbean Sea through the Yucatan Channel. Below about 1,800 m, horizontal distributions of temperature and salinity within the Gulf are essentially uniform. All of these subsurface waters flow into the Gulf from the Caribbean Sea through the Yucatan Channel. Based on historical observations, horizontal distributions of temperature and salinity within the Gulf are thought to be relatively uniform below the effective sill depth of the Yucatan Channel.

Summer heating and stratification affect continental-shelf waters in the Gulf of Mexico. Salinity is generally lower nearshore, although fresh water from the Mississippi and other rivers occasionally moves into outer shelf waters. Freshwater intrusions further lower the salinity after local storms.

Figure 9-2 presents composite plots of temperature vs. salinity, temperature vs. depth, and salinity vs. depth for the winter cruise 62-H-3 that covered the entire Gulf. Evident in these plots is the wide range of near-surface values, especially because sampling extended over the shelves.

Figure 9-3 better illustrates upper-layer waters with two different distributions. Caribbean-type water with a high maximum salinity marking the core of the Subtropical Underwater is found within the region enclosed by the Loop Current and LCE's, illustrated in the figure by station 215. This station was within an older LCE found in the northwestern Gulf. The second type of distribution is illustrated in the figure by station 165, which was located within a cyclone in the northwestern Gulf. At that station 165, the salinity maximum at the Subtropical Underwater core is much reduced by vertical mixing (characteristic of open Gulf waters outside of the Loop Current and of LCE's), and temperatures and salinities are found higher in the water column than within the LCE's. Robinson (1973) describes the seasonal variability of the upper waters of the Gulf in terms of the monthly mean temperatures of the surface and upper 150 m and the depth to the top of the thermocline. Contoured fields of temperature at six levels and the depth of the thermocline are presented. Also shown are time series of temperatures averaged for each 2.5^{o} by 2.5^{o} square.

9.1.3. Meteorological Conditions

General Description

The Gulf of Mexico is influenced by a maritime subtropical climate controlled mainly by the clockwise circulation around the semipermanent area of high barometric pressure commonly known as the Bermuda High. The Gulf of Mexico is located to the southwest of this center of circulation. This proximity to the high-pressure system results in a predominantly southeasterly flow in the Gulf of Mexico region. Two important classes of cyclonic storms are occasionally superimposed on this circulation pattern. During the winter months, December through March, cold fronts associated with cold continental air masses influence mainly the northern coastal areas of the Gulf of Mexico. Behind the fronts, strong north winds bring drier air into the region. Tropical cyclones may develop or migrate into the Gulf of Mexico during the warmer months. These storms may affect any area of the Gulf of Mexico and substantially alter the local wind circulation around them. In coastal areas, the sea breeze effect may become the primary circulation feature during the summer months of May through October. In general, however, the subtropical maritime climate is the dominant feature in driving all aspects of the weather in this region; as a result, the climate shows very little diurnal or seasonal variation.

Selected climatological data for a few selected Gulf coastal locations can be found in Table 9-2.

Pressure, Temperature, and Relative Humidity

The western extension of the Bermuda High dominates the circulation throughout the year, weakening in the winter and strengthening in the summer. The average monthly pressure shows a west to east gradient along the northern Gulf during the summer. In the winter, the monthly pressure is more uniform along the northern Gulf. The minimum average monthly pressure occurs during the summer. The maximum pressure occurs during the winter as a result of the presence and influence of transitional continental cold air.

Average air temperatures at coastal locations vary with latitude and exposure. Air temperature ranges from highs in the summer of 24.7-28.0 ^{o}C to lows in the winter of 2.1-21.7 ^{o}C. Winter temperatures depend on the frequency and intensity of penetration by polar air masses from the north. Air temperatures over the open Gulf exhibit narrower limits of variations on a daily and seasonal basis due to the moderating effect of the large bodies of water. The average temperature over the center of the Gulf is about 29 °C in the summer and between 17 and 23 °C in the winter.

The relative humidity over the Gulf is high throughout the year. Minimum humidities occur during the late fall and winter when cold, continental air masses bring dry air into the northern Gulf. Maximum humidities occur during the spring and summer when prevailing southerly winds bring in warm, moist air. The climate in the southwestern Gulf of Mexico is relative dry.

Surface Winds

Winds are more variable near the coast than over open waters because coastal winds are more directly influenced by the moving cyclonic storms that are characteristic of the continent and because of the land and sea breeze regime. During the relatively constant summer conditions, the southerly position of the Bermuda High generates predominantly southeasterly winds, which become more southerly in the northern Gulf. Winter winds usually blow from easterly directions with fewer southerlies but more northerlies.

Precipitation and Visibility

Precipitation is frequent and abundant throughout the year but does show distinct seasonal variation. Stations along the entire coast record the highest precipitation values during the warmer months of the year. The warmer months usually have convective cloud systems that produce showers and thunderstorms; however, these thunderstorms rarely cause any damage or have attendant hail (USDOC, 1967; Brower et al., 1972). The month of maximum rainfall for most locations is July. Winter rains are associated with the frequent passage of frontal systems through the area. Rainfalls are generally slow, steady, and relatively continuous, often lasting several days. Snowfalls are rare, and when frozen precipitation does occur, it usually melts on contact with the ground. Incidence of frozen precipitation decreases with distance offshore and rapidly reaches zero.

Warm, moist Gulf air blowing slowly over chilled land or water surfaces brings about the formation of fog. Fog occurrence decreases seaward, but visibility has been less than 800 m due to offshore fog. Coastal fogs generally last 3-4 hours, although particularly dense sea fogs may persist for several days. The poorest visibility conditions occur during winter and early spring. The period from November through April has the lowest visibility. Industrial pollution and agricultural burning also impact visibilities.

Mixing Height and Atmospheric Stability

The mixing height is very important because it determines the volume available for dispersing pollutants. Because the mixing height is directly related to vertical mixing in the atmosphere, a mixed layer is expected to occur under neutral and unstable atmospheric conditions. The mixing height tends to be lower in winter, and daily changes are smaller than in summer.

Severe Storms

The Gulf of Mexico is part of the Atlantic tropical cyclone basin. Tropical cyclones generally occur in summer and fall seasons; however, the Gulf also experiences winter storms or extratropical storms. These winter storms generally originate in middle and high latitudes and have winds that can attain speeds of 15-26 m/sec (11.2-58.2 mph). The Gulf is an area of cyclone development during cooler months due to the contrast of the warm air over the Gulf and the cold continental air over North America. Cyclogenesis, or the formation of extratropical cyclones, in the Gulf of Mexico is associated with frontal overrunning (Hsu, 1992). The most severe extratropical storms in the Gulf originate when a cold front encounters the subtropical jetstream over the warm waters of the Gulf. Statistics of 100-year data of extratropical cyclones reveal that most activity occurs above 25°N. latitude in the Western Gulf of Mexico. The mean number of these storms ranges from 0.9 near the southern tip of Florida to 4.2 over central Louisiana (USDOI, MMS, 1988).

The frequency of cold fronts in the Gulf exhibits similar patterns during the four-month period of December through March. During this time the area of frontal influence reaches 10^{o} N. latitude. Frontal frequency is about nine fronts per month (1 front every 3 days on the average) in February and about seven fronts per month in March (1 front every 4-5 days on the average). By May, the frequency decreases to about four fronts per month (1 front every 7-8 days) and the region of frontal influence retreats to about 15^{o} N. latitude. During June-August frontal activity decreases to almost zero and fronts seldom reach below 25^{o} N. latitude (USDOI, MMS, 1988).

Tropical cyclones affecting the Gulf originate over the equatorial portions of the Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. Tropical cyclones occur most frequently between June and November. Based on 42 years of data, there are about 9.9 storms per year with about 5.5 of those becoming major hurricanes in the Atlantic Ocean (Gray, written communication, 1992). Data from 1886 to 1986 show that 44.5 percent of these storms, or 3.7 storms per year, will affect the Gulf of Mexico (USDOI, MMS, 1988). The Yucatan Channel is the main entrance of Atlantic storms into the Gulf of Mexico, and a reduced translation speed over Gulf waters leads to longer residence times in this basin.

There is a high probability that tropical storms will cause damage to physical, economic, biological, and social systems in the Gulf. Tropical storms also affect OCS operations and activities; platform design needs to consider the storm surge, waves, and currents generated by tropical storms. Most of the damage is caused by storm surge, waves, and high winds. Storm surge depends on local factors, such as bottom topography and coastline configuration, and storm intensity. Water depth and storm intensity control wave height during hurricane conditions. Sustained winds for major hurricanes (Saffir-Simpson Category 3 and above) are higher than 49 m/sec (109.6 mph). The Saffir-Simpson scale definitions and a listing of the most damaging hurricanes in the Gulf can be found in Table 9-3.

9.1.4. Artificial-Reefs and Rigs-to-Reefs Development

Artificial-Reef Development

Artificial reefs have been used along the coastline of the United States since the early nineteenth century. Stone (1974) documented that the use of obsolete materials to create artificial reefs has provided valuable habitat for numerous species of fish in areas devoid of natural hard bottom. Stone et al. (1979) found reefs in marine waters not only attract fish, but in some instances also enhance the production of fish.

The long-standing debate as to whether artificial reefs contribute to biological production or merely attract the associated marine resources still continues within the scientific arena. While no unified answer to this dichotomy persist among the artificial-reef researchers, the generally accepted conclusion is that artificial reefs both attract and produce fish. This conclusion depends on a variety of factors, such as associated species, limiting environmental factors, fishing pressure, and type of materials used. The degree to which any of the above factors can be controlled will dictate whether any particular artificial reef attract fish or produce fish. In reality, many artificial reefs probably do both attract and produce fish at the same time.

The U.S. Congress recognizing the social and economic value in developing artificial reefs passed the National Fishing Enhancement Act (NFEA) in 1984. The NFEA called for the development of a national plan to provide guidance to those individuals, organizations, and agencies interested in artificial reef development and management. The NFEA directed the Secretary of Commerce to develop and publish a long-term National Artificial Reef Plan (NARP) to promote and facilitate responsible and effective use of artificial reefs using the best scientific information available. In 1985, the National Marine Fisheries Service (NMFS) wrote and completed the NARP. The NARP states that properly designed, constructed, and located artificial reefs can enhance the habitat and diversity of fishery resources; enhance United States recreational and commercial fishing opportunities; increase the energy efficiency of recreational and commercial fisheries; and contribute to the United States coastal economies.

The NARP provides general criteria for selection of materials for artificial-reef applications. These criteria include: (1) function, which is related to how well a material functions as reef habitat; (2) compatibility, which is related to how compatible a material is with the environment; (3) durability, which is related to how long a material will last in the environment; (4) stability, which is related to how stable a material will be when subject to storms, tides, currents, and other external forces, and (5) availability, which is related to how available a material is to an artificial-reef program.

One of the most significant recommendations in the NARP was to encourage the development of State-specific artificial-reef plans. The Gulf States Marine Fisheries Commission (GSMFC) and Atlantic States Marine Fisheries Commission (ASMFC) began to coordinate State artificial-reef program activities for States along the coast of the Gulf of Mexico and Atlantic Ocean respectively. Most of the States along the Gulf and Atlantic coasts have taken a leadership role in artificial-reef development and management, having developed state-specific plans, and established protocols for siting, deployment, and evaluation of materials for artificial reefs. Each commission formed working committees comprised of State artificial-reef program personnel, and representatives from appropriated Federal agencies, including the MMS. Artificial Reef Working Committees, of the GSMFC and ASMFC, meet jointly to discuss artificial-reef issues of a national scope, and separately to discuss issues specific to the Gulf and Atlantic perspective. As a result, these committees have been influential in shaping regional and national artificial-reef policies and effecting future positive program changes within State and Federal agencies. The working committees have developed guidelines for marine artificial-reef materials. The guidelines provide State and Federal agencies and the general public information related to the history, identification of the benefits, drawbacks, and limitations, and use of selected materials for use in the development of marine artificial reefs. The working committees have also produced the document titled "Coastal Artificial Reef Planning Guide." The document reflects the working committee's recommendations to the NMFS for revisions to the National Artificial Reef Plan.

State Artificial Reef Programs and Plans

All of the five Gulf of Mexico coastal States – Texas, Louisiana, Mississippi, Alabama, and Florida – have artificial-reef programs and plans. The following are brief descriptions of each State's artificial-reef program. The States' artificial-reef planning areas, general permit areas, and permitted artificial-reef sites within the area of influence considered in this EIS are shown on Figure 9-4.

Texas

In 1989, the Texas State legislature passed the State's Artificial Reef Act. The Act provided guidance for planning and developing artificial reefs in a cost-effective manner to minimize conflicts and risk to the environment. The Act also directed the Texas Parks and Wildlife Department to promote, develop, maintain, monitor, and enhance the artificial-reef potential in State waters and Federal waters adjacent to Texas. The Act defined an artificial reef as a structure constructed, placed, or permitted in the navigable water of Texas or water of the Federal exclusive economic zone adjacent to Texas for the purpose of enhancing fishery resources and commercial and recreational fishing opportunities. To fulfill these purposes, the Department was directed to develop a State artificial-reef plan in accordance with Chapter 89 of the Texas Parks and Wildlife code. Texas artificial reefs are mostly retired oil and gas platforms, liberty ships, and military hardware (battle tanks and armored vehicles).

Louisiana

In response to the NFEA, the Louisiana Artificial Reef Initiative (LARI) combined the talents of university, State, Federal, and industry representatives to develop an artificial-reef program for the State of Louisiana. As a result, the Louisiana Fishing Enhancement Act (Act 100) became law in 1986. Subsequently, the Louisiana Artificial Reef Plan was written and contains the rational and guidelines for implementation and maintenance of the State artificial-reef program. The State plan is implemented under the leadership of the Louisiana Department of Wildlife and Fisheries. .

The LARI approved nine artificial-reef planning areas where artificial reefs can be sited (Kasprzak and Perret, 1996). Artificial-reef complexes are established within the planning areas on the basis of the best available information regarding bottom type, currents, bathymetry, and other factors affecting performance and productivity of the reefs. Retired oil and gas platforms are the primary materials that have been use within the Louisiana artificial-reef program. Military battle tanks have also been deployed offshore Louisiana for artificial reefs.

Mississippi

Mississippi's artificial-reef efforts began in the 1960's. A group consisting primarily of charter-boat operators and recreational fishermen obtained funding from their local coastal counties and constructed a car-body reef site in the early 1960's. In 1972, the Mississippi Marine Conservation Commission, the organizational predecessor of the current Mississippi Department of Marine Resources, acquired five surplus liberty ships for artificial reefs. This liberty-ship project was completed in 1978. The excess funds from the project and the reef permits were transferred to the Mississippi Gulf Fishing Banks, Inc., a private reef-building organization made-up of conservationists, charter-boat operators, and recreational fishermen.

Presently, Mississippi has 25 near-shore, low-profile fishing reefs and 9 offshore reefs. Most of the offshore sites are located within 16-23 km from shore. Artificial-reef materials used on these sites include liberty ships, rig quarters, tugboats, barges, boxcars, buses, dumpsters, concrete modules, tires, and Fish Aggregating Devices. All of Mississippi's reef sites have active reef permits and suitable material can be deployed at these sites, as they become available (Brainard, 1996).

Alabama

Alabama's artificial-reef efforts began in 1953. The first reef project resulted in placement of 250 automobile bodies in water depths of 20-30 m offshore Baldwin County. Alabama Department of Conservation and Natural Resources (ADCNR) is the responsible State agency for artificial-reef development in State and Federal waters. Alabama's most impressive and lasting contribution to artificial-reef activities is the acquisition and placement of five liberty ships in five locations in Alabama's offshore waters, which provide excellent offshore fishing opportunities for recreational fisherman. In 1986 and 1987, the ADCNR was granted by the U.S. Army Corps of Engineers (COE) two artificial-reef general-permit areas (Don Kelly North and Don Kelly South) offshore Baldwin County. In 1991, a third artificial-reef general-permit area (Hugh Swingle) was granted by the COE offshore Mobile County. In 1997, a proposal for extension of the three general-permit areas was requested by the ADCNR and permits were issued that year by the COE (Tatum, 1993). Alabama has used a large variety of materials (e.g. shell, concrete, automobile, vehicle tires, aircraft, railroad cars, steel and wooden vessels, and military battle tanks) for reefs with their artificial-reef program.

Florida

Florida's first permitted artificial-reef site was issued in 1918 (Pybas, 1991). A rapid proliferation of artificial-reef sites began in 1980. In the past 20 years, 309 reef sites were established in State and Federal waters off 33 Florida coastal counties on both the Gulf and Atlantic coasts. Almost 1,500 separate deployments of artificial-reef materials have been recorded within these permitted sites. Artificial reefs were built at water depths ranging from less than 3 m to greater than 200 m. For the past 20 years, Florida's artificial-reef program has been a cooperative effort of local governments and State agencies with additional input provided by non-governmental fishing and diving interests. The Florida Fish and Wildlife Conservation Commission, Division of Marine Fisheries, manages the State's artificial-reef program. The primary objective of the State's program has been to provide grants-in-aid to local coastal governments to develop artificial-fishing reefs in State and adjacent Federal waters to increase local sport-fishing resources and enhance sport-fishing opportunities (Dodrill and Horn, 1996; Maher, 1999). Florida has used a large variety of materials previously mentioned for reef within their artificial-reef program

Rigs-to-Reefs Development

Rigs-to-Reefs (RTR) is a catchy term for converting obsolete, nonproductive, offshore oil and gas platforms to designated artificial reefs (Dauterive, 2000). Offshore oil and gas platforms began functioning as artificial reefs in 1947 when Kerr-McGee completed the world's first commercially successful oil well in 5.6 m of water, 70 km south of Morgan City, Louisiana. Approximately 4,000 offshore oil and gas platforms exist on the Gulf of Mexico OCS beyond state territorial waters, with most (>90%) occurring offshore the States of Louisiana and Texas. Distribution of offshore platforms across the GOM is presented in Figure 9-5. Placed with the primary intent of producing oil and/or gas, offshore platforms also provide artificial substrate and marine habitat where natural hard-bottom habitat is at a minimum. Stanley (personal communication, 1998) calculated that the entire submerged portions of oil and gas platforms in the GOM provides some 12 km^2 of hard substrate. These platforms form the most extensive *de facto* artificial-reef systems in the world, providing some of the best habitat for reef-associated species.

The MMS regulations require that platforms be removed within one year after termination of the lease and the platform disposed onshore. Figure 9-6 provides the number of platforms installed (5,862) and removed (1,879) from 1942 through 1999. Between 1990-1999, the removal of platforms almost kept pace with the installation of platforms (Dauterive, 2000). A forecast of the offshore platforms on the Gulf OCS indicates a decline of about 29 percent in the number of platforms over the period 1999-2023 (Pulsipher et al., 2000). Disposal of obsolete offshore oil and gas platforms is not only a financial liability for the oil and gas industry but can be a loss of productive marine habitat (Kasprzak and Perret, 1996).

The use of obsolete oil and gas platforms for reefs has proven to be highly successful. Their availability, design profile, durability, and stability provide a number of advantages over the use of traditional artificial-reef materials. To capture this recyclable and valuable fish habitat, the States of Louisiana, Texas, and Mississippi in 1986, 1989, and 1999, respectively, passed enabling legislation and signed into law RTR plans for their respective States. Alabama and Florida have no RTR legislation. The distribution of RTR location across the GOM is presented in Figure 9-7.

The State laws set up a mechanism to transfer ownership and liability of the platform from oil and gas companies to the State when the platform ceases production and the lease is terminated. The company (donor) saves money by donating a platform to the State (recipient) for use as a reef rather than scrapping the platform onshore. The industry then donates 50 percent of the savings to the State to run the State's artificial-reef program. Since the inception of the RTR plans, more than 150 retired platforms have been donated and used for reefs offshore of the Gulf Coast States. Table 9-4 shows the RTR donations by State.

Texas Rigs-to-Reefs

The State of Texas passed enabling legislation (Texas Artificial Reef Act of 1989) formally recognizing the benefits of artificial reefs and RTR as a fishery development and management tool. At the end of 1999, Texas had 50 RTR platform donations within the State's artificial-reef program. Texas is the leader in using the partial removal method of removing platforms. This nonexplosive method of partial platform removal is the preferred method in support of artificial reefs because of the higher reef profile and the minimal trauma to and loss of platform-associated reef organisms. This method also generally results in more economic savings to the industry and monetary benefit to the State.

Louisiana Rigs-to-Reefs

In 1986, Louisiana passed enabling legislation (Louisiana Fishing Enhancement Act) for transfer and receipt of material for use as artificial reefs. The Act mandated preparation of the Louisiana Artificial Reef Plan. The Plan contains the rationale and guidelines for implementation and maintenance of the state's artificial reef program. The Louisiana Artificial Reef Council approved initially seven artificial-reef planning areas. Subsequently, two additional planning areas were added. These planning areas are strategically located along the Louisiana coast in various water depths and distances from shore for receipt of platform reefs and artificial reef materials. Figure 9-4 shows the location of Louisiana nine reef planning areas. Louisiana is also the leading state with 94 RTR platform donations within the State's artificial-reef program (Table 9-4).

Mississippi Rigs-to-Reefs

The MDMR has developed an artificial-reef plan for the State. The plan includes decommissioned platforms as an important artificial-reef material for deployment on Mississippi's approved artificial-reef sites. Because the continental shelf off of Mississippi has a very gentle slope and the water is shallow for a great distance from shore, the Mississippi RTR program is somewhat limited. Since water deep enough for RTR sites is far from shore, fishermen must travel great distances t reach the reefs. The State passed enabling legislation in 1999 allowing for the transfer of platform and platform liability along with industry cost saving for transfer of the platform to the State's artificial reef program. Platforms have been deployed for RTR at three locations offshore Mississippi.

Alabama Rigs-to-Reefs

Sections of a retired Marathon Oil Company platform were donated to the State of Alabama in 1983, and sunk by the Alabama Department of Conservation and Natural Resources some 60 miles offshore Alabama in 80 m of water (Tatum, 1993). In 2000, the State applied for and was permitted by the COE, to use a partially removed platform as an artificial reef in Main Pass Block 254.

Alabama is considering an RTR plan that will allow the State to accept 50 percent of the cost savings realized by the platform operator by not removing and transporting the platform to shore per MMS requirements.

Florida Rigs-to-Reefs

Obsolete oil and gas platforms have been placed as reefs at four locations on the OCS offshore Florida. In 1980, Exxon donated and placed a sub-sea production template offshore Apalachicola, Florida. In 1982, Tenneco donated and placed a platform's jackets and deck offshore Pensacola, Florida. In 1985, Tenneco again donated and placed two platform jackets offshore Miami, Florida. In 1993, Chevron donated a platform jacket and deck offshore Pensacola, Florida. The Florida Panhandle counties have expressed an interest in platforms as artificial reefs (Dodrill and Horn, 1996).

9.1.5. Existing OCS-Related Infrastructure

Offshore Infrastructure

The numbers below reflect offshore activities in the Gulf of Mexico OCS as of May 2001. All numbers presented are from an analysis of data contained in the MMS Technical Information Management System (TIMS), unless otherwise denoted.

Exploration and Delineation Wells (all wells ever drilled)

	Water Depth			
Planning Area	0-60 m	61-200 m	201-900 m	>900 m
Central	3,014	4,189	2,935	899
Western	459	1,328	722	303
Eastern	1	21	22	4
Total	3,474	5,538	3,679	1,206

Exploration and Delineation Wells (currently active wells)

	Water Depth			
Planning Area	0-60 m	61-200 m	201-900 m	>900 m
Central	871	1,036	745	350
Western	111	176	94	124
Eastern	1	1	0	1
Total	983	1,213	839	475

Development Wells (boreholes) (all wells ever drilled)

Planning Area	Water Depth 0-60 m	61-200 m	201-900 m	>900 m
Central	7,135	9,209	5,850	646
Western	381	1,409	1,171	172
Eastern	0	0	1	0
Total	7,516	10,618	7,022	818

Development Wells (boreholes) (currently active)

Planning Area	Water Depth 0-60 m	61-200 m	201-900 m	>900 m
Central	3,775	5,435	4,276	527
Western	232	821	895	143
Eastern	0	0	0	0
Total	4,007	6,256	5,171	670

Percentage of Development Wells that become Producing Wells

Planning Area	Water Depth 0-60 m	61-200 m	201-900 m	>900 m
Central	90.8%	93.7%	92.6%	94.7%
Western	93.9%	94.9%	95.9%	100.0%
Eastern	0.0%	0.0%	0.0%	0.0%
Total	91.0%	93.9%	93.3%	96.7%

Average Number of Days to Drill a Development Well

Planning Area	Water Depth 0-60 m	61-200 m	201-900 m	>900 m
Central	69	85	96	82
Western	90	120	116	114
Eastern	n/a	n/a	n/a	n/a
Total	70	89	99	87

"n/a" refers to "not applicable"

Average Life of a Producing Well (years)

Planning Area	Water Depth 0-60 m	61-200 m	201-900 m	>900 m
Central	16	11	7	n/a
Western	11	11	4	n/a
Eastern	n/a	n/a	n/a	n/a
Total	16	11	7	n/a

"n/a" refers to "not applicable"

Average Measured Depth of a Development Well (ft)

Planning Area	Water Depth 0-60 m	61-200 m	201-900 m	>900 m
Central	10,400	10,890	9,200	12,840
Western	11,260	9,880	9,520	13,990
Eastern	p	p	p	p
Total	10,440	10,760	9,250	13,080

"p" refers to "proprietary"

Number of Platforms by Platform Type

Platform Type	Central Planning Area	Western Planning Area	Eastern Planning Area	Total
Caisson	1,208	103	1	1,412
Compliant Towers	1	1	0	2
Fixed Leg	1,752	361	0	2,113
Mobile Production Units	1	0	0	1
Mini TLP's	2	0	0	2
SPARS	1	1	0	2
Subsea Manifolds	2	2	0	4
Subsea Templates	8	0	0	8
Tension Leg	6	0	0	6
Well Protectors	383	62	0	445

Gulf of Mexico Rig Utilization and Day Rates

Rig Type	Total Supply	Marketed Supply	Total Contracted	Fleet Utilization	Marketed Utilization	Day Rate Range ($ 000)
Jack-Ups	156	146	144	92.3%	98.6%	30-85
Semi-submersibles	42	35	34	81.0%	97.1%	42-130
Drillships	7	7	7	100.0%	100.0%	140-150
Submersibles	7	6	6	85.7%	100.0%	35-41
Platform Rigs	79	60	49	62.0%	81.7%	n/a

Source: One Offshore, 2001.

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APPENDIX 9.2

STATE COASTAL ZONE MANAGEMENT PROGRAMS

9.2. STATE COASTAL ZONE MANAGEMENT PROGRAMS

Each State's CZM program, federally approved by NOAA, is a comprehensive statement setting forth objectives, enforceable policies, and standards for public and private use of land and water resources and uses in that State's coastal zone. The program provides for direct State land and water use planning and regulations. The plan also includes a definition of what constitutes permissible land uses and water uses. Once a State's CZM program is Federally approved, Federal agencies must ensure that their actions are consistent to the maximum extent practicable with the enforceable polices of the approved program. State and Federal agencies work together on joint planning and permitting, which reduces the regulatory burden on the public (USDOC, NOAA, 1989). Federal agencies provide feedback to the States through each Section 312 evaluation conducted by NOAA.

To ensure conformance with State CZM program policies and local land use plans, the MMS prepares the appropriate consistency document for each proposed OCS lease sale. Local land use agencies also have the opportunity to comment directly to MMS at any time, as well as during formal public comments periods related to announcement of the Draft 5-Year OCS Leasing Program, Call for Information and Notice of Intent to Prepare an EIS, EIS scoping, public hearings on Draft EIS, and the Proposed Notice of Sale.

A State's approved CZM program may also provide for the State's review of OCS plans, permits, and license activities to determine whether they will be conducted in a manner consistent with the State's CZM program. This review authority is applicable to activities conducted in any area that has been leased under the OCSLA and that affect any land or water use or natural resource within the State's coastal zone (16 U.S.C. 1456(c)(3)(B)). Through the designated State CZM agency, local land use entities are provided numerous opportunities to comment on the OCS Program.

State of Texas Coastal Management Program

The Texas Coastal Management Program (TCMP)/Final EIS was published in August 1996. On December 23, 1996, the TCMP was approved by NOAA, and requirements therein were made operational as of January 10, 1997. The TCMP is based primarily on the Coastal Coordination Act (CCA) of 1991 (33 Tex. Nat. Res. Code Ann. Ch. 201, *et seq.*), as amended by HB 3226 (1995), which calls for the development of a comprehensive coastal program based on existing statutes and regulations. The CCA established the geographic scope of the program by identifying the program's inland, interstate, and seaward boundaries. The program's seaward boundary is the State's territorial seaward limit (3 leagues or 10.3 mi). The State's inland boundary is based on the State's Coastal Facilities Designation Line (CFDL). The CFDL was developed in response to the Oil Spill Act of 1990 and basically delineates those areas within which oil spills could affect coastal waters or resources. For the purposes of the TCMP, the CFDL has been modified to capture wetlands in upper reaches of tidal waters. The geographic scope also extends upstream 200 mi from the mouths of rivers draining into coastal bays and estuaries in order to manage water appropriations on those rivers. The program's boundaries encompass all or portions of 19 coastal counties (including Cameron, Willacy, Kenedy, Kleberg, Nueces, San Patricio, Aransas, Refugio, Calhoun, Victoria, Jackson, Matagorda, Brazoria, Galveston, Harris, Chambers, Liberty, Jefferson, and Orange Counties); roughly 8.9 million acres of land and water.

Within this coastal zone boundary, the scope of the TCMP's regulatory program is focused on the direct management of 14 generic "Areas of Particular Concern," called coastal natural resource areas (CNRA's). These CNRA's are associated with valuable coastal resources or vulnerable or unique coastal areas and include the following: waters of the open Gulf of Mexico; waters under tidal influence; submerged lands; coastal wetlands; seagrasses; tidal sand and mud flats; oyster reefs; hard substrate reefs; coastal barriers; coastal shore areas; Gulf beaches; critical dune areas; special hazard areas; critical erosion areas; coastal historic areas; and coastal preserves.

The State has designated the WPA as the geographical area in which Federal consistency shall apply outside of the coastal boundary. The TCMP also identifies Federal lands excluded from the State's coastal zone, such as Department of Defense Facilities.

Land and water uses subject to the program generally include the siting, construction, and maintenance of electric generating and transmission facilities; oil and gas exploration and production; and the siting, construction, and maintenance of residential, commercial, and industrial development on beaches, critical dune areas, shorelines, and within or adjacent to critical areas and other CNRA's. Associated activities also subject to the program include canal dredging; filling; placement of structures for shoreline access and shoreline protection; on-site sewage disposal, storm-water control, and waste management for local governments and municipalities; the siting, construction, and maintenance of public buildings and public works such as dams, reservoirs, flood control projects and associated activities; the siting, construction, and maintenance of roads, highways, bridges, causeways, airports, railroads, and nonenergy transmission lines and associated activities; certain agricultural and silvicultural activities; water impoundments and diversions; and the siting, construction, and maintenance of marinas, State-owned fishing cabins, artificial reefs, public recreational facilities, structures for shoreline access and shoreline protection, and boat ramps.

The TCMP is a networked program that will be implemented primarily through 8 State agencies, 18 local governments, and the Coastal Coordination Council. The program will rely primarily on direct State control of land and water uses, although local governments will implement State guidelines related to beach and dune management. Implementation and enforcement of the coastal policies is primarily the responsibility of the networked agencies and local governments through their existing statutes, regulatory programs, or other authorizations. Networked agencies include the General Land Office/School Land Board, Texas Natural Resource Conservation Commission, Railroad Commission, Texas Parks and Wildlife Department, Texas Transportation Commission, Texas Historical Commission, the Public Utility Commission, the Texas State Soil and Water Conservation Board, and the Texas Water Development Board. Similarly, 18 county and municipal governments, in those counties with barrier islands, are also networked entities with responsibilities for program implementation vis-a-vis beaches and dunes.

Local land uses and government entities are linked to the management of Texas CNRA's in the TCMP. Local governments are notified of relevant TCMP decisions, including those that may conflict with local land use plans or zoning ordinances. The Coastal Coordination Council includes a local government representative as a full-voting member. An additional local government representative can be added to the Council as a nonvoting member for special local matters under review. The Council will establish a permanent advisory committee to ensure effective communication for local governments with land use authority.

In 1994, MMS entered into a Memorandum of Understanding (MOU) with the Texas General Land Office to address similar mineral resource management responsibilities between the two entities and to encourage cooperative efforts and promote consistent regulatory practices. This MOU, which encompasses a broad range of issues and processes, outlines the responsibilities and cooperative efforts, including leasing and CZMA review processes, agreed to by the respective agencies. The MMS is developing coordination procedures with the State for submittal of offshore lease sale consistency determinations and plans of operation. Western Gulf Sale 168 was the first MMS Federal action subject to State consistency review. For plans of operation, the State has agreed that the information requirements of NTL No. 2000-G21 constitute the information needed for their consistency certification review. Effective January 10, 1997, all operators were required to submit to MMS certificates of consistency with the TCMP for proposed operations in the WPA. The MMS and the State of Texas are currently working to revise CZM consistency information for OCS plans, permits and licenses to conform to the revised CZM regulations that were effective January 8, 2001.

State of Louisiana Coastal Resources Program

The basis for Louisiana's coastal zone management program is the Louisiana Coastal Resources Program (LCRP) created by the State and Local Coastal Resources Management Act of 1978 (Louisiana Administrative Code, Vol. 17, Title 43, Chapter 7, Coastal Management, June 1990 revised). The Act puts into effect a set of State coastal policies and coastal use guidelines that apply to coastal land and water use decisionmaking. A number of existing State regulations are also incorporated into the program including those concerning oil and gas and other mineral operations; leasing of State lands for mineral operations and other purposes; hazardous waste and radioactive materials; management of wildlife, fish, other aquatic life, and oyster beds; endangered species; air and water quality; and the Louisiana Offshore Oil Port (LOOP).

The Act also authorized establishment of Special Management Areas. Included or planned to be included as Special Management Areas are LOOP and Marsh Island. For purposes of the CZMA, only that portion of LOOP within Louisiana's coastal zone is part of the Special Management Area. In April

1989, the Louisiana Legislature created the Wetlands Conservation and Restoration Authority and established a Wetlands Conservation and Restoration Trust Fund to underwrite restoration projects. The Legislature also reorganized part of the Louisiana Department of Natural Resources (LDNR) by creating the Office of Coastal Restoration and Management.

Local governments (parishes) may assume management of uses of local concern by developing a local coastal program consistent with the State CZM plan. The State of Louisiana has ten approved local coastal management programs (Calcasieu, Cameron, Jefferson, Lafourche, Orleans, St. Bernard, St. James, St. John the Baptist, Terrebonne, and St. Tammany Parishes). Nine others (Assumption, Iberia, Livingston, Plaquemines, St. Charles, St. Martin, St. Mary, Tangipahoa, and Vermilion Parishes) have not formally been approved by NOAA. The parish police jury often serves as the permitting agency for projects limited to local concern. Parish-level programs function in an advisory capacity to Louisiana's CZM agency, the Coastal Management Division.

Appendix C2 of the LCRP outlines the rules and procedures for the State's local coastal management programs. Under the LCRP, parishes are authorized, though not required, to develop local coastal management programs. Approval of these programs gives parishes greater authority in regulating coastal development projects that entail uses of local concern. Priorities, objectives, and policies of local land use plans must be consistent with the policies and objectives of Act 361 and the State guidelines, except for a variance adopted in Section IV.D. of Appendix C2 of the LCRP. The Secretaries of the Departments of Natural Resources, and Wildlife and Fisheries may jointly rule on an inconsistent local program based on local environmental conditions or user practices. State and Federal agencies review parish programs before they are adopted.

The coastal use guidelines are based on seven general policies. State concerns that could be relevant to an OCS lease sale and its possible direct effects or associated facilities and nonassociated facilities are (a) any dredge and fill activity that intersects more than one water body, (b) projects involving the use of State-owned lands or water bottoms, (c) national interest projects, (d) pipelines, and (e) energy facility siting and development. Other coastal activities of concern that could be relevant to a lease sale include wetland loss due to channel erosion from OCS traffic; activities near reefs and topographic highs; activities that might affect endangered, threatened, or commercially valuable wildlife; and potential socioeconomic impacts due to offshore development.

Effective August 1993, the DNR Coastal Management Division requires that any entity applying for permits to conduct activities along the coast must notify the landowner of the proposed activity. An affidavit must also accompany any permit application. Through this regulation, the State will strive to minimize coastal zone conflicts.

The MMS and the State of Louisiana are currently working to revise CZM consistency information for OCS plans, permits, and licenses to conform to the revised CZM regulations that were effective January 8, 2001.

State of Mississippi Coastal Program

The Mississippi Coastal Program (MCP) is administered by the Mississippi Department of Marine Resources. The MCP is built around 10 enforceable goals that promote comprehensive management of coastal resources and encourage a balance between environmental protection/preservation and development in the coastal zone. The primary coastal management statute is the Coastal Wetlands Protection Law. Other major features of the MCP include statutes related to fisheries, air and water pollution control, surface and groundwater, cultural resources, and the disposal of solid waste in marine waters. The Department of Marine Resources, the Department of Environmental Quality, and the Department of Archives and History are identified collectively as the "coastal program agencies." Mississippi manages coastal resources by regulation and by promoting activities that use resources in compliance with the MCP. The State developed a coastal wetlands use plan, which includes designated use districts in coastal wetlands and Special Management Area Plans that steer development away from fragile coastal resources and help to resolve user conflicts.

For the purposes of the coastal program, the coastal zone encompasses the three coastal counties of Hancock, Harrison, and Jackson and all coastal waters. The Mississippi coast has 594 km of shoreline, including the coastlines of offshore barrier islands (Cat, Ship, Horn, and Petit Bois Islands). According to NOAA, there are no approved local coastal management plans for the State of Mississippi. The Southern

Mississippi Planning and Development District serves in an advisory capacity to the State coastal agencies.

The MMS and the State of Mississippi are currently working to revise CZM consistency information for OCS plans, permits, and licenses to conform to the revised CZM regulations that were effective January 8, 2001.

State of Alabama Coastal Area Management Program

The Alabama Coastal Area Act (ACAA) provides statutory authority to review all coastal resource uses and activities that have a direct and significant effect on the coastal area. The Alabama Department of Conservation and Natural Resources (ADCNR) Coastal Programs Office, the lead coastal management agency, is responsible for the management of the State's coastal resources through the Alabama Coastal Area Management Plan (ACAMP). The ADCNR is responsible for the overall management of the program including fiscal and grants management and public education and information. The department also provides planning and technical assistance to local governments and financial assistance to research facilities and units of local government when appropriate.

The Alabama Department of Environmental Management (ADEM) is responsible for coastal area permitting, regulatory and enforcement functions. All programs of ADCNR Coastal Programs that require environmental permits or enforcement functions are carried out by the ADEM. The ADEM has the responsibility of all permit, enforcement, regulatory, and monitoring activities, and the adoption of rules and regulations to carry out the ACAMP. The ADEM must identify specific uses or activities that require a State permit to be consistent with the coastal policies noted above and the more detailed rules and regulations promulgated as part of the ACAMP. Under the ACAA, State agency activities must be consistent with ACAMP policies and ADEM findings. Further, ADEM must make a direct permit-type review for uses that are not otherwise regulated at the State level. The ADEM also has authority to review local government actions and to assure that local governments do not unreasonably restrict or exclude uses of regional benefit. Ports and major energy facilities are designated as uses of regional benefit.

Local governments have the option to participate in the ACAMP by developing local codes, regulations, rules, ordinances, plans, maps, or any other device used to issue permits or licenses. If these instruments are certified to be consistent with ACAMP, ADEM may allow the local government to administer them by delegating its permit authority, thereby eliminating the need for ADEM's case-by-case review.

According to NOAA, there are no local coastal management plans approved for the State of Alabama. However, local authorities such as municipal and county planning commissions serve in an advisory capacity to local government and, in certain instances, have authority to make development decisions that impact the coastal area. The South Alabama Regional Planning Commission provides ongoing technical assistance to ADCNR for Federal consistency, clearinghouse review, and public participation procedures.

Uses subject to the Alabama's CZM program are divided into regulated and nonregulated categories. Regulated uses are those that have a direct and significant impact on the coastal areas. These uses either require a State permit or are required by Federal law to be consistent with the management program. Uses that require a State permit must receive a certificate of compliance. Nonregulated uses are those activities that have a direct and significant impact on the coastal areas that do not require a State permit or Federal consistency certification. Nonregulated uses must be consistent with ACAMP and require local permits to be administered by ADEM.

The MMS and the State of Alabama are currently working to revise CZM consistency information for OCS plans, permits, and licenses to conform to the revised CZM regulations that were effective January 8, 2001.

Reference

U.S. Dept. of Commerce. 1989. Coastal zone management: a Federal-State partnership; the management of coastal and marine resources. CZM Information Exchange. January 1989.

APPENDIX 9.3

BIOLOGICAL OPINIONS AND ESSENTIAL FISH HABITAT CONSULTATION

BIOLOGICAL OPINIONS

BIOLOGICAL OPINIONS

As required by Section 7 of the Endangered Species Act, MMS requested a formal consultation with NOAA Fisheries on April 17, 2002, and with FWS on April 15, 2002. These consultations are to ensure that activities in the OCS under MMS jurisdiction do not jeopardize the continued existence of threatened or endangered species and/or result in adverse modification or destruction of their critical habitat. The MMS receives the results of each consultation in a Biological Opinion (BO). You may obtain copies of the final BO's by contacting the Minerals Management Service, Gulf of Mexico OCS Region, Public Information Office (MS 5034), 1201 Elmwood Park Boulevard, Room 114, New Orleans, Louisiana 70123-2394 (1-800-200-GULF) or by emailing a request to environment@mms.gov.

ESSENTIAL FISH HABITAT CONSULTATION

Gulf of Mexico OCS Region
MMS
APR 29 2002
Office of the Regional Director

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive N.
St. Petersburg, Florida 33702

April 26, 2002

Mr. Chris C. Oynes
Regional Director
Minerals Management Service
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123

Dear Mr. Oynes:

The National Marine Fisheries Service (NMFS) has received the Minerals Management Service (MMS) letter of March 29, 2002, initiating Essential Fish Habitat (EFH) programmatic consultation for activities associated with Gulf of Mexico (GOM) Central Planning Area (CPA) and Western Planning Area (WPA) Lease Sales included in the 2002 to 2007, 5-Year Program. In addition, project-specific EFH consultation was requested for Lease Sale 184. The EFH programmatic consultation request was made pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) and its implementing regulations [50 CFR 600.920(j)]. Consultation for Lease Sale 184 is consistent with the procedures specified in our interagency findings agreement of March 17, 2000.

The draft environmental impact statement (DEIS) for the 2002 to 2007 lease sales contains detailed descriptions of fishery resources, sensitive coastal environments, sensitive offshore resources, and habitats designated as EFH and Habitat Areas of Particular Concern by the Gulf of Mexico Fishery Management Council and NMFS. Consistent with the requirements of the EFH regulations and our interagency findings, the environmental assessment (EA) for Lease Sale 184 includes similar information, modified as appropriate to address the specific location and timing of the sale. The NMFS finds the EFH assessments contained in each document to be a comprehensive evaluation of potential adverse impacts associated with the two actions. The proposed actions are adequately described and potential impacts to EFH and associated fishery resources are thoroughly addressed. Mitigation measures addressed (i.e., existing environmental stipulations and additional EFH conservation recommendations from the 1999 programmatic consultation agreement) are those developed and implemented through an analytical process associated with past lease sales, MMS-funded research, and interagency coordination activities. The assessments contained in the EA and DEIS fully meet the requirements specified in the EFH regulations at 50 CFR 600.920(e).

In response to the GOM OCS Region's request that NMFS evaluate potential petroleum exploration and production impacts on EFH and Federally managed fisheries through programmatic and lease sale-specific consultations, we offer the following:

EFH Conservation Recommendations

Programmatic Consultation - 2002-2007

In its analysis of the lease sales included in the 5-year program, MMS discusses the 10 EFH conservation measures cooperatively developed in 1999 to minimize and avoid EFH impacts related to exploration and development activities in the CPA and WPA. Among these measures, the MMS routinely includes the following as potential mitigation measures:

1. Environmental stipulations for the protection of live bottom (pinnacle trend) resources, topographic features, and chemosynthetic communities are incorporated, as appropriate, in leases and approval documents prepared by the GOM OCS Region.

2. The Flower Garden Banks are provided added protection, under the topographic features stipulation, by establishing expanded zones of no activity and required shunting.

3. An oil spill response plan is required of all owners and operators of oil handling, storage, or transportation facilities located wholly or partly within Federal waters.

4. Pursuant to existing regulations, lessees are responsible for the control and removal of pollution to avoid risks to EFH and associated fisheries.

The NMFS endorses the implementation of these resource protection measures in future decision documents for lease sales and adopts these conditions as our EFH conservation recommendations for the 2002-2007 lease sales. If any changes are made to MMS programs or these stipulations, such that effects on EFH are potentially changed, MMS shall notify NMFS Southeast Region to allow our agencies to discuss whether this programmatic consultation should be revised. Should NMFS receive new or additional information that may affect EFH conservation recommendations, NMFS will consider whether to request additional consultation with MMS and/or provide additional EFH conservation recommendations. At intervals corresponding to the development of the five-year lease sale planning documents, the MMS Gulf of Mexico OCS Region and the NMFS Southeast Region will review these programmatic EFH conservation recommendations and determine whether they should be revised to account for any new information or new technology.

Lease Sale 184

The NMFS has no EFH conservation recommendations to offer with respect to Lease Sale 184. Specific, post-sale development activities remain subject to the provisions of our 1999 Programmatic Consultation agreement. We continue to believe that those previously agreed upon conservation recommendations concerning petroleum exploration and production would be sufficient to ensure that appropriate measures are taken to protect and conserve EFH in the central and western Gulf of Mexico.

As required by Section 305(b)(4)(B) of the Magnuson-Stevens Act, MMS must respond in writing within 30 days of receiving EFH conservation recommendations. MMS must include in their response the acceptability of the NMFS recommended measures to avoid, minimize, and mitigate adverse impacts to EFH from activities described in the 5-year program. If MMS's response is inconsistent with NMFS's EFH conservation recommendations, MMS must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed actions and the measures needed to avoid, minimize, mitigate, and offset such effects. If you are unable to substantively respond within 30 days, an interim response is acceptable. If an interim response is provided, your final response to our recommendations should be provided at least 10 days prior to signing a record of decision, finding of no significant impact, or similar action to complete your decision making process.

Thank you for this review opportunity. If MMS accepts our EFH conservation recommendations, no further EFH consultation is required, except in cases where the need for coordination on post-sale production and exploration activities has been specified in our 1999 Programmatic Consultation agreement.

Sincerely,

Andreas Mager, Jr.
Assistant Regional Administrator
Habitat Conservation Division

CHAPTER 10

KEYWORD INDEX

10. KEYWORD INDEX

20 Years of Service to America

MMS

Minerals Management Service

1982-2002

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.